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# The sound heritage of Kotagede: the evolving soundscape of a living museum

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## Abstract

Kotagede, the capital of the ancient Mataram Kingdom and currently an area in the Yogyakarta Province of Indonesia, is known as a 'real living museum'. It was previously a residential area with many vital premises and heritage buildings that became a tourist area. Its locally established activities enrich the visual and sound environment of the vicinity. However, it has gradually lost its distinguishing sounds. A series of studies aims to improve the possibility of restoring past soundmarks to preserve the intangible heritage and make living museums as rich as possible. This paper reports the initial stage of the series, which focuses on capturing the rich historical sounds of Kotagede. The study was carefully designed to collect comprehensive data on heritage sounds using qualitative methods consisting of an initial focus group discussion (FGD), in-depth interviews, and a final FGD. These methods resulted in a large amount of data that were processed and classified using the descriptive phenomenology approach with the Colaizzi protocol. The study found that Kotagede has various soundmarks grouped into local and outside sounds. The locally rooted sounds can be grouped into eight categories, some of which can be extended as past and present sounds and a few that have persisted from the past to the present. In the subsequent stage, this classification and local leaders' concerns helped the researchers select and prioritise sounds for preservation and tourism purposes. The study emphasises the importance of choosing suitable participants to provide detailed and comprehensive information.

**Keywords** Sound, Heritage, Living museum, Tourist, Soundmark, Soundscape

## 1 Introduction

A place or area should have markers to make it unique and different from other places. In the past, these markers were in the form of landmarks, soundmarks and even smellmarks. These unique markers arose from activities that produced sounds and smells that were less varied and less crowded in previous times, so they did not mask each other. Heritage sites consist not only of buildings, artefacts and other tangible features but also intangible features. Both aspects are essential, especially when the sites are also intended as museums and tourist destinations. Engagement in a museum allows visitors to form inquiries and to conduct knowledge-based exploration and active understanding (Rozan 2016). A cultural heritage site, such as a living museum, is a venue that combines tangible and intangible cultural heritage (Hitchcock et al. 2004). Living museums engage multiple senses and

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thus constitute organic and integral spheres rather than spaces defined through the relationships between objects that are identified visually (Naumova 2015). Therefore, a heritage site that is also a living museum can create immersive experiences for visitors when tangible and intangible heritage sites are retained.

The terminology of 'living museums' often refers to living history museums, which are 'cultural institutions that teach historical lessons by recreating past environments; ... open-air museums – multibuilding depictions of "historical places" – that explicitly use interpreters in period costumes to demonstrate past ways of life' (Gordon 2016, 9). Living outdoor museums have an explicit curatorial approach that underpins what is on display: which buildings are selected for the museum, how they are restored and fitted, what objects are displayed within them and what kinds of human activities are enacted, usually by occupational animators and actors (Ciolfi and McLoughlin 2012). In line with this definition, many living museums have been established worldwide, such as the Highland Fold Museum in Scotland (Wilkinson 2009; Carruthers 2003); Australia Museum Village (Young 2006); Historic Fort Snelling in Minnesota and Conner Prairie in Indiana (Tyson 2008); China Folk Cultural Village in Shandong (Hitchcock et al. 2004); Bali Museum in Indonesia (Hitchcock 1995); and Sarawak Cultural Village in Malaysia (Latrell 2006, 2008; Muzaini 2018). Nonetheless, the earlier definitions and all of the abovementioned living museums differ from Kotagede. In Kotagede, the tangible and intangible aspects are neither artificial nor played by actors; it is an actual living museum where the actors are locals who live their daily lives in the area. Unlike typical living museums, environmental conditions, both visual and aural, that naturally arise from daily activities can be redeveloped to maintain the authenticity of a 'real' living museum when local activities evolve to meet the community's changing needs.

Kotagede is a subdistrict in Yogyakarta, Indonesia. Its territory was much larger when it was the former capital of the ancient Mataram Kingdom long before the current kingdom in Yogyakarta (Fig. 1a and b). The kingdom was established in the sixteenth century, and this vital civilisation spread Islamic teachings and culture combined with Javanese traditions (Rindrasih and Witte 2021). Yogyakarta's monarchy is now in a sultanate form instead of a kingdom. Kotagede is officially located in two regencies or districts in the Yogyakarta Special Province: Yogyakarta City and Bantul Regency. Within Yogyakarta City, it is a subdistrict, namely, Kotagede, which spreads across three urban villages (in Bahasa Indonesia *kelurahan*), namely, Rejowinangun, Prenggan and Purbayan, with a total area of approximately 3 km<sup>2</sup>. Another part lies in a subdistrict, Banguntapan, which is administratively in

Bantul Regency. The area, which spans different administrative regions, often creates complexity related to policy and development. One of these issues is related to tourism. An example is the increasingly vibrant tourism objects and activities in Yogyakarta City compared to the Bantul Regency due to differences in policies and the involvement of authorities. This study includes both regencies.

Tangible aspects, such as building styles, spatial elements, and community lifestyles, remain largely the same in their authentic conditions, especially in Purbayan and Prenggan, but they have changed significantly in Rejowinangun, in contrast to intangible aspects. Most of Kotagede's intangible elements have changed. Clapp (1999) noted that authenticity is an attribute of heritage quality. This statement is in accordance with MacCannell (1973), who noted that authenticity is the central aspect that attracts tourists who want to experience real things. Authenticity has also been understood as intersubjective and is consequently labelled constructed authenticity. In this view, authenticity depends on the criteria used to define it; thus, it is inherently socially constructed (Cohen 2007). As such, a nonauthentic heritage tourism attraction can still be experienced as authentic according to the subject who experiences it. Dueholm and Smed (2014) suggest that different conceptions of authenticity can coexist within tourism settings and that new technologies can be implemented to strengthen heritage sites as tourist attractions while paying attention to authenticity and ongoing authentication processes. Chhabra et al. (2003) suggest that only some components of an experience need to be authentic as long as the combination of elements generates the expected nostalgic feelings. These are crucial references for restoring Kotagede's sound heritage, which may need to combine authentic aspects and the use of technologies to present past conditions and to generate nostalgic feelings. The authenticity implications are even more challenging as Kotagede embraces different urban villages and districts with potentially different policies.

Kotagede has reasonably maintained visual objects inherited from the past, such as the Great Mosque, the tomb complex (the Royal Cemetery Complex), the Legi Market, and many rich houses, namely, Kalang Houses (Santosa 2007; Nakamura 2012). Some objects might not be entirely authentic as an enormous earthquake struck the area in 2006, severely damaging many buildings (Rindrasih and Witte 2021). Kalang is the name of an ethnic group that migrated to Kotagede. They were exiled because of their physical appearance, which differed from that of the local community. 'Kalang' comes from 'dikalangi' or 'be confined'. The Kalang people were known as hard workers. They worked as carpenters,



**Fig. 1** a The past Mataram Kingdom map over Java, Madura, and Bali Islands with Kotagede as the capital (Source: Museum Nusantara’s website <https://museumnusantara.com/>). b Map of current Java Island in Yogyakarta Province (red), where Kotagede is located. It was the capital city of a vast territory but is now a tiny area in the southeastern part of Yogyakarta City, expanded to the Bantul Regency (Source: Google Map)

blacksmiths, silversmiths, and merchants, and they later played a vital role in developing Kotagede. The Kalang people transformed from the lowest caste into a thriving and prosperous community. They have large, stylish houses that have become tangible symbols of the heritage of Kotagede.

Because the Mataram Kingdom is a Muslim Kingdom, religious life in Kotagede was and still is easily seen and heard. In addition to religious activities, daily activities consisting of domestic and occupational or economic activities enrich the sound environment of Kotagede. Occupational activities included craftsmanship, garment

production, florists, and culinary activities. Sadly, as local activities have shifted along with evolving occupations and lifestyles, the sound environment has changed accordingly, leaving Kotagede less unique than it was previously. This study aims to investigate the heritage acoustic environment that composed the unique soundscape of Kotagede to explore the possibility of restoring its intangible heritage as well as promoting an immersive living museum in Kotagede. The final goal of restoring historical sounds faces significant challenges due to modernised daily activities and possible resistance from local communities. According to Pardoen and Guesney (2024), this

type of study requires numerous cross-checks to validate information and the adoption of different perspectives on the data to regain heritage sounds. This becomes challenging as it involves tourism purposes and the sustainable preservation of intangible heritage.

## 2 Methodology

In soundscape studies, researchers value sounds as resources and assume that all sounds are subject to personal preference (Pijanowski 2024). Thus, collecting data on as many perceptions as possible is essential in a soundscape study. A quantitative approach with a questionnaire survey is widely used to fulfil the need for a large number of entries. However, the entries are primarily superficial. Therefore, a series of qualitative activities were used to collect data on the heritage sounds recalled by locals. Despite the limited resources, data were collected using cross-investigations. Pardoen and Guesney (2024) mention that heritage soundscape studies require several cross-investigations (both in terms of discipline and time, including archival consultation and fieldwork). Three stages of the qualitative approach (two focus group discussions (FGDs) and an in-depth interview) involving ten influential inhabitants and three government officers (urban village heads) were employed.

The varied demographic composition of the participants and the authors' expertise satisfied the cross-investigation with regard to disciplines and time. The FGD and the in-depth interviews involved archival consultations and fieldwork. A trusted source person recommended several vital persons for the FGD, leading to recommendations for more influential persons to be interviewed. Fieldwork was also conducted prior to the study to provide information about the current soundscape and to trigger discussions in the FGDs. Ethical approval for the participants' involvement in this study was granted by the ethics commission of Universitas Aisyiyah Yogyakarta, number 2371/Kep-Unisa/IV/2023. The first stage examined past soundmarks using an FGD (the initial FGD), followed by in-depth interviews with important locals. It concluded with another FGD (the final FGD). The final FGD was also part of in-depth interview data processing using Colaizzi's approach, which is meant for qualitative data (Morrow et al. 2015; Praveena and Sasikumar 2021), as discussed later in the paper. The three stages of data collection and Colaizzi's protocol for data analysis were designed to ensure careful data collection to regain heritage sounds (Pardoen and Guesney 2024) before they were preserved in any format: on-site, virtual, or otherwise.

### 2.1 The initial focus group discussion

As recommended by a trusted source person, for the initial FGD, three local cultural figures who managed

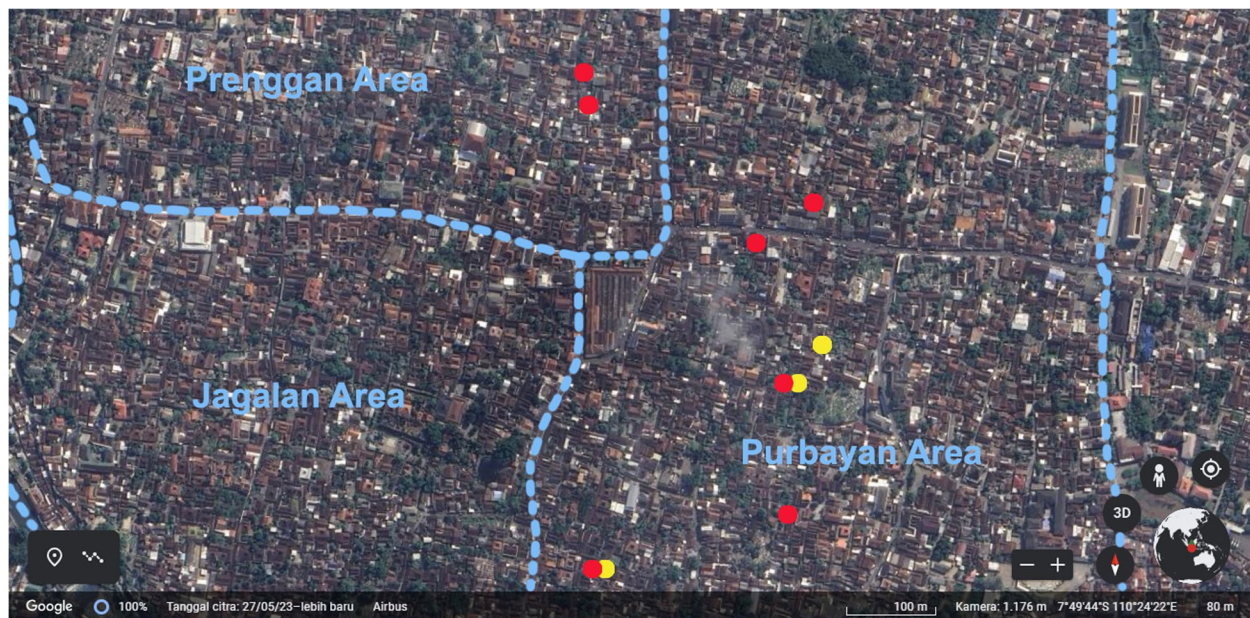
tourism activities while preserving local culture were invited. The FGD participants included two men (aged 60 and 65) and one woman from different generations (aged 47). The source person, who was also part of the research team, had authored several books about Kotagede and maintained consistent communication with locals. Empirical quantitative data from an earlier study were presented during the introductory phase of the FGD. Later, the data were referred to for data enrichment, comparison and completion of the qualitative data reported here. These data included sound pressure level (SPL) measurements and soundscaping activities to outline current sound sources and types in Kotagede (Mediastika et al. 2023). After the introductory phase, a question about what sounds coloured the past soundscape in Kotagede was presented. This question resulted in a casual two-and-a-half-hour FGD. In addition to collecting data on the past acoustic environment, in the initial FGD, a snowball approach was recommended for the next stage.

