



URBAN VISUAL INDEX (UVI) BASED ON PUBLIC PREFERENCES FOR EVALUATING THE VISUAL-SPATIAL COMFORT OF KAYUTANGAN, INDONESIA

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Abstract

Kayutangan is a strategic area that will undergo long-term development to increase its attractiveness as a cultural tourism area. Therefore, the government revitalizes the area by redesigning the pedestrian area to improve the quality of public space. However, after the renovation was finished, problems emerged that affected the Kayutangan road corridor's (KRC) visual and spatial comfort, affecting the visitor's impression of the historic area. Therefore, we investigate the Urban Visual Index (UVI) based on public preferences to evaluate the visual-spatial comfort of Kayutangan as a historic urban area. This study used a quantitative descriptive method with multiple linear regression analysis techniques using SPSS. The data are gathered using an online questionnaire. The results show that each zone has different index scores. Each zone has different building and pedestrian street elements that influence the historical impression of the area, depending on the zone's characteristics. However, some spots in each zone lack historical impression due to the failure of the area's authentic image preservation and poor street furniture layout design. As a result, the design and layout of street furniture and preserving the authenticity of the Dutch colonial building design are crucial considerations when designing pedestrian spaces in a historic area to maintain its visual-spatial comfort.

Keywords: Historical impression; Public preference; Streetscape; Visual-spatial comfort; Regression analysis

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INTRODUCTION

Malang City is one of the cities established in 1914 and designed by Dutch urban architect Thomas Karsten (Widodo, 2006). Some colonial heritage urban areas still exist today, including the Kayutangan area. This area has been the main commercial street of Malang City since the beginning of the city's development during the colonial era. Based on the Regional Spatial Plan (RTRW) of Malang City, Kayutangan has been designated as a socio-cultural strategic area and will undergo long-term development to increase its attractiveness as a cultural tourism area. Historic areas have a heritage identity associated with them. The historical value and character are significant if an area is legally designated as historic (Purwantiasning, 2021). Historic areas can develop adaptively if the socio-cultural elements as the main drivers are alive (Pintossi et al., 2023). Historic areas, now popular for heritage tourism, allow tourists to immerse themselves in diverse cultural settings, performances, local food, handicrafts, and activities that reflect present and past cultures (Chhabra et al., 2003).

As one of the strategic areas in the city, this area is at risk of causing unforeseen problems, both visible (visual) and structural (functional) problems, such as problems with the pedestrian space. The Malang City Government revitalized Kayutangan in 2019 to make this area the heritage capital of Malang City. One of the goals is to improve the quality of pedestrian space as a public space on the road corridor and preserve the remaining historical value. According to Antariksa et al. (2024), the development of this historic road corridor has contributed to three Sustainable Development Goals (SDGs), namely Goal 3 (Good Health and Well-Being), Goal 8 (Decent Work and Economic Growth) and Goal 11 (Sustainable Cities and Communities).

Kayutangan, as a developing historic area, is susceptible to changes. The pedestrian space must be designed to consider user comfort, both visually and spatially. These issues can significantly influence the area's perceived image based on the public's preference (Ernawati et al., 2018). The government's late revitalization efforts have resulted in the loss of historical value at several points in this street corridor. The urban design of the Kayutangan road corridor (KRC) is inconsistent, with differences in street furniture design in several segments of this road corridor. In addition, the placement of street furniture that is too close together takes up pedestrian space, making the space for walking narrow, especially when the corridor is crowded.

Several studies have been conducted about urban comfort. The most common research conducted is outdoor thermal comfort in urban spaces, be it parks or street corridors. In addition to thermal comfort, visual and spatial comfort have been studied in previous studies. Research on visual and spatial comfort can help manage and improve urban streetscape through 3D spatial multimedia systems and urban planning (Santosa et al., 2021; Santosa & Fauziah,

2019). Visual comfort is one of the important visual phenomena in the design of transit-oriented development (Achsani & Wonorahardjo, 2020). Exploring the relationship between urban green space and human perception can be related to visual comfort (Meng et al., 2024; Sun et al., 2023). Meanwhile, spatial comfort can be measured using street-view images (Yang et al., 2021).

