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Cultural elements' influence on visual preferences in urban waterfronts' walkways in Malaysia

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With the rapid urbanization in Malaysia, human activities have caused damage to many waterfront areas. Efforts are being made to restore the connection between the community and river waterfronts while creating attractive urban spaces. However, the implementation of modern design development strategies without sufficient consideration of cultural aspects and societal visual preferences has raised a number of questions with regard to the public's acceptance and appreciation of the newly implemented urban facades. This study aims to comprehensively examine the relationship between cultural elements and visual preferences in the context of urban waterfront walkways in Malaysia. This study implemented a photo survey to assess the visual preferences of the study's respondents. The results indicated a significant correlation between subjects' visual preferences and their cultural backgrounds. Additionally, the analysis of the collected data highlights a strong correlation between the presence of green elements and what the respondents perceived as part of the Malaysian culture. Additionally, the historical character of the study area, as represented by historical buildings, significantly influences the preferences of Malaysian respondents. Furthermore, certain elements, such as food carts, high-rise buildings, and water, are among the least preferred compared to other elements. Ultimately, incorporating these elements in the early design stages can contribute to the creation of culturally connected and visually appealing urban waterfront spaces in Malaysia.

1 Introduction

Our current world is witnessing a rapid surge in urbanization. It has been projected that by the year 2050, a staggering 68% of the global population will inhabit urban areas (United Nations, 2018). Nevertheless, the growth of anthropocentric activities and the rapid increase in urban population have burdened urban areas with a plethora of challenges (Olalekan, 2014). In order to effectively address these urban challenges, the primary focus of local authorities has been placed on incorporating green and blue spaces within their development philosophies and practices, with the aim of tackling the environmental,

economic, and social issues that afflict urban areas (Faivre et al., 2017; Sunita et al., 2021). For example, various studies have provided evidence that green and blue spaces within urban areas serve as effective means to combat urban environmental problems, such as reducing temperatures in urban areas (Žuvela-Aloise et al., 2016), mitigating urban flooding (Dong et al., 2019), reducing air and water pollution (Abhijith et al., 2017), and enhancing the overall visual quality of urban areas (Mundher et al., 2022; Mundher et al., 2023).

Waterfront spaces play a critical role in shaping green and blue spaces within urban areas, and they typically represent areas of high economic value in cities (Zhou et al., 2023). In other words, waterfronts are considered urban ecosystems that offer various development opportunities within cities (Khairabadi et al., 2023). Urban waterfront areas serve as places for public enjoyment, offering people the opportunity to access both green and aquatic spaces both visually and physically (Martí et al., 2018; Awwal and Borsi, 2020; Smetanin et al., 2021). Thus, urban waterfronts can facilitate the existence of suitable living environments and create magnificent and vibrant urban spaces for urban residents (Attia and Ibrahim, 2017). They are also significant in influencing the wellbeing of populations that reside in urban areas where they are located (Knight et al., 2022; Macháč et al., 2022). Generally speaking, urban riverfronts are often connected to places of historical, cultural, and natural importance. The character of waterfronts can vary, whereby each area can possess a specific character and distinct identity that differentiates it from its surroundings. This characteristic differentiation could be a result of the existence of unique elements, whether natural or artificial, unique to a specific section of the waterfront in question (Petrtýlová and Jaššo, 2022). Previous studies have attempted to correlate waterfronts' visual characteristics to the cultural background of the inhabitants of the region (Apriliani and Dewi, 2020). Therefore, it enables the creation of high-quality public space that contributes to the sustainability of urban waterfront areas as an important part of the urban fabric where they are located.

The configuration of the cultural landscape at the waterfront plays a pivotal role in preserving the identity and symbolism of the location (Hussain et al., 2022). Urban waterfront walkways encompass cultural elements that contribute to the overall identity of the city and create a unique sense of place. These cultural identities are a result of the presence of a set of visual characteristics within regions of the waterfront, which can represent distinct attributes, purposes, and uses (Petrtýlová and Jaššo, 2022). Wu (2021) indicated that shaping urban waterfront spaces should involve more than creating visually pleasant urban spaces, suggesting that it should also encompass enhancing the city's ecology. This concept leads to the conclusion that waterfront planning and design should be a multifaceted approach that can accommodate the characteristics of the diverse cultural nature of cities, reinforcing cultural attributes through design elements (Zhu and Duan, 2011; Üzümcüoğlu and Polay, 2022). Furthermore, the distinct characteristics of the regions where waterfronts are located contribute to the overall identity of the city and can provide reasons for people to explore riverfront areas (Yang, 2014).

Communities' cultural foundations and value systems play a significant role in shaping their visual preferences for urban scenery. The cultural heritage and background of a community can be crucial in influencing how communities engage with their surroundings

(Lesan and Gjerde, 2020). Ethnic sectors within a community can exhibit variations in their cultural foundations and value systems due to a number of factors, such as the collective's aspirations to preserve the community's identity (Sekhon and Szmigin, 2009). Additionally, there are differences in cultural values among various groups within the community, with varying degrees of alignment observed across these groups (de Mooij and Beniflah, 2017). Moreover, the theoretical foundations and composition of value systems can impact the interpretation of cultural values at the individual level (Schwartz, 2006). Overall, these distinctions and similarities in cultural values among groups within their communities have implications for understanding user behavior and interest in cultural values (Minkov and Hofstede, 2012).

