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THE EFFECT OF THE ENVIRONMENT ON THE EVALUATION OF TALL BUILDING FORMS

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ABSTRACT

The study examines the impact of the environment on the perception and appreciation of tall buildings. It also questions how perception and appreciation change when the quality of the environment changes. The working hypothesis is that the environment and the quality of the environment will be effective in the perception and appreciation of a building. In line with this objective; eight (8) tall building forms were determined with reference to the studies in the literature and these forms were modeled through the Sketchup program. Then the plots where the forms will be installed were determined. Ulus, consisting of low-rise historical buildings that form the backbone of the city of Ankara, and Kavaklıdere, consisting of high-rise modern buildings, were taken as reference. These lands were also modeled through the Sketchup program. After both building models and environmental models were produced, the images were mounted together using Photoshop. In this way, a total of 24 images were obtained: eight (8) single buildings, eight (8) buildings mounted in historical environments and eight (8) buildings mounted in modern environments. These images were shown to the final year students of Gazi University Department of Architecture and they were asked to evaluate the images within the scope of the variables of liking, impression and complexity. As a result, it was found that the environment has an effect on the perception and appreciation of a tall building. The environment decreases the impressiveness of the forms, increases their complexity and decreases their appreciation. Tall buildings are appreciated more and found more impressive in a modern environment.

Keywords: Tall Buildings, Environment, Impressiveness, Liking, Complexity, Perception.

1. INTRODUCTION

1.1. What is a Tall Building?

There is no universal definition of tall buildings in the literature. The definitions and height limits of tall buildings vary according to the structure of the buildings, construction systems, fire and earthquake regulations, building standards, professions and specialties (Ali & Armstrong, 1995; Yıldız, 2023). When various guidelines on tall buildings are examined, it is seen that definitions are shaped depending on many criteria such as land and road widths, urban silhouette, surrounding structures and visual impact. The height limits of buildings also vary considerably from one city to another. Table 1 shows the height limits and definitions of various cities. Accordingly, a 4-story building in a historic city is considered a high-rise building, while a 4-story building in a modern city is considered a low-rise one. In cities such as Chicago and

Los Angeles, where high-rise buildings were first developed, the minimum height limit is 20 stories. In cities such as London, where high-rise buildings develop in a more controlled manner, relative height is determined instead of setting any height limit. In other words, height limits are determined according to sub-regions determined as a result of urban analysis, rather than covering the entire city. When the building definitions in the table are evaluated, the fact that the building is significantly higher than the surrounding buildings and that it can be distinguished in the urban silhouette are effective in defining it as a tall building. In addition, in some cities, land and road widths are also influential in determining building heights and forms. All these definitions emerge as a result of the specific relationships that tall buildings establish with cities. In each city, developments are shaped depending on urban data.

Table 1. Definitions of tall buildings and height limits in various guidelines

City	Definition	Height	City	Definition	Height
Bristol	Structures that are significantly taller than their surroundings and/or change the city skyline	>9 floor	Merton	Buildings whose height is greater than the road width of the neighboring street or the wider of two intersecting streets	Relative height
Burlington	When carefully designed and positioned, they are unique elements of the city character and skyline.	>11 floor	Nelson Mandela	A building that is 50% or more higher than the surrounding buildings within an area of 100 meters in diameter	>8 floor
Cambridge	Any building that stands out from the existing city skyline and is taller than the surrounding buildings	>6 floor	New Castle	A building that stands out from the city skyline and/or is significantly higher than the surrounding buildings	-
Cardiff	Buildings that have the potential to create significant value in the city	>8 floor	Northam pton	A building that stands out from the city's skyline and/or is significantly higher than the surrounding building stock	-
Hackney	Buildings or structures that are significantly taller than their surroundings	>10 floor	Pickering	The building consists of a podium with active areas and a lobby on the ground floor and a tower with living areas, condominiums and office spaces on the upper floors	>13 floor
Los Angeles	-	>20 floor	Ottowa	-	>10 floor
Hamilton	Buildings that are taller than the width of the neighboring street and exhibit slenderness depending on the context they are associated with	>12 floor	Toronto	Buildings whose height is greater than the road width of the neighboring street or the wider of two intersecting streets	>12 floor
London	Buildings that dominate the local and city silhouette with their presence and impact as they increase in height	Relativ e height	Worting	Structures that are significantly taller than their surroundings and/or change the city skyline	>7 floor

