

Quality Assessment of Public Spaces: The Case of Beyazit Square and Its Surroundings

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Abstract Public spaces are one of the main areas of urban life. They can be accessed and used by all individuals and groups in a city, and therefore lay the foundation for a common social life to thrive. The social, economic, cultural, and spatial diversity of a city develops in parallel to the diversity of its public spaces. The existence of an individual within the context of a city and the meaning of the city in an individual's mind are in direct relationship with the activities that take place in its urban spaces. This relationship becomes as strong as the capacity of urban spaces in supporting social life and collective events in both social and physical aspects. Today, the conception of physical urban space is unfortunately rather detached from the societal composition and the social construct of the city as it became a critical commodity in our market economy which leads to the creation of chunks of urban elements without any qualities and in-depth meaning for its users and can often easily become unsafe and unhealthy. The study aims to create a method for the increasingly commodified public spaces to become an element that improves the quality of life of the communities. For this purpose, PCA and CATPCA statistical methods were applied, and subsequently, a parameter set was formed. As a result, a data set that can be used in public space design has been obtained, and new parameters have been created through the method used in the formation of this data set.

Keywords Public Space, Quality of Public Space, CATPCA Methodology, Beyazit Square

1. Introduction

The motivation of this study is to reveal how and in which directions open public spaces can influence the daily lives of individuals through the analysis of the relationship between public spaces and society. Within this context, Istanbul Beyazit Square and its surroundings as an important cultural and historical center that is pedestrianized were chosen as our case study. The public space and its elements were evaluated through the investigation and analysis of the definition of different sections of the space through its users, how and towards which purpose these spaces are used, the interactions that take place at certain places, and to what extent these places facilitate these interactions and other socio-spatial actions as a result of their physical properties. Therefore, the qualitative features of the public sphere are related to its quantitative features. Throughout this investigation, the qualitative and quantitative aspects of urban space and their relations are a constant topic and as a result, gain the utmost importance.

The examination of the social and physiological dimensions of the interactions between individuals and the place they live, the meaning and importance of open public spaces as more than just basic physical aspects of a city, and as an actor play a significant role in forging these interactions and making cities a livable place are some of

the most important goals of this study.

Accordingly, the CATPCA method has been applied to reveal the importance of the quality of the public space in the lives of individuals and to ensure its impact on social life with measurable values. With this method, it is provided that the variables are reduced to a representative variable, and factors are obtained from these variables without losing data.

2. Multidimensional Level of Service in a Public Space

Urban life occurs in public spaces. People who use the same public spaces often interact socially. In this respect, the quality of urban life is in direct relationship to the usability and performance of public spaces [1] [2]. As such, public spaces are only as successful as they provide their capacity to serve all individuals, meet their needs, and facilitate social interaction [3], [4].

In general, public spaces are defined as urban places, which do not belong to a specific person or institution [5] and provide the physical space for individuals or groups of individuals [6] to meet, interact, converse and exchange culture. For a space to be recognized as “public”, it should be accessible and be free to be used by all residents of the city [7]. The concept of “quality” in public spaces has been explained based on certain parameters by many architects and urban planners and the relationships of public spaces to their users have been defined through the examination of concrete physical as well as social data.

According to Sennett, public space is the upholder of democracy, the heart, the nature, and the soul of the city which embodies the memories and spirit of being a citizen [8]. This definition of Sennett carries importance as it refers to a multitude of properties such as equality, sharing, and genius loci, and both the physical and societal contexts of public spaces. In parallel, Norberg Schulz defines the city as a place of encounter through public spaces where people from different parts of the society co-exist [9]. This definition is especially important within the context of the goal of this study in emphasizing the relationships between the city, individuals, and public spaces. Kevin Lynch, who defined the most important characteristics of a good city emphasized in his book “Good City Form” the importance of human beings is compatible with all environments they live in and they are able to bind their common values. Lynch suggests measuring parameters such as vitality, emotion, appropriateness, access, and control as control criteria to develop a good city structure [10]. Gehl examines the parameters that a good urban structure depends on and compiles the activities performed in public space as necessary, optional, and social activities [11]. He observes that public spaces of high quality especially facilitated a relatively high volume of optional and social activities.

According to Hannah Arendt, everything that occurs

within public space is widely open to the perception of all individuals. In that respect, the public domain represents a world that belongs to everyone and not just to us alone [12]. According to Arendt, freedom can emerge in open public spaces where people meet and build new relationships precisely because its emergence requires the forging of new interactions and phenomena between people in their attempts to act together, in other words, to create a common world. Parallel to this, Madanipour defines public spaces as areas where all people have access to activities within the realms of the interest of the public and are governed while providing access to events and occurrences that are within the control of public actors [13].

Jacobs mentions the livability of cities by emphasizing that human and social life are the priority in planning the physical, economic, and social environments of cities [14]. The concept of livability (albeit relatively) indicates a sense of satisfaction and quality of the user's experience in the city.