### 2.2 In-depth interviews

In the initial FGD, seven influential locals from various occupations were recommended for the in-depth interview stage. In addition to these seven, the three initial FGD participants were also asked to be interviewees. They claimed that more past sounds could be recalled by showing several domestic tools they had at home. The interviews were guided by several questions to keep the responses on topic. The questions were not asked rigidly as in a questionnaire but rather in a relaxed way. The interviewees could convey their opinions freely, add examples, and provide detailed descriptions or additional information that might be slightly off the topic to comprehensively describe their opinions. The questions for the in-depth interviews included (a) past sounds they experienced, (b) past sounds they had not experienced but that were depicted by predecessors, (c) activities and locations of unique past sounds, (d) activities with unique sounds they preserved individually or communally, and (e) opinions about the current sound environment. Furthermore, (f) when the interviewees did not mention the two most iconic premises in Kotagede, the market and the mosque, an additional question was asked about these two objects. This stage was intended to collect data on the daily sound environment experienced by the participants. Thus, the interviews were conducted at their houses or the places where they spent most of their time.

Figure 2 shows the locations associated with the sounds mentioned in the interviews. This figure consists of two legends: red dots (the interview locations) and yellow dots (the FGD participants' houses). As the initial FGD participants were also the interviewees, some dots





**Fig. 2** Initial FGD participants and in-depth interviewees' locations from which they recalled and shared opinions about the past and current sounds of Kotagede (Source: Google Earth)

overlap. The number of dots does not fully match the number of participants because some reside in the same place, such as a husband and wife or a mother and son. However, each individual had a different role in developing Kotagede's tourism. Additionally, one participant stayed in another house during childhood and after marriage, resulting in nonoverlapping yellow and red dots. Figure 2 shows that participants' living areas were mainly in Purbayan rather than Prenggan. This indicates that Purbayan has more cultural and tourism stakeholders and is supported by more tangible heritage sites than Prenggan does. Because Jagalan urban village belongs to the Bantul Regency, which was not officially covered in this study, no important persons from this area were invited as participants. Nonetheless, the FGD participants and interviewees identified their childhood activities in this area, and the historical site within Bantul's urban village (i.e., Soka Alley) was covered in earlier fieldwork to investigate current sounds and measure the SPL.

### 2.3 Final focus group discussion

A final FGD was held to validate the findings from the initial FGD and the interview, to link previous quantitative and current qualitative data, and to confirm the initial findings on the basis of the Colaizzi protocol. The final FGD was attended by the authors, enumerators, the trusted source person from Kotagede, Kotagede

urban village heads, and the initial FGD participants. The final composition of the FGD was meticulously organised to ensure thorough data finalisation following the recommendations of Pardoen and Guesney (2024) and in accordance with the Colaizzi protocol. Enumerators were involved to confirm that the findings were rooted in the collected data. The initial FGD participants, who were also interviewees, were invited to represent the interviewees to verify that the findings were derived from their responses to the enumerators without any bias, deductions, or additions, as stated in Colaizzi. Urban village leaders were invited to learn about the findings and provide input on implementing sound preservation in accordance with local policies.

Unlike the initial FGD, the final FGD did not involve asking the participants questions. Instead, it began with the presentation of the quantitative data from the previous study in the series and the qualitative data gathered from the initial FGD and in-depth interviews. This comprehensive presentation aimed to collect feedback, opinions, agreement, and disagreement on the preliminary findings resulting from data processing. This is part of the data confirmation process outlined in the Colaizzi protocol used in this study, which will be explained further. The final FGD lasted one and a half hours and was shorter than the initial FGD as it was more of a confirmation session than a discussion.

### 3 Results and discussion

Kotagede is a residential area. Over time, as modernity has reshaped numerous traditional facets, Kotagede has transformed into a captivating destination for tourists, beckoning them with its vast array of heritage treasures and engaging domestic and cultural activities. With the modernisation and development of Kotagede, narrow alleys among houses utilised for pedestrians have recently been seized by motorised vehicles. This resonates with similar findings by Supriyadi et al. (2012) over a decade ago. This study utilised qualitative methods and built upon a previous quantitative study that incorporated SPL measurements and sound recordings at 10 locations in Kotagede (Mediastika et al. 2023). Fieldwork conducted prior to the study revealed that Kotagede’s sound environment is above the stipulated noise standard of residential areas in Indonesia by the Regulation of the Ministry of Environment of the Republic of Indonesia from 1996 (Mediastika et al. 2023). On the basis of this rule and because it is now a residential area as well as a tourist and economic area, two noise levels are applied. The maximum sound pressure level is 55 dBA for residential areas and 65 dBA for public spaces. Approximately 80% of the surveyed spots exceeded both levels of the stipulated standard (Mediastika et al. 2023). These data align with the participants’ opinions about the current sound, as discussed later in this paper. The word cloud visualisation of the sound recordings revealed the prevalence of nonheritage sounds, which contrasted with the heritage sounds recalled in the FGDs and in-depth interviews (Fig. 3). The participants conveyed their opinions in Bahasa Indonesia, and the authors translated them into English as closely as possible. Untranslatable terms are written in single quotation marks and are defined in Table 1.

#### 3.1 The initial focus group discussion

The initial FGD, to which only the most well-known influential cultural figures were invited, was conducted as an initial data collection that was expected to lead to the possibility of snowball sampling for the later stage. This objective was achieved. The discussion was restricted to the participants’ recollection of Kotagede’s past sounds following the presentation of quantitative data indicating Kotagede’s current acoustic environment. No specific methods were used to process the minimal data other than extracting significant statements verbatim. The important statements provided by the participants are as follows:

*‘When I was little, the environment was relatively quiet, and I could hear elephants from the zoo. It was the sound outside of Kotagede that enriched our soundscape. From inside Kotagede, on certain evenings, we heard arts and religious performances such as ‘keroncong’ music, ‘sholawat’ readings and the local opera: ‘ketoprak’. During the day, we heard local people weaving with traditional tools and gold, copper, brass and silver artisans working on making various items ranging from accessories to tableware and kitchenware. The sound of the blacksmith’s tools was enriched with traditional songs sung by the blacksmiths while working, as they were mostly also artists for the evening arts and cultural performances. The sound made by the blacksmiths’ tools consisted of smelting metal, then forging, combing, carving, etc., until the product was finished. The goods were then loaded onto traditional horse-drawn carts for sale at the market. The metal wheels rolling on the cobblestones combined with the horseshoes and horse outfits created a beautiful yet unique soundmark along the way.*



**Fig. 3** a Current sound environment b Past sound environment memorised by the initial FGD participants. (Source: reproduced from Mediastika et al. 2023)

**Table 1** Glossary

Term	Meaning
adhan	early morning call to prayer
adhan awal	early morning call to prayer before the adhan time
andong	horse-drawn cart
angklung	traditional music instrument
angkup	jackfruit's flower
ba'dadiyah	a particular method of the Koran recitation
bedug	a drum in a mosque used to call prayers before the use of modern sound systems
ceramah	religious lecture
dandang	a large pan, usually to steam rice or vegetables
doromuluk	the quick and constant beat of 'bedug' or 'kentongan'
drum band	marching bands that use drums only
fongers	a type of old bicycle ridden by rich people in Kotagede
gamelan	a set of traditional musical instruments
gerobak	cow-drawn carriages
gong	traditional musical instrument
jamu	traditional medicines that are mostly made from natural ingredients
kebluk	traditional musical instrument
kempul	traditional musical instrument
kemrincing	the sound of horses' harnesses
kentongan	slit drum
keroncong	traditional music orchestra
kompang	traditional music instrument
kotekan	mystical sound at a small mosque, namely, 'langgar dhuwur'
lampor	the sound of mystical troops
langgar	small mosques
long bumbung	bamboo canons
markabayan	like sholawat and serokal but with lower expenses
matri	brazing process
mercon	traditional fireworks
musholla	small mosques
nahyidin	Muslims who follow the Nahdlotul Ulama organisation
nasyid	Islamic song
ngaji	the Koran recitation
ngerik	a part of metal processing
ngondel	a process of metal thinning
qunut	a method to praise God
rambutan	hairy lychees
rijal	a roaring mystical sound
ronda	local patrolling at night by residents
serokal	pray to be blessed with a good fate
sholawat	blessing or laudation with a high-frequency voice, namely, 'ngelik'
surau	small mosques
tadarus	mass Koran recitation
tahlilan	mass activity to ask for God's blessing
takbiran	chants of 'Allahu Akbar' on the Eid Al-Fitr Eve
urun	DIY small loudspeakers made by local people



*But now it is quieter as blacksmiths use modern tools and vehicles to bring their products to the market. At the beginning and end of the month of Ramadan, a large drum called 'bedug' in the great mosque was beaten by many players in a relay for about two hours, which in recent years has been replaced by a sound system.'*

*'I agree about the elephant sound; Kotagede's soundscape was indeed unique, but I think it was not just by the external sound but mainly because of traditional tools for weaving, sewing, making batik, making kitchen utensils and making crackers from 'gnetum gnemon' or 'melinjo' seeds. There was also the morning call to prayer from a mosque every day, namely, 'adhan', which overlaps with the 'adhan' of nearby mosques I used to miss when I was away from home.'*

*'I am the youngest participant of all, so I only remember a little of the soundmark in Kotagede. The two unique sounds I remember were the enormous sound of birds owned by bird enthusiasts and the narrow alleys full of high walls on either side that give off an echo. So, when I was a kid, my friends and I would happily scream in the alleys to make an echo. But any sound in the alley is now less resonant as some of the alley's walls were renovated to create new facades of the houses. I also remember that in the past, the activity of reciting the Koran was carried out every day in many places, not only during Ramadan as it is today.'*

The discussion was finalised with statements given by the trusted person, an expert of Kotagede:

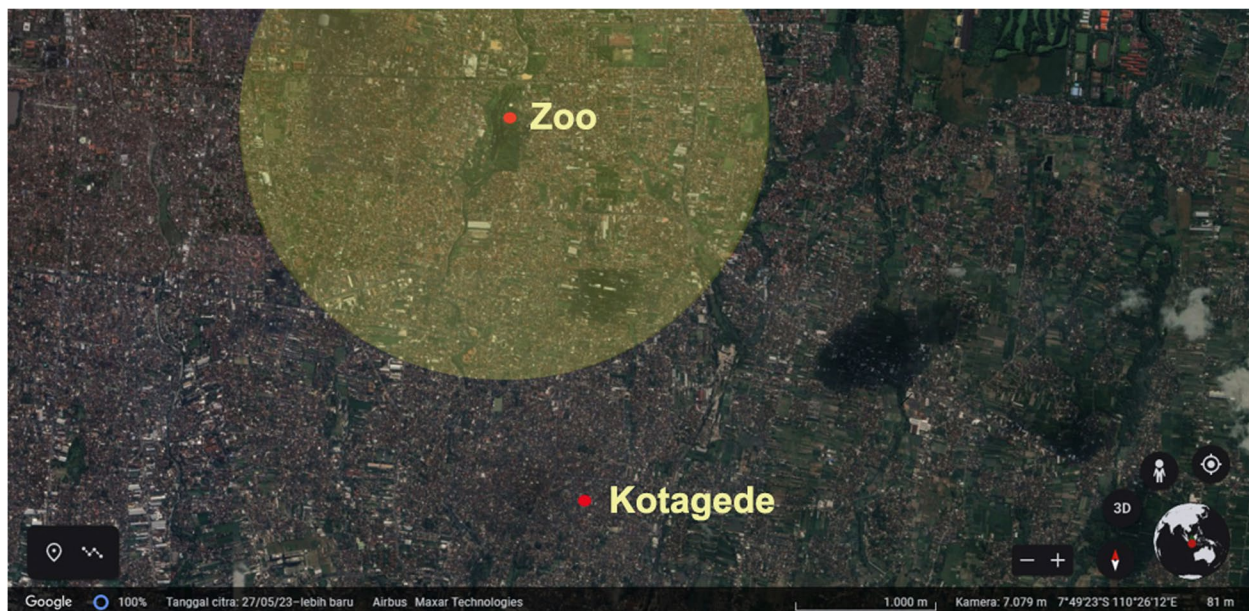
*'The soundmark of Kotagede fades because community activities have changed significantly so that both moving and steady sounds are almost inaudible. Moving sounds were from traditional modes of transportation and mobile food vendors, while steady sounds were from arts, culture, work and household activities and natural sounds as well as religious activities (except for the community parade, which was held along Mondorakan Street at the end of the month of Ramadhan and the first day of Eid al-Fitr). The Kotagede area was quiet in the past because no vehicles were allowed to enter it. The area around the 'Intro Living' museum on Tegal Gendu St. was the final point for vehicles. That was why narrow alleys were enough because they only served pedestrians. In addition, the soundscape of Kotagede was heavily influenced by Legi Market activity on the Legi day when people and modes of transportation were on the move.'*