When the definitions and height limits of tall buildings in our country are examined in the light of these definitions; it is understood that the definitions are shaped according to the limited data determined by the standards and regulations. In the Istanbul Zoning Regulation (2007), a tall building is defined as "a type of building that generally affects its immediate and distant surroundings in terms of physical environment, silhouette, urban texture and all kinds of urban infrastructure. It is defined as "buildings with a building height of at least 60.50 meters at the lowest level visible from any facade of the building". In the Planned Areas Zoning Regulation (2018), high-rise buildings are defined as 'buildings with a building height of more than 21.50 meters or a structure height of more than 30.50 meters are high-rise buildings. Buildings with a building height of more than 52.50 meters or a structure height of more than 60.50 meters are very high buildings'. In the New Turkey Building Earthquake Regulation (2018), buildings with building height class 1 are considered as high-rise buildings, while the height limits according to the earthquake design class are determined as H>70 meters for 1st and 2nd class, H>91 meters for 3rd class and H>105 meters for 4th class (AFAD, 2018). Therefore, although the height limits in the regulations have been increased over time, the relationships of the buildings with the urban environment are ignored in the definition of tall buildings. As a result, when evaluated in the light of guidelines and regulations, tall buildings are complex structures that are very difficult to define. According to urban data, height limits and height perception vary considerably. In order to eliminate this complexity, the Tall Buildings Council (CTBUH) has developed three (3) criteria for defining tall buildings; contextual conditions, building proportion and technological advancement of the building (Figure 1). A building is considered tall if it meets one or more of these criteria.

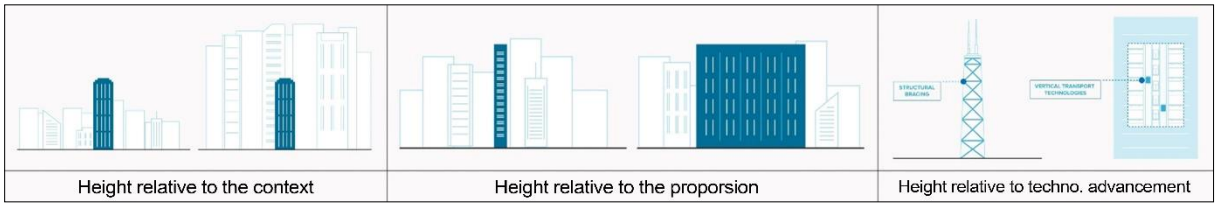


Figure 1. Height criteria according to the Tall Building Council (CTBUH, 2023)

In this study, based on the definitions in the guidelines and the CTBUH's proposal, tall buildings are defined as buildings that are significantly higher than the surrounding buildings, distinguishable in the urban skyline, slender in terms of building proportion and technologically innovative.

1.1. Tall Building Forms

Tall buildings can be classified in various ways in terms of form. While orthogonal forms such as squares, rectangles and circles were common in the 19th century, when tall building construction first emerged, today quite complex forms can be produced thanks to the possibilities of technology and construction systems. Therefore, due to the difficulty of classifying tall buildings in terms of form, classifications have been developed according to various parameters. Inspiration from computer commands (Vollers, 2008); shaping according to structural and energy efficiency principles (Taghizadeh & Seyedinnoor, 2013) and shaping according to aerodynamic effects (Kim & You, 2002; Irwin, 2009; Amin & Ahuja, 2010; Amin & Ahuja, 2010; Tanaka et al., 2013; Ilgın & Günel, 2021) are the parameters according to which tall building forms are frequently classified. Especially aerodynamic loads are very effective in

determining the form as they are one of the most exposed loads as the height of the building increases. In this study, eight (8) basic form categories were determined for tall buildings with reference to the studies in the literature; simple form, circular form, hyperbol form, tapering form, layered form, opening form, conoid and twisted form (Figure 2).

