The Role of Complexity, Coherence, and Imageability on Visual Preference of Urban Street Scenes

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Abstract. This study meant to explore the role of several visual quality concepts, i.e., complexity, coherence, and imageability, on people's preference for street scenes in the urban area. The study chose three different street characteristics in the town of Malang-Indonesia as the case study sites that consist of commercial street, historic commercial street, and historic residential street. This research applied a field survey using a questionnaire with a five-point Likert scale and seven-point multiple rating scale techniques. There were 363 respondents participated in the survey. Data analysis employed descriptive statistics and simple regressions analysis to identify the influence of complexity, coherence, and imageability quality on urban street scenes' visual preference. Results indicated that coherence and imageability consistently play essential roles in people's preference for the three types of street scenes. Meanwhile, complexity quality only influences visual preference on a historic residential street and does not influence people's preferences on commercial streets.

1. Introduction

Cities are a complex system consisting of various people interacting in urban physical space (Boeing, [1]). In this case, knowing the appearance of a place in terms of environmental design is an issue that needs attention. Urban design must relate to people and their interactions with cities (Aslan & Atik, [2]). Various previous studies have examined the perceived quality of the environment, especially urban environments, to restore the relationship between humans and their environment (Kalin & Yilmaz [3]; Alpak et al. [4]). In this context, urban areas are subject to evaluation based on the community's perceptions of urban environmental characteristics (Alpak et al. [4]).

Much of the literature shows some visual quality studies to determine the environmental characteristics that influence the interaction level between humans and the environment. Visual quality pays attention to how people perceive the environment, which, in turn, values the environment (Val et al. [5]). There were various studies have been conducted to find out the factors that can increase visual preferences. Urban developments that do not pay attention to the environment's visual quality can decrease people's preference for an environment.

For many years, many researchers have researched the visual preferences of an environment (Alpak et al. [4]; Svobodova et al. [6]). Visual quality generates many theories, including the quality of urban design by Purcel & Marrone [7], Ewing & Handy [8], Ewing [9], Ewing & Clemente [10]. Nevertheless,
their studies focus on evaluating urban design's perceptual quality and have not linked it with visual preferences.

The literature review conducted by Alpak et al. [4]) revealed that studies of visual quality and preferences in urban areas had been developed based on Berlyne [11] concept about environmental components that include novelty, order, and complexity. Their review also found that the study of visual quality was also developed by the model of Information Processing Theory developed by Kaplan & Kaplan [12], which includes mystery, complexity, legibility, and coherence. Although many kinds of research examine the effect of the built environment on the community, it is usually limited to evaluating one or two concepts without linking each other (Boeing [1]; Cubukcu et al. [13]; Heath et al. [14]; Kalin and Yilmaz [3]). Describing the city area's visual quality with several concepts is expected to reveal more benefits in determining people's preferences.

Further literature in urban design shows various environmental perceptual qualities (Ewing & Handy [8]). The environmental design knowledge generates studies on visual preferences and visual assessment, such as architecture and urban design (Ewing [9]). Previous research found eight perceptual qualities of urban design: (1) imageability, (2) enclosure, (3) human scale, (4) transparency, (5) linkage, (6) complexity, (7) coherence, and (8) legibility (Ewing [9]; Ewing & Handy [8]). Literature studies revealed the critical role of complexity, coherence, and imageability in urban space's visual display among the eight urban design qualities. However, research on the quality of urban design, particularly complexity, coherence, and imageability in Indonesia is still very limited in number. Moreover, seeing these qualities' effect on visual preferences in urban areas is still very rarely studied. Therefore this research is intended to fill in the gap.

According to Stamps [15], complexity is how much the view of an environment contains different elements. This study employed this simple definition of complexity. In essence, complexity refers to the diversity of the area's visual structure and the difference in each place's component. In this study, complexity is considered to have a high value if objects in the environment reflect high variation and diversity (Boeing [1]).

According to Rapoport [16], complexity refers to the degree of diversity in a place that observers can see clearly. This situation refers to a place's visual wealth (Ernawati et al. [17]). Theoretically, pedestrians who are users require a higher level of complexity to be interested in activities in an urban area (Ernawati et al. [18]). However, the preference for complexity varies from person to person, and it may even be different from one culture to another. Stamps [15] illustrates that complexity is how much a view in a city environment contains many elements of different types. However, too little environmental information obtained causes sensory deprivation, while too much information received, which refers to too high complexity, can cause sensory overload (Ewing & Handy [8]).