In short, the discussion concluded that Kotagede's sound environment was indeed unique. Many unique sounds have been naturally composed in the soundscape of Kotagede, including external and internal sounds. Internal sounds consist of domestic, occupational, cultural and religious activities and can be grouped into daily and occasional sounds. The everyday sounds can be grouped according to specific time slots, such as early morning, morning, midday, afternoon, evening, and late evening. However, all these sounds are in harmony to compose the Kotagede natural orchestra without masking each other, so each one is heard perfectly (Mediastika et al. 2023). We learned that different generations living in the same area have different opinions about heritage sounds, a crucial consideration for the following data collection stage. The younger generation lives in a modern yet noisier environment, making them unable to experience the external sounds that played a role in composing Kotagede's past sounds. It was surprising that elephant sounds from the zoo, approximately 3 km away, could be heard in Kotagede (Fig. 4); according to Poole et al. (1988) and Ben-Ari (1999), elephant sounds as loud as 117 dB are usually audible within 2 km. This implies that far sound can create a high-fidelity soundscape to colour the sound signature of a particular area when the environment is extraordinarily calm. In the FGD, several formulated meanings were noted: (i) the past sounds of Kotagede were unique; (ii) they were composed of external and internal sounds; (iii) internal sounds were based on the time of occurrence; and (iv) they consisted of domestic, economic, cultural and religious activities (presented in a word cloud; Fig. 3b).

### 3.2 In-depth interviews

The in-depth interviews included nine participants instead of ten as planned. One participant (female, aged nearly 85 years) consistently battled health issues related to seniority and faced considerable severity during the interview timeline. Consequently, we decided to exclude her from the list. Semi-structured, face-to-face interviews were conducted using a prepared interview guide. The nine participants were (1) female, aged 62, a dressmaker and religious activist; (2) female, 57, a housewife, tour host, and homestay owner; (3) female, 58, a florist; (4) male, 65, a tour guide and tour host, event organiser, and writer; (5) male, 62, a silversmith; (6) male, 60, a tour host and homestay owner; (7) male, 54, a garment entrepreneur; (8) female, 83, a religious activist; and (9) female, 47, an event organiser and tour guide. The participants' ages spanned 36 years (from 47 to 83). One generation in the Indonesian community spans approximately 20 years (Indonesians are married and have children when they are aged 18 to 20 (Najib et al. 2021)), which means that



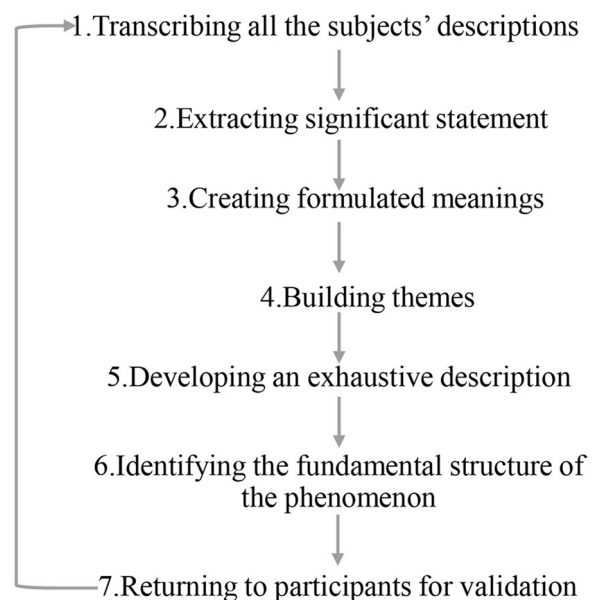


**Fig. 4** An area around the zoo where the deafening sounds of elephants can be heard within a radius of 2 km (the yellow circle) and the area of Kotagede, approximately 3 km away from the zoo. This shows that with quiet surroundings, elephant sounds might travel more than they do naturally, but within noisy surroundings, this may now be even less than the 2 km radius (Source: Google Earth)

the interviews covered three generations (people around the ages of 47, 65, and 83). Participant (7) was the son of Participant (8), and Participant (9) mentioned that Participants (4) and (6) were of the same generation as her father. The age range spread over three generations was deemed perfect for the study. The 83-year-old participants covered the sound environment around the founding of the Republic of Indonesia in 1945, after Dutch colonialism. The data spanned approximately 80 years before 2007–2012, when motorcycles began to occupy streets in Yogyakarta (Herwangi et al. 2015), until 2023, the year of the study. It would be ideal to have participants aged 100 to cover one older generation, but even if they were still alive, factors related to dementia would hinder the interview process. In the interviews, the participants were encouraged to talk freely and tell stories in their own words. Each interview lasted from 45 min to one hour. The interviews were recorded and transcribed verbatim.

The descriptive phenomenology approach (Husserl 2013) was used instead of interpretive-hermeneutic phenomenology because the data were based on direct factual experiences described by the participants, mostly without hidden meaning, which may create biases and different interpretations. The data processing of descriptive phenomenology involves four steps: bracketing, intuiting, analysing and describing. Instead of using only these four steps to analyse the data, this study used the Colaizzi protocol to process the verbatim transcripts.

Colaizzi’s approach is similar to that of descriptive phenomenology but uses seven stages instead of four, making it more detailed and facilitating the construction of descriptions at the end of the analysis (Morrow et al. 2015; Praveena and Sasikumar 2021). Figure 5 shows the seven stages of Colaizzi’s method compared with the four



**Fig. 5** The seven steps of the Colaizzi approach (Source: Zhang et al. 2022)

stages of the descriptive phenomenology approach. We note that there is a slight difference in the use of the term ‘intuiting,’ which is not found in Colaizzi’s protocol. Intuiting is the stage in which researchers remain open to the meanings attributed to phenomena by those who have experienced them. Although it is not explicitly included in the Colaizzi approach, it is still within the seven steps because when a qualitative method is used, the researcher’s background knowledge and intuition play vital roles in describing and interpreting the data (Ratner 2002; Mruck and Breuer 2003). Colaizzi’s protocol neutralises the subjective intuition of the researcher by returning the findings to the source in the final stage of step seven. This study used the final FGD instead of returning the findings to the interviewees one by one given the author’s intention to gain objectivity and validity in a more general manner. In fact, the use of six steps was considered sufficient for two reasons: (1) the last step is still debatable and controversial (Giorgi 2006), and (2) this research collected data through several methods, including in-depth interviews as well as FGDs and a pre-study using a quantitative approach.

Tables 2 and 3 show the extraction of significant statements comprising the opinions of nine interviewees and the formulated meanings and themes, respectively.

The source persons spanned three generations. The youngest was 47 and had not experienced the external and mystical sound. Their opinions added more colour to how and which past sounds can be reconstructed. Generations younger than the age of 47 were not invited as participants because they were not recommended by the trusted source person or by the snowball sampling of the initial FGD, which is appropriate for this study considering the subtle past sounds the participants experienced. Therefore, this generation did not participate in the data collection process. In this study, different genders did not construct different sound perceptions, as seen from the initial FGD and data extraction presented in Table 2. However, the participants’ age and occupation accounted for significant data variations. This allowed for the collection of comprehensive data that were validated by the participants. As shown in Table 2, each participant memorised and conveyed sounds similar to the others. The only differences in perception were due to variations in verbal forms, such as ‘tek...tek...tek’ and ‘teng...teng...teng’ for silversmith activities.

The stage of formulating meanings enables researchers to group the themes identified by the participants. As shown in Tables 2 and 3, the first theme was time frame. There were two dominant time frames: past and present. Between the two subthemes, there was also a bridging time frame of the past and present, which means that sound existed in the past and

continues today. The second theme developed by the formulated meanings was the type of sound grouped into religious, mystical, traditional, occupation, daily activity, transportation and natural sounds, including animals. Here, more variants and different terms of sound groups emerged compared with the initial FGD. These were domestic, economic, cultural and religious sounds, implying that cross-investigations work more comprehensively with more source persons. Among the seven subthemes of sound types, religious, mystical, traditional and occupational sounds dominated the soundmark of Kotagede. Above all, we can see significant strong bonds between religious, cultural, and traditional sounds. Moreover, the three activities seem inseparable, which suggests that cultural and traditional activities affect the spiritual life of the Kotagede community. This aligns with the findings of Nakamura (2012). The data also show that mystical and occupational sounds mostly dominated the past sounds of Kotagede, whereas sacred sounds exist continuously in Kotagede but with different intensities and variants. All of these factors reflect the influence of animism in the area in ancient times.

On the basis of the initial FGD and the interviews presented in Tables 2 and 3, exhaustive descriptions are developed as follows:

*‘Kotagede, as a heritage area in the southeastern part of the current Yogyakarta City, was rich in unique sounds linked to its locally rooted activities combined with faraway sounds heard in the vicinity, which became the soundmarks of the area. The locally rooted activities combined mainly religious–cultural–traditional–mystical sounds in addition to daily activity, occupational, transportation and nature sounds. Daily activity sounds were grouped into domestic and venture or economic activities. Faraway sounds, such as animal sounds from the zoo and train, were audible when noise was minimal in the past (Fig. 6). The sound environment of Kotagede has drastically changed along with the changing lifestyle, leading to changes in the occupation of the locals, the existence of more buildings, and the use of modern transportation modes. Some of the past sounds still exist today, although not as rich as in the past, such as religious sounds that now mostly use loudspeakers to call for prayers instead of traditional sound instruments, animal sounds limited to birds, transportation sounds limited to modern transport modes instead of traditional carriages, the sound of silversmiths, although less than in the past, and everyday activities, mostly dominated*