Lang evaluates the quality of urban spaces according to Maslov's hierarchy of needs [15]. These needs are physiological, safety and security, commitment, respect, and self-fulfillment. Jacobs and Appleyard pointed out that American cities are consumer-oriented and accentuated that poor quality urban spaces emphasize individuality and encourage the privatization of social and cultural life [16], [14]. Referring to the elements of spatial quality, Rapoport defines them as the prominent features that stand out in design. Just as spatial quality is examined in terms of its functional, aesthetic, technical and economic performance, Voort and Wegen also discuss it through the additional parameters of order, identity, and attraction [17]. DQI (The Design Quality Indicator) was established to measure environmental quality in 1999 and examine spatial quality through the concepts of value and perfection.

In his study, Carmona elucidates urban spaces according to the common criterion set including form, accessibility, image, activity, sociality, comfort, ownership, and governance and as a result reveals spatial typologies based on the overarching topics of form, function, and ownership/rights [18]. In parallel, Mehta defines five main factors and further subsections for the quality measurement of open public spaces by matching them with various research methods which she applies in the resulting studies [19]. This method, called the PSI (Public Space Index) covers the inclusiveness, meaningful activities, comfort, safety, and pleasurable aspects of a defined area [20]. Similar to this, PPS (Project for Public Spaces Inc.) was founded in 1975 and is an organization with several successfully realized public space projects. According to PPS, a successful public space must fulfill for following four core functions: Access and connections, purpose and activities, comfort and image, and socialization [21]. Another for evaluation is the “Level of Service (LOS)” method. It is based on the quality of urban

design for pedestrians and its relationship with walking needs [22]. “It was mainly developed as a part of an initiative from the USA to make cities more livable and reinforce multimodality [23].

As a result of the literature review, four main criteria were taken as the basis for this study of Beyazıt Square and its surroundings. The factors were grouped according to accessibility, security, comfort, and attractiveness.

3. The Investigation of Beyazıt Square and Its Surroundings in Terms of Spatial Quality Based on Parameters Defined by the CATPCA Method

The study area which is located in the center of the Istanbul historical peninsula laid on the main transport axes in the Ottoman and Byzantine periods and was already an area of significant importance in terms of its urban functions. In the early periods of Byzantium, the area was

named egnatia (army road) and was used as a cemetery. Emperor Theodosius made a forum in the middle of necropolises between 375-395 [24], making Beyazıt Square the focal point in the city. The Tauri Forum [25], the Theodosius Forum, and in its final form the Beyazıt Square have been an area that has undergone many changes throughout its history. The square is now one of the most important historical locations of Istanbul, located at the center of the city's commercial, cultural, and touristic activities on the Eminönü-Ayasofya-Beyazıt-Aksaray axis, where the city's historic rib is formed and is also home to subterranean archaeological remains of utmost significance. Although it had undergone numerous changes, it still boasts an early monumental complex such as the Bayezid Complex and the ruins of a late Roman structure such as the Theodosius Arch-Arch, other several buildings from the 18th and 19th centuries, and continues to be an important center for trade and education. The campus complex (külliye) within the area directly affects the physical character and visual perception of the square [26] (Figure 1, Figure 2).