Cultural background is defined by socio-moral values, religious influences, geographical discoveries, economic influences, and legal norms that contribute to forming a person's identity and worldview. Cultural background plays a crucial role in decision-making across various aspects of life, including societal, historical, and institutional contexts. Previous research initiatives have demonstrated that individuals' cultural backgrounds and their related visual preferences are of great importance in influencing their perceptions regarding urban regions in general and waterfront spaces in specific. Many are of the belief that enhancing the overall visual quality of these urban waterfront spaces can significantly contribute to the creation of high-quality living environments (Kostopoulou, 2013; Wang et al., 2020). Among various human preferences, it is estimated that visual preferences account for approximately 80% of the preferences that influence the design of spaces (Gao et al., 2021). The prevailing state of public preferences in urban landscape areas primarily revolves around a set of landscape elements. Previous research attempts suggested that assessing the aesthetic qualities of environments through visual-based, public-centered surveys can be effective (Mundher et al., 2023b; 2Mundher et al., 2022b; Song et al., 2023). Zhou et al. (2023) found that diverse landscape elements, including bodies of water, botanical features, man-made structures, and integrated scenery, influenced the preferences of the general public due to their visual attributes. Similarly, Wang et al. (2020) conducted a study on the Qiantang riverside promenade and found that participants had a positive reaction to the scenery that featured supporting amenities and road functionality. Petrtýlová and Jaššo (2022) emphasized the importance of preserving and enhancing the unique characteristics of certain areas of river waterfronts to highlight the overall identity of the city, which in turn can provide incentives to visit the river waterfront spaces. Ultimately, the importance of accommodating the population's cultural and visual preferences in waterfront landscapes has been widely acknowledged to promote physical activities, psychological rejuvenation, and nature preservation (Jovanovska et al., 2020; Li et al., 2022). Furthermore, visual preferences are increasingly being recognized as imperative subjects to be taken into consideration when promoting urban development initiatives, and they are being suggested as important elements to be included in sustainable local policy-making in urban landscapes (Shah and Roy, 2017; Luo et al., 2019; Kang and Liu, 2022). Cultural elements can significantly contribute to the overall experience and attractiveness of an urban waterfront walkway. Consequently, the integration and arrangement of cultural elements in waterfront developments is

thought to be crucial for creating diverse, sustainable, and all-encompassing spaces (Zhu et al., 2023). Thus, cultural elements can play a significant role in shaping the user experience, which, in turn, influences the individual's perceptions and visual preferences within urban waterfront walkways.

1.1 The study aim

With the rapid pace of urbanization in Kuala Lumpur, waterfront areas have played a significant role in shaping the city's Image. Urban waterfronts have been transformed into mixed residential-commercial areas with high population density. Various challenges face local municipalities in revamping waterfront areas (Khairabadi et al., 2023). Development efforts of previous waterfront projects have mainly concentrated on addressing environmental challenges, namely climate change, air pollution, water pollution, and urban flooding (Yassin et al., 2011; Lorens, 2019; Pelorosso, 2020). However, challenges could arise when development initiatives are implemented without adequately considering cultural aspects and societal visual preferences (Ginzarly and Teller, 2016; Krsmanovic, 2020). This can lead to a loss of place identity and strain the city-river relationship, affecting long-term projects' sustainability (Hussain et al., 2022).

Hence, the primary focus of this study is the investigation of the visual characteristics of waterfront areas and their association with the inhabitants' spatial affiliation. Therefore, this study aims to comprehensively explore the influence of cultural elements on forming visual preferences in the context of urban waterfront walkways in Malaysia. By understanding these relationships and factors influencing of visual preferences for cultural elements, urban design strategies can be refined to prioritize elements that align with the cultural inclinations of cities' residents.

2 Materials and methods

2.1 Study area

Kuala Lumpur, the capital city of Malaysia, is a rapidly growing urban metropolis and is recognized as one of the most attractive tourists' destinations in Asia. The city's dynamism and its progress in social, economic, industrial, and business sectors have led to unprecedented urbanization and expansion (Mundher et al., 2023). Furthermore, Kuala Lumpur annually attracts nearly nine million visitors, thanks to its numerous cultural attractions and its status as a prominent tourist destination in Asia (Yasin et al., 2022). These factors collectively attract a substantial number of residents, making Kuala Lumpur the most populous city in the nation. One of the most important projects developed in recent years is the River of Life project.

The proposed study area is (the River of Life), the first phase of a project that the government of the city of Kuala Lumpur have initiated on 20th of December 2017. The River of Life project area encompasses the confluence of the Gombak and Klang rivers and is surrounded by various cultural and historical destinations, which hold historical significance. Centered around what was once known as the "Government House", now the Sultan Abdul Samad building

(historical building) constructed in 1897, and the Masjid Jamek (mosque) constructed in 1909. The project area consists of a diverse mix of residential, cultural, and business districts, offering an exciting challenge and significant potential for future development. The city's government development strategy aims to preserve Kuala Lumpur's rich history while revitalizing the waterfront, creating a promising future for this area. The River of Life project seeks to reconnect the community with the river by transforming and invigorating the river context into a vibrant waterfront, while embracing the city's historical, cultural, and heritage values and reintegrating them into the surrounding urban fabric.

The first phase of the project successfully established a movement walkway on both sides of the river. On the right side, it connects the historic commercial building "Central Market" to the train station at the entrance of the historic mosque "Masjid Jamek," covering a distance of approximately 480 m. On the left side, it links the commercial building known as one of the city's oldest skyscrapers, the "Dayabumi Complex," to the Independence Square called "Merdeka Square," which overlooks the historical building called "Sultan Abdul Samad Building," spanning a distance of approximately 520 m. Therefore, for the purposes of this study, the designated distance is 1,000 m, see (Figure 1) for more details.

2.2 Materials of the study

In this study, photos were used as the primary materials for assessing visual preferences in the context of urban waterfront walkways. For this purpose, photographs were taken on-site at approximately 50-m intervals while walking on both sides of the waterfront walkway along the River of Life. Photos were captured in both directions (going and coming back), using a camera settings of (ISO 25, wide camera 26 mm f/1.8 aperture, 9 MP), maintaining the same perspective and aspect ratio (landscape16:9) (Figure 2). Following this approach, the total distance of 1,000 m was divided into 50-m intervals, resulting in 20 photos. However, the process was carried out in both directions; therefore, a total of 40 photos were captured, and each of them was assigned a unique code (V01–V40) for inclusion in an online survey, and all photos can be seen in the (Supplementary Figure SA1).

