

Quests for Improving Visual Quality in Streets

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Abstract

The visual quality of streets is an important factor that determines the attractiveness of public spaces. Studies conducted on this subject emphasize the effect of environmental perception and aesthetic evaluation on people and street views. One of the elements that increase the visual quality of streets is the green texture, the seasonal change of trees on streets is also an important component of environmental perception and aesthetic evaluation. Therefore, in order to understand the visual quality of streets, a mixed approach should be adopted that includes not only objective evaluations of physical features but also subjective perceptions of people. The aim of this study is to question the relationship between measurable design qualities (diversity/complexity, green area density, openness ratio, closedness ratio, facade density, and light/shadow effect) that affect visual quality through street views and perceived aesthetic appreciation, taking into account the seasonal changes of street trees.

Keywords: Public space, street trees, visual quality, seasonal differences

1.Introduction

It is stated in the literature that visual quality is an important element of urban design. In particular, it is emphasized that the design elements on the streets and their effects on visual quality should be measured quantitatively. This evaluation should be made in order to contribute to making effective urban design decisions and creating high-quality streets and avenues (Ye et al., 2019, Demir and Gürel, 2024).

However, visual quality is an abstract concept and is usually associated with physical features. However, it is not possible to fully understand people's general perception based on physical features alone. Therefore, when evaluating the physical elements of a space, it is necessary to take into account people's perceptual experiences.

Lothian (1999) suggests a mixed approach where both objective and subjective paradigms are used together to evaluate the visual quality of the natural and built environment. The objective approach views quality as an intrinsic property of the environment, while the subjective approach assumes that quality is a value based on the perception of the observer (Lothian, 1999; Tveit, 2009). Qualitative methods used to evaluate visual quality include surveys, interview techniques, case, and behavioral studies, and aesthetic preference questionnaires. Quantitative methods include approaches such as fractal geometry, visual statistical analysis, the golden ratio, correlation methods, content analysis, Brunswik's lens model, entropy, artificial intelligence, spatial index, and fuzzy logic theory.

In order to develop and improve the visual quality of streets, it is first necessary to determine the elements that affect the visual quality of the streets (Tekel, 2021). Research shows that determining these elements has a significant impact on people's perception and use of the urban environment.

There are many variables and design qualities that affect the visual quality of the built environment. While some of these qualities are measurable, some cannot be. In this research, a query was made on measurable design principles and criteria. The aesthetic evaluation on the streets was examined on the measurable design qualities that affect visual quality, such as diversity/complexity, green area density, openness ratio, closedness ratio,

facade density, and light/shadow effect.

Streets are important public spaces of daily life. The presence of green areas in these spaces is an important factor that increases visual quality (Cooper et al., 2013). Studies suggest that seasonal differences in green areas are an important component of environmental perception and aesthetic evaluation (Junge et al., 2015). Landscape physiognomy can vary greatly depending on seasonal changes, which can affect people's perceptions and preferences. However, few studies have taken seasonal dynamics into account (Palang et al., 2007; Stobbelaar and Hendriks, 2007; Junge et al., 2015).

In the literature, it is stated that comparative studies on visual quality through street images are limited according to different seasons (Palang et al., 2007; Stobbelaar and Hendriks, 2007; Junge et al., 2015). In this study, a detailed literature review was conducted with the keyword "seasonal differences". The total number of sources reached in the WoS (Web of Science) database is 131. The shortcomings in these studies limit our full understanding of how human perception and aesthetic preferences are affected by different seasons. However, it is stated that comparative studies conducted according to different seasons provide important information about how they affect people's perceptions and aesthetic preferences (Zhao et al., 2017; Kuper, 2020).

This study aims to identify design elements that increase aesthetic appreciation on the streets and to understand how these elements are affected by seasonal changes. It also aims to provide a basis for better understanding the impact of seasonal factors on visual quality and aesthetic perception and to develop more effective strategies in public space design.

2. Materials and Methods

This study aims to question the relationship between measurable design attributes (diversity/complexity, green area density, openness ratio, closedness ratio, facade density, and light/shadow effect) affecting visual quality through street views, taking into account seasonal changes in street trees, and perceived aesthetic appreciation. Thus, a mixed approach was adopted, including objective evaluations addressing physical characteristics and subjective evaluations considering aesthetic appreciation in order to identify design elements that increase aesthetic appreciation in streets.

In this context, the method followed in the study was designed in three stages. In the first stage, the study area was determined. Data collection was carried out by taking photographs in the field study. For the photography, first of all, sample streets were determined within the study area and photo shooting points were created.