**Table 2** Extraction of significant statements into sound types, timeframes, and sound groups

Participant	Significant statements (See Table 3. Glossary for specific definitions)	Extraction	
		Sound and time frame	Sound grouping
#1 (female, age 62, a dressmaker and religious activist)	'When I was a kid, I heard drum bands'.	Drum bands	Mystical
	'It is evident that nowadays it is noisier, so many motorcycles, so, we frequently hear motorcycles. It is hectic and noisy every morning when motorcycles deliver students to school. They pass by the 'musholla'.	Motorcycle	Transportation
	'There is the sound of wind and the sound created by nearby 'rambutan' trees when hit by strong wind at night. When the fruit falls on the roof, there is also the sound of rolling objects on the roof'.	Wind	Nature
	'At night, I heard people's voices reciting the Koran. Also, people passed my house after reciting the Koran or other commemorations at the mosque'.	'Ngaji'	Religious
	'I heard a lot of bird sounds around my house, especially on the second floor; some birds with beautiful sounds also entered my house'.	Bird	Animal
	'The sound of drum bands and the 'takbiran' carnival, when there were special events, is also heard even though it was far away. At the New Year, there were traditional and modern fireworks, which are very beautiful'.	Drum bands	Tradition
	'The sound of a drum bands and the 'takbiran' carnival, when there were special events, is also heard even though it was far away. At the New Year, there were traditional and modern fireworks, which are very beautiful'.	'Takbiran'	Religious
	'About the sound of animals, when I was a kid, especially in the morning, I could hear elephants clearly. But not anymore; the last time I heard elephants was around 1980'.	Animal	Animal
	'Oh yes, local patrolling at night, yes there is, but not during the pandemic'.	'Ronda'	Tradition
	'People greeted each other when they passed other houses, such as, 'Are you going to school? Be careful!' Or 'whose son or daughter are you? What is your name?'	Greeting	Tradition
	'Formerly, the sound of andongs woke me up from a nap, 'kethok kethok kethok', but not anymore now'.	'Andong'	Transportation
	'Formerly, there was a noodle vendor with the sound of 'tekh tekh tekh' that I could hear because it was tranquil'.	Noodle vendor	Occupation
	'I could hear religious lectures from here'.	'Ceramah'	Religious
	'Currently, tambourine, 'nasyid', and 'angklung' are started to be used (for special occasions)'.	Tambourine	Religious
	'When I was in elementary school, when I walked from home to the market after Maghrib time, I could hear 'tadarus.' In the morning, during call to prayer, I heard the voices of seniors reciting the Koran. During the Maghrib time, I also heard the voice of those reciting the Koran, but not anymore now; maybe it is done individually or with family at home'.	'Tadarus'	Religious
	'There was an oration at the corner of the market or nearby'.	Oration	Daily life
	'Nowadays, the sound (of the sewing machine) is still heard only when they (the vendors) pass my house. Formerly, there were many sounds of sewing machines'.	Sewing machine	Occupation
	'Oh, 'kentongan,' do you know that? It is made from bamboo used for local patrolling or calling to prayer. I think there was when the mosque was small, or we named it surau'.	'Kentongan'	Tradition
	'Formerly, many people used bicycles with their unique sound of 'kring kring kring'. Also, the bicycles produced the sound 'cik cik cik', which was unique'.	Bicycle	Transportation
'Formerly, we could hear the radio when I was on the street, the RRI or Retjo Buntung broadcasting stations. They played drama, but not anymore now'.	Radio	Daily life	
'When we walked down the street, we heard the sound of trees'.	Tree	Nature	
#2 (female, age 57, a housewife, tour host, and homestay owner)	'Domestic sounds, such as rubbing sound of many domestic objects'.	Rubbing sound	Daily life
	'Formerly, I listened to the radio because we did not have entertainment shows, so we listened to the radio'.	Radio	Daily life
	'Usually, they knocked on the door first, then greeted with a Muslim greeting of 'assalamualaikum'. Also, there were greetings by saying uncle, aunty, sister. So, it was the sound 'tok tok tok' and 'wo wo wo'. 'Wo' is a local appellation for aunty'.	Greeting	Tradition
	'Formerly, before there were many buildings, at night, I heard the friction of tree leaves, which was like a sound of snoring. It wasn't very comforting'.	Leave	Nature
	'I don't have a bird, but there were many big trees where birds were nesting'.	Bird	Animal
	'The sound of geckos, usually in ancient houses—suddenly there was the sound of geckos. Not too sure where they came from'.	Gecko	Animal
'Old doors created the sound of 'jgler' because old doors were usually large and could not be closed slowly. They must be slammed a bit'.	Old door	Daily life	

**Table 2** (continued)

	'The sound of wind entered gaps between roof tiles'.	Wind	Nature
	'The sound of the house lizard is like a dropping object 'tuk tuk tuk' behind a cupboard. I looked for it and discovered it was a sound from a house lizard'.	House lizard	Animal
	'The sound of the mouse 'kritik kritik kritik' is just like the mouse biting something, the friction of teeth'.	Mouse	Animal
	'Sometimes there is the sound of vehicles and pulled carts to carry goods here because cars cannot enter this area'.	Vehicle	Transportation
	'Sometimes people also express their disagreement with each other using the polite Javanese language. It could be insulting sometimes. Also, people were shouting when calling someone far away'.	Grumpy	Daily life
	'Call to prayer, namely adhan, are so many here. There is also early adhan, which is early morning; we name it 'adhan awal'.	Early Adhan	Religious
	'Announcements from the mosque use loudspeakers because loudspeakers are only in mosques. It is also used to announce the event of Koran recitation, community sport, or communal breakfast'.	Announcement	Daily life
	'Yes, I heard transactions and people bargaining at the market. It is common because it is Legi Day, the market day'.	Transactions in the market	Daily life
#3 (female, age 58, a florist)	'I said about the call to prayer, namely adhan, right? It is too much here, one after the other, but none is good'.	Adhan	Religious
	The mosque's loudspeakers are also used to make announcements, such as a community member who dies. However, the announcer mispronounced the Muslim sentence, leading to a different meaning, which was a pity'.	Announcement	Daily life
	'Before the early call to prayer, there is also an earlier call, namely adhan awal, before 3 a.m. It was done by the same person whom I said the voice was not good. It even made one of my friends say it was too much and disturbing. I do not know what about other places, but here it is like that. The adhan awal is also to wake up those who fast each Monday and Thursday. After that, the sound of sewing machines'.	Early Adhan	Religious
	'Formerly, there was the sound of sewing machines. My grandparents used to have a garment production, and we had 'sabat', friends who helped my grandparents sew'.	Sewing machine	Occupation
	'There is a new tradition here: teenagers lit fireworks 'dar der dor' on the 'takbiran' night, a night before Eid Al-Fitr. During the day, they lit traditional 'mercon' fireworks for Eid Al-Adha and other celebrations. The fireworks are beautiful. It was not before, but now it is'.	'Mercon'	Religious
	'As a teenager, we lit a traditional bamboo cannon, namely 'long bumbung', which was much louder than 'mercon'.	'Long bumbung'	Tradition
	'The sound of a person sweeping the ground using stick sweepers at night'.	Floor sweeping	Mystical
	'Also, the sound of drum bands. I heard it in the late afternoon before dawn and early morning. Every Yogyakartanese also hear that. Some said it came from the Air Force base camp in Adi Sucipto, but it is still uncertain'.	Drum bands	Mystical
	'The sound of jackfruit flower, namely angkup. Formerly, I heard that from my neighbour's tree. I have the tree now, but there is no sound from my tree'.	'Angkup' flower	Nature
	'There was a story about the sound of falling coconuts at the corner of the graveyard. I never heard it myself. But now the coconut trees are not there anymore'.	Coconut falls	Nature
	'Formerly, there was the sound of a slit drum and a drum at the mosque. Also when some males did laudation called 'marawis', but not anymore'.	'Kentongan' 'Bedug'	Tradition Religious
	'Also, there is the sound of birds, namely 'emprit ganthil', which was believed to be a sign of something that would happen, something that was unseen'.	Bird	Animal
	'Sometimes the fallen fruit carried by bats sounds on the roof. Bats carried various fruits and then fell on the roof'.	Fruit falls	Nature
'Formerly, the night local patrolling had a specific name in Kotagede called 'impleng'. The 'impleng' created the sound of footsteps and people's conversation, but it was like people whispering from my house'.	'Ronda'	Daily life	
'Formerly, there were laudations, namely 'wirit'. If it was not near my house, it was far away at the mosque'.	Laudation	Religious	
'My relatives told me that near the Langgar Dhuwur, ghosts like to hit the wooden box inside this small mosque. It was named 'klotekan', just like the sound 'klotek klotek klotek'; my uncle and aunty said they heard it'.	'Kotekan'	Mystical	
'There was also a giant ghost, Grandfather Nur Ngaliman, who liked to wear wooden clogs, so it produced sound along the way he walked—the sound of wooden clogs'.	Wooden clog	Mystical	
'The market here only operates during a particular day in the Javanese calendar, Legi. Many sellers from outside Kotagede came to sell their products, such as traditional medicine and animals, mainly birds. But now it is quieter. Most males in this area knew it because they sold traditional medicine for men, just like Viagra. The seller was very attractive as they used a loudspeaker and sometimes even snakes'.	Transactions in the market	Daily life	



**Table 2** (continued)

#4 (male, age 65, a tour guide and host, event organiser, and writer)	'I will start the story about the mystical past, as many mystical sounds could be heard, such as the sound called 'rijal' at night. It is a mystic sound that I named 'kemrosak'. It was mystical because when I approached it, it went farther away'.	'Rijal'	Mystical
	'Also, the sound of nature from the flower of jackfruit, namely 'angkup'. When the angkup bloomed at night, the flower could be giant'.	'Angkup' flower	Nature
	'The giant drum sound at the grand mosque, namely the 'bedug', was heard. It was before the existence of sound systems, so 'bedug' was used to call prayer'.	'Bedug'	Religious
	'The 'bedug' was beaten fast and continuously at certain times. The style of hitting 'bedug' like that was called 'tidur' or 'doromuluk', a specific name given only in Kotagede'.	'Doromuluk'	Religious
	'Another sound of vegetation, the sound of the Wijayakusuma flower, was in the middle of the night at 00.00. It sounded like a bamboo sound. I was told about this by my parents. I wrote this story in my diary'.	'Wijayakusuma' flower	Nature
	'My other note concerns the rustling sound of bamboo trees hit by night wind at the cemetery. The local community of Kotagede claimed it was the sound of ghosts of the cemetery'.	Bamboo	Nature
	'Also, a unique activity was done by Kaji Thohir, a very senior man who liked to walk with a walking stick and then hit his stick to a metal column of electricity at the pedestrians. He hit his walking stick as a sign of local patrolling to be alert and gather to do their job. It was also a sign for the residents of Kotagede that it was precisely midnight'.	Voice	Daily life
	'Also, there was the sound of keroncong, a local music played by residents while practising their keroncong musical skill. They all used non-electrical instruments. It could be as a group or individually at their home. When people were at the passageway, they knew Mr. X played his violin, Mr. Y played a flute, and so on'.	'Keroncong'	Tradition
	'As a kid, I could still hear the sound of elephants from the Gembira Loka Zoo in the morning. Elephants, siamang (a family of monkeys), and water buffalos were very noisy'.	Animal	Animal
	'Even the trains from Lempuyangan Station could be heard from Kotagede when the air was still pure, there was no pollution, and buildings were rare. Now, all those sounds are gone'.	Train	Transportation
	'Also, a religious sound, namely 'sholawatan'. It is like laudation, where high-frequency voices called 'ngelik' were used. It became the colour of the night in Kotagede. There were so many 'sholawat' in the past'.	'Sholawat'	Religious
	'You could easily hear 'sholawat' in Kotagede commemorating the 35 days of a baby. Sholawat intoned the history of Prophet Muhammad when it came to the part named 'serokal'; the baby was to be held by their parents accompanied by grandparents. The 'serokal' part is a part of asking for God's good fates'.	'Serokal'	Religious
	'So the fate was prayed to God to become a good fate using a 'sholawat' ritual. In Kotagede, it was also 'markabayan' rituals. It was like 'sholawat' but cheaper because fewer parties were involved'.	'Markabayan'	Religious
	'Usually the ritual included a shadow puppet show, which was quite expensive. However, using 'sholawat' was slightly cheaper because it only invited 20 persons, less than it was for a shadow puppet show. The 'sholawat' used musical instrument, namely, 'terbang kumpul' (such as 'gendang', 'kebluk', 'kempul', and 'gong'). The 'markabayan' was even cheaper'.	'Kebluk' 'Kempul' 'Gong'	Religious Religious Religious
	'The cultural performance, namely 'ketoprak', created many sounds, complete when performed, and individual sounds heard from surrounding houses when house owners were practising their 'ketoprak' role'.	'Ketoprak'	Tradition
	'Of the religious aspect, many Koran recitations and laudation used a specific method, namely 'Ba'dadiyah', held at the small mosque, namely 'langgar'.	'Ba'dadiyah'	Religious
	'There was also laudation at the small mosque when kids waited for the 'wudhu' or cleaning time before praying, filling the water barrel in a queue. They could be very noisy then, but kids sat and sang laudation when it was all finished, and they waited for a part named 'iqamah'.	Laudation	Religious
	'The sound of 'takbir' at the Eid Al-Fitr Eve when people paraded along the street carrying tambourines and sang laudation. The Muhammadiyah Organisation initiated the takbir night using 'becak' (a non-motorised three-wheeled vehicle) carrying portable loudspeakers circling the neighbourhood'.	'Takbiran'	Religious
	'Time is evolving; now we have marching bands on the Eid Al-Fitr Eve'.	Marching bands	Tradition
	'Weaving activities of local people also created sound when the part of the traditional tools named 'sekoci' slid and created sound'.	Loom	Occupation
'The silver jewellery making also created a unique sound, but not anymore, as the tools used to make it have changed'.	Machine	Occupation	
'The rich needed to pronounce their level among communities, so when ordinary people walked, the rich rode 'fongers' bicycles that sounded 'cit cit cit', which the riders were proud of'.	Bicycle	Transportation	
'Hearing the sound behind the nearby houses' walls at night was exciting. Many loved to listen to the radio to accompany their sleepy time. They listened to audio shadow puppets, drama, and comics. These sounds shaped the night environment along the small alleys'.	Radio	Daily life	
'Locals love to keep birds at their homes. The sound of birds was very peaceful'.	Bird	Animal	