2.3 Methods of the study

In this study, a photo survey was adopted as the main method of assessing visual preferences in the context of urban waterfront walkways. The photo survey method is one of the most common techniques for exploring visual preferences in urban landscapes as well as being a popular human-environmental interaction assessment technique in general (Mundher et al., 2022c). The photo survey was conducted through an online platform called Qualtrics. In this survey, photos were displayed in a random order to prevent respondents from encountering sequenced images with similar scenery. To conduct the survey, the primary investigator (PI) conducted four separate site visits during the weekends of August 2023, with each visit lasting more than 6 h. The site visits

FIGURE 1
The location of the study area.

FIGURE 2
Examples of the photos taken at approximately 50 m distances.

took place during the weekends of the aforementioned month due to the fact that this area is popular for hosting a number of cultural events during the weekends. During these visits, the PI surveyed site visitors who expressed their ability to complete the survey using a tablet device. The sample was solely comprised of adults with normal vision, meaning they aren't suffering a significant visual impairment that would make it challenging for them to partake in the study. This approach was taken to ensure that all respondents were acquainted with the site's features while limiting the investigator's influence on subjects' responses.

The online preference photo survey was divided into two sections: (A) including the respondents' demographics and (B) including the photo survey. The demographic section (A) consisted of seven questions, including inquiries about the respondents' citizenship, gender, ethnicity, marital status, and other relevant factors to the subject matter. Section (B) was composed of three subsections. In the first subsection, respondents were asked to identify their preferred element and it reflected their cultural background by clicking on the element within

each photo; the question was prompted as follows: "Click within this photo on the cultural element you prefer." In the second subsection, the respondents were asked to rate the visual preference of the photos by responding to the question: "How much do you prefer the scene in the photo above?" This was accomplished by rating the photos on a Likert-type scale, with ratings ranging from 1 (very low preference) to 5 (very high preference) for each photo. In the third subsection, respondents were instructed to assess the extent to which the scene reflected their cultural background by responding to the question: "How much does the scene in the photo above reflect your cultural background?" This was also accomplished by rating the photos on a 5-point Likert Scale, with ratings ranging from 1 (very low reflective of cultural background) to 5 (very high reflective of cultural background) for each photo.

2.4 Analysis of the study

The analysis in this study centers on the perceived visual preference indicator and involves a comprehensive statistical

TABLE 1 Demographic data of the survey.

Category		Demographic	Percentages (%)	N
Citizenship	1	Local Malaysian	92.1%	280
	2	Foreigner	7.9%	24
Gender	1	Male	50.7%	154
	2	Female	49.3%	150
Ethnicity	1	Malay	48.4%	147
	2	Chinese	40.5%	123
	3	Indian	3.3%	10
	4	Others	7.9%	24
Marital Status	1	Single	60.5%	184
	2	Married	39.5%	120
Age	1	20–29	37.2%	113
	2	30–39	44.7%	136
	3	40–49	13.2%	40
	4	50–59	4.9%	15
Educational level	1	High school	7.6%	23
	2	Undergraduate/Bachelor's degree	70.1%	213
	3	Postgraduate/Master's or Ph.D. degree	22.4%	68
Living area	1	Urban area	80.6%	245
	2	Rural area	19.4%	59

examination of how this perception varies among individuals. To yield results, three techniques were employed.

First, Qualtrics heatmap analysis was used to identify elements preferred by respondents that also reflected their cultural backgrounds. This analysis method is highly regarded for its effectiveness in enabling authors to discern respondent preferences and has been successfully utilized in prior studies, as demonstrated by Mundher et al. (2022c) and Gao et al. (2023).

Secondly, to assess the strength of the connection for each cultural element, one can consider both the mean visual preference M (VP) and the element frequency (EF). A straightforward approach is to calculate a composite score by multiplying M (VP) and EF (Eq. 1). The output of this equation indicates that a higher number of outputs correspond to a stronger connection.

$$CS = M\,(VP) \times EF \tag{1}$$

where; CS = composite score, M (VP) = mean visual preference, and EF = element frequency.

Due to variations in results, a normalization process is undertaken. Normalization involves adjusting the values of a composite score to ensure they share a common scale or range. This is commonly applied to facilitate the comparison or combination of numbers with different units of measurement or scales. In this study, the Min-Max normalization equation is employed to standardize various scales, simplifying the comparison of values. Moreover, to enhance the practicality and ease of use in the assessment, the result is multiplied by an integer,

yielding normalized integer values. These can be employed to determine the final score of cultural elements influencing visual preferences in urban waterfront walkways in Malaysia (Eq. 2). This equation was previously demonstrated by Mundher et al. (2023b).

$$Wcs = CS/MaxCS \times n \tag{2}$$

where; Wcs = normalization composite score, CS = composite score, MaxCS = maximum composite score, and n = normalized integer values.

Third, the survey findings were analyzed using the SPSS V.26 program to determine factors influencing visual preference and relation to cultural backgrounds.

3 Results

3.1 Demographic statistics description of the respondents

In this survey, a total of 304 respondents participated, most being local Malaysian citizens (N = 280, 92.1%). The respondents were almost equal numbers among males (N = 154, 50.7%) and females (N = 150, 49.3%). The respondents' ethnicity was according to the population distribution in Malaysia as follows: Malay (N = 147, 48.4%), Chinese (N = 123, 40.5%), Indian (N = 10, 3.3%), and others (N = 24, 7.9%), reflecting the diverse population around the

TABLE 2 The ranking of each photo's mean values.