The study area was determined as Mebusevleri Neighborhood, one of the original neighborhoods of Ankara during the Republican Period, which attracts attention with its tree texture on its streets. All original streets within the neighborhood were included in the sample, and 9 shooting points were determined to reflect these differences from the streets with differences in terms of structure and tree texture. A database was created by taking photos in the winter and summer periods at the created photo shooting points. Impartiality was observed while taking photos from the research area, and no tendency that could affect the participants was shown. In the study conducted by Jiang et al. (2017), it was stated that eye-level photography is widely used by designers, planners, and researchers in obtaining information about green areas and examining human reactions in real environments. In this study, the photos were taken at eye level and from the very center of the streets where the shots were taken.

In the second stage, measurable design qualities that determine the visual quality of the streets (diversity/complexity, green area density, openness ratio, closedness ratio, facade density, and light/shadow effect) and the measurement methods of these qualities were determined. In this context, the photographs obtained were analyzed using fractal and image statistical analysis methods (HarFa v5.5 and Photoshop). Diversity/complexity was analyzed using fractal analysis method; image statistical analysis was used for the analysis of other design

qualities. In addition, the aesthetic appreciation assessment of the sample streets was carried out using the photo-survey method conducted on the obtained photographs. Table 1 presents information on the demographic characteristics of 150 volunteer students who participated in the survey conducted via Google Forms.

Tablo 1. Demographic characteristics of participants

Variable	Category	n	%
Gender	Female	118	78,66
	Male	32	21,33
Department	Architecture	53	35,33
	Urban and Regional Planning	97	64,66
Academic Year	1st year undergraduate	17	11,33
	2nd year undergraduate	16	10,66
	3rd year undergraduate	26	17,33
	4th year undergraduate	57	37,99
	Master's degree	17	11,33
	PhD degree	17	11,33
Total number of participants: 150			

As seen in Table 2, the necessary procedures were applied to the photographs to be used in the analysis.

Table 2. Stages of preparation of street images for analysis.

			
1. Street images are deleted in PhotoShop software, such as cars, people and clouds.	2. The resolution of the street images was kept constant at 672 × 1200 pixels.	3. The color of the street images was removed and the images were used in grayscale for analysis.	4. For the fractal analysis of street images, black and white images were used.

In the third stage, the relationship between seasonal differences and measurable design attributes affecting visual quality and aesthetic appreciation was statistically analyzed using SPSS program. It was tested with Spearman correlation analysis and measurable design attributes according to seasonal differences were compared using Mann-Whitney U test.

2.1. Fractal analysis

Fractal analysis, which is frequently used in analyzing visual complexity in built environments, provides effective results with morphological measurements (İşınkaralar and Varol, 2023, p.2). Fractal dimension, which is the basic statistical parameter in fractal analysis, measures the ability of a pattern to fill the gaps and therefore the level of complexity. The more complex the pattern, the higher the fractal dimension. The value obtained varies between 0 and 2 (İşınkaralar, 2023).

The complexity of a place depends on the diversity of the physical environment, especially the number and types of buildings, architectural diversity/complexity and ornamentation, landscape elements, street furniture, signs, and human activity (Ewing et al., 2006). In the study of Cooper and Oskrochi (2010), a positive relationship was found between fractal dimension levels and visual diversity/complexity levels. According to the research of Yılmaz (2021), areas with a fractal dimension value of approximately 2 represent complex and rich urban spaces, while areas with a value of approximately 1 represent less complex regions.

In this study, the diversity/complexity values of the sample streets were calculated using the HarFa 5.5 program. According to the study, the fractal dimension values of the street images in the winter season varied between 1.3152 and 1.7758. In the summer season, the fractal dimension values of the street images varied between 1.3473 and 1.7176. The fractal dimension values of the sample street images selected from the study area calculated in different seasons are given in Table 3.

Table 3. Diversity /Complexity analysis of example images

Mebusevleri Neighbourhood		
	Winter	Summer
Şerefli St.		
1	BW FD=1.5954	BW FD=1.5127
Ören St.		
2	BW FD=1.6477	BW FD=1.5213

2.2. Image statistical analysis

In this study, measurable design attributes such as green area density, openness ratio, closedness ratio, facade density, and light/shadow effect were analyzed on photographs obtained by image statistical analysis method.

Green area density

Green spaces provide many benefits, such as inspiring an individual's visual aesthetic perception of streetscapes, increasing outdoor time, and preventing stress and negative psychological symptoms (Chen., 2021). The restorative potential of nature has been theoretically and empirically associated with a strong affinity and aesthetic preference for natural environments (Ibarra et al., 2017).

Existing research shows that most studies on the measurement of street trees focus on the "amount of greenery", whereas the assessment of aesthetic qualities is neglected due to methodological shortcomings (Hu et al., 2022).



