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Walkability: Perceived and measured qualities in action

Özlem ÖZER, Ayşe Sema KUBAT
Istanbul Technical University, Faculty of Architecture, Department of Urban & Regional Planning, İstanbul, TURKEY

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Abstract:
The research into walkability has two common approaches to the variables: one depends on measuring the spatial configuration of street networks and the other depends on operationalizing urban design qualities such as imageability, enclosure, transparency and complexity by measuring the actual physical environment. Environmental perception has often been a subject in research into wayfinding behaviour, but not so much in research into walkability.

In this paper, we argue that it is possible to obtain a more accurate walkability forecast by comparing spatial configuration measures with the environmental perceptions of pedestrians to evaluate their effects on pedestrian movement levels.

In order to do this comparison, three case areas were selected, all of which are central retail districts in İstanbul, and which have a similar socio-economic user profile, similar public and private transportation links with the city and a similar relationship with the waterfront. All the three case areas were limited to cover a 1km x 0.5km area. The similar qualities of the three case areas are expected to offset the effects of land use, user profile, transportation links and recreational qualities.

The research was conducted in three basic steps. The first step was to record pedestrian movement levels in approximately 20 locations in each case area. The second step was to apply space syntax methodology to measure spatial configuration. The third step was to conduct a questionnaire to understand how users perceive those exact observation locations. The questionnaire made use of a semantic differential technique where participants are given pairs of oppositional adjectives with a rating scale.

The data recorded in this study was analysed statistically to define the correlational relationships among the three variables, which are pedestrian movement levels, spatial configuration and user perception. It is believed that the results of this study will contribute to a better understanding not only of the walkability measures, but also of the level of relation between the space syntax methodology and pedestrian perception. The method and the findings of this study constitute an analytical model that could shed fresh light on future research on walkability as well as on controlling levels of use within urban design proposals.

Keywords: *Walkability, space syntax, semantic differential, urban design.*

1. Introduction

Walking is the simplest form of transportation for it is universal, it is cheap, it connects different modes of transport and it is healthy and enjoyable (Littman, 2011). Although urban designers have supported the creation of more walkable cities for years, the subject has recently gained importance with the evidence from health research and walkability is now one of the rising subjects in the field of public health.

Physical activity has been found to be related with cardiovascular fitness, stronger bones, mental alertness, creativity, increased longevity and reduced risk of stress, cardiovascular diseases, diabetes and even some types of cancer (Forsyth and Southworth, 2008; Ewing et al., 2006; Ewing and Handy, 2009; Owen et al., 2007; Leslie et al., 2007; Greenberg and Renne, 2005; Cerin et al., 2007). With the growing awareness of benefits of walking, the meaning of "walkable" has been revised as "encouraging physical activity". However, the word itself carries meanings of short distance, not having barriers that would restrain pedestrians, being safe in terms of both traffic safety and security, and having a proper infrastructure for walking (Forsyth and Southworth, 2008). As an indicator of the physical quality of urban environments, walkability is also being considered as an environmental justice issue (Greenberg and Renne, 2005).

Almost all the developments in transportation technologies have degraded the pedestrian environment. Roads serve high-speed traffic; and they have lost their human scale (Forsyth and Southworth, 2008). Research into types of transportation usually overlook the part of the journey that includes walking as it has been found to be easier to collect data on vehicle movement such as traffic flow rates and speed, and to run tests for transportation models. Walking is an invisible type of transportation for most transportation planners (Littman, 2011).

