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To cite this article: N H Abdul Hamid *et al* 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1167** 012047

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# Visual perception factors on the soundscape of urban shopping streets: Environmental factors

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**Abstract.** In urban areas, the urge to improve acoustic environments has led to an increasing interest in the soundscape as an alternative approach to address noise pollution issues. Several studies have shown that the soundscape approach can manage the unwanted sound and transform it into resource sound in the areas, while the urban street context is expected to play an important role too. Thus, this study aims to assess visual perception factors on soundscape (appropriateness, calmness, and eventfulness) of urban shopping street as an environmental factors. Data was collected in three urban shopping streets at Kuala Lumpur, Malaysia through a soundscape survey (n = 411) according to the ISO12913-2 technical specifications standards. Multiple Linear Regression was used to analyse the data. The findings revealed in three aspects, that are: (1) The interesting, beautiful and harmonious indicators under visual quality of environment dimension were highly preferred by the users. (2) All the soundscape dimensions have significant effects on the predictors. Appropriateness ($R^2$=.454) is the most prominent factor, followed by eventfulness ($R^2$=.298) and calmness ($R^2$=.139). (3) All soundscape dimension has a higher impact on visual perception (β=.536, β=.356, and β=.202) than other predictors by comparing the standardised coefficients. The result from the present study showed that visual perception factors could be helpful indicators for better understanding soundscapes and assist the urban planners, architects and landscape architects in designing conducive acoustic environment of urban shopping streets.

**Keywords:** Soundscape, Visual Perception, Appropriateness, Eventfulness, Calmness

## 1. Introduction

Over the earlier decade, globally there has been expanded advancement in soundscape research. On the report of International Standard, ISO 12913, the soundscape is portrayed as the acoustic environment as perceived or experienced and/or understood by a person or people, in context [1]. Soundscape has been measured and analysed through the human perception of the proper acoustic environment. Hence, the measurement methods should focus on collecting physical or perceptual data which contain information on how human perceive the acoustic environment. The local planning and design should take a comprehensive approach to assess the quality of public realms. Kuala Lumpur City Hall has prepared an urban design strategy which includes the creation of new and improving the quality of public realm, environmental quality and livability of Kuala Lumpur City Center streets show the absence of thoughtfulness regarding the strategy. In urban morphological research discourse, understanding how the physical form for each particular towns and cities been formed and transformed has received a significant contribution in shaping various approaches to analysed the evolutionary process [2]. Recently, it was observed that the soundscape component was not integrated into the Kuala Lumpur Structure Plan 2020 [3] and Kuala Lumpur Urban Design Guidelines [4]. It is noticeable that there is a lack of attention to the soundscape approach in Malaysia and generally appear on the urbanisation agenda very late [5,6]. Non-adequate sound environments will reduce the usefulness of places or even could obliterate their usability. The soundscape approach is similar to the biomimicry implementation by identifying human problems and looking into the solution in the built environment [7].

Several scholars and practitioners have commented on this problem over the years, and it has been stated that there has been visual dominance within the built environment field, with other sensory impressions (including sound) not receiving enough attention [8]. As a result, the acoustic aspect has been overlooked [5,6]. However, the soundscape approach is a rapidly expanding sector, fulfilling the gap [9]. The soundscape concept has significant practical implications in terms of policy as well as the design process. The soundscape concept was largely used in countries such as Greater London, Berlin, Stockholm, and Antwerp, which were actively promoting practical examples of soundscape projects around the world [9], but there were only a few research on soundscape application in Malaysia. Evidently, this gap gives substance and significance to the execution of local soundscape preference criteria research, for the design and planning process. Hence, to ensure that the acoustic environment does not neglected, urban designers need public input to understand and implement the soundscape approach. Through these efforts, this research will contribute incorporating the urban soundscape approach as the component necessary to ensure the sustainable urban development in future. Nevertheless, there has been no documentary evidence that examines the influence of urban street context on the soundscape perception in Kuala Lumpur. Therefore, this research aims to assess visual perception factors (visual distractibility and visual appraisal) on the soundscape (appropriateness, calmness, and eventfulness) of urban shopping street as an environmental factors.