However, few studies on visual-spatial comfort focus on pedestrian space-creating elements in historic street corridors. Therefore, this paper seeks to fill this research gap by investigating and developing the visual-spatial comfort of pedestrian placemaking elements through an Urban Visual Index (UVI) based on public perception. This research introduces the UVI, an innovative tool to measure urban visual aesthetics systematically. By combining street view images and quantitative spatial analysis, the UVI offers a new perspective on the relationship between urban design and people's impressions. This contribution enriches the science of urbanism and supports urban policies more responsive to visual aspects.

LITERATURE REVIEW

Preference can be described as an individual's perception of the environment. Preferences are formed through a series of processes in the sensory perception of visual information (Widyawati, 2021). The physical characteristics of the environment, the quality of urban design, and people's reactions can determine the public's preferences when walking along a street corridor (Ernawati et al., 2018). From an architectural perspective, visual preferences involve judgments about the visual appearance of building elements. The factors that can influence visual memory capture are shape, form, color, and texture.

Visual and spatial comfort can affect people's impression and experience of a road corridor by the street furniture and the surrounding buildings. Spatial comfort is affected by road obstruction, spaciousness, vegetation, sky view, and openness (Yang et al., 2021). It can also be affected by building mass, pedestrian shading, space utilization, space functionality, street network complexity, and the liveliness of the street (Li et al., 2023; Marisa & Fuad, 2023). Natural elements, landscape diversity, openness, neighborhood density, and cleanliness can affect the urban landscape's visual comfort (Achsani & Wonorahardjo, 2020; Meng et al., 2024). In summary, visual and spatial comfort can be determined by the physical elements of the street, such as the building, vegetation, and openness, to support clear visibility and user activity in the corridor throughout the day.

Urban Visual Index (UVI) is a concept for evaluating and analyzing visual elements in urban environments. The UVI concept refers to several theories that cite books related to urban and psychology, such as *The Image of the City* by Kevin Lynch (1960), *Environmental Psychology* by Robert Gifford

(2013), *The Theory of Aesthetics and Spatial Quality from Cities for People* by Jan Gehl (2010), *Theory of Experience and Emotion in Urban Design* from A Pattern Language by Christopher Alexander (1977), *Social Theory and Urban Identity from Social Justice and the City* by David Harvey (1973). The basic concept of the UVI combines various theories from urban planning, environmental psychology, aesthetics, and technology.

In discussing the development of a framework for assessing the historical significance of the Kayutangan historical corridor, the UVI plays an important role in improving the visual and aesthetic character of the urban environment, including the historic corridor. In the context of the Kayutangan historical corridor, the UVI can be used to authenticate and ensure consistency in the architectural and street design elements, determine the extent to which the corridor maintains its historical character, and assess the overall visual-spatial quality of the surrounding environment from the public's preferences as the primary user of the urban space.

RESEARCH METHODOLOGY

The research method used a descriptive quantitative approach. There are several historic road corridors in Malang City; one of them is the KRC, Jl. Basuki Rachmat, Malang City, East Java (see Fig. 2). This road corridor was chosen because this area has undergone massive changes since the renovation and is crowded with visitors compared to other historic road corridors in the city. However, the urban design of the pedestrian area differs between each corridor segment (see Fig. 1). This difference is the main reason for the area's division into three zones. The condition of Zone 1 is not as crowded as the other zones, and the design processing is not as good as that of Zones 2 and 3, making this zone quieter than the other zones. Zone 2 is the busiest of the three research zones. In addition, the design processing in this zone was done more optimally than in Zone 1. Similar to Zone 2, the design processing in Zone 3 is also maximized compared to Zone 1, even though the activities in this zone are not as much as in Zone 2.

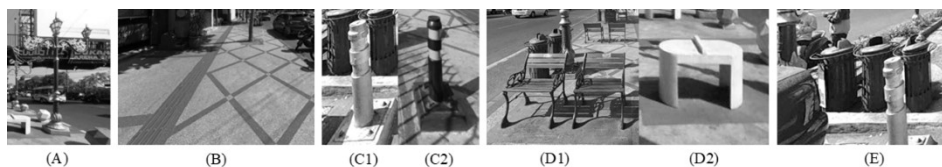


Figure 1: Streetscape elements; (A) Lamp; (B) Pathwalk pattern design; (C1) Bollard design in Zones 1 and 2; (C2) Bollard design in Zone 3; (D1) Chair design in Zone 1 and 2; (D2) Chair design in Zone 3; (E) Trash bin.