**Table 2** (continued)

	'As time evolves, now in Kotagede, we have 53 mosques, so the call for prayers creates resonance. Kampongs were very proud when they had a mosque. It is very prestigious for those who have a mosque'.	The resonance of Adhan	Religious
	'Previously, I could hear people bargaining at the market, but currently, no more because there is no more resonance'.	Bargaining between vendor and buyer	Daily life
	'I also heard andongs returning from the city centre. The horse harness and shoes created a specific sound called 'kemrincing'.	'Kemrincing'	Transportation
	'Also, the sound of 'gerobak' carrying red bricks, leaving in the morning, and returning at night'.	Metal wheels of 'gerobak'	Transportation
	'The sound of loud mufflers during the campaign for the national election. The campaigners might enjoy the noise, but it wasn't enjoyable for the listeners'.	Muffler	Transportation
	'I remember there were announcements about the performance of 'ketoprak' when the organiser circled the neighbourhood using an andong to promote the event. They usually hold the event for about four months, so they must make a profit from it'.	Announcement	Daily life
	'The sound during the celebration of Independence Day during the 80s, when many competitions created happiness in the community'.	The noise of Independence Day	Tradition
	'The current trend is many cafe businesses in the neighbourhood that create a new atmosphere in the surroundings'.	Youngsters at coffee shops	Daily life
	'The five majorettes of the marching bands were all girls but looked very strong. When they prepared for the parade, they produced the unique sound of 'leketom leketom leketom'.	Majorette	Tradition
	'Ah, I almost forgot the sound of 'keblak' birds. It was its wings that flapped. The bird is quite big, so the wings sound loud. It happened at night. They usually used to scare kids (not to go outside and go to bed) '.	Wings flap	Mystical
#5 (male, age 62, a silversmith)	'There was a unique sound of Kotagede called 'ngondel'. It was the activity of a silversmith hitting the raw silver to make it thin or slab. The sound was beautiful, 'teng teng teng' and 'dheng dheng dheng'. It happened from morning until afternoon, as the silversmith was to make it thin and shape it. All these sounds are gone along with the use of modern machines, namely rolling mills. Yes, there is a slight sound of 'teng teng teng', but only for a very short time. Of course, the machine makes the work faster and more effective, but it diminishes the unique sound. The device also produces sound but is not specific and can only be heard when we are near'.	'Ngondel'	Occupation
	'From a natural point of view, I am impressed by the sound of the 'angkup' flowers—the flower of jackfruits'.	'Angkup' flower	Nature
	'There was also a mystical sound of cows at night, which was believed to come from the graveyard'.	Cow	Animal
	'The sound of the drum bands on Eid Al-Fitr Eve was considered phenomenal in Kotagede. Gamelan sound was also here because residents owned a set of gamelan instruments in this kampong (namely Kampong Basen), but now all are gone'.	Drum bands	Tradition
	'The sound of the drum bands on Eid Al-Fitr Eve was considered phenomenal in Kotagede. Gamelan sound was also here because residents owned a set of gamelan instruments in this kampong (namely Kampong Basen), but now all are gone'.	'Gamelan'	Tradition
	'There was also the sound of silversmiths doing brazing 'tuk tuk tuk', though not as dominant as the sound of 'ngondel'.	'Matri'	Occupation
	'I remember the waiting time between the call for prayers of Adhan and Iqamah in Muslims and locals doing laudation like 'nahyidin'.	Laudation	Religious
	'On the religious side, there was the activity of praising God, namely, 'qunut'.	'Qunut'	Religious
	'Some kampongs still had religious yet social activity, namely 'tahlilan', to praise God, but there were also kampongs that did not have 'tahlilan' anymore'.	'Tahlilan'	Religious
	'But now, with so many loudspeakers at the mosques, transportation, motorcycles, or cars around the market that are too dominant, they diminish the market sound'.	Motorcycle	Transportation
	'But now, with so many loudspeakers at the mosques, transportation, motorcycles, or cars around the market that are too dominant, they diminish the market sound'.	Loudspeaker	Daily life
	'But now, with so many loudspeakers at the mosques, transportation, motorcycles, or cars around the market that are too dominant, they diminish the market sound'.	Transportation	Transportation
	'The making of weapons, traditional weapons with a loud sound'.	Making weapon	Occupation
	'When I was at the elementary schools, the market was lively on a particular day of Legi. There was a 'jamu' vendor using a loudspeaker. It was very interesting'.	Jamu vendor	Occupation
	'Also, a toy seller selling dolls needed to promote that the doll could move; its key must be turned on before rotating. But before that, the seller described the doll first'.	Toy vendor	Occupation
	'There was also tooth extraction activity in the market done by a person who claimed to be a tooth expert but not a dentist. Those who got their tooth extracted, especially women, were screaming. I memorised that sound'.	Female's scream	Daily life
	'The market sound has now gone along with modernity, especially the use of radio broadcasts at the market; it diminishes the natural market sound'.	Radio	Daily life

**Table 2** (continued)

	'On Eid Al-Fitr Eve, a parade of local people carried bamboo torches. Then, this parade met a parade from other kampongs. This event was beautiful even though it created jams'.	'Takbiran'	Religious
	'When we sat along the street, hearing 'andong's, especially horseshoes on pavements, was straightforward'.	'Andong'	Transportation
#6 (male, age 60, a tour host and homestay owner)	'The sound of the market day of Legi was easy to hear because it was very noisy; even the sound of people's conversation at the market could be heard. But it was in the past'.	Conversation	Daily life
	'The sound of the market day of Legi was easy to hear because it was very noisy; even the sound of people's conversation at the market could be heard. But it was in the past'.	Noisy market	Daily life
	'I also could hear the sound of many animals from Gembira Loka Zoo at night'.	Animal	Animal
	'There was also the mystical sound of drum bands, but no one knew where the source was. When people tried to approach it, it moved farther'.	Drum bands	Mystical
	'In Kotagede, the sound of the morning call to prayer, namely, 'adhan', was many and created an orchestra. They overlapped with each other'.	Overlapped call for prayers	Religious
	'People heard a troop passing by the street, but it was mystical. They said it was the troop of the South Ocean's queen'.	Mystical troop	Mystical
	'There was rustling sound of bamboo trees, which I considered unique'.	Bamboo	Nature
	'The sound of birds is also reduced now, along with the inexistence of big trees'.	Wild bird	Animal
	'Now, if we hear birds, it comes from pet birds, not wild birds. The sound is different, I think'.	Pet bird	Animal
	'The sound of chickens also still exists, but not as much as in the past'.	Chicken	Animal
	'The sound of tigers. I frequently heard them in the past'.	Tiger	Animal
	'Also, the sound of house lizards'.	House lizard	Animal
	'There was a sound from the weaving activity. There was a rhythm from the wooden part of the traditional weaving tools 'tak tak tak' or 'dhag dhag dhag', the looping of the bullet called sekoki. It was the unique sound of Kotagede—also the sound, namely, 'ngerik', even though not very loud'.	Weaving	Occupation
		Wood hits wood	Occupation
		Bullet throw	Occupation
		'Ngerik'	Occupation
	'The coppersmith hit copper very loud to make a large pan, namely, 'dandang'.	Copper workshop	Occupation
	'The blacksmith's work at the market also became the unique sound of Kotagede'.	Blacksmith	Occupation
	'The sound of 'andong's that pooled at the west side of the market created the sound of horseshoes, 'tak tak tak', which was very impressive'.	'Andong'	Transportation
	'When we cooked, there was sound and smell, of course'.	Cooking	Daily life
'I just needed to knock on my neighbour's door if I needed something. These are things that do not happen in the modern residency area'.	Neighbour	Daily life	
'A group of vendors sold roof tiles in the Kotagede market'.	Group of vendors	Occupation	
'The locals made look-alike small loudspeakers, namely, 'urun'. It was made from tin that was shaped like a funnel. It could be used by anyone who came to the mosque to do Adhan. It was also used for the Koran recitation'.	'Urun'	Religious	
'Now, at the small mosque, namely 'musholla', or at the regular mosque, loudspeakers become the tool for communication, and many events or occasions are announced from those loudspeakers. It is the media of information. This sound also represents Kotagede, especially in the morning time'.	Loudspeaker	Daily life	
'Before the new technology era, the market was positioned as the centre of communication, conversation, and gossiping'.	Chatting and gossiping	Daily life	
#7 (male, age 54, a garment entrepreneur)	'An example was the sound of horseshoes from 'andong' waiting for passengers to go to the Yogyakarta central market at Beringharjo Market or the shopping centre'.	Horseshoe	Transportation
	'The noise in the streets was already loud when I was a kid'.	Street noise	Transportation
	'A cow's bell sounded, 'kluntung kluntung kluntung'.	Cow's bell	Animal
	'There was the event of the Prophet Muhammad's birthday when the gamelan music instruments were sounded'.	'Gamelan'	Tradition
	'People rode cow-drawn carriages on the Prophet's birthday event in a parade mode. They went to the east, and it sounded 'kluntung kluntung kluntung'.	'Gerobak'	Transportation
	'The sound of frogs in the rainy days has now gone'.	Frog	Animal
	'During the national election campaign, there were sounds of mufflers from motorcycle parades'.	Muffler	Transportation
		Motorcycle	Transportation
'The sound of the silversmith hitting the silver to make it thinner, 'tek tek tek tek'.	Metal encrusts	Occupation	

**Table 2** (continued)




	'The famous sound of drum bands. It was heard in the Kotagede area and Yogyakarta City in general'.	Drum bands	Mystical
	'There were many descriptions when people said about 'lampor' or the mystical troop; some said it was the sound of musical instruments, marching troops, or 'gamelan'.	Noisy troop	Mystical
	'There were many descriptions when people said about 'lampor' or the mystical troop; some said it was the sound of beaten musical instruments, marching troops, or gamelan. People believed it was the troop of the South Ocean queen'.	Beaten instrument	Mystical
		'Gamelan'	Mystical
	'The story about 'lampor' with drum bands roared in the neighbourhood'.	Drum bands	Mystical
	'When I was a kid, the Koran recitation was done after Maghrib time, and kids went home after Isya time, but now it was done after Ashar time. Almost every kid learning to read the Koran in Kotagede shifts their learning time from Maghrib to Isya to Ashar to Maghrib'.	the Koran recitation	Religious
	'Artisans were doing the craft of copper, sometimes aluminium. The most frequent is the encrusting aluminium cap. It is still now but as souvenirs'.	Copper encrusts	Occupation
	'My father liked to create DIY bells. He connected the bell with nylon string to the door so we would know when someone opened the door. There is still one at my mom's house, resulting in a sound called 'kemrincing'. Also, when we still had a shop after early morning prayer, we installed a bell at the shop'.	Bell	Daily life
	'A DIY bell using cowbells connected with nylon strings to the front doors, or any doors would sound when the door was opened to alert the residents'.	Cowbell	Daily life
	'It was very noisy on market day; the sound of transactions was everywhere, such as transactions of birds, chickens, ducks, etc.'	Transaction	Daily life
		Loudspeaker	Daily life
	'Kids used loudspeakers (at the mosque) to call their friends. It was unique'.	Kid calling friends	Daily life
	'We see now that people are in a hurry. Even motorcycles are speedy'.	Fast motorcycle	Transportation
#8 (female, age 83, a religious activist)	'I still remember that I heard drum bands early in the morning, which people said did not exist'.	Drum bands	Mystical
	'There was a roaring sound called 'lampor,' which was mystical'.	Roaring sound	Mystical
	'The sound of the bathroom; when we entered, the lamp was automatically on, and when I opened my door, the DIY bell would ring the door'.	DIY bell	Daily life
	'Chickens were many previously but now are rare'.	Cock	Animal
	'House lizards are still here'.	House lizard	Animal
	'Sometimes the sound of bees'.	Bee	Animal
	'The sound of 'kulik' birds was believed as a sign by locals. When it was the sound of this bird, a person would die'.	'Kulik' bird	Animal - Mystical
		'Bedug'	Religious
	'There were traditional drums, namely 'bedug'. Also slit drums, namely 'kentongan.' Bedug was for prayer calls, and 'kentongan' was for local patrolling at night'.	'Kentongan'	Tradition
	'Neighbours could call and visit using connecting or back doors, so they no longer like guests using the front doors'.	Neighbour	Daily life
	'They were listening together to the radio at night because some did not have radios. They listened to drama, usually a series of local dramas'.	Radio	Daily life
	'A motorcycle enters (a house) '.	Motorcycle	Transportation
	'Old bicycle bells'.	Bicycles' bell	Transportation
	'There was the sound of crying dragonflies or crying bees'.	Dragonfly	Animal
	'The market corner was usually used for oration or locals practicing dance at night. It was a spooky night'.	Oration	Daily life
	'The Koran recitation that finished at 10 PM'.	Koran recitation	Religious
		Choir	Religious
	'Were people practicing "kompang", chatting, or reciting the Koran, Madam? Yes, not only that but there were also locals practicing choir, practicing angklung (musical instrument from bamboo) or gamelan. But it was rare; it was usually local females in the afternoon, and then they recited the Koran at night'.	'Kompang'	Religious
		'Angklung'	Tradition
		'Gamelan'	Tradition
'The sound of the slit drum for local patrolling at night. It was very lively'.	'Kentongan'	Tradition	
'Call to prayer from the Perak Mosque'.	Adhan	Religious	
'Formerly, it was the sound of the blacksmith at the market, but it has now gone'.	Blacksmith	Occupation	
'When I opened my doors, the bell of the doors sounded'.	DIY bell	Daily life	