## 2. Methods

### 2.1. Study area

Kuala Lumpur emerged as a capital of the new independent Federation of Malayan States in 1957. The urbanisation rate in Malaysia increased to 75.1% (24.3 million people) in 2020 and is expected to increase to 88.0% in 2050 [10]. Kuala Lumpur has exceeded the national urban rate, with 100% of the population living in an urban area. The rapid development in the Kuala Lumpur has opened a discourse on the necessity of imposing soundscape and sustainable planning and design requirement on future developments. Kuala Lumpur was chosen for this study area because it was the only city in Malaysia to be classified as the most liveable city in the Liveable City Ranking, coming in at number 70 [11]. Improving Kuala Lumpur's appearance and reputation as a liveable city is vital. Apart from the tangible aspects, intangible aspects such as soundscape can also impact and contribute to the quality of life in urban environments. The seven main street typologies in Kuala Lumpur City Centre are defined or identified based on a detailed study of the existing functions and activities, circulation patterns, usage, physical and visual linkages [12]. Kuala Lumpur street typologies consists of a city-wide connector, main shopping street or entertainment district, character street, market street, local connector, city boulevard, and back alley. This study concentrates on the area's main core, which shares the same characteristics:

i. The Kuala Lumpur's major nodes for the commercial area.
ii. Situated in the centre of a wide range of economic activities.
iii. The large number of pedestrians, shoppers, and tourists.
iv. Encompasses a wide variety of sound sources, including human generated sounds, traffic noise, mechanical sounds, and natural sounds.
v. There was no difference in the overall sound source identification across the various urban shopping streets, implying that the streets have similar soundscape components and were treated as similar environments.

The street typology that fulfils all the criteria falls under a main shopping street or an entertainment street. Changkat Bukit Bintang, Jalan Bukit Bintang, Jalan Kenanga, Jalan Masjid India, Jalan Melayu, and Jalan Tuanku Abdul Rahman are the six areas of this type of street. From six urban shopping streets, only Jalan Bukit Bintang (JBB), Jalan Tuanku Abdul Rahman (JTAR), and Jalan Masjid India (JMI) were chosen because they fulfilled predetermined criteria.


**Figure 1.** Location of sample site areas in Kuala Lumpur.
Source: Google Maps direction to Kuala Lumpur, Malaysia. Retrieved 15th October 2022, from https://goo.gl/maps/KVXq1ayfYyu

**Table 1.** Determinants of study area for soundscape perception of urban shopping street.

| Name of street | ROW | Road hierarchy in ROL |
|---|---|---|
| Jalan Bukit Bintang (JBB) | 66' | Minor arterial and major collector street |
| Jalan Tuanku Abdul Rahman (JTAR) | 80' | Minor arterial and major collector street |
| Jalan Masjid India (JMI) | 50' | Local street |

Note: ROW – right of way; ROL – river of life
Source: Kuala Lumpur City Hall (2014)

An integrated framework for assessing land-use/land-cover [13] can adopted to produce a macro-scale analysis for soundscape maps. However, for micro scale, this study was used a determining factor for urban street areas, as demonstrated by a previous study. The sample streets in this study were chosen to represent the most common urban streets based on the scale factor. For a clear understanding of comfort and security in a street canyon, the width of the urban streets should be between 8 m and 25 m [14]. They are also regarded as the standard width of urban streets based on previous studies of the soundscape in street space that have a similar width range [15]. The widths of the selected sample sites range from 5 m to 30 m, while the lengths of the surveyed streets range from 150 m to more than 1 km.

### 2.2. Sampling techniques

A large area of Kuala Lumpur was surveyed using the multi-stage cluster sampling under probability sampling. Kuala Lumpur's urban shopping streets serve as the clusters' units. The researchers employed the following additional processes to narrow down the sample instead of gathering data from every single unit in the urban shopping street clusters. Then, inside JBB, JTAR, and JMI, a simple random sampling sample is taken from each street.