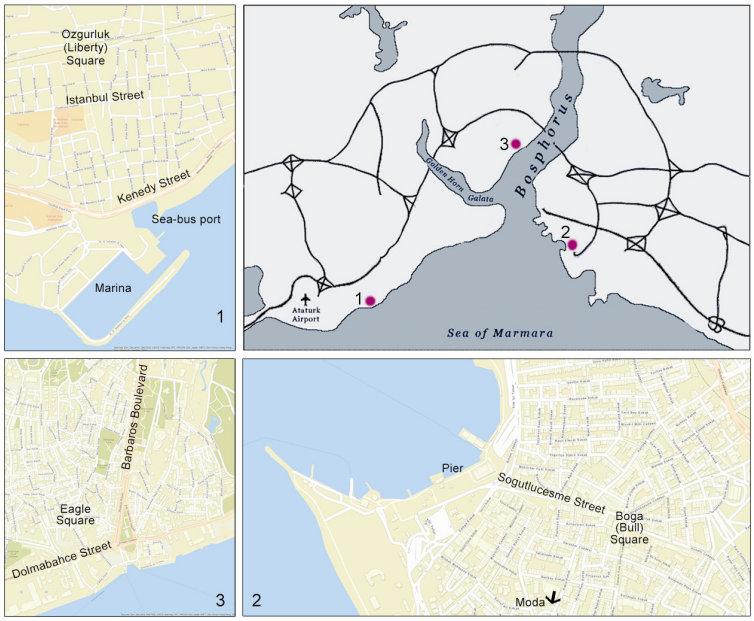
The movement potential generated by the urban grid has direct or indirect effects on many factors other than land use. Movement is a strong phenomenon and it brings liveliness to an area. According to Helbing et al. (2001), patterns of movement of pedestrian crowds are predictable, although there are individual preferences, aims and destinations in effect. The walking behaviour of pedestrians is influenced by other pedestrians' movement and if their footprints were traced, it would be possible to see systems within their trails (Helbing et al, 2001).

To explain the walkability of a neighbourhood, primary measures have been operational indicators such as density, connectivity, proximity to main destinations. It is also a strong assumption that indicators such as imagebility or enclosure, which are difficult to measure, are also significant factors affecting the liveliness of the streets (Ewing et al., 2006; Ewing and Handy, 2009). Research into the effects of urban space on walking behaviour have developed techniques to operationalize perceptual qualities such as enclosure, complexity, and human scale and have suggested using the measurable attributes of the physical environment to evaluate perceptual qualities (Ewing and Handy, 2009). The most often used physical environment attributes to explain perceptual qualities are building height, block length, street and sidewalk width, building density, number of intersections within the street network, mixed land use and net retail area, proximity to specific destinations such as recreational areas or retail centres and number of people (Ewing and Handy, 2009; Ewing et al., 2006; Cerin et al., 2007; Owen et al., 2007).

The relationship between pedestrian movement and spatial configuration has widely been studied in space syntax literature. According to the research, spatial layout has a movement potential that is independent of all the other factors. Integration and choice measures of space syntax strongly estimate not only current but also potential movement levels. Extensive research has shown that pedestrian movement levels are highly correlated with spatial layout, and space syntax measures provide consistent estimations of movement levels (Hillier et al., 1993; Hillier, 1996; Peponis et al., 1997).

Considering that the effects of physical attributes of a place on individuals are similar, it seems possible to predict their likely effects on walkability by simply measuring those physical attributes. However, considering only the physical measurements and disregarding the human aspect would not give robust results.

One of the techniques developed to understand how physical environment affects feelings is the Semantic Differential Scale. The Semantic Differential Scale uses pairs of opposite words and, usually, a 7-level evaluation scale. This technique of using pairs of polar concepts is founded on research into synaesthesia (Osgood, et al., 1957). According to the Warren's Dictionary of Psychology, synaesthesia is explained as a "phenomenon of defining the experience when a stimulus is triggered as a result of stimulating another sense". Research has shown that visualization in synaesthesia is closely related to verbal metaphors; such as expressing basses as low, trebles as high, hope as white and pessimism as black (Osgood, et al., 1957). There is no standardized template or standard scale for the semantic differential technique, and within the scope of research, it can be adapted to the concepts that need to be measured (Osgood, et al., 1957).



2. Methodology

The analysis of this research was designed in three basic steps, those are pedestrian counts, syntactic analyses and questionnaires. Three case areas were selected, all of which are central retail districts in İstanbul, with a similar socio-economic user profile, similar public and private transportation links with the city, a similar relationship with the waterfront and similar topography which rises from sea level towards their inner areas (Özer, 2014). The selected case areas are the main centres of Bakırköy, Kadıköy and Beşiktaş (Figure 1).

Figure 1. *Study areas.*

In order to have a more comprehensible idea of the similarities between case areas, their land use ratios, average block sizes and building densities have been compared (Table 1).