Codes	M (VP)	M (CB)	Codes	M (VP)	M (CB)	Codes	M (VP)	M (CB)
V01	3.36	3.02	V15	3.76	3.75	V29	4.19	3.99
V02	3.52	3.13	V16	3.62	3.44	V30	3.89	3.78
V03	2.49	2.46	V17	3.58	3.04	V31	3.84	3.50
V04	3.84	3.72	V18	3.63	3.06	V32	3.35	3.14
V05	3.63	3.60	V19	3.64	3.04	V33	3.99	3.68
V06	3.62	3.60	V20	3.60	3.31	V34	3.74	3.44
V07	3.76	3.61	V21	4.05	3.86	V35	3.91	3.67
V08	3.42	3.16	V22	4.05	3.84	V36	3.52	3.12
V09	3.37	3.03	V23	3.82	3.68	V37	3.34	3.06
V10	3.62	3.15	V24	3.39	3.21	V38	3.67	3.32
V11	2.54	2.52	V25	3.71	3.58	V39	3.47	3.11
V12	3.22	3.02	V26	3.41	3.28	V40	3.41	3.24
V13	3.30	3.03	V27	3.39	3.38			
V14	3.59	3.21	V28	4.17	3.97			

TABLE 3 Reliability statistics of the respondents' answers.

Items	Cronbach's alpha	N of items
Reliability of Visual Preference respondents' answers (VP)	0.945	40
Reliability of Cultural Background respondents' answers (CB)	0.966	40

site. The majority of respondents were single (N = 184, 60.5%), which was approximately two-thirds the number of respondents. Additionally, most respondents belonged to the twenties generation, the age group of 20–29 (N = 113, 37.2%), and the thirties generation, the age group of 30–39 (N = 136, 44.7%). Furthermore, over 90% of respondents (N = 281, 92.5%) in this group had higher education levels than high school. Moreover, the majority of respondents lived in urban areas (N = 245, 80.6%). Based on these results, it can be concluded that the respondents consisted of local Malaysian citizens, both males and females, primarily young adults who were single, highly educated, and residing in urban areas. Since the survey was conducted on-site, they had sufficient information about the study area and were relatively familiar with the waterfront areas (Table 1).

3.2 Respondents' visual preferences

3.2.1 Photo rating according to respondents' answers

The visual preference scores and cultural background scores for each of the 40 photos in the survey were computed as mean values (Table 2). The results of the photo screening indicated a direct relationship between the visual preferences (VP) of the respondents and their cultural backgrounds (CB), as evidenced by the convergence of the mean value scores. Based on the Likert scale, the findings revealed that most photos received high preference ratings, with mean value scores ranging from 3.00 to 4.00. However, two photos received low preference ratings, with mean value scores below 3.00 (Codes = V03, V11). Conversely, four photos received very high preference ratings, with mean value scores greater than 4.00 (Codes = V21, V22, V28, V29).

3.2.2 Reliability of respondents' answers

Using SPSS, a reliability test was conducted to evaluate the accuracy of respondents' responses. The results, as displayed in (Table 3), indicate a high level of reliability in the categories of visual preference accuracy and cultural background accuracy, with Cronbach's Alpha values of 0.945 for VP and 0.966 for CB. These values suggest that the scale respondents' answers used to gauge visual preference accuracy and cultural background accuracy are internally consistent. In essence, the high-reliability scores confirm the dependability and consistency for both VP and CB categories, further affirming the reliability of the respondents' answers.

3.2.3 Correlation between respondents' visual preferences and their cultural back-ground

The mean values of visual preference and cultural background for each of the 40 photos were input into SPSS to comprehensively explore the correlation (Table 4). The results indicate a very strong and statistically significant positive

TABLE 4 The correlation test between mean value of respondents' visual preferences and cultural background.

Correlation		M (VP)[b]	M (CB)[b]
Mean Value of VP	Pearson Correlation	1	0.917[a]
	Sig. (2-tailed)		0.000
	N	40	40
Mean Value Reflective of CB	Pearson Correlation	0.917[a]	1
	Sig. (2-tailed)	0.000	
	N	40	40

[a]M (VP), mean value of visual preferences; M (CB), mean value reflective of cultural background.
[b]Correlation is significant at the 0.01 level (2-tailed)

correlation (0.917) between the mean value of visual preferences (VP) and the mean value reflecting cultural background (CB) for all 40 photos. This finding demonstrates a clear and consistent relationship between people's visual preferences and their cultural background. This suggests that the more the photos are related to their cultural backgrounds, the stronger their preference for the scenes, and *vice versa*. Also, the fact that the correlation is significant at a low *p*-value (0.000) indicates that this relationship is unlikely to be due to chance.

3.3 Heatmap analysis for cultural elements

A heatmap analysis was employed to identify elements that align with cultural inclinations based on visual preferences. This analysis was conducted by analyzing the respondents' 'click density,' where areas in red received the most clicks while those in blue received the fewest. To illustrate this, Table 5 serves as an example displaying the heatmap analysis photos, and all the heatmap analysis photos have been included in Supplementary Figure SA2.

In the heatmap analysis, elements with the highest number of clicks were high-lighted in red, while those with fewer clicks were excluded. The heatmap results indicated that participants identified several preferred elements, reflecting their cultural background. Based on participants' visual preferences, identified nine elements that reflected their cultural background and categorized them into three groups: public facilities (sculpture, food cart, walkway), buildings (high-rise building, graffiti building, religious building, historical building), and nature (water, greenery) (Table 6). The results found the mean value of the visual preferences' influence for all cultural elements above 3.00, indicating a high level of cultural elements' influence on visual preferences in urban waterfront walkways in Malaysia. Furthermore, the results highlighted a very high frequency of the connection between the "greenery element" and Malaysian culture, attributed to the element frequency (EF = 23).