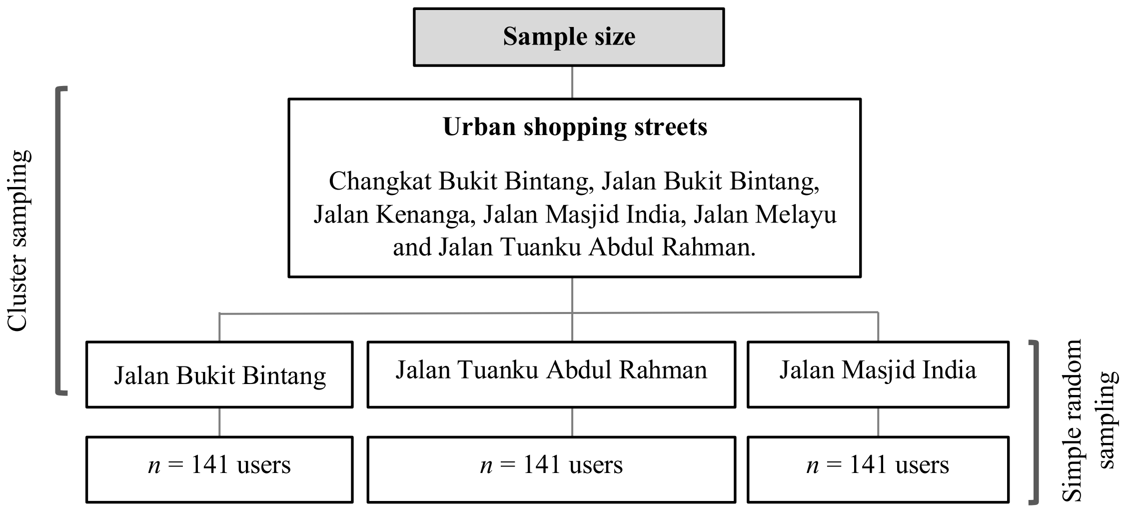


**Figure 2.** Multi-stage sampling of users from three urban shopping streets

### 2.3. Respondent selection

According to previous studies in the field of soundscapes, the minimum sample size of semantic differential method requires more than 150 samples [16]. After performing a factorial analysis, the main factors extracted became relatively stable after the sample number reached 300, indicating that the sample number for the urban soundscape research was sufficient [14]. According to the previous researcher, the target population is limited to users who do not have a hearing impairment [17,18]. The experience of acoustic environment is only available to persons with normal hearing because this study will only be relevant and yield valid results if the user has excellent hearing to evaluate his or her perception of soundscape. The respondents were chosen to represent a cross-section of Malaysia's population. Furthermore, equal rationing of males and females was thought to lessen the gender-bias effect on the outcome's reliability and validity. In order to achieve an inclusive sample size that represents the entire population of Kuala Lumpur, the respondents were selected from a diverse range of people from various backgrounds. A details distribution of the respondents is based on the site as is shown in Table 2.

**Table 2.** Sample size for surveys

| Sample site | Respondents (n) |
|---|---|
| JBB | 148 |
| JTAR | 131 |
| JMI | 132 |
| Total | 411 |

The respondents' ages ranged from 20 to 40 years old (68.4%), with male (43.8%) and female (43.8%) respondents having equal weightage. More specifically, out of 411 respondents, a majority are Malaysians (95.4%) while the rest are classified as non-citizens (4.6%). The most significant sampled population for ethnicity is Malay (74.5%), followed by Indian (11.7%), Chinese (9.5%) and Others (4.4%). A total of 63.2% of the respondents had completed either an undergraduate or postgraduate degree. Respondents who live in urban areas make up most of the living area responses (72.7%).

*2.4. Survey Instrument*

In brief, the instrument design process consists of five steps: background identification, conceptualisation, instrument formatting, data analysis, and determining validity and reliability. The initial component of the questionnaire design is to include five basic sections, including demographic and behaviour, noise sensitivity, sound source, contextual characteristics (visual), and soundscape perception, as are further discussed here. The questionnaire items to explore the influence of visual perception factors on soundscape of urban shopping streets depended on a similar tool used by [14,19,20] in previous research. Tables 3 and 4 contain a list of dependent and independent variables. The four types of soundscape perception as a dependent variable are appropriateness, eventfulness, and calmness dimension.