**Table 2** (continued)

#9 (female, age 47, an event organiser, and tour guide)	'When I was a kid, I used to play with my friends along the narrow alleys. We shouted, so the resonance was there. I loved it'.	Resonance of voice & shout	Daily life
	'A beef curry vendor was selling food, circling the neighbourhood using cow's bell 'klonthong, klonthong, klonthong'.	Cowbell	Occupation
	'Sellers carried cracker products on their shoulders and promoted the product using the sound of 'ting ting ting'.	Cracker vendor	Occupation
	'Someone sold local ice drinks, namely 'es tape', by sounding their glass'.	Sound of drinking glass	Occupation
	'Sellers who promote their product using the voice of 'heik heik heik'.	'Heik' sound	Occupation
	'Sewing machines' sounds were many formerly'.	Sewing machine	Occupation
	'Every day between the Maghrib and Isya, children recited the Koran and played'.	Children playing	Daily life
	'Teenagers now focus more on the parade of Eid Al-Fitr Eve that Angkatan Muda Muhammadiyah held instead of reciting the Koran, so the religious vibes can only be felt during Ramadhan; but formerly, I could feel the vibe daily'.	the Koran recitation	Religious
	'Formerly, the call for prayers, namely, adhan, could be heard, although it did not use loudspeakers since the environment was quiet. A traditional drum called 'bedug' is loud here because the mosque is near'.	'Adhan'	Religious
	'Sometimes I heard drum bands'.	Drum bands	Mystical
	'The sound of gamelan music instruments at night'.	'Gamelan'	Tradition
	'I could enjoy the sound of birds without needing to keep them as pets'.	Bird	Animal
	'Neighbours shouted at each other because of kids' matters but using polite Javanese language'.	Neighbours' disagreement	Daily life
	'Some people keep roosters as pets and put them on a fighting cock event. They did it in alleys, but then the activity was forbidden by a Muslim organisation of Muhammadiyah'.	Fighting cock	Animal
	'The resonance of the sound market, the roaring market'.	Roaring sound of market	Daily life
	'The sound of bamboo friction, especially bamboo 'ori'. It is the name of the bamboo family. The sound was a bit mystical'.	Bamboo	Nature
	'There was the sound from mosques alongside the sound of birds; some big trees still exist, so birds are still there. Yes, there are still some open spaces in Kotagede, even though it is gradually reduced'.	Bird	Animal
Sound of transaction		Daily life	
Conversation		Daily life	
Local gathering		Daily life	
'Even over midnight, there are sounds of motorcycles passing by alleys'.	Motorcycle	Transportation	

**Legends:**

-  Past sound
-  Past and present sound simultaneously
-  Present sound

*by interaction between neighbours. A sound that is very rarely heard today is the mystical sound. Locals believe the entry of modernity in Kotagede also diminished the mystical sound, which was believed to be present only within the tranquil environment of the past. The current modernity in Kotagede has created a noisier neighbourhood that masks and dissipates the mystical sound. The diminished mystical sound in line with the presence of the noisy modern sound is logical. The mystical sounds heard by the people of Kotagede might come from natural sounds such as the sounds of soil (Rillig et al. 2019), the sound of earth or moving ground (Kahn 2013), or the sound of clouds*

*and cloud droplets (Colgate and McKee 1969; Qiu et al. 2021), which would be audible in a quiet environment'.*

People's perception of mystical sounds is not unusual considering the strong animism that characterised their daily lives before the existence of modern religions. It is respected and noted as a part of their tangible heritage, though it may sound illogical within modern and scientific paradigms. Aligning with the sound of elephants from a distance, the 'mystical sound' (scientifically, the sound of nature) might still exist in the vicinity but is masked by the noisy environment to make it less

**Table 3** Formulated meanings and themes

Formulated meanings		Themes	
		Timeline and cluster of themes	Additional data
The most bustling activities in Kotagede occurred during religious celebrations, such as the Prophet's birthday, which consisted of gamelan music, a cow carriage parade, and crowds during the festival. Related to religious activities, there was also a routine activity of the Koran recitation that was both held as a mass activity and privately in houses. The sound of 'bedugs'; the call to prayer (adhan), and social yet religious events like 'sholawat', 'serokal', 'maikabayari', and 'ruwatan', also shaped the spiritual sound environment of Kotagede		Past—Religious	n.a
The original sounds during market days were from stationary and itinerant vendors who used sound-generating devices to attract customers, conversations in the market, orations, and dances at the corner of the market, screaming female patients during dental treatment by commoners, the ringing of the shop's bell, and radio streaming. The market in Kotagede used to be a source of information and a centre of activity. Itinerant vendors used sound-generating devices, such as cowbells by beef curry vendors, drinking glasses by ice drink vendors, traditional noodle vendors, etc		Past—Daily activities	Noise generated by loudspeakers, radios, and modern transportation has now dominated the sound environment, replacing the original sounds of the market
There used to be the sound of Angkup flowers blooming and bamboo rustling		Past—Nature	The growth of buildings has led to the disappearance of trees, resulting in the loss of some of the natural sounds that used to be audible during the nighttime
There used to be several mystical sounds at night, such as lowing cows; a drum band, the South Ocean Queen's troops with the 'lampor' sound (the sound of beaten instruments) accompanied by gamelan music and the loud footsteps of people (sometimes also during the day); the 'kulik' bird that brought the sign of death, the 'keblak' bird's wings flap, the sound of someone using broomsticks, wood-tap sounds in the mosque, a person walking with wooden clogs, the sound of 'rijal', and the rustling bamboo		Past—Mystical	n.a
The most distinctive mode of transportation was the sound of horse-drawn carriages, namely 'andong' or sometimes called 'doker', particularly the rhythmic clip-clop of horses' footsteps caused by metal horseshoes and the jingling of their harnesses. Other transportation sounds included the bell of vintage bicycles, the sound of moving pedals of bikes, namely 'fonger', and heavily loaded cow carriages. Back then, the sound of trains from a train station in the city centre could still be heard from Kotagede		Past—Transportation	n.a
The sounds of animals at Gembira Loka Zoo (screeching elephants, roaring lions or tigers, elephants, gibbons, water buffalos) could be heard. Also, the sound of local and domestic animals, such as frogs, weeping beetles, chickens, cocks, house lizards, and geckos		Past—Animals	n.a

**Table 3** (continued)

Themes		Timeline and cluster of themes	Additional data
Formulated meanings	Regarding the sounds associated with occupations, the garment industry was dominated by the sound of sewing and weaving machines. The sounds of manual yet traditional tools to thin and shape metals were prevalent in the metal industries, which are sounds in metal workshops spread all over Kotagede and the sound of a blacksmith in the market. However, some occupations have disappeared due to shifts in skills and business changes	Past—Occupations	n.a
	The gamelan music instruments were sounded during the Prophet Muhammad's birthday, and traditional musical instruments were played for 'marawis'	Past – Religious—Tradition	n.a
	There was the sound of 'keroncong', a piece of local music played by residents while practising their 'keroncong' musical skills. A cultural performance, namely 'ketoprak', and individual sounds were heard from surrounding houses when locals were practising their 'ketoprak' roles before performing	Past – Cultural—Tradition	n.a
	Local patrolling at night using 'kentongan' to alert locals or the use of 'kentongan' calling to prayer. Also, a traditional bamboo cannon by teenagers	Past—Tradition	n.a
	Some dominant natural sounds included the sound of the wind (as it passed through gaps in the roof tiles), the rustling trees, the sound of blooming flowers, fruits falling onto the roof, and the friction of branches	Past and present—Nature	Lesser than in the past
	The knock of the connecting back door of a house followed by greetings from neighbours who pay a visit like family members instead of guests, morning greetings among neighbours, the sound of the slit drum during night patrols, tools and equipment creaking inside houses, disagreements in polite Javanese language, transactions inside the market, sounds of drum bands, and public announcements were past sounds that are heard slightly now	Past and present – Daily activities—Tradition	n.a
	The sound of motorcycle engines and the rumble of modified mufflers were the sounds during the national election campaign that still exists now. Daily, there are sounds of motorcycles' and cars' engines. Sometimes, the sounds of cow carriages passing by are still there	Past and present—Transportation	n.a
	The sounds of cocks, chickens, birds, geckos, beetles, house lizards, and mice	Past and present—Animals	n.a
	Mosques were and are broadcasting overlapped calls to prayer as they use loudspeakers to create a resonance of Adhan all over Kotagede. Religious gatherings and celebrations with various sounds can easily be found, such as the sounds of the crowd during the Eid Al Fitr festivities, including the 'takbiran', drum bands, firecrackers, and fireworks. The mosque's loudspeakers are also used to announce various information	Present—Religious	n.a

**Table 3** (continued)

Formulated meanings			Themes	
	Timeline and cluster of themes	Additional data		
The sound of the artisan's hammers thins and shapes silver and copper crafts	Present—Occupations	n.a		
Radio sounds amidst the activities in the market, the ringing of doors when they are opened, the crowd sound during Eid Al Fitr (fireworks, firecrackers, and marching bands), the sound of campaign rallies, and the younger generation at local new coffee shops	Present – Daily activities	The remaining sounds of the bustling markets are covered by transportation noise, especially motorcycles and cars		
The remaining sounds of the bustling market are covered by transportation noise, especially motorcycles and cars	Present—Transportation	n.a		
The sound of the mosque's loudspeakers, especially during the call to prayer, resonated with the presence of 53 mosques in Kotagede. It is a pride for each kampong to have mosques	Present—Religious	n.a		
The sounds of domesticated animals, particularly birds, are still heard	Present—Animals	n.a		