Figure 1. Beyazıt Square and Beyazıt Mosque

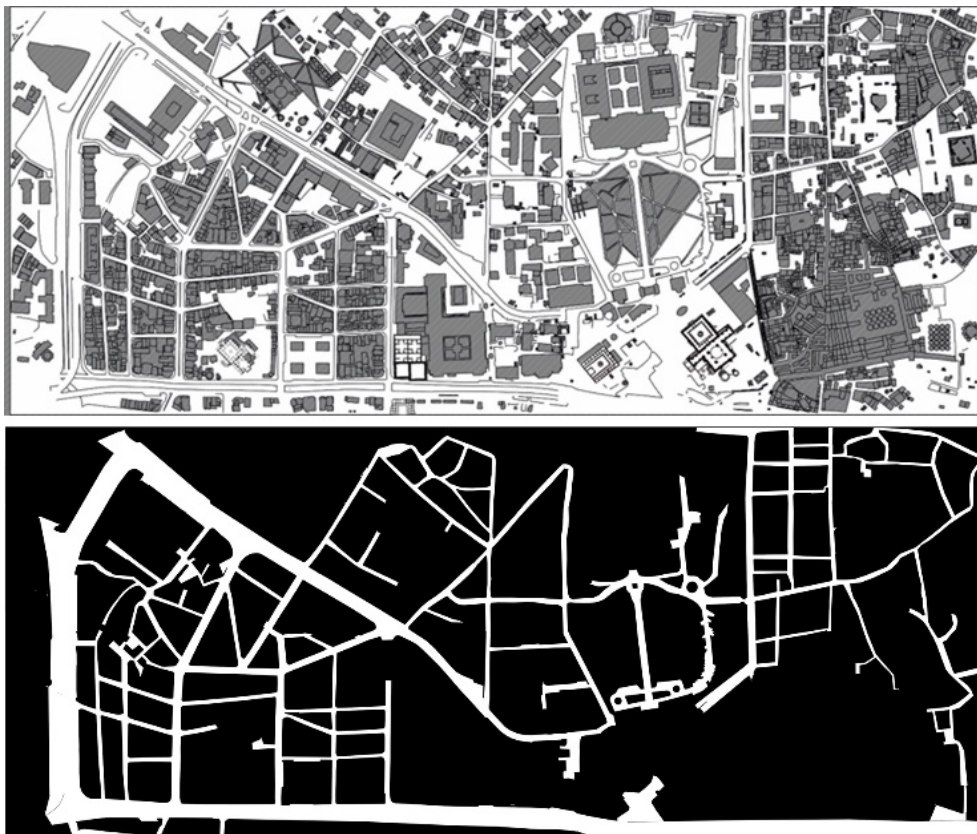


Figure 2. Urban Public Places in Beyazıt, and Street Pattern

The map depicts the urban patterns within the selected area, which is defined by Vezneciler street, Atatürk boulevard, and Army Street which act as the main transport arteries. The educational, religious, and commercial entities densify along these arteries.

3.1. Reduction of the Dimension

According to the measuring the quality of public space, a questionnaire based on these factors is prepared and applied to 120 participants in Beyazit square and the surrounding in Istanbul. 20 variables evaluate the level of surfaces within different categories. All of these variables consist of categorical values where 8 variables are ordinal and 12 variables are nominal values. Since nominal values do not have any mathematical meaning in statistical analysis, we only present the statistical summary of ordinal variables in Table 1. Due to the nominal values, Categorical Principal Component Analysis is performed on the questionnaire data. Based on the eigenvalues of the correlation matrix of the data, it was found that four of the eigenvalues are above one which is the threshold for reducing the dimension of the original data. Thus, we reduced the 20 factors (dimensions) to 4 dimensions shown in Table 1 and Table 2 with their corresponding component loadings. Component loadings that refer to the effect of the components to reduced dimensions above 0.5 can be assessed to be effective, and below 0.5 ineffective.

Table 1. Statistical Summary of Ordinal Variables

	Mean	Std. Deviation	Min.	Max
Place Attachment	3.290	1.414	1	5
Night Security	2.533	1.355	1	5
Day Security	3.682	1.233	1	5
Cleanliness	3.234	1.263	1	5
Noise	3.935	1.168	1	5
Lighting	3.215	1.174	1	5
Green Areas	1.411	0.800	1	5
Parking lot on pedestrian access	3.477	1.475	1	5

According to Table 1, place attachment, day security, cleanliness, lighting, and parking lot on pedestrian access are the important factors that can be referred for a good public space quality validated in Beyazit square and its surroundings. Although cleanliness and lighting are sufficiently employed with respect to the level of service, noise is found to be a disturbing factor. It is understood from the mean and standard deviation in Table 1 that the other green areas are insufficient when evaluating the quality of public space. In addition, car parking areas and traffic regulations limit the use of space.

Considering Table 2, this area is mostly used by men and most of the users do not reside in Beyazit and its vicinity. According to the answers, people feel comfortable there

and they find the area friendly and warm. It is observed that people do not have any problems with transportation and public transportation meets the transportation needs of people. In addition, people use the space for working purposes.

Table 2. Statistical Summary of Nominal Variables

	Mode	Std. Deviation	Min.	Max
Gender	1	0.478	1	2
Residence	2	0.339	1	2
Perception of Public Places	2	1.743	1	6
Activities	5	1.784	1	6
Sights	3	1.050	1	6
Transportation Type	2	0.933	1	4
Transportation Problem	2	0.486	1	2
Satisfaction of Public Transportation	1	0.456	1	2
Purpose of usage	3	1.280	1	6
Frequency of usage	5	1.437	1	5
Connectivity	5	2.473	1	8
Focus Points	1	1.125	1	4

3.2. Methods of Analysis: Categorical Principal Component Analysis (CATPCA)

In a multivariate statistical analysis, the p-variable (feature) of an individual (object) is examined. The fact that many of these variables are related and the number of variables (p) is too large makes it difficult to make various evaluations. In such cases, the main component of the analysis is the most important technique. This is a multivariate statistical method that provides data reduction and interpretation by explaining the variance-covariance structure of these sets of variables through linear combinations of the variables. In this method, the p-variable is n, which is the number of measurements, showing the linearly independent structure; k ($k \leq p$) and orthogonal to each other, are converted to a new variable.

Considering a system created by the p variable in each n measurement, the total variability (variance) of the system is explained by the whole p variable. In the situation of a significant portion of the total variance is explained by the k (k, p) component, the k component may represent the original p variable. In this case, the p variable in the measurement n is reduced to the variable k, without causing a significant loss of information (variance). The new variable was obtained by CATPCA [27], [28]. Nonlinear multivariate analysis is the various linear combinations of the original variables, which are formed based on some constraints. The first desired result with the

basic component analysis aims to find representative variables among original variables X_1, X_2, \dots, X_p , without causing a significant loss of information to reduce and obtain the general factors affecting the variables. Then, with these new variables, various results were achieved in line with the purpose of this study.