**Table 3.** Dependent variables.

| Construct | Variable | Indicator |
|---|---|---|
| Soundscape perception | Appropriateness (AP) | 'I find the soundscape is appropriate with the context', 'There is an accordance between what I like to do and this soundscape', 'I describe overall experience today when using the street as good', and 'I rate the loudness of the environment noise from the street as loud' |
| | Eventfulness (EV) | 'Overall, the soundscape I just experienced was Meaningless-Meaningful', 'Overall, the soundscape I just experienced was Unvaried-Varied', and 'Overall, the soundscape I just experienced was Uneventful-Eventful'; |
| | Calmness (CA) | 'Overall, the soundscape I just experienced was Everywhere-Directional', 'Overall, the soundscape I just experienced was Chaotic-Calm', 'Overall, the soundscape I just experienced was Noisy-Quiet', 'Overall, the soundscape I just experienced was Disordered-Ordered', 'Overall, the soundscape I just experienced was Uncomfortable-Comfortable', and 'Overall, the soundscape I just experienced was Intense-Relaxing' |

**Table 4.** Independent variables.

| Construct | Variable | Indicator |
|---|---|---|
| Noise sensitivity | Perceived noise (PN) | Promptly wake up, easy get mad, bothered, nervous |
| Contextual characteristic (visual) | Visual perception (VD) | Expectation, satisfaction, fascinating, interesting, stay, preference |
| | Visual quality of environment (VA) | Uninteresting-interesting, Disharmonious-harmonious, ugly-beautiful |
| Sound source | Perceived sound source (PS) | Frequently of human sound, dominant of human sounds, preference of natural sounds, important of natural sounds |
| | Urban sound environment (US) | Mitigate traffic noise, mitigate mechanical sounds, enhance human sounds, preference of traffic noise, preference of mechanical sounds |

### *2.5. Statistical procedures for data analysis*
The IBM SPSS Statistics version 25.0 software was used to analyse the data collected from the survey. To achieve the research aims, descriptive analysis and analysis of relationships were utilised. For descriptive analysis, the user's preference soundscape were examined. Meanwhile, the multiple regression analysis with the stepwise method was used to analyse the relationship between a dependent variable and several independent variables to support the findings. This method is used to figure out which independent factors are significant predictor of the dependent variable. Furthermore, only the independent variables that were significantly associated with the dependent variables (soundscape preferences dimensions) would be used to predict the dependent variables, to reduce the influence of collinearity. This method was used by the previous studies on examining visual impacts on the soundscape perception [21,22]. All statistical analysis were examined at the 95% significant level, allowing for a more flexible interpretation of data.

## 3. Result
### *3.1. Reliability and normality test*
The Cronbach's alpha value for soundscape perception and contextual characteristic (visual) is .954 and .908, respectively. Meanwhile, the skewness (S) and kurtosis (K) value for soundscape perception and contextual characteristic (visual) is normally distributed (S = -.302, K = -.023; S = -.184, K = -.128 respectively).

### *3.2. Descriptive statistics of soundscape perception*
Frequency analysis was used to determine the type of users in an urban shopping street based on their understanding and ability regarding the questionnaire instrument. For the seven continuous scale variables, the mean scores were categorised into three categories: low (1.00 – 3.00), medium (3.00 – 5.00) and high (5.00 – 7.00). The mean (M) preference and standard deviation (SD) was calculated for each component of soundscape statements (Table 5). It could be observed that among all the components, 'eventfulness' (M = 4.74, SD = 1.588) was rated higher by the respondents. The mean rating for 'appropriateness' was M = 4.52, SD = 1.354 and the mean for 'calmness' component was rated the lowest (M = 4.35; SD = 1.467). The reason for the higher preference of eventfulness component (varied, changing, lively and eventful) could be where the soundscape is appraised based on the familiarity and adaptive to the overall pattern of JBB, JTAR and JMI as the urban shopping streets. Thus, creating a sequence in the area and appropriateness to the function of the place and human activities

[20,23]. The respondents react positively with the involvement of human activity with the soundscape. The perception was mainly influenced by the soundscape ability to support the respondent's activities, such as shopping.