Using the equation (CS = M(VP) × EF), a composite score (CS) was calculated and determined. After obtaining the CS through the equation and observing variations in results, a normalization process was initiated. The final score (Wcs) was determined using the normalization equation (Wcs = CS/MaxCS × n), where n = 10 is an integer assumed to provide normalized integer values. These values are utilized to standardize various scales and simplify the comparison of values. The final results indicated that the highest score (Wcs = 10) was achieved for the "greenery" cultural element. Following, the second-highest score (Wcs = 5) was attained for the "historical building" cultural element. These findings can be utilized to assess the extent of the influence of cultural elements on visual preferences in urban waterfront walkways in Malaysia (Table 7).
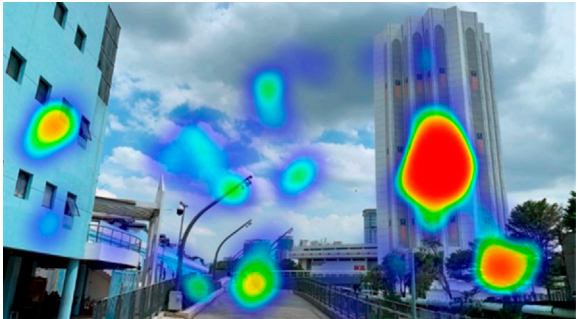
3.4 Factors influencing of visual preferences for cultural elements

This section has focused on the analysis of various demographic factors among respondents that influence their preference for cultural elements using SPSS. In this analysis, parametric analytical tests such as T-tests and One-way ANOVA were used, and only results with significant differences ($p < 0.05$) are listed. These significant differences may intrinsic value in terms of understanding preferences and needs for cultural elements and have the potential to influence the field of urban planning and design in urban waterfront areas.

The T-test results indicate a significant difference between genders in seven cultural elements in urban waterfront areas, namely: "sculpture, food cart, walkway, high-rise building, graffiti building, historical building, and greenery," as shown in (Table 8). Across all eight elements, the results indicate that male respondents had higher mean scores compared to female respondents. This suggests that male respondents exhibited a stronger preference for these cultural elements in the waterfront context compared to female respondents. The results also revealed agreement between both genders, with the highest mean observed for the "food cart" cultural element in urban waterfront areas, where men scored (M = 4.17) and women scored (M = 3.93).

Additionally, the results indicate a significant difference between marital statuses in four cultural elements in urban waterfront areas, namely: "sculpture, walkway, religious building, and greenery," as shown in (Table 9). These results indicate that married respondents had higher mean scores in all five elements compared to single respondents. This means that married respondents showed a stronger preference for cultural elements in all five elements compared to single respondents. The results also revealed agreement among respondents, with the highest mean observed for the "art sculpture" cultural element in urban waterfront areas, where married respondents scored (M = 3.56) and single respondents scored (M = 3.32).

TABLE 5 Heatmap analysis photos of the lowest and highest visual preference values in the photo survey.

	Code	M (VP, CB)[a]	Original photos survey	Heatmap analysis photos
Lowest visual preference	V03	M = 2.49, 2.46		
	V11	M = 2.54, 2.52		

(Continued on following page)

TABLE 5 (*Continued*) Heatmap analysis photos of the lowest and highest visual preference values in the photo survey.

	Code	M (VP, CB)[a]	Original photos survey	Heatmap analysis photos
Highest visual preference	V28	M = 4.17, 3.97		
	V29	M = 4.19, 3.99		

[a]M = mean value; VP, visual preferences; CB, cultural background.

TABLE 6 Show cultural elements and Influence on visual preferences.

Category	Photos codes	Cultural Elements	M (VP)[a]	EF[b]	Composite score CS = M(VP)×EF
Public Facilities	V14, V20, V26, V40	Sculpture	3.47	4	3.47 × 4 = 13.88
	V21	Food Cart	4.05	1	4.05 × 1 = 4.05
	V02, V12, V13, V17, V18, V19, V25, V27, V37, V38	Walkway	3.50	10	3.50 × 10 = 35.00
Buildings	V08, V11, V28	High-rise Building	3.38	3	3.38 × 3 = 10.14
	V09, V10, V16, V36, V37, V38, V39	Graffiti Building	3.52	7	3.52 × 7 = 24.64
	V04, V05, V06, V07, V15, V21, V22, V23	Religious Building	3.82	8	3.82 × 8 = 30.56
	V24, V25, V27, V29, V30, V31, V32, V33, V34, V35	Histoerical Building	3.74	10	3.74 × 10 = 37.40
Nature	V03, V21	Water	3.27	2	3.27 × 2 = 6.54
	V01, V02, V03, V08, V09, V10, V12, V13, V14, V17, V18, V19, V20, V21, V24, V32, V33, V34, V35, V36, V37, V38, V39	Greenery	3.52	23	3.52 × 23 = 80.96

[a]Mean value of Visual Preferences (VP) = Total mean value of photos selected element/Total number of photos selected element
[b]EF, elements frequency.

TABLE 7 Show normalization final score of cultural elements.

Category	Cultural elements	Composite score (CS)	Normalization CS/MaxCS × n[a]	Final score (wcs)
Public Facilities	Sculpture	13.88	13.88/80.96 × 10 = 1.72	2
	Food Cart	4.05	4.05/80.96 × 10 = 0.50	1
	Walkway	35.00	35.00/80.96 × 10 = 4.32	4
Buildings	High-rise Building	10.14	10.14/80.96 × 10 = 1.25	1
	Graffiti Building	24.64	24.64/80.96 × 10 = 3.04	3
	Religious Building	30.56	30.56/80.96 × 10 = 3.77	4
	Historical Building	37.40	37.40/80.96 × 10 = 4.62	5
Nature	Water	6.54	6.54/80.96 × 10 = 0.80	1
	Greenery	80.96	80.96/80.96 × 10 = 10.0	10

[a]n integer assumed number = 10.

On the other hand, the results of the t-test indicate that there is a significant difference in the living area category between the responses of those who live in urban and rural areas in five cultural elements, namely: "food cart, walkway, high-rise building, historical building, and greenery," as shown in (Table 10). These results indicate that those who live in rural areas had higher mean scores in all six elements compared to those who live in urban areas. This means that respondents living in rural areas showed a stronger preference for cultural elements compared to respondents living in urban areas. The results also revealed agreement among respondents, with the highest mean observed for the "food cart" cultural element in urban waterfront areas, where respondents living in rural areas scored (M = 4.27), and respondents living in urban areas scored (M = 4.00).