Complexity in this research is examined perceptually. It is assumed that the community can intuitively feel the complexity of a place, the object of study, by observing the place or doing activities in the place. Although measurement of complexity principally can be approached by various methods, such as temporal, spatial, and visual dimensions, this study is limited to measuring visual dimensions only.

The second concept of urban design qualities in this study is coherence. Coherence quality assessment, which is based on human perceptions, depends on the scale of the environment. For the neighborhood environment and street corridors in urban design, the quality of coherence is related to the height of the building or height of the building elements (Boeing [1]), the unity of building style, and building facade. Coherence refers to the visual order and unity of elements in an area or place (Ernawati et al. [18]). According to Jacobs [19], coherence can be achieved if buildings in the street can be united. They are different, but express mutual respect, both in terms of the building's height and appearance (Ernawati et al. [18]). This notion also refers to the unity of the street view. Coherence is how well a scene blends and how easy its organization to form a street view (Stamps [15]).

The third quality of urban design examined in this study is imageability. Imageability is the quality of an area that makes it easy to remember because it has a distinctive character and is different from other places or easily recognized (Ewing & Handy [8]; Ernawati et al. [18]). A place with a high value
in the quality of imageability has a particular physical element, which is easy to remember, both because of its shape, color, and location.

In this study, the three qualities of urban design, namely complexity, coherence, and imageability in three different street characters, i.e., commercial street, historic commercial street, and historic residential street, are evaluated by the community's perception. This study also examines visual preferences for urban street scenes. Because the perceptual quality and visual preference for urban street scenes are subjective, urban scene evaluation depends on the users (Ernawati & Moore [20]). However, previous research studies have not focused on the influence of the three concepts of urban design quality on urban street scenes' visual preference, especially in Indonesia. Therefore, this study means to fill in the gap.

2. Methods
This research uses a quantitative approach by applying a field survey method. The case study sites are in Malang, a historical city built during the Dutch colonial era. Main streets in Malang City, particularly in the downtown area, are commercial areas. However, there is a historic residential area in the main street known as one of the icons of Malang City, i.e., the Ijen Boulevard. Therefore, this study chose three streets in the city center with different characteristics as research samples, namely Agus Salim Street (characterized as a contemporary commercial street), Kayutangan Street (characterized as a historic commercial street), and Ijen Boulevard as an example of a historic residential street.

Figure 1. Commercial street: Agus Salim Street

Figure 2. The street scenes of Agus Salim Street
Figure 3. Historic commercial street: Kayutangan Street

Figure 4. The street scenes of Kayutangan Street

Figure 5. Historic residential street: Ijen Boulevard
2.1. Population and samples
The population in this study were all pedestrians in the three streets. Pedestrian on each road was chosen randomly. By following the survey techniques of Ernawati & Moore [20] and Ernawati et al. [17], the researcher visited all three streets at various random times. The researcher chose the five respondents that first met when conducting a site visit. Although random sampling is the most representative sampling technique representing the population, seven respondents in Agus Salim Street did not appropriately fill out the questionnaire so that the data could not be used. Three hundred and sixty-three respondents consisting of 103 respondents on Agus Salim Street, 110 respondents on Kayutangan Street, and 150 respondents on Ijen Boulevard participated in this study. Therefore data analyses use all data gathered from questionnaires consisting of 363 respondent data.

2.2. Instruments and Variables
This study measured four main variables: complexity, coherence, imageability, and visual preferences. Complexity, coherence, and imageability are three basic urban design perceptual qualities (Ewing & Clamente [10]; Purciel & Marrone [7]; Ernawati et al. [17]). This study employed a research instrument in the form of a questionnaire consisting of two parts. The first part is to record respondent characteristic data. The second part explores user perceptions of the quality of complexity, coherence, imageability, and user's visual preference for each street studied. Evaluations of the qualities of complexity, coherence, and imageability used a Likert scale consisting of five scales, ranging from "strongly disagree" (value '1') to "strongly agree" (value '5'). Whereas the visual preference for the view of the street on each place is measured using a multiple rating scale technique with seven scales, ranging from value '1' indicating the least preferred up to value '7', which shows the most preferred urban scenes.