**Table 5.** Respondents' soundscape perception component

| Component | Mean (M) | Standard Deviation (SD) | Users' Preference |
|---|---|---|---|
| Eventfulness (EV) | 4.71 | 1.450 | Moderate |
| Appropriateness (AP) | 4.52 | 1.354 | Moderate |
| Calmness (CA) | 4.35 | 1.467 | Moderate |

*3.3. Descriptive statistics of contextual characteristic (visual)*

The findings from the descriptive analysis indicated that an overall mean of M = 4.68, SD = 1.171 was attained, thus indicating the level of score were moderate (refer Table 6). From Table 6, it can be noted that the mean scores of contextual characteristics (visual) range from 4.02 to 5.24. Among the statements with the highest mean of contextual characteristic (visual) were statement D7 (M = 5.24, SD = 1.503), statement D8 (M = 5.06, SD = 1.502), and statement D9 (M = 5.02, SD = 1.517) and the rest of the statements fall under the moderate level of score. As a result, it may have an impact on the respondents' perceptions of the sounds they heard, because certain sounds may seem appropriate, and thus lead to a positive evaluation of the contextual characteristic (visual). Living on a 'pretty street' can reduce the user perception of noise annoyance [24]. The ideal urban shopping street that respondents want to experience is a varied, lively, and eventful soundscape. This relationship is similar to the theory that one's expectations influence one's acceptance of sounds and the context. In the less visually appealing environments, the inverse may also be relevant.

**Table 6.** Respondents' experience with contextual characteristic (visual).

| Code | Statement | Mean (M) | Standard Deviation (SD) | Users' Preference |
|---|---|---|---|---|
| D7 | Overall, the street's character I just experienced was uninteresting-interesting | 5.24 | 1.503 | High |
| D9 | Overall, the street's character I just experienced was ugly-beautiful | 5.06 | 1.502 | High |
| D8 | Overall, the street's character I just experienced was disharmonious-harmonious | 5.02 | 1.517 | High |
| D2 | The street character meets my expectation | 4.68 | 1.441 | Moderate |
| D1 | I find this street character is interesting | 4.66 | 1.529 | Moderate |
| D3 | I am satisfied with this street's character | 4.64 | 1.462 | Moderate |
| D6 | This street is fascinating | 4.52 | 1.653 | Moderate |
| D5 | Being here fits with my personal preference | 4.30 | 1.622 | Moderate |
| D4 | I would like to stay longer due to this street's character | 4.02 | 1.638 | Moderate |
| | Overall mean | 4.68 | 1.171 | Moderate |

### *3.4. Multiple linear regression*

Three (3) multiple linear regression analyses were carried out to predict the values of each dependent variables (i) AP, (ii) EV and (iii) CA given the set of independent variables (PN, VD, VA, PS and US).

**Table 7.** Multiple linear regression – Independent variable predicting AP.

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .674 | .454 | .449 | 1.005 | 1.808 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 341.535 | 4 | 85.384 | 84.477 | .000 |
| | Residual | 410.358 | 406 | 1.011 | | |
| | Total | 751.894 | 410 | | | |

**Coefficients**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | -.201 | .376 | | -.535 | .593 | | |
| | VD | .557 | .045 | .536 | 12.426 | .000 | .721 | 1.387 |
| | PS | .147 | .044 | .135 | 3.378 | .001 | .845 | 1.184 |
| | VA | .152 | .058 | .120 | 2.608 | .009 | .640 | 1.562 |
| | US | .159 | .075 | .079 | 2.129 | .034 | .964 | 1.037 |

**Table 8.** Multiple linear regression – Independent variable predicting EV

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .546 | .298 | .293 | 1.219 | 1.726 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 256.773 | 3 | 85.591 | 57.592 | .000 |
| | Residual | 604.869 | 407 | 1.486 | | |
| | Total | 861.642 | 410 | | | |

**Coefficients**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | .363 | .434 | | .837 | .403 | | |
| | VD | .396 | .054 | .356 | 7.282 | .000 | .721 | 1.387 |
| | VA | .316 | .067 | .232 | 4.731 | .000 | .716 | 1.396 |
| | US | .232 | .090 | .108 | 2.567 | .011 | .970 | 1.031 |

**Table 9.** Multiple linear regression – Independent variable predicting CA.

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .373 | .139 | .133 | 1.366 | 1.768 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 123.140 | 3 | 41.047 | 21.988 | .000 |
| | Residual | 759.772 | 407 | 1.867 | | |
| | Total | 882.912 | 410 | | | |

**Coefficients**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 1.135 | .487 | | 2.331 | .020 | | |
| | VD | .227 | .061 | .202 | 3.733 | .000 | .721 | 1.387 |
| | VA | .268 | .075 | .195 | 3.586 | .000 | .716 | 1.396 |
| | US | .199 | .101 | .092 | 1.967 | .050 | .970 | 1.031 |