The ANOVA test results indicate a significant difference between ethnicities in eight cultural elements in urban waterfront areas, namely: "sculpture, food cart, walk-way, high-rise building, graffiti building, religious building, historical building, and greenery," as shown in (Table 11). The results indicate that Malay respondents had higher mean scores in all cultural elements except "high-rise building" compared to Chinese, Indian, and Other respondents. This suggests that Malay respondents exhibited a stronger preference for these cultural elements in the waterfront context compared to Chinese, Indian, and Other respondents. In this context, Other respondents (foreigners) showed a higher mean preference for the cultural element of "high-rise building" compared to the three ethnicities comprising the Malaysian population. Moreover, the results revealed agreement among respondents, with the highest mean observed for the "food cart" cultural element in urban waterfront areas.

Additionally, the results indicate a significant difference between ages in eight cultural elements in urban waterfront areas, namely: "sculpture, food cart, walkway, high-rise building, glass building, graffiti building, religious building, historical building, and greenery," as shown in (Table 12). The results indicate that

respondents from the fifties generation (aged 50–59) had higher mean scores in all cultural elements compared to respondents from other generations. It was also observed that in all elements, the older the respondent, the greater their preference for cultural elements. This indicates that participants in the oldest age group exhibited a stronger preference for and connection to cultural elements in the waterfront context.

On the other hand, the results of the ANOVA test indicate that there is no significant difference in the educational level category between the responses of those with a high school education, undergraduate/bachelor's degree, and postgraduate/Master's or Ph.D. degree.

Ultimately, it should be noted that the cultural element "water" did not exhibit any statistically significant differences across all demographic characteristics of the respondents. This indicates that all participants do not differ in preference for the cultural element of "water" in the waterfront context in Malaysia.

4 Discussion

4.1 The influence of cultural elements on shaping visual preferences

This study has produced a wide array of findings through a comprehensive exploration of cultural elements and their influence on shaping visual preferences within the urban waterfront walkways of Malaysia. Initially, the results obtained from the photo survey indicated a clear and consistent correlation between people's visual preferences and their cultural background. Conducting a correlation test indicates a strong correlation between respondents' cultural backgrounds and their visual preferences. This association is consistent with the findings of previous research (Petrova et al., 2015), wherein respondents tend to favor scenes that include elements associated with their cultural background. This implies that the more the scenes are related to the cultural backgrounds of viewers, the more they will be preferred, and *vice versa*. Additionally, the photo survey results revealed favorable mean values indicating high visual preferences for the scenes, with only two photos being exceptions. This suggests that respondents generally perceive the scenes to possess high visual quality and to be closely related to their cultural background within the study area (River of Life).

The heatmap analysis reveals respondents' preferences for nine cultural elements across three categories. It was found that certain elements, such as greenery and historical buildings, are preferred over other elements. The heatmap analysis highlights respondents' inclination towards green elements in the visible landscape within the photos, as evidenced by a higher click density. This finding is consistent with previous research (Semeraro et al., 2021; Adam et al., 2022; Mundher et al., 2023b), suggesting that visible greenery elicits positive responses in subjects regarding visual aesthetics in urban areas. Furthermore, the greenery could be considered not

TABLE 8 T-test results show differences in responses between genders.

Category	Cultural elements	Gender		t	Sig. (2-tailed)[a]
		Male (N = 154) Mean	Female (N = 150) Mean		
Public Facilities	Sculpture	3.62	3.20	5.006	0.000
	Food Cart	4.17	3.93	2.545	0.011
	Walkway	3.27	2.41	6.004	0.000
Buildings	High-rise Building	2.62	2.11	3.751	0.000
	Graffiti Building	3.03	2.71	1.998	0.047
	Historical Building	3.08	2.45	4.080	0.000
Nature	Greenery	3.34	2.55	5.125	0.000

[a]Sign indicates that the significant at $p \leq 0.05$.

TABLE 9 T-test results show differences in responses between marital statuses.

Category	Cultural elements	Marital status		t	Sig. (2-tailed)[a]
		Single (N = 184) Mean	Married (N = 120) Mean		
Public Facilities	Sculpture	3.32	3.56	−2.671	0.008
	Walkway	2.64	3.15	−3.344	0.001
Buildings	Religious Building	2.66	3.13	−2.853	0.005
Nature	Greenery	2.78	3.21	−2.638	0.009

[a]Sign indicates that the significant at $p \leq 0.05$.

TABLE 10 T-test results show differences in responses between living areas.

Category	Cultural elements	Living area		t	Sig. (2-tailed)[a]
		Urban area (N = 245) Mean	Rural area (N = 59) Mean		
Public Facilities	Food Cart	4.00	4.27	−2.284	0.023
	Walkway	2.73	3.32	−3.161	0.002
Buildings	High-rise Building	2.29	2.68	−2.224	0.027
	Historical Building	2.64	3.31	−3.347	0.001
Nature	Greenery	2.84	3.41	−2.843	0.005

[a]Sign indicates that the significant at $p \leq 0.05$.

TABLE 11 ANOVA test shows differences in responses between ethnicities.

Category	Cultural elements	Ethnicity				F	Sig[a]
		Malay N = 147 Mean	Chinese N = 123 Mean	Indian N = 10 Mean	Others N = 24 Mean		
Public Facilities	Sculpture	3.70	3.54	3.63	3.11	11.889	0.000
	Food Cart	4.34	3.73	4.20	3.83	14.074	0.000
	Walkway	3.46	2.03	3.10	3.13	35.725	0.000
Buildings	High-rise Building	2.63	1.98	2.40	2.71	7.425	0.000
	Graffiti Building	3.16	2.48	3.50	2.92	6.235	0.000
	Religious Building	3.54	2.20	1.50	2.38	31.824	0.000
	Historical Building	3.35	2.14	2.30	2.71	20.944	0.000
Nature	Greenery	3.63	2.13	3.10	2.96	34.560	0.000

[a]Sign indicates that the significant at $p \leq 0.05$.