Variables in this study elaborate in a simple way to eliminate any bias to the respondents. The research measured complexity, coherence, and imageability quality with a single item scale so that lay people easily understand it. Complexity is measured based on how much the street scenes contain many
different types, variation, and diversity elements (Stamps [15]; Boeing [1]; Rapoport [16]). Coherence is measured based on visual order and unity of elements in the street scene; they may be different but still unite in harmony (Ernawati [18]; Jacobs [19]; Boeing [1]; Stamps [15]). Meanwhile, imageability is measured based on the level of easiness to recognize and remember because of the street's visual character (Ewing & Handy [8]; Ernawati et al. [18]). What environmental features influence people's assessment of these visual qualities are not discussed in this study.

2.3. Data analysis
This study applies a descriptive statistic analysis based on mean score analysis to determine the quality of complexity, coherence, and imageability of the three case study sites. In finding out the influence of the three variables (namely complexity, coherence, and imageability) of each street on urban street scenes' visual preference, the data analysis performed a simple regression analysis. In the regression analysis, complexity, coherence, and imageability are treated as independent variables, while people's visual preference of urban street scenes as dependent variables. All of those data analyses used the SPSS software.

3. Results and discussions
The research participants on Agus Salim Street (as a commercial street) consist of 53% male and 47% female. Most of the respondents (around 83.8%) aged between 16 to 35 years old, and they mostly visitors of the place (around 86.6%), who visited the street one to three times a week. These characteristics show that most respondents, as users of Agus Salim Street, are relatively young people. The majority of respondents (62%) have been living in Malang for more than five years. This condition means the participants are quite familiar with the town.

Looking at the respondents on Kayutangan Street (as a historic commercial street), most participants (64.5%) are male, and 35.5% are female. The majority of respondents on that street (79.1%) aged between 16 to 35 years old. Respondents in this street, similar to them on Agus Salim Street, were mostly visitors of the place (91.6%) who come to the street for shopping or come to banks located in this street. They visited the place one to three times a week. Furthermore, around 87% of respondents have been living in Malang for more than five years. Same as the situation on Agus Salim Street, the participants on Kayutangan Street are familiar with the town's appearance.

On the Ijen Boulevard, the respondents consist of 49% male and 51% female. Most of the participants (96%) aged between 16 to 35 years old. All respondents were visitors to the place, not inhabitants of the street. The respondent mostly (91%) came to Ijen Boulevard just for refreshing and exercise. Although around 32% of the respondents live in Malang for more than five years while 68% of them live in Malang for less than five years, they already familiar with the place since Ijen Boulevard is used to be a car-free day street on every Sunday.

Results indicated people's preference for the visual quality of the street is mediocre on Agus Salim Street (M=4.13 out of seven scales) and slightly preferred on Kayutangan Street (M=4.65 out of seven scales) while relatively high on Ijen Boulevard (M=5.77 out of seven scales). These results relate to the visual characteristics of different street environments. This study's results indicate that people are not interested in the area's visual appearance in commercial streets. Their presence in the street is more determined by its function as a commercial area. Even though they do not find it captivating, they do not like the street's visual scenery, but they still come to the area to shop to meet their daily needs. While the case with the Ijen Boulevard area, although the area is a historic residential area, where they do not need to go to the area with a specific purpose such as shopping, the user community may come because they like the visual quality of the historic street.

The results show that coherence and imageability in the three streets significantly influence people's visual preferences for urban street scenes. Meanwhile, complexity does not affect the urban street scene's visual preferences on Agus Salim Street as a commercial street, and on Kayutangan Street as a historic commercial area. In the Ijen Boulevard area, complexity affects the people's visual preference of the urban street scenes. Table 1 - Table 7 show the influence of coherence, imageability, and complexity on
urban street scenes' visual preferences on the three case study streets presenting by ANOVA generated through regression analyses. These results show that the effect of coherence, imageability, and complexity on the street scenes' visual preferences by regression analysis is more appropriate than predicting based on average values only.