Figure 1. Green area density (Demir & Gürel, 2024)

In this study, the green area density of sample streets was calculated using the Histogram command in Photoshop software using the Image Statistical Analysis (GIA) method. The total number of green area pixels in the street images was proportional to the total number of pixels in the street images. In the winter season, the green area density of the sample street images varied between 24.54 and 43.53. In the summer season, the green area density of the sample street images varied between 37.38 and 65.12. The green area density values of the sample street images selected from the study area are given in Table 4.

Table 4. Green area density of example images (Original, 2024)

Mebusevleri Neighborhood		
	Winter	Summer
Şerefli St.		
1	41.31	65.12
Ören St.		
2	36.77	55.82

Openness ratio

Openness refers to the portion of the sky that can be seen from a vantage point, and the height and alignment of building facades directly affect this openness. For example, setbacks create a broad horizon, while dense clusters of tall buildings divide the sky into narrow visual areas.

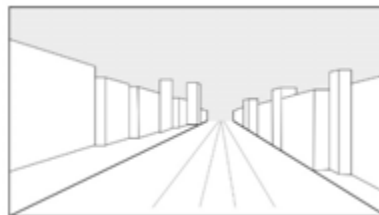


Figure 2. Openness (Demir & Gürel, 2024)

The openness ratio of the sample streets was calculated using the Histogram command in Photoshop software using the Image Statistical Analysis (ISA) method. The total number of visible sky pixels in the street images was proportional to the total number of pixels in the street images. In the winter season, the openness ratio of the sample street images varied between 28.96 and 37.24. In the summer season, the openness ratio of the sample street images varied between 0.7 and 33.05. The openness ratio values calculated for the sample street images selected from the study area in different seasons are given in Table 5.

Table 5. Openness ratio of example images (Original, 2024)

Mebusevleri Neighborhood		
	Winter	Summer
Şereflî St.		
1	32.13	5.92
Ören St.		
2	31.79	0.7

Closedness ratio

Closedness refers to the space created by buildings and is related to people's perception of spatial confinement. A well-closed street increases the sense of security and provides more opportunities for physical activities. Therefore, closedness is considered an important feature in street designs.

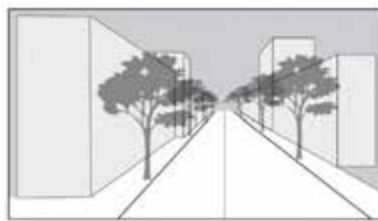


Figure 3. Closedness (Demir & Gürel, 2024)

The closedness ratio of sample streets was calculated using the Histogram command in Photoshop software using the Image Statistical Analysis (ISA) method. The closedness ratio in street images is the ratio of the total number of pixels of visible building facades to the total number of road pixels in street images. In winter, the closedness ratio of sample street images varies between 1.89 and 62.39. In summer, the closedness ratio of sample street images varies between 1.41 and 26.56. The closedness ratio values calculated for sample street images selected from the study area in different seasons are given in Table 6.

Table 6. Closedness ratio of example images (Original, 2024)

Mebusevleri Neighborhood		
	Winter	Summer
Şerefli St.		
1	35.42	7.67
Ören St.		
2	62,39	10,6

Facade density

Studies on street photographs show that measurable design elements such as facade density and the presence of landscape elements play an important role among the factors that determine the aesthetic quality of the street. The facade density of the streets is among the critical elements that determine the characteristics of the space and the integrity of the street wall (Akbaba, 2022).



Figure 4. Facade density (Demir & Gürel, 2024)

The facade density of the sample streets was calculated using the Histogram command in Photoshop software using the Image Statistical Analysis (GIA) method. The facade density in the street images is the ratio of the total number of pixels of the visible building facades to the total number of pixels in the street images. In the winter season, the facade density of the sample street images varies between 0.82 and 19.98. In the summer season, the facade density of the sample street images varies between 0.71 and 7.7. The facade density values calculated for the sample street images selected from the study area in different seasons are given in Table 7.

Table 7. Facade Density of Example Images (Original, 2024)

Mebusevleri Neighborhood		
	Winter	Summer
Şerefil St.		
1	12.23	2.36
Ören St.		
2	19.98	4.24

Light / Shadow effect

The effect of light and shadow (contrast) in street images is related to the amount of detail in the image (Kalavi, 2021). According to literature research, light and shadow deeply affect the perceived beauty of street scenes. Properly arranged landscapes and structures, when used in harmony with natural light sources, increase the aesthetic value of the landscape. The correct use of shadows increases the perception of depth and size, increasing visual appeal. Shadows in cities often leave important impressions on individuals. Shadows and light can transform the depth and atmosphere of an area. Street greenery and tree shadows affect thermal comfort and are advocated for the creation of pleasant urban environments. (Demir, 2024)



Figure 5. Light/Shadow effect (Demir & Gürel, 2024)

The light/shadow effect of the sample street images, namely the contrast ratio, was calculated using the Histogram and Luminosity commands in Photoshop software using the Image Statistical Analysis (GIA) method (Table 5.6). According to the table, the light/shadow effect of the sample street images in the winter season varies between 64.17 and 85.78. In the summer season, the light/shadow effect of the sample street images varies between 52.47 and 89.97. The light/shadow effect values calculated for the sample street images selected from the study area in different seasons are given in Table 8.