CATPCA offers a more general approach to deal with some limitations of traditional PCA. Most importantly, it allows considering both nominal and ordered variables, and can also explore non-linear relationships between variables. Since the questionnaire used in this study consisted of categorical variables, it was found appropriate to use CATPCA.

Data on 20 variables applied to 120 people by random sampling in this region were collected for the study of the quality of public spaces in Beyazit and its environs. To explain the quality of the space, 20 variables shown in Table 3 were used. CATPCA by SPSS was used to determine the main variables affecting the quality of the space. The main variables used in this analysis are given below in Table 3. Those variables belong to the questions that are related to attractiveness, safety, comfort, and accessibility. For each of these categories, we employed CATPCA separately. The relations and effect of each variable to their categories are illustrated in Results and Discussion.

Table 3. Variables

X1	Cleanliness
X2	Noise
X3	Parking lot on pedestrian access
X4	Gender
X5	Residence
X6	Perception of Public Place
X7	Activities
X8	Sights
X9	Transportation Type
X10	Transportation Problem
X11	Satisfaction of Public Transportation
X12	Purpose of usage
X13	Frequency of usage
X14	Amenities
X15	Connectivity
X16	Place Attachment
X17	Night Security
X18	Day Security
X19	Lighting
X20	Green Areas

4. Results and Discussion

In this study, the important components were selected according to the CATPCA method which was found to be

2 for each category. CATPCA is applied to variables for each category separately which consists of both nominal and ordinal variables. It is found that Cronbach's alpha value is consistent with the number of dimensions and the model. Model summaries and CATPCA loadings for each variable are shown under their respected categories. The corresponding model summaries for each category are given in Table 4, Table 6, Table 9, and Table 11, which show that Cronbach's Alpha and eigenvalues related to two dimensions have eigenvalues greater than one.

4.1. Accessibility

The ability of public space to provide access to people of different ages, genders, races, classes, and physical abilities, is one of the primary criteria. The variables under this category are frequency of usage, connectivity, transportation type, transportation problem, and satisfaction with public transportation. CATPCA is applied to these variables consisting of both nominal and ordinal variables where the model is reduced into two dimensions (Table 4).

According to Table 5, frequency of usage, transportation type and satisfaction of public transportation are highly consistent with the first dimension while connectivity and transportation problems are dependent on the first dimension.

Component loadings are visualized in Figure 3, which is consistent with the analysis. It is also obvious that transportation type and satisfaction of public transportation have higher values in the direction of dimension 1 than in dimension 2, and connectivity and transportation problems have higher values in the direction of dimension 2.

Table 4. Summary of Accessibility

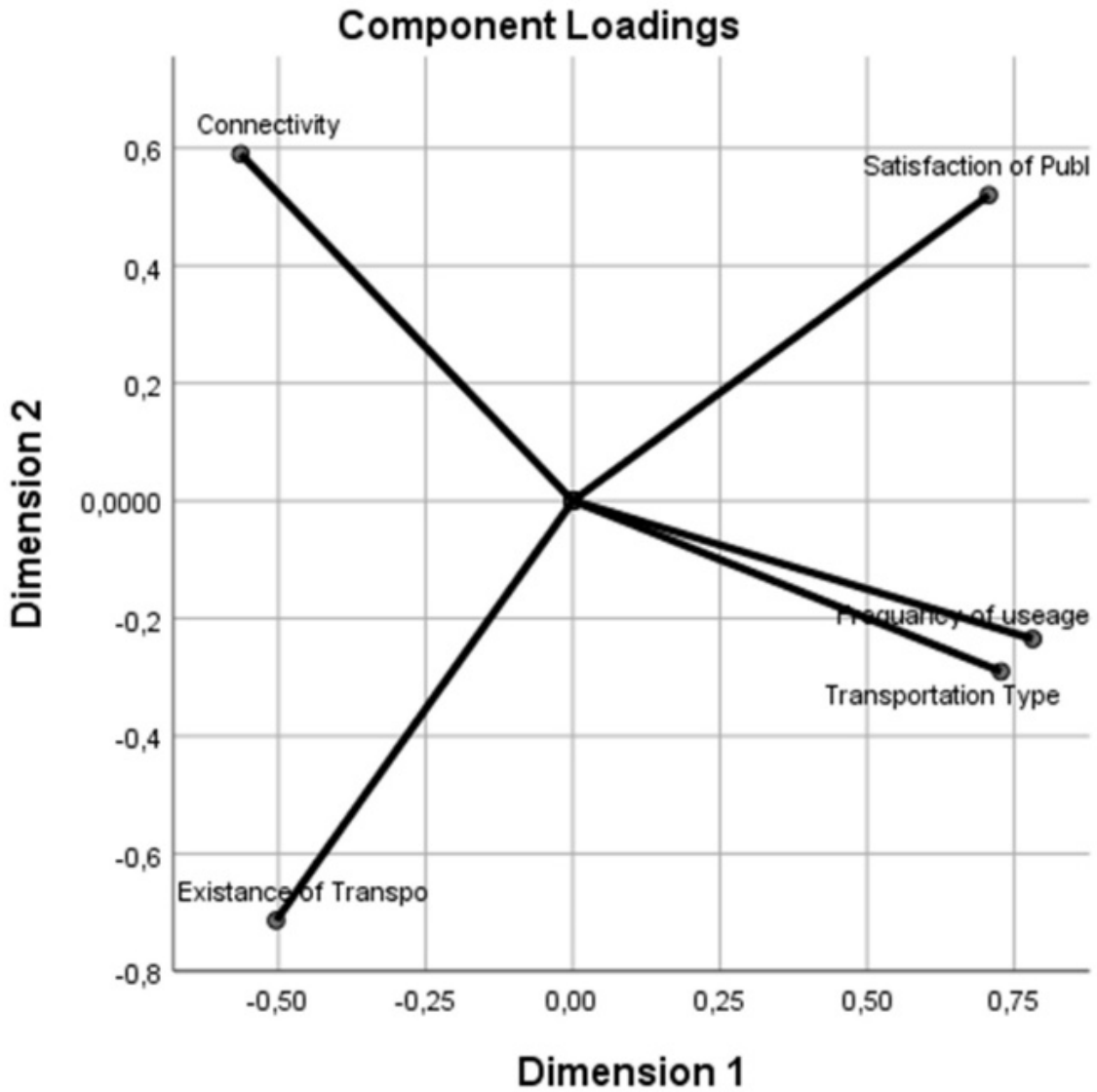
Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	0.685	2.210	44.206
2	0.263	1.267	25.336
Total	,891a	3.477	69.543