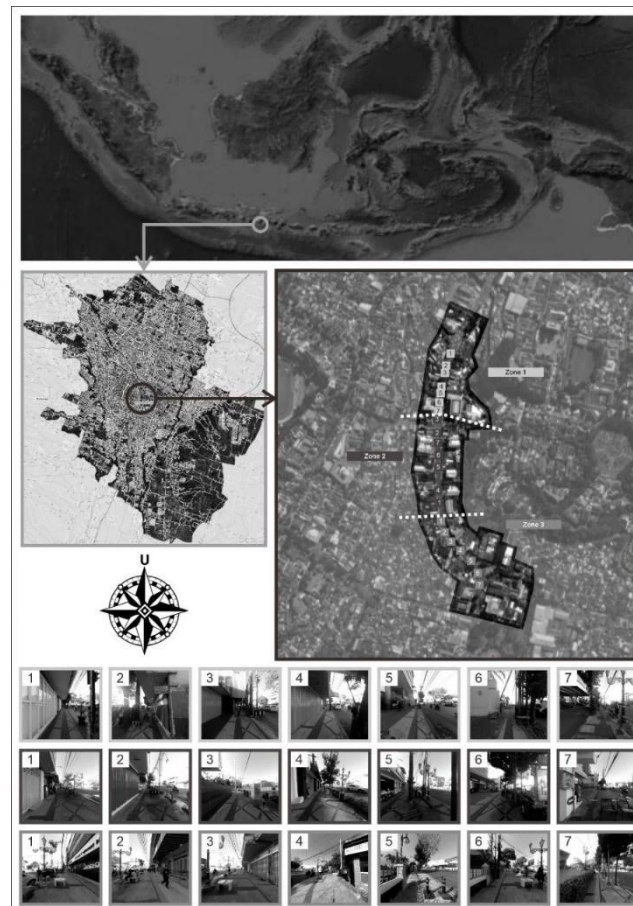


Figure 2: Research location

The sampling method employed was non-probability sampling. The number of samples taken was withdrawn based on the population. However, if the population is uncertain, then a technique or formula from Malhotra (2019) states that the number of samples must be at least four or five times the number of question items. In this study, 16 questions about the variables are to be analyzed. If multiplied by four, the minimum number of samples in this study is 64, to which a 5% margin of error is added so that it is rounded up to 70 samples.

This study's total number of samples was 254 individuals across the three research zones: 80 respondents in Zone 1, 98 in Zone 2, and 76 in Zone 3. The research variables comprised five streetscape elements and three elements of building visual composition within the area (see Table 1). Data were collected

using a questionnaire distributed online via Google Forms. The acquired data were analyzed using the multiple linear regression method.

Table 1: Research variables

No.	Variables	Sub Variables
1.	Streetscape elements	Lamp Design
		Pathwalk Pattern Design
		Bollard Design
		Chair Design and Layout
		Trashbin Design and Layout
2.	Building composition of the area	Building Colour
		Building Material
		Building Signage

Before entering the linear regression stage to analyze the data that has been collected, a prerequisite test of the questionnaire must be carried out. The questionnaire prerequisite test has two tests, namely the reliability test and the validity test. The reliability test is carried out to determine the level of consistency of the answers submitted. Reliability means that the characteristics of the measurement process or instrument itself do not cause the numerical results produced by an indicator to vary (Neuman, 2014). Validity is how well an empirical indicator "fits" the conceptual definition of the construct it is intended to measure (Neuman, 2014). Testing the validity of question items is done by correlating the score of each item with the total score of all question items.