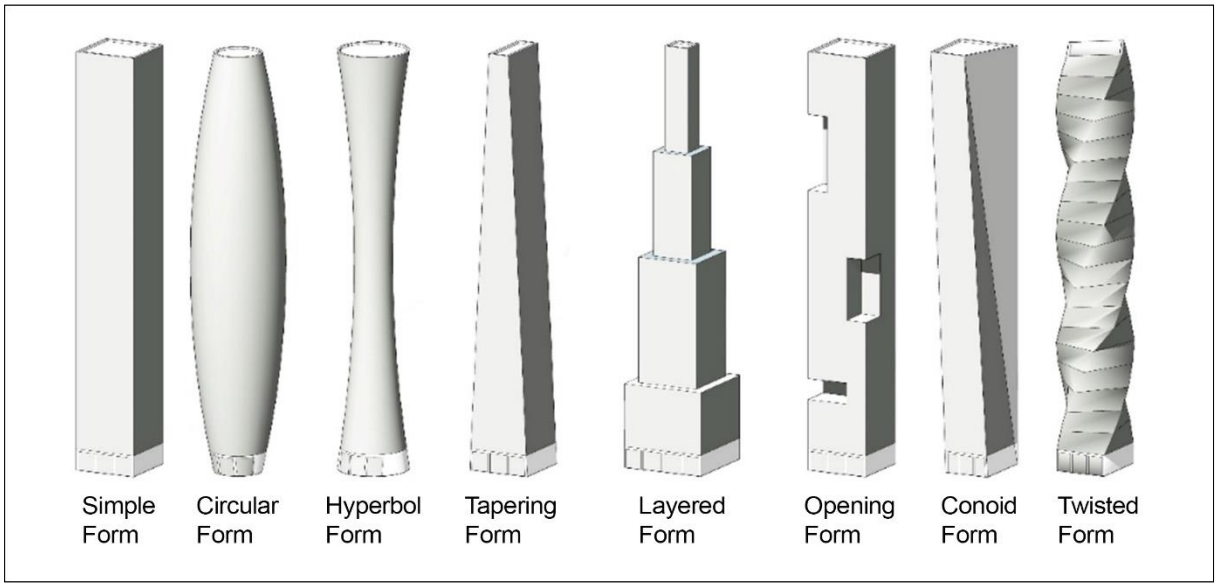


Figure 2. Tall building forms

1.3. What is the Environment and the Impact of the Environment on Tall Buildings

Environment, in the most general sense, is the physical, biological, social, economic and cultural environment in which humans and other living things maintain their relations and interact with each other (Berkes & Kışlalıoğlu, 1990). The urban environment is the environment where people's interactions are shaped with all its physical components such as streets, squares, avenues, houses, sculptures, parks and architecture. Urban environments create a whole and unique character with their natural factors such as topography, climate, vegetation and geological structure (Ocakçı, 1995). Historical environments are places that reflect the social, cultural and economic structure, philosophy of life and aesthetic concerns of past civilizations. They are places where culture and historical accumulation are revealed, and which illuminate the past by bringing the architectural styles, technological developments, interactions, experiences and cultural achievements of past periods to the present day (Arabacıoğlu & Aydemir, 2007).

The urban environment and especially the historic environment have many effects on tall buildings. In fact, this is a mutual interaction and the effects of tall buildings on the environment are generally questioned. In this study, unlike generalizations, how the environment affects tall buildings is investigated. First, the environment plays a direct role in the perception of the building. A tall building must compromise with the existing urban environment. The scale of the building must solve the problem of the image of the city, its relationship with the surrounding structures, and mass (Beedle et al., 2007). The character of the surrounding structures and open spaces is important in whether the building is perceived as high, low, dominant, naive, or overwhelming. In an environment consisting of low-rise historical

buildings, a high-rise building is perceived as more dominant and overwhelming as it separates from its surroundings, while in an area surrounded by multi-storey buildings, the building becomes more noticeable as it separates from its surroundings. Features such as the location of the building, material selection and form are also very effective in the perception of the building. Location and site selection can enable the building to be adopted as a reference point within the area. When the material selection of the building is in harmony with the environment, it creates a value within the area, while the use of incompatible materials can destroy the effect of the building. The environment creates a framework for defining a building and determining its boundaries. In addition, a sense of closure is necessary in defining streets and avenues (Özer, 1992).