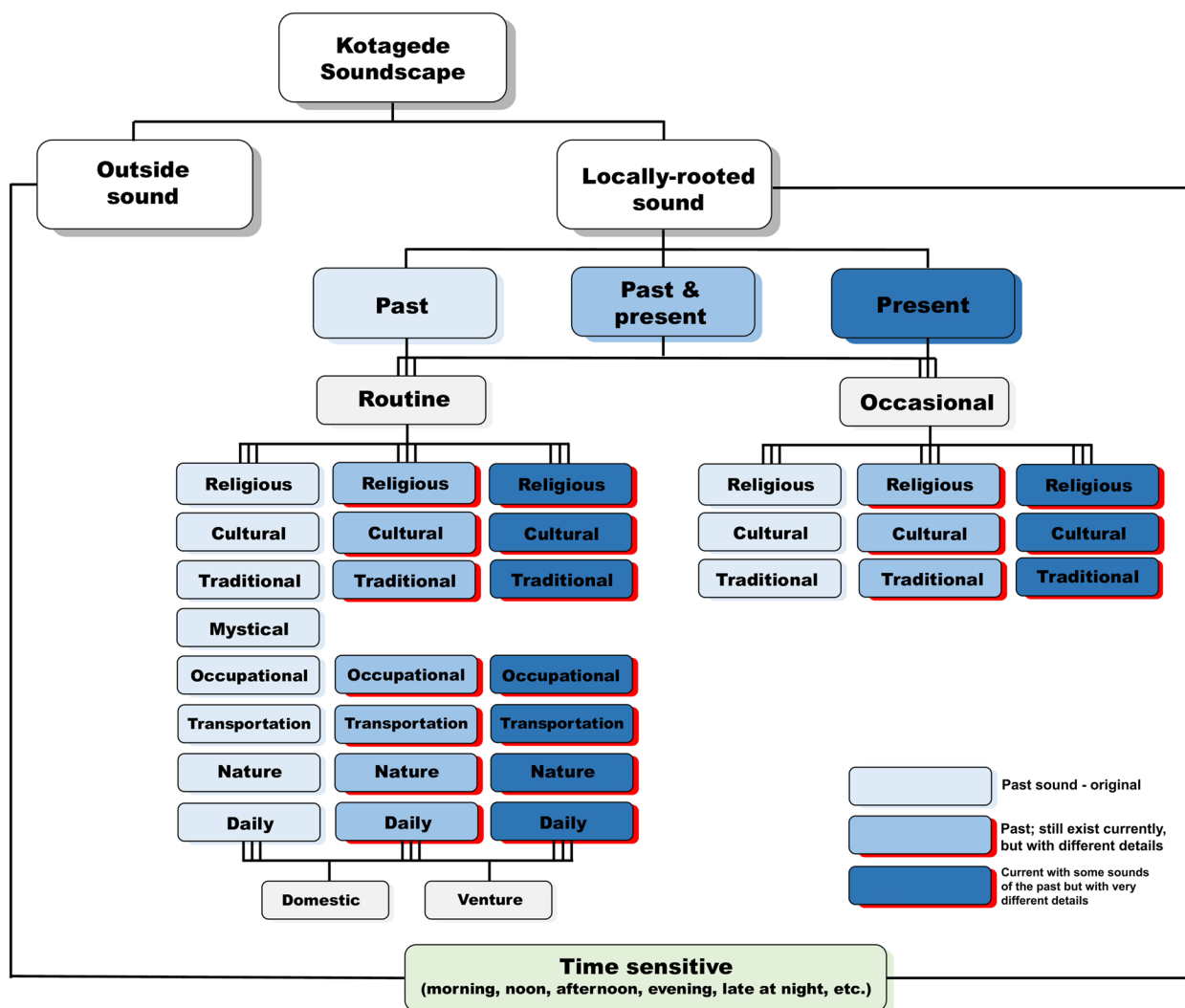


Fig. 6 Sound taxonomy in Kotagede based on the findings

audible. The specific sound environment in which distant and subtle sounds are audible must be considered when Kotagede’s past sounds are presented to visitors in the future.

*‘Within the modern environment, a new type of sound, entirely new to the sound environment, is the crowd sound during Eid Al Fitr from fireworks, firecrackers and real marching bands (to differentiate between the mystical drum band sound), and the sound of local coffee shops. In the past five years, coffee shops have been trending in Indonesia (Aguse-tyaningrum and Kistanto 2021; Purnomo et al. 2021; Nurhasanah and Dewi 2019), especially the Instagramable ones that turned old or ancient or heritage buildings from their past functions into cof-*

*fee shops (Oktafarel et al. 2021) or in new buildings with unique interiors. Some premises in Kotagede also want to take advantage of the opportunity to be transformed into coffee shops by owners or tenants. This trending economic activity also creates new sound in Kotagede.’*

Through this exhaustive description, a fundamental structure of the phenomenon is thus developed as follows:

*‘Kotagede was enriched with locally rooted and outside sounds that mark the area. It comprised religious, cultural, traditional, mystical, daily activity, occupational, transportation and nature sounds. Modern lifestyles that accompany the changing of local lifestyles have diminished most past sounds,*

even though some are still slightly audible. The remaining past sounds, added with new sounds, are now colouring the sound environment. Sadly, the new sound is also a trend elsewhere in Yogyakarta and Indonesia, leaving the Kotagede sound environment less unique and quite similar to other areas in Yogyakarta and Indonesia.'

### 3.3 Final focus group discussion

The final FGD, as part of the confirmation session related to the findings of the earlier stage, was intended to be brief and effective. The time slots were mostly used by the researcher to convey the research findings. However, important statements arose as aspects of validation:

*'It is true that past sounds of Kotagede are now disappearing, including the animal sounds from the zoo that I also heard. The sounds of birds were also many, splashing water and pinwheel sounds, which are not audible now. The sound from the silversmith and the religious sounds are still here, but the details are different. The findings presented by the researchers aligned with the information I shared earlier. I expect that maybe the realisation of the development on the aural aspect would be provided in the barcode. Maybe? So tourists may select the type of sound they will hear and connect to the visual heritage.'*

*'Kotagede, indeed, is now a prima donna in Yogyakarta tourism as the municipality intends to put on a new tourist destination in addition to Malioboro (the main tourist attraction in Yogyakarta) by presenting an alternate site that may attract tourists with special intentions, such as to learn about a particular historical site. So Kotagede is not for general tourists but more for tourists with specific intentions.'*

*'It is now time to bring Kotagede back to look like it was in the past, especially in the intangible aspect. The current sound characteristic delivered by respondents is our reference to construct an immersive environment so tourists can experience the past environment of Kotagede. But one thing to remember is that, sometimes, planned activities were not fully worked; instead, things that came up unintentionally were perfectly worked.'*

*'Purbayan Urban Village received the second award for tourist village development in Indonesia and an award from the Ministry of Tourism and Creative Economy based on the well-preserved heritage. But it is limited to the visual heritage; the sound aspect*

*of Kotagede has never been looked at. I agree with the comments by the interviewees that specific locations have specific sounds in Kotagede. I think those are the places where we need to develop the acoustical aspects. I also agree with the attention paid to 'keroncong'. I believe this will enrich the intangible tourism aspect in the future as long as it does not drastically change current physical conditions since there might be rejection from locals.'*

*'I agree with what has been said; it perfectly represents what I have conveyed. The sound of the past is indeed important in developing an immersive experience for tourists in this heritage tourist destination. The past sound was just as mentioned, and the current sound was just as measured. If I can suggest, for the application, we may need audio kits for tourists to hear the past sound of Kotagede.'*

The FGD closed with a statement from one of the researchers:

*'Our intention to bring the past audio alive in Kotagede was intended not to interfere too much with the physical and visual aspects of Kotagede. Instead, what we have in mind based on all data collected is to add features to the existing premises, maybe at some appropriate spots only to provide sounds of the past. It may be with some real activities on site if possible and acceptable by locals. We intend to collaborate with locals to develop the aural experience for tourists.'*

On the basis of the statements collected from the final FGD, the data from the initial FGD, the in-depth interviews, and the earlier quantitative survey were linked and validated. The participants confirmed the initial findings presented by the authors. They agreed with the quantitative data from the earlier study, which suggested that Kotagede is a noisy environment. This noise has made many past sounds less audible or completely inaudible. Through the interviews, it was found that the past sounds in Kotagede were diverse. The participants also emphasised the importance of restoring these past sounds. Many aspirations for how the aural element could be implemented also arose. Concerns about physical changes are understandable because it is difficult for people to comfortably accept changes (Berger 2022) to their daily experience. This aspiration was a crucial reference for researchers when moving to the next stage of this study. A cross-investigation covering as many generations as possible would enable the study to gain archival characteristics (Pardoen and Guesney 2024).

#### 4 Conclusions

The brief observation that Kotagede is a living heritage museum that has gradually lost its sound signature is in line with the findings of this study. This study concludes that many types of sounds have coloured the Kotagede sound environment in the past. These can be grouped into locally rooted sounds and external sounds heard in the vicinity. The locally rooted sounds are categorised as religious, cultural, traditional, mystical, daily activity, occupational, transportation or nature sounds. Kotagede's welfare has changed drastically along with lifestyle changes, including changes in locals' livelihoods, an increasing number of buildings and modern transportation modes. These phenomena have caused the sounds of Kotagede to be categorised further as past sounds only, present sounds only and past sounds that are slightly audible at present. Religious, occupational, and transportation sounds are the sound types that are still in the vicinity but with different details. All of these sounds are time sensitive, meaning that the sounds emerge only at certain times (Fig. 6). The study also indicates that the local sound heritage might also be coloured by sounds from outside the area, and their restoration requires specific consideration due to environmental changes and differing policies in these sound source areas.

This study gathered a large amount of data using limited resources, indicating that accurate informants were able to thoroughly provide the intended data. Conducting a preliminary study to identify the most appropriate informants was essential. This study involved individuals from different age groups spanning several generations and various occupations, as a previous study indicated that local soundmarks were associated mainly with occupational activities. Efforts to preserve the gradually fading soundmarks within an evolving heritage site should begin by collecting data on sound classification (Parker and Spennemann 2022), as was done in this study by collecting data as comprehensively as possible. Sound classification is a practical starting point for the restoration of sound heritage, which involves evolving local activities, spans different municipalities, and has two objectives for preservation and tourism purposes. By carefully categorising sounds, researchers can gain a strong foothold to decide which sounds to restore onsite (and at which sites) and which ones are not feasible for onsite restoration, instead opting for virtual alternatives. They can also identify which sounds are unique soundmarks or just background sounds that should be preserved to enhance the tourist experience and which are suitable for both purposes. These are critical recommendations for subsequent studies without excluding local leaders' concerns about making careful and minimal physical changes while restoring intangible aspects.

Changes in the lifestyles and occupations of local people imply that future studies will face a massive challenge in reconstructing and applying the aural aspect of Kotagede since most of the fading heritage sounds were produced from lifestyle and occupational activities. Kotagede's circumstances are also experienced by heritage sites whose lifestyles created their sound signatures, suggesting that reconstructing aural elements in similar heritage sites will face similar challenges. Kotagede, with its few remaining heritage sounds, is even worse because of the predominance of traffic noise over current sounds. Once traffic noise becomes a regular part of daily life, such as motorcycles passing through narrow alleys, it can be challenging to minimise. As local leaders noted, making drastic changes to restore conventional sounds may not be readily accepted by locals.

For the later stage of aural element implementation in this type of heritage site, similar to several world soundscape projects (Volz et al. 2008; Schulte-Fortkamp et al. 2008; Schulte-Fortkamp 2010; Kang et al. 2016), the goal is not to remove the unavoidable modern transportation noise but to create a high-fidelity sound environment by lowering unwanted sounds and boosting wanted sounds. The informants implicitly conveyed their dissatisfaction with the dominant traffic noise and longed for the quieter and more conventional sounds of the past. However, again, some of the traffic noise sources were also created by locals. Therefore, policies that address the needs of both groups are crucial. When it is difficult to reconstruct past sounds on the ground, an alternative is to create a virtual aural museum in the area (Bijsterveld 2015; Cliffe et al. 2019). This should be achievable because only certain components of an experience need to be authentic as long as the combination of elements evokes the desired nostalgic feelings (Chhabra et al. 2003). Finally, the authors concur with Pardoen and Guesney (2024) that this kind of study needs extensive cross-checks to validate the information and continuously examine the data to accurately regain heritage sounds from the past. This should be done with minimal physical changes while balancing evolving needs, preservation, and tourism functions.

#### Abbreviations

FGD	Focus group discussion
SPL	Sound pressure level

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#### Authors' contributions

Christina E. Mediastika: conceptualisation, methodology, data curation, final analysis, writing-original draft, writing-review & editing, visualisation, funding acquisition; Anugrah S. Sudarsono: methodology, data processing, data

visualisation; Sentagi S. Utami: methodology, data processing, data extraction; Teguh Setiawan: methodology, data collection; James G. Mansell: methodology, data collection; Revianto B. Santoso: methodology, data collection; Army Wiratama: data collection; Ressay J. Yanti: data collection, data processing; Laurence Cliffe: methodology. All authors read and approved the final manuscript.

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### Availability of data and materials

Not applicable.

### Declarations

### Competing interests

The authors declare that they have no competing interests.