RESULTS

The multiple linear regression tests are done using the Enter method. The results of the reliability statistical analysis stated that the data collected through the questionnaire for Zone 1 and Zone 2 of the KRC had a high level of reliability ($\alpha > 0.80$), and Zone 3 had a very high level of reliability ($\alpha > 0.90$). The independent and dependent variables in each zone were confirmed valid using Pearson Correlation based on the validity results. Each zone has a normal data distribution based on the Kolmogorov-Smirnov Test ($p > 0.050$). Therefore, the data can be continued for further analysis. The regression analysis reveals that each zone along the KRC demonstrated unique characteristics. Specific to each zone, these characteristics play a pivotal role in shaping the pedestrian environment. The prevalence of these zone-specific elements within the corridor, whether visual elements of buildings or street furniture, significantly influences the strength of the historical impression associated with these zones.

Table 2: Summary of Regression Analysis of Pedestrian Street Elements in Each Zone

Variable	Coefficients ^a								
	Zone 1			Zone 2			Zone 3		
	B	t	Sig.	B	t	Sig.	B	t	Sig.
(Constant)	0.218	0.568	0.572	0.558	1.623	0.108	0.447	0.882	0.381
Lamp Design	0.149	1.906	0.061	0.107	1.913	0.059	0.354*	3.234*	0.002*
Pathwalk Pattern Design	0.108	1.226	0.224	0.076	1.355	0.179	-0.143	-1.135	0.260
Bollard Design	-0.004	-0.063	0.950	0.113	1.889	0.062	0.352*	3.693*	0.000*
Chair Design and Layout	0.054	0.659	0.512	0.251*	3.916*	0.000*	-0.062	-0.694	0.490
Trashbin Design and Layout	0.152	1.910	0.060	0.007	0.114	0.909	0.130	1.779	0.080
Building Colour	0.203*	2.471*	0.016*	0.097	1.354	0.179	-0.018	-0.158	0.875
Building Material	0.052	0.638	0.525	0.069	0.941	0.349	0.299*	2.596*	0.012*
Building Signage	0.221*	3.273*	0.002*	0.180*	3.228*	0.002*	-0.010	-0.107	0.915

a. Dependent Variable: Overall elements score
*) Variable with significant positive relationship, B and t value is positive, $p < 0.05$

Zone 1

The pedestrian space elements in Zone 1 can explain 59.3% of the historical impression along Zone 1 ($F(8,71) = 12.929, p < .001, R^2 = .593$). The pedestrian space forming elements that have a partial effect on the suitability of the historical impression along Zone 1 are Building Color ($b = .203, t = 2.471, p = .016$) and Building Signage ($b = .221, t = 3.273, p = .002$) (see Table 2). Based on the results of the t-test, a regression model can be formulated based on the eligible independent variables, resulting the UVI of Zone 1:

$$Y_1 = 0.218 + 0.203.B\text{uilding Colour} + 0.221.B\text{uilding Signage}$$

Regression was also applied to 7 photo spots within Zone 1, where each pedestrian space element was analyzed against 7 spots in this zone. The results reveal that the pedestrian space elements influence the historical impression of the spots in Zone 1 ($p < 0.050$). However, the elements in spot 7 do not affect the historical impression of this spot ($p > 0.050$).

The historical impression of the spots in this zone is mostly influenced by Building Signage (5 spots) and Pathwalk Pattern Design (4 spots). However, in spots 6 and 7, no elements affect the historical impression of the area because the area has modern buildings, causing the impression to be lost (see Table 4).