Environment is effective in determining the form of tall buildings. High-rise buildings are generally shaped in a tripartite configuration called base-middle-top (Sev, 2009). The environment is effective in shaping this form. The base part of the building is usually the part related to the street. By keeping this part wider than the upper parts, the building is prevented from creating a dominant effect on the environment. Single masses, on the other hand, have a more dominant effect on the environment and negatively affect the human scale. However, single masses are the most appropriate form of construction for buildings on narrow parcels. Therefore, parcel and land conditions are also effective in determining the mass and form of the building. Topographical features of the environment, vegetation, underground and surface water resources, transportation and infrastructure systems are other factors that influence the shaping of tall buildings.

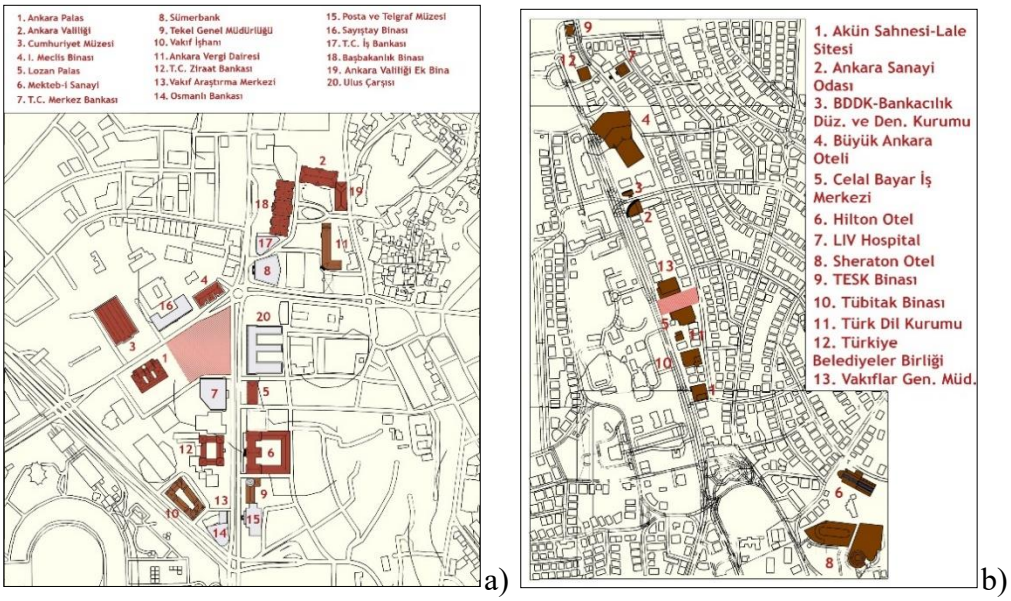
When the studies on the effect of the environment on the perception and appreciation of buildings are examined in the literature, the effect of geology, topography, and local environmental character on the design of buildings is questioned through the complexity variable in Bovill's study in 1996. In Heath, Smith & Lim's (1993) study, tall building facades were evaluated according to complexity and silhouette variables. The impact of the environment was not questioned in this study. In Imamoğlu's (2000) study, traditional and modern residential facades were evaluated through the variables of liking, complexity, and familiarity. It was found that there was an inverted 'U' relationship between complexity and liking. In other words, a moderately complex image was preferred more than very complex and less complex ones. In Stamps' (2002) study, the relationship between the silhouette line of the built environment and the silhouette line of the mountains and hills was questioned. In Akalın et al.'s 2008 study, detached house facades were analyzed in terms of complexity, desirability, and impressiveness. In Erdoğan et al.'s study (2013), residential facades of different styles were analyzed in terms of familiarity, impressiveness, complexity and liking variables. Ostwald and Vaughan (2016) measured the visual diversity and complexity of different forms of representation (from simple to complex) on building facades. Lionar & Ediz (2020) examined the impact of urban background on the design of buildings. As a result, there are few studies in the literature that investigate the impact of the environment on

the perception and appreciation of buildings, and these studies generally examine residential facades. There is no study that evaluates the effects of the environment on tall buildings. The contribution and differentiation of this study to the literature is to classify high-rise buildings in a typology from simple to complex and to question the impact of the environment on perception and taste. The study evaluates two contrasting types of environments and questions how the quality of the environment affects perception and taste.