According to user perceptions, the quality of coherence on the Agus Salim Street is considered low (M=2.67 out of five scales). This result means that the Agus Salim Street view does not blend between one element and the other. It seems there is no any particular element in the area, so that the user community also rated the quality of the imageability of the place to be low (M=2.43). From the aspect of complexity, the community considers it neutral (M=3.23), which means that the community evaluates the street scenes' complexity as ordinary. These findings show that nothing specific can make users feel attracted to the street's visual quality. So it can be estimated that people visit the place not because they like the street appearance, but it is more likely because of the need to shop in the area, as a trade and service area.

The research findings presented in Table 1 show that coherence significantly influences community preferences for visual views on the Agus Salim Street (p < 0.01), as well as imageability (p < 0.05). In terms of complexity quality, the research found that complexity does not affect urban street scenes' visual preferences on Agus Salim Street. The regression analysis results shown in Table 2 found that if coherence is alone without other factors in determining visual preferences, then coherence exerts about 15.6% variations in visual preferences. This situation means there are still around 84.4% of other factors that affect visual preferences.

| Table 1. ANOVA* The Influence of coherence, imageability, and complexity on visual preference of urban street scenes on Agus Salim Street |
|-----------------------------------------------|
| Model | Sum of Squares | df | Mean Square | F | Sig. |
|-------|----------------|----|-------------|---|------|
| 1 Regression | 18,973 | 1 | 18,973 | 18,717 | .000b |
| Residual | 102,386 | 101 | 1,014 | | |
| Total | 121,359 | 102 | | | |
| 2 Regression | 5,865 | 1 | 5,865 | 5,129 | .026c |
| Residual | 115,494 | 101 | 1,144 | | |
| Total | 121,359 | 102 | | | |
| 3 Regression | 574 | 1 | 574 | 480 | .490d |
| Residual | 120,786 | 101 | 1,196 | | |
| Total | 121,359 | 102 | | | |

a. Dependent Variable: Visual Preference
b. Predictors: (Constant), Coherence
c. Predictors: (Constant), Imageability
d. Predictors: (Constant), Complexity
The research found that imageability also significantly affects visual preference ($p < 0.05$) of Agus Salim Street. However, the regression summary model reveals that the effect of imageability on preferences is minimal, only about 5% of the formation of visual preferences (see R Square in Table 3). This situation can be understood because the user community considers Agus Salim Street not to have the imageability quality. Although the effect is small, the study results indicate the significant role of imageability in urban street scenes' visual preferences.

### Table 2. Model summarya: The influence of coherence on visual preference in Agus Salim Street

| Model | R    | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|------|----------|-------------------|----------------------------|---------------|
| 1     | .395a | .156     | .148              | 1.00684                    | 1.961         |

a. Predictors: (Constant), Coherence
   b. Dependent Variable: Visual Preference

### Table 3. Model summaryb: The influence of imageability on visual preference in commercial street (Agus Salim Street)

| Model | R    | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|------|----------|-------------------|----------------------------|---------------|
| 1     | .220a | .048     | .039              | 1.06935                    | 1.825         |

a. Predictors: (Constant), Imageability
   b. Dependent Variable: Visual Preference

In conclusion, the research findings showed that visual preference on Agus Salim Street is more determined by the coherence factor than by imageability quality. In contrast, complexity does not affect visual preferences in Agus Salim Street as a commercial street. This situation could be because the community felt that the area was considered neutral from complexity. So they do not feel it as something that attracts attention, which influences visual preferences for the street's view.

In Kayutangan Street, as a historic commercial street, the users consider the quality of coherence of the place as mediocre (M=3.23 out of five scales). This condition shows that the community does not see the street scenes integrated between one element and the other elements. It might be due to ordinary conditions, so the community may not feel the importance of coherence quality. As such, they do not pay too much attention to it. Likewise, people also consider the place's imageability quality as ordinary (M=3.48 out of five scales). Although Kayutangan Street is a historical place, the combination of old and new seems to have reduced the historic buildings' singularity. This condition makes the place does not provide reliable image quality. As a result, the street loses its identity, making the street scenes hard
to remember. They only remembrance is because they were familiar with the place as a local community. However, they feel there is no strong character that can shape the quality of imageability. Results also found that the quality of complexity in Kayutangan Street was considered slightly more than ordinary (M=3.54 out of five scales). However, the user community does not feel the Kayutangan street scenes having high or low-quality of complexity.