Table 3: Summary of Regression Analysis of Pedestrian Street Elements in Zone 1

Coefficients ^a										
Spot	(Constant)	Lamp Design	Pathwalk Pattern Design	Bollard Design	Chair Design and Layout	Trashbin Design and Layout	Building Colour	Building Material	Building Signage	
1	B	2.070	-0.249*	0.300*	-0.067	-0.130	0.378*	0.082	-0.047	0.216*
	t	4.142	-2.439*	2.623*	-0.765	-1.206	3.656*	0.768	-0.438	2.455*
	Sig.	0.000	0.017*	0.011*	0.447	0.232	0.000*	0.445	0.663	0.017*
2	B	0.427	-0.134	0.348*	-0.134	0.158	-0.132	0.083	0.314*	0.257*
	t	0.881	-1.354	3.148*	-1.575	1.521	-1.313	0.804	3.021*	3.015*
	Sig.	0.381	0.180	0.002*	0.120	0.133	0.194	0.424	0.004*	0.004*
3	B	0.427	-0.134	0.348*	-0.134	0.158	-0.132	0.083	0.314*	0.257*
	t	0.881	-1.354	3.148*	-1.575	1.521	-1.313	0.804	3.021*	3.015*
	Sig.	0.381	0.180	0.002*	0.120	0.133	0.194	0.424	0.004*	0.004*
4	B	1.286	-0.158	0.282*	-0.029	-0.139	0.243*	0.207	-0.061	0.243*
	t	2.389	-1.436	2.295*	-0.308	-1.198	2.183*	1.791	-0.528	2.566*
	Sig.	0.020	0.155	0.025*	0.759	0.235	0.032*	0.078	0.599	0.012*
5	B	1.156	-0.122	0.254	-0.014	0.092	0.162	0.151	-0.146	0.218*
	t	1.917	-0.992	1.842	-0.133	0.711	1.295	1.170	-1.133	2.050*
	Sig.	0.059	0.325	0.070	0.895	0.479	0.199	0.246	0.261	0.044*
6	B	1.435	-0.125	0.260	0.110	-0.161	0.167	-0.036	0.165	0.127
	t	2.452	-1.046	1.945	1.065	-1.280	1.376	-0.288	1.315	1.232
	Sig.	0.017	0.299	0.056	0.291	0.205	0.173	0.774	0.193	0.222
7	B	2.285	0.027	0.210	0.084	0.258	-0.151	0.004	-0.092	0.032
	t	3.629	0.207	1.459	0.755	1.909	-1.162	0.028	-0.68	0.288
	Sig.	0.001	0.837	0.149	0.453	0.060	0.249	0.978	0.499	0.774

a. Dependent Variable: Overall elements score

*) Variable with significant positive relationship, B and t value is positive, $p < 0.05$

**) Variable with significant negative relationship, B and t value is negative, $p < 0.05$

Zone 2

The pedestrian space elements in Zone 2 can explain 57.3% of the historical impression along Zone 2 ($F(8,89) = 14.912, p = < .001, R^2 = .573$). The pedestrian space forming elements that have a partial influence on the suitability of the historical impression along Zone 2 are Chair Design and Layout ($b = .251, t = 3.916, p = < .001$) and Building Signage ($b = .180, t = 3.228, p = .002$) (see Table 2). Based on the results of the t-test, a regression model can be formulated based on the eligible independent variables, resulting in the UVI of Zone 2:

$$Y_2 = 0.558 + 0.251. \text{Chair Design and Layout} + 0.180. \text{Building Signage}$$

Regression was also applied to 7 photo spots within Zone 2, where each pedestrian space element was analyzed against 7 spots in this zone. The results reveal that the historical impression of all spots in Zone 2 is influenced by pedestrian space elements ($p < 0.050$).

Table 4: Summary of Regression Analysis of Pedestrian Street Elements in Zone 2

Coefficients ^a									
Spot	(Constant)	Lamp Design	Pathwalk Pattern Design	Bollard Design	Chair Design and Layout	Trashbin Design and Layout	Building Colour	Building Material	Building Signage
1	B	0.401	0.254*	0.134	0.134	0.112	-0.126	0.030	0.279*
	t	0.859	3.352*	1.752	1.637	1.289	-1.536	0.312	3.677*
	Sig.	0.393	0.001*	0.083	0.105	0.201	0.128	0.756	0.000*
2	B	0.919	0.196	0.175	0.136	0.197	-0.007	0.180	-0.044
	t	1.371	1.799	1.604	1.158	1.582	-0.056	1.289	-0.402
	Sig.	0.174	0.075	0.112	0.250	0.117	0.955	0.201	0.689
3	B	0.875	0.088	0.316*	0.128	0.022	-0.131	0.113	-0.135
	t	1.236	0.764	2.740*	1.034	0.167	-1.047	0.770	-0.899
	Sig.	0.220	0.447	0.007*	0.304	0.868	0.298	0.444	0.010*
4	B	1.462	0.317*	0.143	-0.080	0.305*	-0.089	0.045	-0.040
	t	2.823	3.767*	1.692	-0.887	3.167*	-0.980	0.419	-0.366
	Sig.	0.006	0.000*	0.094	0.377	0.002*	0.330	0.677	0.715
5	B	1.366	0.375*	0.192*	-0.157	0.253*	-	-0.126	0.153
	t	2.694	4.555*	2.321*	-1.772	2.684*	-	-1.195	1.420
	Sig.	0.008	0.000*	0.023*	0.080	0.009*	0.010*	0.235	0.159
6	B	1.844	0.062	0.091	-0.072	0.229	-0.133	0.064	0.294
	t	2.623	0.546	0.795	-0.583	1.754	-1.073	0.436	1.971
	Sig.	0.010	0.586	0.429	0.561	0.083	0.286	0.664	0.052
7	B	0.180	0.056	0.030	0.166	0.306*	-0.102	0.021	0.241
	t	0.298	0.572	0.306	1.568	2.720*	-0.954	0.169	1.886
	Sig.	0.766	0.569	0.760	0.120	0.008*	0.343	0.866	0.063