In the study evaluated on the form variable, tall building models were developed according to eight building forms obtained from the literature. These models were evaluated in terms of complexity, liking and impression by means of a questionnaire study, both individually and assembled in two different environments. The results show whether the environment influences the perception and appreciation of a building.

2. MATERIALS and METHODS

The study methodology is based on a questionnaire survey. According to the data obtained from literature studies, eight (8) building forms were determined; simple, circular, hyperbol, tapered, layered, opening, conoid and twisted forms (Figure 2). Each form was modeled with the Sketchup 2021 program. The building models have the same height (200 m), floor area (30-30 m), ground floor arrangement and roof area, but differ only in form. Then, the backgrounds (environment models) on which these models will be mounted are designed. In the study where both environment models were designed with the Sketchup program, their opposite qualities were decisive in the development of the environments. While one of the environments consists of historical, low-rise, ornamented, and detailed buildings; the other one consists of multi-storey, modern, simple and plain forms buildings. For this purpose, the buildings in Ulus and Kavaklıdere, two sub-regions on Atatürk Boulevard, which form the backbone of the city of Ankara, were used as reference. Two undeveloped plots of land were identified in both areas. High-rise building models were developed to be positioned on these lands. For the Ulus area, the land at the intersection of Atatürk Boulevard, Cumhuriyet Street and Anafartalar Street, which is currently planned to be demolished, was selected. In Kavaklıdere area, an empty land between the General Directorate of Foundations and Celal Bayar Business Center on Atatürk Boulevard was selected. Topography, roads and buildings that shape the character of both areas were modeled.



a) b)

Figure 3. a) Ulus region b) Kavaklıdere region

After both building models and environmental models were developed, the images were mounted together using Photoshop software. In this way, a total of 24 images were obtained: eight (8) single buildings, eight (8) buildings mounted in the historic environment and eight (8) buildings mounted in the modern environment. In the study, the perspective of the images is arranged according to the urban perspective. Since only the ground floors of tall buildings can be perceived from the street, it was deemed appropriate to limit the study to an urban perspective.