Table 4 presents the results of the regression analysis through the ANOVA. The results of the study presented in Table 4 show that coherence significantly influences the visual preferences of urban street scenes on the Kayutangan Street (p < 0.01) as well as imageability (p < 0.01). Like Agus Salim Street, complexity does not influence urban street scenes' visual preferences in this area.

**Table 4.** ANOVA: Influence of coherence, imageability, and complexity on visual preference of urban street scenes on Kayutangan Street

| Model | Sum of Squares | df  | Mean Square | F     | Sig.   |
|-------|----------------|-----|-------------|-------|--------|
|       | Regression     | 24,794 | 1 | 24,794 | 44,571 | 000b   |
|       | Residual       | 60,079 | 108 | ,556 |        |        |
|       | Total          | 84,873 | 109 |        |        |        |
| 2     | Regression     | 8,578 | 1 | 8,578 | 12,143 | 001c   |
|       | Residual       | 76,294 | 108 | ,706 |        |        |
|       | Total          | 84,873 | 109 |        |        |        |
| 3     | Regression     | ,011 | 1 | ,011  | ,014   | 905d   |
|       | Residual       | 84,862 | 108 | ,786 |        |        |
|       | Total          | 84,873 | 109 |        |        |        |

a. Dependent Variable: Visual Preference  
b. Predictors: (Constant), Coherence  
c. Predictors: (Constant), Imageability  
d. Predictors: (Constant), Complexity

As seen in Table 5, the research found that coherence significantly influenced visual preference variance for around 29% on a historic commercial street. This result means that coherence has a role of around 29% in shaping the street's visual preferences. This study’s results have implications for the importance of prioritizing coherence quality in historical area development that function as commercial areas. The old and the new harmonious combination affects the community's preference for the street scenes' visual quality.

**Table 5.** Model summary: The influence of coherence on visual preference in historic commercial street (Kayutangan Street)

| Model | R   | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Wat |
|-------|-----|----------|-------------------|---------------------------|-----------|

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The findings also show that imageability had a significant influence on the visual preferences of Kayutangan Street ($p < 0.01$). However, the effect of imageability on visual preferences is smaller than the effect of coherence. As shown in Table 6, the regression analysis summary model shows that imageability only influences about 10% of the visual preference variance.

**Table 6.** Model summary*: The influence of imageability on visual preference in historic commercial street (Kayutangan Street)

| Model | R   | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-----|----------|-------------------|----------------------------|---------------|
| 1     | .318* | .101     | .093              | .84049                     | 1.341         |

|   | a. Predictors: (Constant), Imageability | b. Dependent Variable: Visual Preference |
|---|---------------------------------------|----------------------------------------|

In sum, although the study result shows that complexity does not affect the visual preferences of the street scene, as a whole, coherence and imageability affect the visual preferences of the urban scene of around 39% in the historic commercial street (Kayutangan Street). These findings show the two qualities of urban design, namely coherence and imageability, have a significant role in determining urban street scenes’ visual preferences, especially in historic commercial areas. However, there are still about 61% of other factors left that influence visual preferences for street scenes other than those two qualities of urban design.

In Ijen Boulevard, a historic residential street, people considered the quality of coherence slightly more than ordinary ($M=3.58$ out of five scales). The area seems quite organized and integrated. This situation may be because Ijen Boulevard is still a historic area that has not undergone many changes. Although some houses have been renovated, the renovated house is somehow still in harmony and unity with their surrounding. The complexity quality of the place is considered somehow just ordinary ($M=3.38$ out of five scales). This evaluation may because of the visual layout of the area that tends to be homogeneous. It does not show a high level of complexity. Although some buildings have changed their style, they do not significantly differ from the existing old buildings. The user community considered the Ijen Boulevard area with relatively high imageability quality ($M=3.95$ out of five scales). This finding shows that the Ijen Boulevard area has a visual identity that makes users and observers easy to remember. Therefore, Ijen Boulevard is the most preferred place by the user community of the three street samples.