a. Dependent Variable: Overall elements score

*) Variable with significant positive relationship, B and t value is positive, $p < 0.05$

**) Variable with significant negative relationship, B and t value is negative, $p < 0.05$

Significant pedestrian space elements inside the spots in Zone 2 are dominated by Building Signage (4 spots), Chair Design and Layout (3 spots), and Lamp Design (3 spots). Spots 2 and 6 do not have any elements that affect the historical impression of the area because they are an area with modern buildings, which causes the loss of historical impression of the spots (see Table 4).

Zone 3

Pedestrian space elements in Zone 3 can explain 57.9% of the historical impression along Zone 3 ($F(8,67) = 11.518, p < .001, R^2 = .579$). The pedestrian space forming elements that have a partial effect on the suitability of the historical impression along Zone 3 are Lamp Design ($b = .354, t = 3.234, p = .002$), Bollard Design ($b = .352, t = 3.693, p < .001$), and Building Material ($b = .299, t = 2.596, p = .012$) (see Table 2). A regression model can be formulated based on the eligible independent variables, resulting in the UVI of Zone 3:

$$Y_3 = 0.447 + 0.354.Lamp\ Design + 0.352.Bollard\ Design + 0.299.Building\ Material$$

Regression was also applied to 7 photo spots within Zone 3, where each pedestrian space element was analyzed against 7 spots in this zone. The results reveal that the historical impression of all spots in Zone 3 is influenced by pedestrian space elements ($p < 0.050$).

Table 5: Summary of Regression Analysis of Pedestrian Street Elements in Zone 3

Coefficients ^a									
Spot	(Constant)	Lamp Design	Pathwalk Pattern Design	Bollard Design	Chair Design and Layout	Trashbin Design and Layout	Building Colour	Building Material	Building Signage
1	B	0.961	0.280*	0.215	0.053	0.130	0.051	-0.145	0.071
	t	1.932	2.609*	1.735	0.571	1.489	0.707	-1.274	0.755
	Sig.	0.058	0.011*	0.087	0.570	0.141	0.482	0.207	0.453
2	B	1.038	0.517*	-0.196	0.248*	0.104	-0.020	0.032	-0.003
	t	1.919	4.429*	-1.453	2.436*	1.089	-0.257	0.261	-0.025
	Sig.	0.059	0.000*	0.151	0.018*	0.280	0.798	0.795	0.980
3	B	0.053	0.357*	0.417*	-0.092	-0.099	0.160	0.017	0.221
	t	0.093	2.877*	2.905*	-0.854	-0.979	1.929	0.126	1.691
	Sig.	0.926	0.005*	0.005*	0.396	0.331	0.058	0.900	0.095
4	B	1.402	-0.058	0.408*	-0.007	-0.130	0.208*	-0.123	0.125
	t	2.489	-0.474	2.904*	-0.065	-1.309	2.570*	-0.954	0.975
	Sig.	0.015	0.637	0.005*	0.948	0.195	0.012*	0.344	0.333
5	B	1.16	0.286	0.043	0.290*	-0.086	0.155	-0.065	-0.045
	t	1.705	1.947	0.253	2.267*	-0.722	1.585	-0.417	-0.29
	Sig.	0.093	0.056	0.801	0.027*	0.473	0.118	0.678	0.773
6	B	0.659	0.367*	0.174	0.055	0.003	0.045	0.018	0.139
	t	1.184	3.058*	1.253	0.523	0.029	0.558	0.144	1.100
	Sig.	0.241	0.003*	0.215	0.603	0.977	0.579	0.886	0.275
7	B	0.918	0.090	0.286	0.201	-0.064	0.183	-0.048	0.042
	t	1.395	0.631	1.742	1.620	-0.556	1.932	-0.320	0.281
	Sig.	0.168	0.530	0.086	0.110	0.580	0.058	0.750	0.779