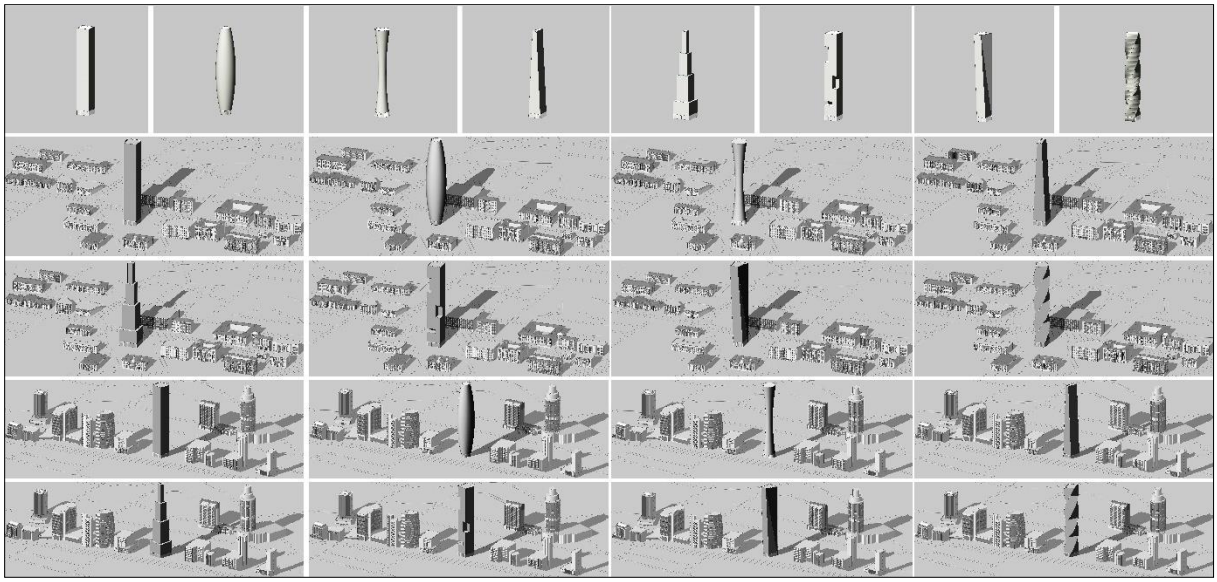


Figure 4. Images used in the study

The survey was conducted with a total of 52 fourth year (4) students of Gazi University Department of Architecture. Since the study was conducted with a homogeneous group, the number of samples was kept limited. The images were shown to the students in the classroom environment by projecting them on the screen. The images are presented in random order. Each image was shown on the screen for 15 seconds and the students were asked to evaluate these images according to the variables of liking, impression and complexity. The survey was completed in a total of 6 minutes. The data obtained were analyzed with statistical methods in the SPSS program. The relationship between the variables was evaluated by correlation analysis and semantic differences were evaluated by Anova test.

3. FINDINGS and DISCUSSION

The reliability analysis of the dependent variables in the study was analyzed according to Cronbach's Alpha. The Cronbach's Alpha value of the impression variable is 0.96; the complexity variable is 0.89; and the liking variable is 0.9. Generally, a value above 0.7 is considered as an acceptable reliability value. Therefore, the dependent variables have statistically high reliability values. The study was conducted with a total of 52 participants. 65% of the participants were female students and 35% were male students. Before showing on to the visual questions, the participants were asked to indicate how effective the urban environment is in the perception and appreciation of a tall building. Participants were asked to rate their evaluations on a scale of 1: very unimportant to 5: very important. In response to this question, 56% of the participants stated that the environment was very important in the perception and

appreciation of the building and 36% stated that it was important. In other words, with a rate of 92% in total, the participants evaluated the environment as an important criterion in the appreciation of the building.

The proportional relationship between the participants' responses to the dependent variables (liking, complexity and affect) and the environment and form variables was analyzed. In the correlation evaluation, the correlation coefficient takes a value between 1 and -1. A value of 1 indicates a strong positive correlation, 0 indicates no correlation, and -1 indicates a strong negative correlation. Accordingly, there is a statistically significant relationship between impression and regions ($p<0.05$). There is a significant relationship between impression and circular form (0.2 units), hyperbol form (0.22), tapering form (0.35), layered form (0.36), opening form (0.67), conoid form (0.39), and twisted form (0.69). There is a statistically insignificant relationship between complexity and regions ($p>0.05$). There is a significant relationship between complexity and circular form (0.44), hyperbol form (0.31), tapering form (0.18), layered form (0.70), opening form (0.82) and conoid form (0.59). There is a statistically significant relationship between liking and regions ($p<0.05$). There is a significant relationship between liking and circular form (-0.21), hyperbol form (0.24), tapering form (0.16), opening form (0.11), conoid form (-0.07) and twisted form (-0.19).

Table 2. The relationship between dependent variables and independent variables

Variables	Impression		Complexity		Liking	
	Estimated Std.	Pr(>|t|)	Estimated Std.	Pr(>|t|)	Estimated Std.	Pr(>|t|)
Region 2	0.20	9.92e-06***	-0.00	0.81417	0.14	1.37e-05***
Form 2	0.20	0.028797*	0.44	1.42e-10***	-0.21	0.000983***
Form 3	0.22	0.017539*	0.31	7.12e-06***	-0.24	0.000304***
Form 4	0.35	0.000162***	0.18	0.00851**	0.16	0.016717*
Form 5	0.36	8.10e-05***	0.70	<2e-16***	0.00	0.950279
Form 6	0.67	2.84e-13***	0.82	<2e-16***	0.11	0.091521
Form 7	0.39	2.52e-05***	0.59	<2e-16***	-0.07	0.320361
Form 8	0.69	1.34e-13***	1.13	<2e-16***	-0.19	0.003565**

Signif. Codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.', 0.1 '', 1

In the study, Anova test was applied to reveal the significant difference of each variable. P values in the Pr(>F) column indicate whether the effect of independent variables on dependent variables is statistically significant or not. Region and Form variables contain significant differences as a result of ANOVA analysis.

The stars () in the output indicate the significance of the p-values. For example, if "**" is represented by two stars, the p-value is less than 0.001 and this result is highly statistically significant.