TABLE 12 ANOVA test shows differences in responses between ages.

Category	Cultural elements	Age				F	Sig[a]
		20−29 N = 113 Mean	30−39 N = 136 Mean	40−49 N = 40 Mean	50−59 N = 15 Mean		
Public Facilities	Sculpture	3.19	3.51	3.63	3.73	6.200	0.000
	Food Cart	3.90	4.03	4.43	4.43	4.603	0.004
	Walkway	2.38	2.94	3.50	3.67	11.177	0.000
Buildings	High-rise Building	2.27	2.24	2.73	3.20	4.369	0.005
	Graffiti Building	2.55	2.93	3.07	3.40	3.784	0.011
	Religious Building	2.47	2.87	3.30	4.20	9.386	0.000
	Historical Building	2.50	2.74	3.25	3.93	7.057	0.000
Nature	Greenery	2.45	3.08	3.63	3.73	10.991	0.000

[a]Sign indicates that the significant at $p \leq 0.05$.

only a contextual landscape element but also a cultural element within the visible landscape. The inclusion of cultural greenery aims to heighten awareness that waterfronts are not isolated islands, emphasizing the interdependence of people and social structures with the landscape and associated ecological systems. This finding aligns with previous research (Mohammad et al.,

2013; Taylor, 2019), indicating that natural landscape elements can be integral to the visual preferences and aesthetics of cultural folklore in a specific area. Moreover, the historical character of the study area, represented by historical buildings with green areas, plays an important role in increasing respondents' preferences. This result aligns with the objectives of recent efforts to develop the "River of Life" area and create a vibrant historical river bank. This is attributed to the fact that historic waterfronts with green areas have been proven to hold the highest potential for meeting people's preferences compared to other waterfront typologies. This finding is supported by Keyvanfar et al. (2018), who assert that urban historic waterfronts with green areas not only serve to consolidate the identity of the city but also bring various benefits that help sustain the city as a whole.

On the other hand, it was found that certain elements, such as food carts, high-rise buildings, and water, are among the least preferred compared to other elements. However, these elements were scored based on their preferences and influenced by the cultural background of the Malaysian respondents. Food carts may be less favored on urban waterfront walkways for several reasons. One possible explanation is that urban waterfront spaces are not primarily designed for social activities, such as street food vending. This can lead to heavily trafficked streets that are unsafe and unattractive for pedestrians, resulting in a negative visual quality, as emphasized in the findings by Mundher et al. (2022c). Furthermore, the presence of high-rise buildings in urban waterfront spaces may disrupt the aesthetic quality of the landscape and disturb the order of the urban space. Additionally, physical features and visual factors significantly influence the preference for high-rise buildings, a result consistent with Khaleghimoghaddam (2023). Moreover, waterfront walkways in urban areas often lack water engagement due to various factors. One reason is that the current design of urban waterfront spaces primarily focuses on visual aesthetics on the walkway and overlooks the potential for active water engagement. Additionally, the impact of water quality on the visual preferences of waterfront walkways is evident. For example, Breen et al. (2017) found that waterfront developments along Sungai Danga have had negative impacts on society due to lower water quality.

This exploration of preferences for cultural elements underscores the critical need to integrate culturally responsive design into waterfront developments. Rooted in principles of social equity and place-making, this concept emphasizes designing inclusive spaces that resonate with the multifaceted communities they serve. By acknowledging these preferences, urban planners can create environments that foster heightened user satisfaction, increased engagement, and a strengthened sense of community belonging within the urban landscape (Li et al., 2024). Furthermore, the strong correlation between cultural background and visual preferences indicates that urban planners should prioritize culturally responsive design. Incorporating elements that reflect local cultural identities can create spaces that foster a sense of belonging and community. This approach aligns with the principles of place-making, emphasizing the creation of public spaces that reflect the unique character and culture of the communities they serve. By doing so, urban planners can promote social equity, ensuring

that diverse cultural groups feel represented and valued in the urban landscape.

4.2 Visual preference responses among respondents' demographics

Exploring how preferences vary across demographic groups—such as age, ethnicity, and residential background—provides valuable insights for creating user-centered design strategies. Investigating the differences in responses amongst various demographic groups yielded a set of differences in responses that are not easy to justify by the available literature. The results indicate that male respondents exhibited a stronger preference for the cultural elements in the waterfront context compared to female respondents. Similarly, a study conducted in China revealed that men check in more frequently at waterfronts and have more preferences compared to women (Wu et al., 2019). This finding suggests that gender differences play a role in shaping preferences for cultural elements in waterfront contexts. Additionally, the results indicate married respondents showed a stronger preference for cultural elements in the waterfront context compared to single respondents. Married couples often share common interests and may have a mutual appreciation for cultural elements such as sculpture, religious buildings, or walkways with greenery in waterfront areas, viewing them as ideal places for family outings or educational experiences; these results are consistent with Sowa-Behtane (2020). Furthermore, respondents living in rural areas showed a stronger preference for cultural elements in the waterfront context compared to respondents living in urban areas. This could be attributed to several factors. Firstly, rural areas often have a stronger connection to traditional cultural practices and values, which may influence their preference for cultural elements in their surroundings (Wang et al., 2020). Additionally, rural areas may have a slower pace of life and a closer-knit community, leading to a greater appreciation for cultural elements that foster a sense of identity and belonging (Getzner, 2020). Overall, the rural-urban divide in preferences for cultural elements in the waterfront context can be attributed to differences in cultural heritage and community dynamics.