a. Total Cronbach's Alpha is based on the total Eigenvalue.

Table 5. Component Loadings of Accessibility

		Dimension	
		1	2
Frequency of usage	0.781	-0.235	
Connectivity	-0.564	0.590	
Transportation Type	0.727	-0.290	
Transportation Problem	-0.504	-0.714	
Satisfaction of Public Transportation	0.706	0.520	
Variable Principal Normalization.			

The area is surrounded by metro, tram, and bus stops and offers a wide range of public transportation facilities. However, the intensity of transportation brings about disruptions in pedestrian mobility.



Variable Principal Normalization.

Figure 3. Visualization of Component Loadings of Accessibility

4.2. Safety

The variables under this category are the perception of the public place, day security, night security, and lighting. CATPCA is applied to four variables consisting of both nominal and ordinal variables where the model is reduced into two dimensions (Table 6).

According to Table 7, perception of public space and lighting is highly consistent with the second dimension while day security and night security are dependent on the first dimension.

Table 6. Model Summary for Safety

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	0.621	1.870	46.745
2	0.231	1.211	30.265
Total	,900a	3.080	77.011

a. Total Cronbach's Alpha is based on the total Eigenvalue.

Table 7. Component Loadings of Safety

	Dimension	
	1	2
Perception of Public Places	-0.216	0.839
Day Security	0.897	-0.106
Night Security	0.906	-0.041
Lighting	0.446	0.703

Variable Principal Normalization.

Component loadings are visualized in Figure 4 which is consistent with the analysis. It is also obvious that night security and day security have higher values in the

direction of dimension 1 than dimension 2. The rest of the components have a higher value in the direction of dimension 2.