Table 3. Anova test evaluation of independent variables

Variables	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Region	1	8.5	8.54	23.670	1.22e-06***
Form	7	21.7	3.10	8.589	1.93e-10***
Gender	1	23.5	23.51	65.173	1.06e-15***

Signif. Codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.', 0.1 '', 1

In the study, the effect of the environment was questioned through dependent variables. Firstly, when the graphical data are evaluated in terms of the impression variable (Figure 5), the presence of the environment had a negative effect on the impressiveness of the forms. The opening form, conoid form, twisted form, circular form and hyperbol form, which were impressive when evaluated individually, took lower values when evaluated together with the environment. The simple form was evaluated as more impressive with the environment. However, as a result, the environment negatively affected the impressiveness of the forms. The impression of forms is lower in Ulus than in Kavaklıdere. This is related to the fact that the buildings shaping Ulus are low-rise, detailed, and ornamented facades. Tall building construction is considered less impressive in the historic environment than in the modern environment.

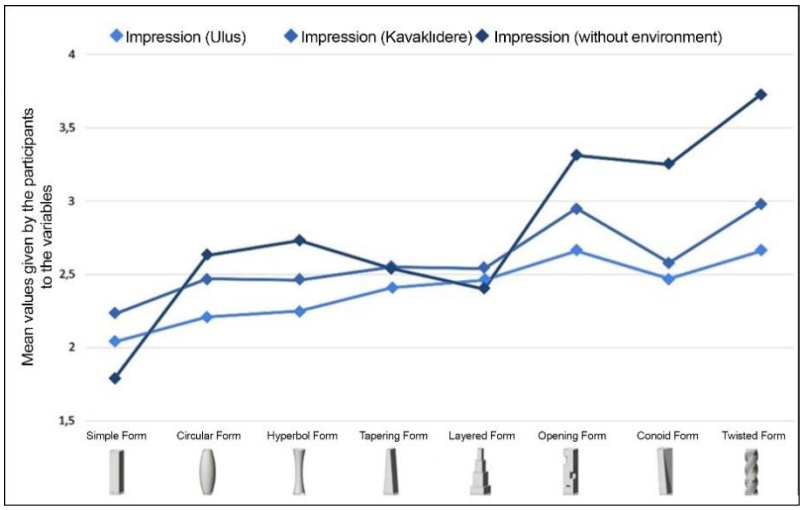


Figure 5. Average values of variables in terms of impression

When the graphical data is evaluated in terms of the complexity variable (Figure 6), the presence of the environment had a positive effect on the forms. All forms were evaluated as more complex with the environment. Simple, circular, hyperbol, tapering, layered and opening forms, which were considered complex with the environment, were found to be less complex when evaluated independently of the environment. In terms of conoid and twisted forms, the presence of the environment had no effect on complexity. In Ulus and Kavaklıdere, the results showed a similar distribution. Both regions have similar values in terms of complexity.