a. Dependent Variable: Overall elements score

*) Variable with significant positive relationship, B and t value is positive, $p < 0.05$

**) Variable with significant negative relationship, B and t value is negative, $p < 0.05$

The pedestrian space elements that influence the strength of the historical impression in the spots in this zone are dominated by Lamp Design (5 spots). The same phenomenon is observed in Zones 1 and 2, namely spots that do not have elements that influence their historical strength (see Table 5).

DISCUSSION

This study highlights that the configuration of pedestrian space elements exerts a significant influence on the historical impression of the KRC across its three distinct zones. The analysis reveals that in Zone 1, the historical impression is predominantly shaped by building color and signage, with the building façade functioning as a critical determinant of visual quality. Although recent revitalization initiatives have altered certain façade colors, color continues to act as a central factor influencing the perception of the pedestrian environment in historic urban spaces (Kurniawan et al., 2017). In Zone 2, the historical character is primarily defined by chair design and layout in conjunction with building signage. The vintage style of the chairs and their strategic spatial distribution contribute not only to the visual identity of this zone but also enhance functional comfort for visitors, providing rest areas and serving as popular photo spots (Marisa & Fuad, 2023). The concentration of commercial activities in this zone results in a greater number of building signages compared to Zones 1 and 3. Importantly, the placement of signage attached to building façades ensures that pedestrian visual corridors remain unobstructed, thereby reinforcing both spatial and visual comfort (Ach sani & Wonorahardjo, 2020; Meng et al., 2024; Yang et al., 2021). In contrast, the distinctive historical impression of Zone 3 emerges from lamp design, bollard design, and building materials. The broader pedestrian dimensions in this zone allow for the installation of bollards that successfully restrict vehicular access without impeding pedestrian sightlines or movement. This arrangement contributes positively to spatial comfort while simultaneously protecting pedestrian safety (Marisa & Fuad, 2023; Meng et al., 2024; Yang et al., 2021). Furthermore, the substantial presence of Dutch colonial-style heritage buildings, alongside the visibility of their original materials, strengthens the authenticity of the historical impression in this area (Andrian et al., 2021).

To further substantiate these findings, the UVI was simulated for each zone, with the regression model incorporating the substitution of minimum values. The results are presented as follows:

$$\begin{aligned} \text{Zone 1} &= 0.218 + 0.203(1) + 0.221(1) = 0.642 \\ \text{Zone 2} &= 0.558 + 0.251(1) + 0.180(1) = 0.989 \\ \text{Zone 3} &= 0.447 + 0.354(1) + 0.352(1) + 0.299(1) = 1.452 \end{aligned}$$

The simulation outcomes demonstrate that Zone 3 achieves the highest UVI score (1.452), followed by Zone 2 (0.989), while Zone 1 records the lowest score (0.642). These disparities highlight the fragmented nature of urban design treatment along the KRC. Such inconsistency risks undermining the unified historical image of the area and may subsequently reduce its cultural significance (Andrian et al., 2021). Hence, the results underscore the necessity of harmonizing urban design interventions across all zones to achieve spatial unity and a coherent visual identity. More broadly, the findings of this research affirm that streetscape elements and building composition play a pivotal role in determining the visual-spatial comfort of historic urban landscapes (HUL). These tangible urban attributes reinforce cultural meanings and support the interpretation of place identity (Che Amat, 2018). Moreover, the preservation of architectural elements constitutes a vital strategy in maintaining the uniqueness and authenticity of HULs while accommodating urban development pressures (Harun et al., 2015). Strengthening historical character not only safeguards heritage values but also enhances placemaking processes, which in turn improve tourist experiences and contribute to the sustainable development of heritage-based tourism destinations (Ernawati et al., 2018; Marisa & Fuad, 2023; Xiang & Mohamad, 2023).