Some conclusions can be drawn from the results that are presented above. Tests were conducted at a 95% significance level. Based on Table 7, 8 and 9, the R square ($R^2$ = .454) of the 'appropriateness' model is the highest between other soundscape perception components. The R square value presented about 45.4% variance changes in 'appropriateness' and were explained by four predictors. The variability of the soundscape perception dimensions values is 1-.454 times the original variance. The R square ($R^2$ = .298) of the 'eventfulness' can be predicted from the variables 'visual perception', 'visual quality of environment' and 'urban sound environment'. The results suggest that the soundscape perception for JBB, JTAR and JMI were primarily influenced by the users' visual perception and the spatial design of urban shopping streets. This is proven by referring at the beta coefficient, in every standard deviation increases in soundscape perception the dimensions would yield a standard deviation increase in the predicted 'visual perception' respectively (β =.536, β =.356, and β =.202). Thus, the 'visual perception' has a higher impact on all soundscape perception dimensions than another predictor by comparing the standardised coefficients.

## 4. Discussion

### *4.1. Effects of contextual characteristic on visual perception*

Finding has revealed that the 'visual perception' become the most impacting factors to be considered in a soundscape preference criterion that have significant effects on the individuals' responses. The F-test is highly significant, Table 7, 8, and 9 explain a significant amount of the variance in soundscape perception and illustrated that the model in Table 7, 8 and 9 is a good fit for the data .05 level of significance. This indicates that people may appreciate the soundscape more in the presence of expected visual elements in the urban shopping streets. In the context of a city park, the physical characteristics of the visual landscape have a significant impact on soundscape perception [22]. The people perceptions are influenced by the conditions of the visual environment in the acoustic environment [25] to enhance the sense of place and visual interest. The effect of spatial layout statistically significant with human emotions and their behavioural intentions in the business setting [26]. Furthermore, visual elements improve the benefit of soundscape-context affection, whether through visual or auditory stimuli [27]. The city and built environment indicator presented the highest result of 20 articles, which suggested that built environment attributes influenced urban development and provided opportunities for commercial activities in livening the place [28].

In Malaysia, these types of urban shopping streets may be found almost everywhere, particularly in urban areas. The results have shown that with an excellent design of "visual quality of environment" in JBB, JTAR and JMI, the respondents are not easily disturbed by the excessive noise. However, in the areas where users face lesser potential of being distracted by the visual elements, controlling the unwanted sounds that are listed in the 'urban sound environment' and adding more preferred sound source as appear in 'perceived sound sources' should be the primary goal for soundscape design. The 'perceived sound sources' has the potential to mitigate unwanted sound and improve the soundscape environment. This is particularly important, especially to enhance the initial stage in any soundscape work in comparing with its presence in a different environment.

### *4.2. Future outlook*

In future investigations, it might be possible to investigate different factors such as the type of area (entertainment, cultural, heritage, and characteristic) where the urban shopping street is located. The urban shopping streets were not obviously different regarding the socio demographics of the users, but the cultural differences related to Malaysian culture greatly influenced the acoustic environment. In this study, these variables have not been controlled, thus, they might be the basis for further empirical studies. The findings of this study indicate that the 'visual perception' variable can produce a significant difference when the soundscape of the urban shopping street is assessed.

## 5. Conclusion

In conclusion, finding has discovered that the 'visual perception' and 'visual quality of environment' factors are strong predictors of the user's soundscape perceptions. The physical visibility of urban shopping streets has influenced how the users perceive, understand, experience, and judge the information that is gathered from the acoustic environment. This allows for a pleasant sensory experience as well as significant visual aesthetic effects when the users are in the urban shopping streets. This study would bring a new contribution for better understanding soundscapes and assist the urban planners, architects and landscape architects in designing conducive acoustic environment of urban shopping streets. The designers need to take the initiative by adding value in their designing using the significant factor that influences the soundscape perception. Indeed, designers should look closely at the users' needs by seeking insights into variation or changes that look appealing to potential users.

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## Acknowledgments

The authors would like to express the deepest gratitude to the Universiti Malaysia Kelantan for the grant award of UMK Fundamental Research Grant (UMK-FUND) R/FUND/A1200/00795A/002/2022/0103.