Table 8. Light/Shadow effect of example images (Original, 2024)

		Mebusevleri Neighborhood			
		Winter		Summer	
Şereflî St.					
	1	72,31		85,10	
Ören St.					
	2	71,72		89,97	

Conclusion

Seasonal change of green areas on streets is an important component of landscape perception and aesthetic evaluation in studies on visual quality (Junge et al., 2015). In this context, when the relationship between seasonal differences on streets and aesthetic appreciation values is questioned, it is seen that the summer and winter season averages of the variables are different from each other. It is observed that the aesthetic appreciation average of the summer period is greater than the aesthetic appreciation average of the winter period. When the values of measurable design qualities are evaluated together with aesthetic appreciation, it can be said that when the values of diversity/complexity, green area density, closedness ratio, facade density, and light/shadow effect are high, aesthetic appreciation increases, whereas when the openness value is high, aesthetic appreciation decreases.

- Cooper and Oskrochi (2010) found a positive relationship between fractal dimension levels and visual diversity/complexity levels. In this study, when the relationship between diversity/complexity level (fractal dimension) and aesthetic appreciation was examined with Spearman's Rank Correlation Coefficient analysis, there was no statistically significant relationship between aesthetic appreciation and fractal dimension for the winter season. Similarly, no significant relationship was found between aesthetic appreciation and fractal dimension for the summer season. When the diversity/complexity level in street images in the sample was examined according to seasonal differences, it was shown that there was no statistically significant difference between fractal dimension levels.

- When the green area density is examined, it is observed that the green area density of street images is higher in summer than in winter. According to the correlation analysis, there is no significant relationship between aesthetic appreciation and green area density in winter. However, a positive and significant relationship was found between aesthetic appreciation and green area density in summer. In addition, the comparison of green area density according to seasonal differences was made with the Mann-Whitney U test and the obtained significance value was determined as 0.002 ($P < 0.05$). These results show that seasonal changes have a significant effect on green area density.

- When the openness ratio is examined, the openness ratio of street images is lower in summer than in winter. In the correlation analysis, there is no statistically significant relationship between aesthetic appreciation (winter) and openness ratio (winter). Similarly, no statistically significant relationship was found between aesthetic appreciation (summer) and openness ratio (summer). Comparison of openness ratio according to seasonal

differences was made with Mann-Whitney U test and the obtained significance value was determined as 0.002 ($P < 0.05$). This result shows that seasonal changes have a significant effect on the openness ratio. It was observed that the openness ratio was higher in winter.

- When the closedness ratio is examined, it is shown that the closedness ratio of street images is higher in summer than in winter. According to the correlation analysis, there is a positive and statistically significant relationship between the aesthetic appreciation (winter) value and the closedness ratio (winter). However, there is no statistically significant relationship between the aesthetic appreciation (summer) value and the closedness ratio (summer). The significance value obtained as a result of the Mann-Whitney U test conducted to examine the closedness ratio according to seasonal differences was determined as 0.038 ($P < 0.05$). This result shows that there is a significant difference between the closedness ratio depending on seasonal changes. According to the rank average values, it is observed that the closedness ratio is higher in winter than in summer.

- When facade density is examined, it is shown that facade density of street images is lower in summer than in winter. According to the correlation analysis, there is a positive and statistically significant relationship between the aesthetic appreciation (winter) value and facade density (winter). In other words, there is a strong and significant relationship between the aesthetic appreciation values in street images and the facade density in winter. However, there is no statistically significant relationship between the aesthetic appreciation (summer) value and facade density (summer). The significance value obtained as a result of the Mann-Whitney U test conducted to examine the facade density according to seasonal differences was calculated as 0.019. This result shows that the facade density in winter is significantly higher than in summer.

- According to the correlation analysis conducted to examine the relationship between the Light / Shadow effect and aesthetic appreciation, there is no statistically significant relationship between the aesthetic appreciation (winter) value and the light / shadow effect (winter) and between the aesthetic appreciation (summer) value and the light / shadow effect (summer). The significance value obtained as a result of the Mann-Whitney U test conducted to examine the Light / Shadow effect according to seasonal differences was determined as 0.627. This result shows that there is no significant difference between the light / shadow effect level depending on seasonal changes.

As a result, it has been determined that seasonal changes in street trees may affect individuals' evaluation of the visual quality of streets and may lead to differences in measurable design attributes that shape perceptual differences.

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