The result of the regression analysis between complexity and visual preference, as presented in Table 7 and Table 8, shows a significant effect of complexity in shaping the visual preference of Ijen Boulevard.
Boulevard ($p < 0.01$). Unfortunately, the effect is minimal, only 1%. However, since the influence is significant, it should not be ignored. Considering the condition of Ijen Boulevard, which has moderate complexity, it could be that if the buildings in the Ijen boulevard turn modern and lose their identity as a historic area, which causes complexity to be high, it may affect the people's visual preferences. Therefore, in developing this area, the complexity aspect needs to be well considered. The results show that the quality of low or ordinary complexity on a historic street makes people like the area. Perhaps this is due to the street's appearance that tends to be unified and homogeneous, showing its historical value and the existing atmosphere.

Table 7. ANOVA\(^a\) Influence of coherence, imageability, and complexity on visual preference of urban street scenes on Ijen Boulevard

| Model | Sum of Squares | df | Mean Square | F   | Sig.  |
|-------|----------------|----|-------------|-----|-------|
| 1     | Regression     |     | 6,638       | 1   | 6,638 | 9,578     | .002\(^b\) |
|       | Residual       | 622,362 | 898         |     | .693  |
| 1     | Total          | 629,000 | 899         |     |       |
| 2     | Regression     | 12,255 | 1           | 12,255 | 19,591 | .000\(^c\) |
|       | Residual       | 92,578 | 148         |     | .626  |
| 2     | Total          | 104,833 | 149         |     |       |
| 3     | Regression     | 7,224  | 1           | 7,224  | 10,433 | .001\(^d\) |
|       | Residual       | 621,776 | 898         |     | .692  |
| 3     | Total          | 629,000 | 899         |     |       |

a. Dependent Variable: Visual Preference
b. Predictors: (Constant), Coherence
c. Predictors: (Constant), Imageability
d. Predictors: (Constant), Complexity

Table 8. Model summary\(^b\): The influence of complexity on visual preference in historic residential street (Ijen Boulevard)

| Model | R     | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------|----------|-------------------|-----------------------------|---------------|
| 1     | .107\(^a\) | .011     | .010              | .832                        | 1.585         |

a. Predictors: (Constant), Complexity
b. Dependent Variable: Visual Preference
The regression results between coherence and visual preference of Ijen Boulevard found that coherence had a significant influence on visual preferences (p < 0.01). The effect of coherence on visual preferences is relatively the same as complexity, which is only about 1%. However, as of complexity, this influence cannot be ignored, especially in development planning. Despite the small contribution of complexity and coherence to people's preference, these results highlight those qualities' influence on urban street scenes' visual preference.

However, imageability in Ijen Boulevard has the most significant influence on visual preferences (p < 0.01), with a regression coefficient of 0.279. The regression analysis results revealed that imageability influenced the formation of visual preferences by 11%.

In conclusion, coherence and imageability consistently play essential roles in people's preference for the three types of street scenes. These research findings are in line with previous studies, such as Alpak et al. [4], Ernawati et al. [17], Ernawati et al. [18], Abkar et al. [21], and many more. The research findings mean that people prefer an urban street scene with visual regularity, harmony, and unity between elements. Besides the coherence quality, the street's imageability quality also influenced people's visual preference. The place with a particular scene, which makes it distinctive, can create a memorable experience. This situation, in turn, might make people love to come again and experience the place.

Meanwhile, complexity only influences visual preference on a historic residential street and does not influence people's preferences on commercial streets, both modern and historic. This finding shows that the role of complexity quality on visual preference depends on place characteristics. The research results imply a valuable contribution to the concept of people-based planning and design. However, to establish these findings, it is necessary to conduct a similar study elsewhere. As people's preferences might vary between cultures, cross-cultural studies might make a valuable contribution to establishing the similarities and differences in visual preference between cultures.

4. Conclusions and recommendations
The study found that coherence and imageability affect urban street scenes' visual preference, regardless of the street characteristics. In contrast, the effect of complexity on urban street scenes' visual preference depends on the street characteristics. Then the role of complexity in visual preferences needs to be studied further. Since people's preference might vary between culture, multicultural research is also required to reveal the role of those qualities in visual preference universally. Further studies also need to reveal other visual preference factors that do not include in this study.

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