The results indicate that ethnicity can play an important role in shaping respondents' visual preferences, as well as their scenic associations with their cultural back-grounds. Malay respondents exhibited a stronger preference for cultural elements in the waterfront context compared to Chinese, Indian, and other respondents, likely due to their higher level of attachment to the place and their psychological understanding of the local culture. Malay respondents showed a stronger preference for cultural elements, including sculpture, food carts, walkways, graffiti buildings, religious buildings, historical buildings, and greenery, indicating a high quality and positive view of the place. These results differ from those from Rosehan et al. (2020), who suggested that Malay respondents had a weaker attachment to certain physical elements like walkways, buildings, and greenery due to accessibility issues and a negative view of the place. However, foreign respondents exhibited a higher preference for high-rise buildings in the waterfront context compared to the three ethnicities comprising the Malaysian population. This finding

aligns with the study by Suratman et al. (2019), suggesting that foreign respondents perceive high-rise buildings as having a higher preference and contributing to a vibrant and diverse community.

Similarly, the results indicated a significant difference in respondents' responses based on their age groups. The findings suggest that the older generation exhibited a higher preference for cultural elements in the waterfront context compared to respondents from other generations. It was also observed that all elements showed a positive correlation between age and respondents' cultural backgrounds; the older the respondents, the greater their preference for cultural elements. The older generation may have a stronger connection to and appreciation for culture and heritage, which makes them more inclined towards cultural elements in the waterfront context. The presence of cultural elements in the waterfront design can enhance the authenticity and identity of the community, which is particularly important for the older generation, who may have a deeper sense of attachment to their cultural heritage. This finding is consistent with the conclusions of Gong et al. (2019) regarding the significance of old age as a factor shaping people's cultural interaction with urban waterfronts. This aligns with theories of environmental psychology, which recognize the importance of familiarity and connection to place for wellbeing in older adults.

It should be noted that the results also revealed agreement among respondents' demographics regarding the high preference for food carts as a cultural element in urban waterfront areas in Malaysia. This finding is consistent with a study by Hilaluddin et al. (2018), which highlighted the aesthetic values and cultural involvement of various ethnic groups in the preference for food carts as a cultural element in Malaysia. Additionally, the results did not show any statistically significant differences among respondents' demographics regarding the water element. However, the water element was not highly preferred, even though it is an essential element of a scene. These results differ from the study of Mundher et al. (2023b), where Malaysians expressed a high preference for the element of water as a high visual aesthetics preference element. By addressing these diverse preferences, waterfront development can be strategically leveraged as a powerful tool for promoting social cohesion and fostering a robust sense of place for all residents.

5 Limitations and future studies

Despite the findings of this research, it is not without limitations. Firstly, this study focuses on river waterfronts in highly urbanized areas; investigating river waterfronts in semi-urban and rural areas may reveal a different set of visual preferences. Secondly, the scope of this study is limited to examining the elements and their impact based on the cultural background of Malaysian respondents. Therefore, the study is confined to Malaysia, and while similar results may be anticipated in other countries, it is necessary to replicate this study in those regions for confirmation. Thirdly, some of this study's findings were not easy to justify by the available literature at the time of writing this manuscript, such as the differences in preferences amongst several demographic sections based on cultural elements. Lastly, photo surveys are a popular human-environmental interaction investigation technique, and this technique is also limited to the respondents reacting to still images of

the site; hence, future initiatives that employ volunteers to conduct on-site trips could provide a richer behavioral understanding of subjects' preferences.

6 Conclusion

The development of urban waterfront walkways is prominent in bringing societal benefits that contribute to the overall sustainability of the city. It aimed at addressing the challenges arising from the design and construction of new waterfront developments while considering cultural elements and societal visual preferences. Therefore, this study underscores the significance of cultural elements and visual preferences in the development of urban waterfront walkways in Malaysia. The study reveals that respondents generally find waterfront scenes visually pleasing, indicating a positive overall perceived scenic visual quality. This research suggests that greenery emerges as a key element in eliciting positive responses. Furthermore, greenery serves not only as a contextual element but also as a cultural signifier within the visual landscape, aligning with the concept of natural landscape elements as part of the visual aesthetic folklore of an area. Additionally, historical elements, such as historical building landmarks, play a pivotal role in enhancing visual preferences, aligning with ongoing efforts to create vibrant historic riverbanks. Historic waterfronts with green areas are deemed most preferred, consistent with scholarly assertions about their benefits for city sustainability and identity consolidation. Overall, the strong correlation between respondents' cultural backgrounds and their visual preferences highlights the importance of considering cultural elements in shaping visual preferences and enhancing urban waterfronts' appeal. Ultimately, this study emphasizes that for urban waterfront spaces to thrive and be designed sustainably, they must harmonize with the cultural elements and visual preferences of the community, offering valuable insights to urban planners and designers in their pursuit of creating culturally resonant and aesthetically pleasing waterfront environments.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Department of Landscape Architecture, Faculty of Design and Architecture, Universiti Putra Malaysia, Malaysia. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin because Institutional Review Board Feedback: Following a thorough review by the Institutional Review Board, the research design and plan of this study have been deemed scientifically reasonable, fair, and impartial. The IRB

has confirmed that the research will not cause harm or undue risk to participants. The recruitment process is based on principles of voluntary and informed consent, and adequate measures are in place to protect the rights and privacy of participants. Furthermore, the IRB has ascertained that there is no conflict of interest or violation of ethical and legal standards within this project. The board agrees that the work on this project should proceed as planned. Written informed consent was not obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article because Informed Consent of Participants: Participants voluntarily click on a link to access the online questionnaire. Before filling out the questionnaire, participants were provided information about the research purpose, procedures, and potential risks. By voluntarily continuing with the questionnaire, participants are considered to have given informed consent. Importantly, participants retain the right to exit the questionnaire at any point without consequence.

Author contributions

TL: Conceptualization, Data curation, Investigation, Project administration, Visualization, Writing–original draft. MM: Conceptualization, Investigation, Supervision, Validation, Writing–review and editing. AM: Data curation, Investigation, Resources, Writing–original draft. RM: Data curation, Formal Analysis, Methodology, Software, Writing–original draft. NI: Supervision, Validation, Writing–review and editing.

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Supplementary material

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