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### References

- Agusetyaningrum, A., and N.H. Kistanto. 2021. Hanging out phenomenon at coffee shop as an environmental-based economic tool in covid-19 pandemic era. *E3S Web of Conference* 317: 01044. <https://doi.org/10.1051/e3sconf/202131701044>. EDP Sciences.
- Ben-Ari, E.T. 1999. A throbbing in the air: The discovery of infrasonic communication among elephants has given researchers a whole new way of hearing things. *BioScience* 49 (5): 353–358. <https://doi.org/10.2307/1313627>.
- Berger, J. 2022. *The catalyst: How to change anyone's mind*, 4. New York: Simon and Schuster.
- Bijsterveld, K. 2015. Ears-on exhibitions: Sound in the history museum. *The Public Historian* 37 (4): 73–90. <https://doi.org/10.1525/tpb.2015.37.4.73>.
- Carruthers, A. 2003. House museums and domestic life displays in Scotland. *Journal of Scottish Historical Studies* 23 (2): 85–98. <https://doi.org/10.3366/jshs.2003.23.2.85>.
- Chhabra, D., R. Healy, and E. Sills. 2003. Staged authenticity and heritage tourism. *Annals of Tourism Research* 30 (3): 702–719. [https://doi.org/10.1016/S0160-7383\(03\)00044-6](https://doi.org/10.1016/S0160-7383(03)00044-6).
- Ciolfi, L., and M. McLoughlin. 2012. Designing for meaningful visitor engagement at a living history museum. In *Proceedings of the 7th Nordic conference on human-computer interaction: Making sense through design*, edited by Lone Malmberg, and Thomas Pederson, 69–78. <https://doi.org/10.1145/2399016.2399028>.
- Clapp, G. 1999. Heritage tourism. Heritage tourism report. North Carolina Division of Travel, Tourism, Film, Sports and Development. Raleigh.
- Cliffe, L., J. Mansell, J. Cormac, C. Greenhalgh, and A. Hazzard. 2019. The audible artefact: Promoting cultural exploration and engagement with audio augmented reality. In *Proceedings of the 14th International Audio Mostly Conference: A Journey in Sound*, 176–182. <https://doi.org/10.1145/3356590.3356617>.
- Cohen, E. 2007. 'Authenticity' in tourism studies: Après la Lutte. *Tourism Recreation Research* 32 (2): 75–82. <https://doi.org/10.1080/02508281.2007.11081279>.
- Colgate, S.A., and C. McKee. 1969. Electrostatic sound in clouds and lightning. *Journal of Geophysical Research* 74 (23): 5379–5389. <https://doi.org/10.1029/JC074i023p05379>.
- Dueholm, J., and K.M. Smed. 2014. Heritage authenticities—a case study of authenticity perceptions at a Danish heritage site. *Journal of Heritage Tourism* 9 (4): 285–298. <https://doi.org/10.1080/1743873X.2014.905582>.
- Giorgi, A. 2006. Concerning variations in the application of the phenomenological method. *The Humanistic Psychologist*. 34 (4): 305–319. [https://doi.org/10.1207/s15473333thp3404\\_2](https://doi.org/10.1207/s15473333thp3404_2).
- Gordon, A. 2016. *Time travel: Tourism and the rise of the living history museum in mid-twentieth-century*. Vancouver: UBC Press.
- Herwangi, Y., I. Syabri, and I. Kustiawan. 2015. Peran dan pola penggunaan sepeda motor pada masyarakat berpendapatan rendah di kawasan perkotaan Yogyakarta. *Jurnal Perencanaan Wilayah dan Kota* 26 (3): 166–176. <https://doi.org/10.5614/jpwk.2015.26.3.2>.
- Hitchcock, M., Stanley, N., and Chung, K. 2004. The South-East Asian 'living museum' and its antecedents. In *Heritage, Museums and Galleries: An Introductory Reader*, edited by Gerard Corsane. 320–339. London: Routledge. <https://doi.org/10.4324/9780203326350>.
- Hitchcock, M. 1995. The Indonesian cultural village museum and its forbears. *Journal of Museum Ethnography* (7), 17–24. <http://www.jstor.org/stable/40793562>
- Husserl, E. 2013. *Cartesian meditations: An introduction to phenomenology*. Springer Science & Business Media.
- Kahn, D. 2013. *Earth sound earth signal: Energies and earth magnitude in the arts*. California: University of California Press.
- Kang, J., F. Aletta, T. T. Gjestland, L. A. Brown, D. Botteldooren, B. Schulte-Fortkamp, P. Lercher, et al. 2016. Ten questions on the soundscapes of the built environment. *Building and environment* 108:284–294. <https://doi.org/10.1016/j.buildenv.2016.08.011>.
- Latrell, C.T. 2008. Exotic dancing: performing tribal and regional identities in East Malaysia's cultural villages. *The Drama Review* 52 (4): 41–63. <https://doi.org/10.1162/dram.2008.52.4.41>.
- Latrell, Craig. 2006. Performance and Place-Making at Sarawak Cultural Village. *Budhi: A Journal of Ideas and Culture* 10 (3): 127–142. <https://ajol.ateneo.edu/budhi/issues/197>.
- MacCannell, D. 1973. Staged authenticity: Arrangements of social space in tourist settings. *American Journal of Sociology* 79 (3): 589–603. <https://doi.org/10.1086/225585>.
- Mediastika, C. E., A. S. Sudarsono, S. S. Utami, T. Setiawan, J. G. Mansell, J. G. L. Cliffe, R. B. Santosa, and R. J. Yanti. 2023. Local soundmark to conquer traffic noise. Case of Kotagede, Indonesia. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings (InterNoise23, Chiba, Japan)*, 6874–6882. Institute of Noise Control Engineering. [https://doi.org/10.3397/IN\\_2023\\_1027](https://doi.org/10.3397/IN_2023_1027).
- Morrow, R., A. Rodriguez, and N. King. 2015. Colaizzi's descriptive phenomenological method. *The Psychologist* 28 (8): 643–644 <http://eprints.hud.ac.uk/id/eprint/26984/>.
- Mruck, K., and F. Breuer. 2003. Subjectivity and reflexivity in qualitative research—A new FQS issue. *Historical Social Research/Historische Sozialforschung* 28 (3): 189–212. <https://www.jstor.org/stable/20758011>.
- Muzaini, H. 2018. *Informal heritage-making at the Sarawak cultural village, East Malaysia*. In *Theming Asia*, 102–122. London: Routledge.
- Najib, N., U. Triwijayanti, and W. Utomo. 2021. Demographic characteristics related to first married age in Indonesia. *Jurnal Kesehatan Masyarakat* 17 (1): 94–101. <https://doi.org/10.15294/kemas.v17i1.26144>.
- Nakamura, M. 2012. *The Crescent Arises Over the Banyan Tree: A Study of the Muhammadiyah Movement in a Central Javanese Town, c. 1910-2010. 2nd enlarged edition*. Singapore: Institute of Southeast Asian Studies.
- Naumova, A. 2015. "Touching" the past: Investigating lived experiences of heritage in living history museums. *International Journal of the Inclusive Museum* 7 (3/4): 1–8.
- Nurhasanah, S., and C. Dewi. 2019. The emergence of local coffee shops in Indonesia as a counter to American culture hegemony. *Rubikon Journal of Transnational American Studies* 6 (1): 1–11. <https://doi.org/10.22146/rubikon.v6i1.61485>.
- Oktafarel, K.M., D.N.A. Mario, D.N. Augusta, A. Arifin, A.S. Ekomadyo, and V. Susanto. 2021. Coffee culture and heritage:(demystifying the heritage value of coffee shops inside historical buildings in Jakarta and Bandung). *Local Wisdom* 13 (1): 51–66. <https://doi.org/10.26905/lw.v13i1.5088>.
- Pardoen, M., and M. Guesney. 2024. Study and analysis of the sound environment of the Notre-Dame construction site between the 12th and 18th centuries. *Journal of Cultural Heritage* 65: 155–159. <https://doi.org/10.1016/j.culher.2023.06.009>.
- Parker, M., and D.H. Spennemann. 2022. Classifying sound: A tool to enrich intangible heritage management. *Acoustics Australia* 50 (1): 23–39. <https://doi.org/10.1007/s40857-021-00257-y>.
- Pijanowski, B.C. 2024. *Principles of Soundscape Ecology; Discovering Our Sonic World*. Chicago and London: The University Chicago Press.

- Poole, J.H., K. Payne, W.R. Langbauer, and C.J. Moss. 1988. The social contexts of some very low frequency calls of African elephants. *Behavioral Ecology and Sociobiology* 22: 385–392. <https://doi.org/10.1007/BF00294975>.
- Praveena, K. R., and S. Sasikumar. 2021. Application of Colaizzi's method of data analysis in phenomenological research. *Medico Legal Update* 21 (2): 914–918. <https://doi.org/10.37506/mlu.v21i2.2800>.
- Purnomo, M., Y. Yulianti, A. Shinta, and F.D. Riana. 2021. Developing coffee culture among Indonesia's middle-class: A case study in a coffee-producing country. *Cogent Social Sciences* 7 (1): 1949808. <https://doi.org/10.1080/23311886.2021.1949808>.
- Qiu, J., L.J. Tang, L. Cheng, G.Q. Wang, and F.F. Li. 2021. Interaction between strong sound waves and cloud droplets: Cloud chamber experiment. *Applied Acoustics* 176: 107891. <https://doi.org/10.1016/j.apacoust.2020.107891>.
- Ratner, C. 2002. Subjectivity and Objectivity in Qualitative Methodology. *Forum Qualitative Sozialforschung Forum: Qualitative Social Research* 3 (3). <https://doi.org/10.17169/fqs-3.3.829>.
- Rillig, M.C., K. Bonneval, and J. Lehmann. 2019. Sounds of soil: A new world of interactions under our feet? *Soil Systems* 3 (3): 45. <https://doi.org/10.3390/soilsystems3030045>.
- Rindrasih, E., and P. Witte. 2021. Reinventing the post-disaster cultural landscape of heritage tourism in Kotagede, Yogyakarta Indonesia. *Journal of Heritage Tourism* 16 (2): 136–150. <https://doi.org/10.1080/1743873X.2020.1781870>.
- Rozan, A. R. 2016. *Audience Engagement: How Museums Learned to Love their Visitors* (A course title in the Museum Studies program at Harvard University's Extension School). <https://museum-id.com/audience-engagement-how-museums-learned-to-love-their-visitors-by-adam-rozan>. Accessed 22 Dec 2023.
- Santosa, R. B. 2007. *Kotagede: life between walls*. Jakarta: Gramedia Pustaka Utama.
- Schulte-Fortkamp, B. 2010. The daily rhythm of the soundscape "Nauener Platz" in Berlin. *The Journal of the Acoustical Society of America* 127 (3\_Supplement): 1774–1774. <https://doi.org/10.1121/1.3383871>.
- Schulte-Fortkamp, B., R. Volz, and A. Jakob. 2008. Using the soundscape approach to develop a public space in Berlin-perception and evaluation. *The Journal of the Acoustical Society of America* 123 (5\_Supplement): 3808–3808. <https://doi.org/10.1121/1.2935519>.
- Supriyadi, B., B. Sudarwanto, and H. Werdiningsih. 2012. In search of the power of Javanese culture against the cultural urbanization in Kotagede, Yogyakarta-Indonesia. *Procedia-Social and Behavioral Sciences* 68: 676–686. <https://doi.org/10.1016/j.sbspro.2012.12.258>.
- Tyson, A.M. 2008. Crafting emotional comfort: Interpreting the painful past at living history museums in the new economy. *Museum and Society* 6 (3): 246–262.
- Volz, R., A. Jakob, and B. Schulte-Fortkamp. 2008. Using the soundscape approach to develop a public space in Berlin-measurement and calculation. *The Journal of the Acoustical Society of America* 123 (5\_Supplement): 3808–3808. <https://doi.org/10.1121/1.2935520>.
- Wilkinson, B. 2009. A study of turf: Historic rural settlements in Scotland and Iceland. *Architectural Heritage* 20 (1): 15–31. <https://doi.org/10.3366/e135075240900017x>.
- Young, L. 2006. Villages that never were: The museum village as a heritage genre. *International Journal of Heritage Studies* 12 (4): 321–338. <https://doi.org/10.1080/13527250600727059>.
- Zhang, W., X. Jia, X. Yao, X. Zhang, Y. Liang, Y. Zhang, X. Zhang, et al. 2022. Exploring the perceptions and barriers of nurses working in remote areas on tele-educational delivery of pharmacy knowledge in Henan, China: a qualitative study. *BMJ open* 12 (2): e051365. <https://doi.org/10.1136/bmjopen-2021-051365>

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