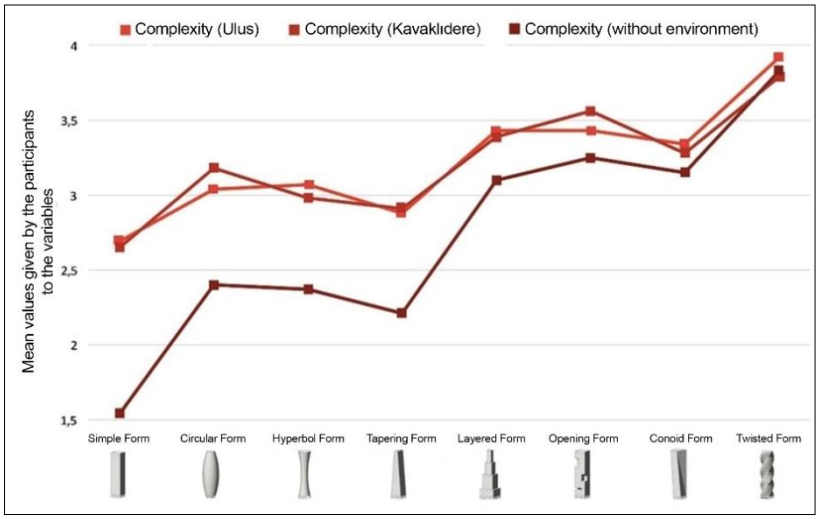


Figure 6. Average values of variables in terms of complexity

When the graphical data are evaluated in terms of the liking variable, the presence of the environment had a negative effect on the forms. When evaluated independently of the environment, the opening form, conoid and twisted forms were liked, while these forms received low values when evaluated together with the environment. When evaluated independently of the environment, the simple form was the least liked form, while it was liked when evaluated together with the environment. In addition, the Kavaklıdere district received higher values in terms of appreciation than Ulus. Tall building construction was liked more in the modern environment than in the historic environment. Therefore, the results in the graph show that the environment has a significant effect on the appreciation of forms. The environment decreases the impressiveness of the forms, increases their complexity, and decreases their liking. In the historical environment, the impression decreases, the complexity takes a neutral value and the liking decreases compared to the modern environment. Based on the results in the graph, it is understood that the environment has a significant effect on the perception and appreciation of the forms. The presence of the environment changes the level of complexity, impression and liking of buildings. The quality of the environment also has a significant effect on these variables. Tall buildings are more appreciated and more impressive in a modern environment.

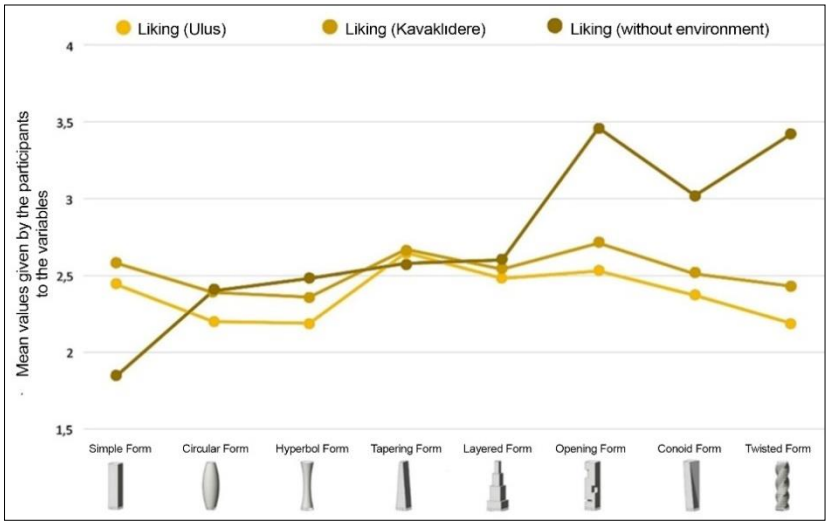


Figure 7. Average values of variables in terms of liking

4. CONCLUSION and RECOMMENDATIONS

In this study, the presence and quality of the environment in the perception and appreciation of tall buildings are questioned. Although the history of tall buildings dates back to ancient times, there has been a significant increase in the production of buildings all over the world in the 21st century. The fact that tall buildings reflect the economic development, modern and innovative aspects of cities and contribute to the prominence of cities globally has increased the importance of these buildings. In parallel with these developments, the visibility of buildings in cities has begun to become more noticeable. Based on the increasing importance of tall buildings, this study examines how the environment affects the perception and appreciation of these buildings. In this context, tall building forms were determined for the study and these forms were mounted in different environments. Then, the values of the buildings according to the variables of impression, complexity and liking were compared.

As a result, it was determined that the environment was effective in the evaluation of building forms. The addition of environmental data affected the perception and appreciation of the forms. It had a negative effect in terms of impressiveness and made the buildings perceived as more complex. In terms of liking, both environments had a negative effect. In other words, while the buildings were liked on their own, their level of appreciation decreased within an environment. This situation has developed independently of the quality of the environment. Even in a modern environment where tall buildings can be compatible, they are not appreciated as much as they are appreciated on their own. The quality of the environment also had a significant impact on the variables. Tall buildings are more appreciated and more impressive in a modern environment. Therefore, these results show that the environment is very effective on the perception and appreciation of buildings.

This study was conducted on high-rise buildings. In future studies, the results can be improved by examining different building types/styles. The environment variable was limited to modern and historical environment. More comprehensive data can be obtained by diversifying these variables (e.g. natural environment data can be added). In addition, determining the criteria by which the environment influences the perception and appreciation of buildings would contribute to the expansion of the findings obtained in this study.

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