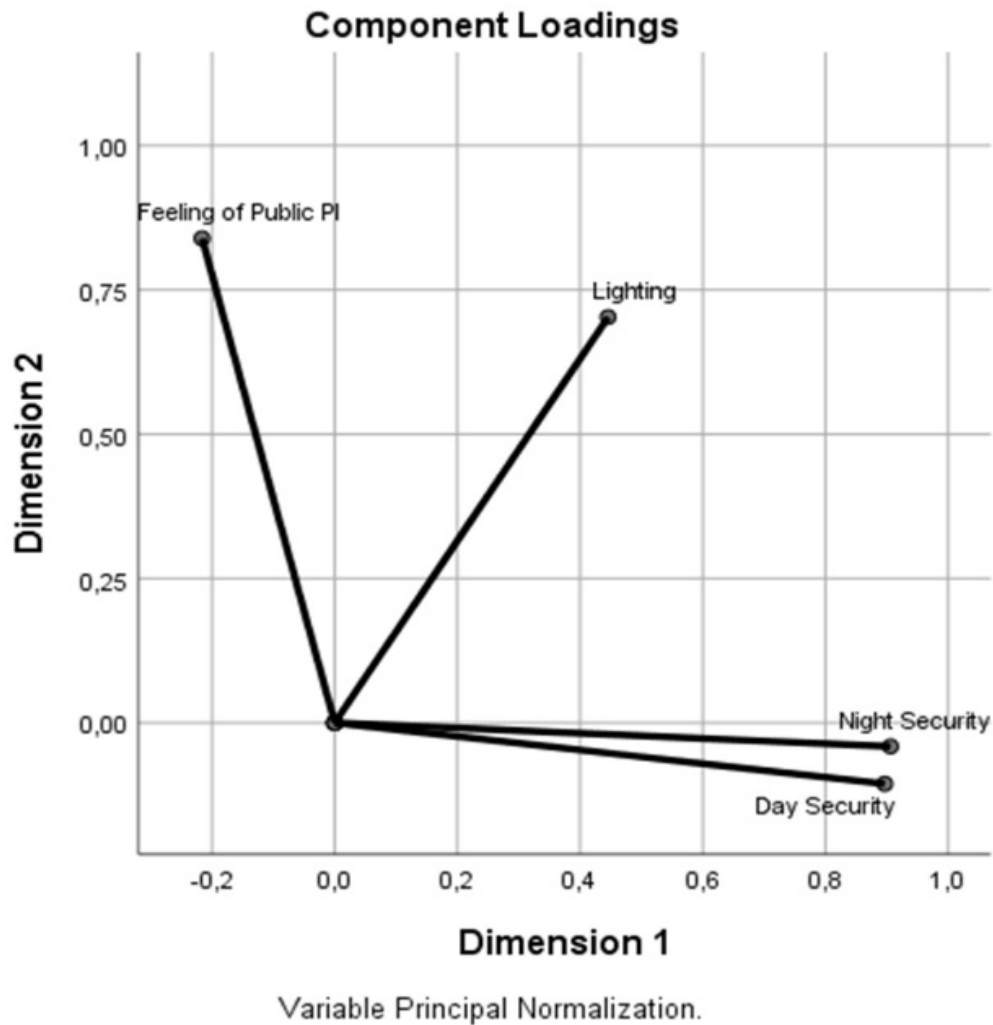


Figure 4. Visualization of Component Loadings for Safety

Table 8. Descriptive Statistics of Safety Variables

Perception of Public Space ^a			Day Security ^a		
Frequency			Frequency		
Valid	1	26	Valid	1	9
	2 ^b	29		2	9
	3	7		3	22
	4	22		4 ^b	34
	5	8		5	33
	6	15		Total	107
	Total	107			
a. Optimal Scaling Level: Nominal.			a. Optimal Scaling Level: Ordinal.		
b. Mode.			b. Mode.		

Night Security ^a			Lighting ^a		
Frequency			Frequency		
Valid	1 ^b	30	Valid	1	8
	2 ^b	30		2	21
	3	21		3 ^b	37
	4	12		4	22
	5	14		5	19
	Total	107		Total	107
a. Optimal Scaling Level: Ordinal.			a. Optimal Scaling Level: Ordinal.		
b. Mode.			b. Mode.		

Based on descriptive statistics in Table 8, we concluded that people feel safe during the daytime, and depending on the lack of lighting, they feel unsecure during nighttime.

4.3. Comfort

Comfort involves a large number of highly diverse factors that make this need a complicated issue to analyze.

The factors such as cleanliness, noise, and satisfaction of public transportation are included in “comfort”. CATPCA is applied to these variables consisting of both nominal and ordinal variables so that the model is reduced into two dimensions (Table 9).

Table 9. Model Summary of Comfort

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	0.489	1.483	49.439
2	-0.284	0.841	28.032
Total	,855 ^a	2.324	77.471

a. Total Cronbach's Alpha is based on the total Eigenvalue.

According to Table 10 and Figure 5, cleanliness and satisfaction of public transformation are highly consistent with the first dimension while noise is dependent on the second dimension negatively.

Table 10. Component Loadings of Comfort

	Dimension	
	1	2
Cleanliness	0.770	-0.080
Noise	-0.643	-0.712
Satisfaction of Public Transportation	-0.691	0.573

Variable Principal Normalization.

Component loadings are visualized in Figure 5, which is consistent with the analysis. Figure 5 indicates that cleanliness and satisfaction of public transformation have higher values in the direction of dimension 1 than in dimension 2 and noise has a higher value in the direction of dimension 2.