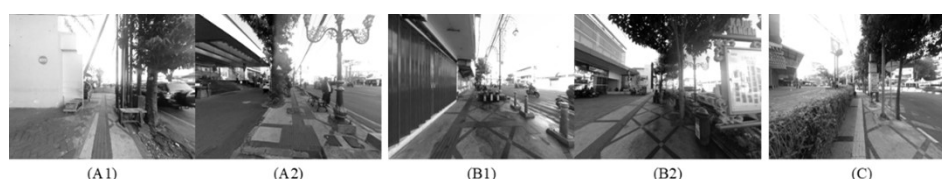


Figure 3: Spots that have no influencing streetscape elements and building composition; (A1) Spot 6 Zone 1; (A2) Spot 7 Zone 1; (B1) Spot 2 Zone 2; (B2) Spot 6 Zone 2; (C) Spot 7 Zone 3.

In each zone, there are some spots in which the pedestrian space elements do not significantly influence its historical impression strength (see Fig. 3). There are several factors that cause this phenomenon. The strength of the historical impression of the spot is not influenced by the pedestrian space elements when the building style is not a Dutch colonial style. This is in line with the results of previous studies, which stated that the urban heritage artifacts on every scene indisputably reveal the city's socio-cultural value (Phetsuriya & Heath, 2023). The loss of the Dutch colonial style's character in several spots has diminished the HUL's character as a historic street corridor. Another factor is the absence of points of interest on the spot. No impression can be influenced because it does not have attractive elements. The attractiveness of a streetscape can affect people's preferences for a HUL's imageability (Ernawati, 2020). This phenomenon can be found in all zones in the KRC.

The placement of street furniture and building elements that obstruct people's vision and movement can affect visual-spatial comfort along the HUL. A study by Santosa et al. (2023) revealed that the visibility of landmarks of HUL from the pedestrian lane can be affected negatively by the layout of street furniture design and the placements and density of the vegetation. When people's vision is obstructed, it can reduce their comfort while walking on the road (Yang et al., 2021). Lack of space for pedestrians due to obstruction by activities other than walking or wrong placement of street furniture can reduce the spatial comfort pedestrians feel (Marisa & Fuad, 2023; Meng et al., 2024).

CONCLUSION

The result of this study suggests that both streetscape elements and building composition can influence the strength of the historical impression of a HUL according to the public's preferences, in this case, the KRC. Each zone has a different UVI, depending on each zone's characteristics and points of interest. However, some spots lack historical impression due to modern building styles, absence of points of interest, or poor street furniture layout, which can hinder pedestrian movement and obscure landmarks. These findings emphasize the need for careful design and preservation to strengthen the character of the HUL. The historical impression will be more significant when the pedestrian's visual of the road is unobstructed. Additionally, the visual composition of intact Dutch colonial-style buildings contributes to the strength of the historic impression. Therefore, the design and layout of street furniture and the preservation of the authenticity of the Dutch colonial building design are crucial considerations when designing pedestrian spaces of a HUL.

To enhance the UVI, governments should adopt cohesive streetscape designs, integrate creative architectural and street furniture elements, and leverage emerging technologies such as AI and AR, supported by community engagement and clear design guidelines. This study faced several challenges, particularly in applying regression analysis techniques to accommodate diverse data outcomes, as well as the limited scope of data collection within a single heritage area. Given that UVI remains a relatively new theoretical framework, these findings should be viewed as an initial reference. Future research should expand by comparing street furniture design styles across multiple historic corridors and by incorporating diverse respondent categories—such as researchers, policymakers, and stakeholders—to provide more comprehensive insights into UVI development.

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DISCLOSURE STATEMENT

The authors declare that they have no conflicts of interest regarding the paper's publication. All co-authors have seen and agreed with the manuscript's contents, and the authors certify that the submitted work is original and not under consideration for publication elsewhere.

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