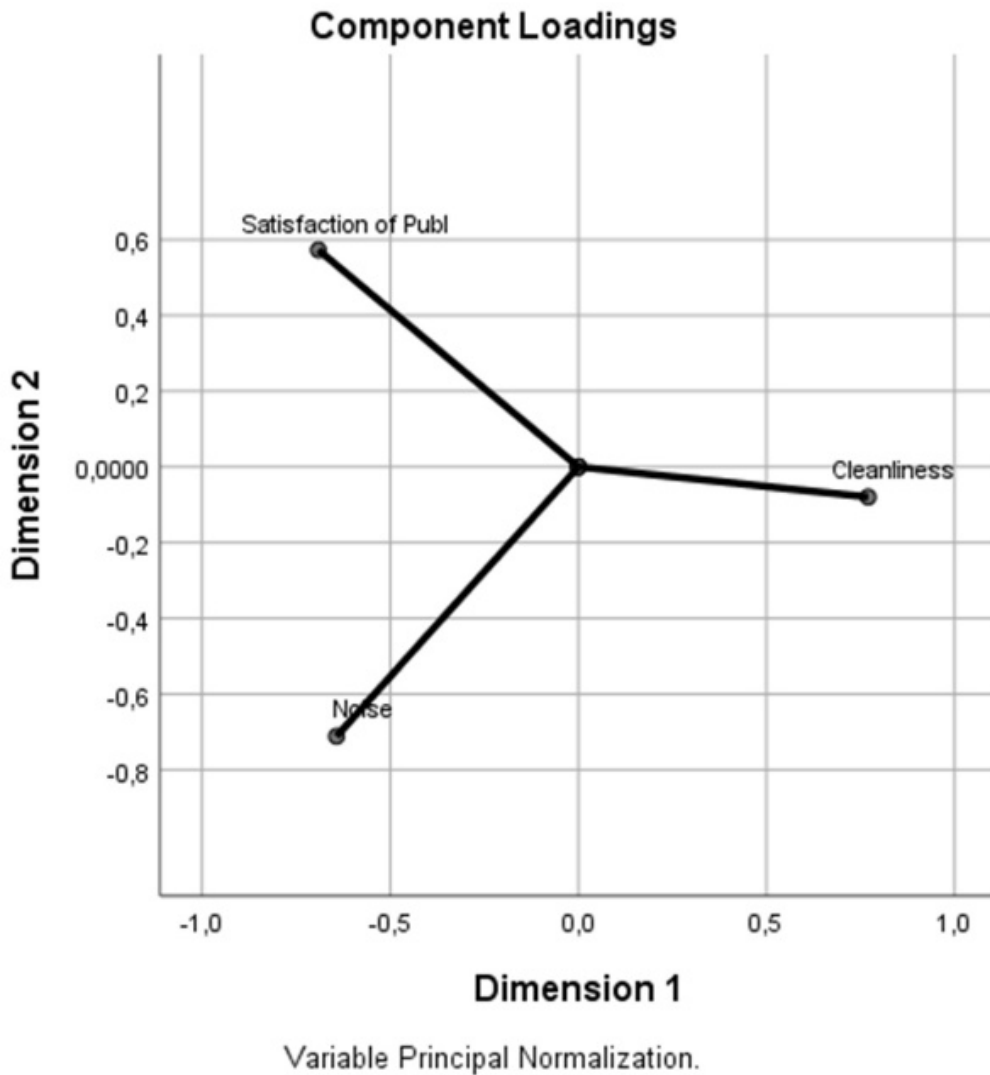


Figure 5. Visualization of Component Loadings for Comfort

From these results, people find the area clean. However, they are uncomfortable with noise. It is observed that public transportation meets the transportation needs of people as can be seen from the statistics summary given in Table 1 and Table 2.

4.4. Attractiveness

Attractiveness is based on the capacity of pedestrian mobility for social interaction. (Gehl, 2011). The variables under this category are activities, sights, the purpose of usage, amenities, place attachment, and green areas.

We analyzed the CATPCA loadings through the relation between each variable with the reduced new dimensions in Table 11. All of these computations are performed by SPSS 25.

Table 11. Model Summary for Attractiveness

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	0.592	1.973	32.887
2	0.475	1.655	27.585
Total	0,869a	3.628	60.473

a. Total Cronbach's Alpha is based on the total Eigenvalue.

According to Table 12, activities, the purpose of usage, and amenities are highly consistent with the first dimension while the rest of the variables are dependent on the second dimension except for place attachment. Since the loadings of place attachment in both dimensions are too close to each other, it is difficult to differentiate and put this variable into a specific dimension.

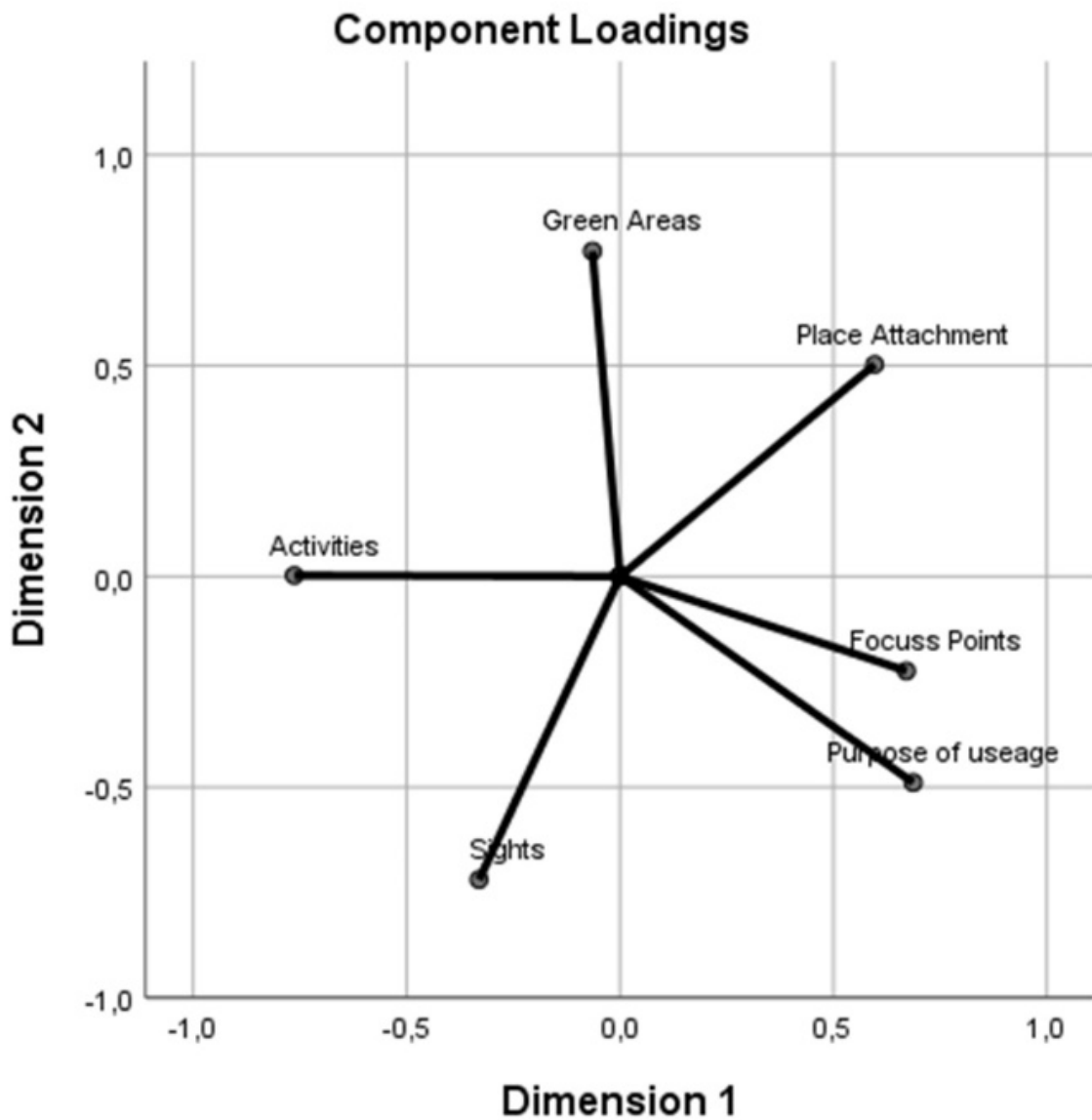
Table 12. Component Loadings for Attractiveness

	Dimension	
	1	2
Activities	-0.763	0.002
Sights	-0.330	-0.719
Purpose of usage	0.687	-0.489
Amenities	0.671	-0.224
Place Attachment	0.597	0.503
Green Areas	-0.065	0.772

Variable Principal Normalization.

The quality of activities that take place, the means of use, and the overall feeling or perception of users in the public space are of larger significance and impact than the identity of the public space itself. The accessibility of Sultanahmet Square and its surroundings play a significant role in the use of public space.

Component loadings are visualized in Figure 6 which is consistent with the analysis. It is also obvious that amenities and purpose of usage have higher values in the direction of dimension 1 than dimension 2. The rest of the dimension 1 has a higher value in the direction of dimension 2 except place attachment.



Variable Principal Normalization.

Figure 6. Visualization of Component Loadings for attractiveness

As a result, 4 different categories, accessibility, security, comfort, and attractiveness, were obtained with the CATPCA method, in which the quality of public space can be measured. These categories are also consistent with previous studies in the literature.

Mehta's [19] PSI model is similar in terms of comfort and safety factors, and parallels between the two models are increasing with the sub-parameters. The results of the PSI based on literature review and empirical research support this study based on statistical data. The model used by Evans et al. [20] by developing the PSI also supports this inference. Similarly, Praliya, S. and Garg, P. [29] determined public space quality parameters in 8 categories with the PSQI (Public Space Quality Index) model. Among them, accessibility and connections, attractiveness and appeal, and comfort support the factors of this study. The PPS organization [21] has defined public space quality parameters with the data collected from all over the world. Two of these (access and comfort) support the factors established in this study.

Therefore, these determining factors also express the common points of many studies. It shows similarities and parallels with studies carried out in various communities. However, the most important difference of this study from other studies is the determination of findings by statistical analysis. The method used has a structure that can be re-analyzed in every society, even if the communities differ and contain values based on different factors. Consequently, despite sociological and cultural differences, the model can be developed and adapted with this method.

5. Conclusions

Public spaces affect the lives of their inhabitants and their spatial quality, in turn, affects their impact significantly. For public spaces to be resilient, to positively influence people and the events that take place in them, designers must pay attention to the quality of these spaces which is strongly correlated to the initial approach to design in earlier phases of planning. This paper makes use of the statistical learning method CATPCA as a framework to understand the significance of the investigated factors and analyze them in detail based on respective component loadings. Additionally, to obtain a valid result, descriptive statistical values are matched and explained for each category, i.e. accessibility, comfort, safety, and attractiveness. Results show that, with the four subcategories which are gathered by reducing components into two dimensions by CATPCA, future evaluations and criteria for improving the level of quality for public spaces can be formulated following similar steps.

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