All three case areas have been limited to cover an area of 1kmx0,5km. The similar qualities of the three case areas are expected to offset the effects of land use, user profile, transportation links and recreational qualities.

Table 1. *Initial measures of case areas.*

		Bakırköy	Kadıköy	Beşiktaş
Ground Floor	Residential	29,21%	6,67%	16,65%
	Retail	60,42%	73,60%	60,61%
	Other uses	10,37%	19,73%	22,74%
Average block size (sqm)		3432	3457	3945
Building density		55,65%	52,52%	49,62%

To get a thorough representation of the case areas, a number of street segments from each case area have been identified for observations based on preliminary spatial analyses. The resulting number of observation points is specified as 20 locations from Bakırköy, 22 locations from Kadıköy and 23 locations from Beşiktaş, making a total of 65 observation points (Figure 2).

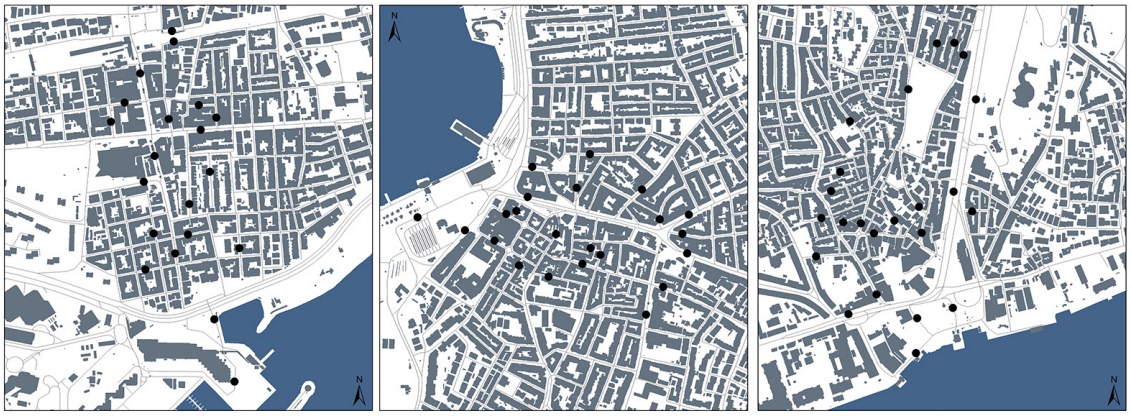


Figure 2. *Locations of observation points.*

2.1 Observing pedestrian movement

The most significant step of the walkability research is pedestrian flow rates. To distinguish the different movement patterns generated by people who use the area for work and those who use the area for recreation or entertainment, pedestrian counts were carried out on one week day and one weekend day. Each location was observed for five minutes within two-hour time periods, between 08:00 and 20:00, and pedestrians were recorded separately according to their direction of travel.

Since the observed locations were sampling points from the case areas, the observations did not record all the pedestrian movement within the study areas, which means there were more people than those who were recorded. The findings show that, highest level of movement throughout the day was recorded in the Kadıköy area and it is nearly twice as much as the movement recorded in the Beşiktaş area. Bakırköy has a relatively higher level of movement than Beşiktaş but still significantly lower than that of Kadıköy (Table 2, Figure 3, 4).

Table 2. *Pedestrian movement rates in the case areas.*

	Weekday	Weekend
Bakırköy	264,144	323,496
Kadıköy	430,800	557,664
Beşiktaş	201,768	199,920

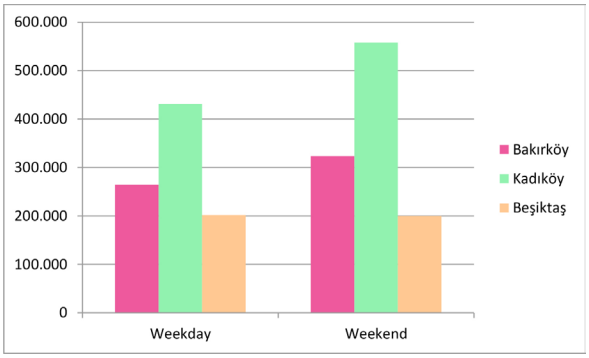


Figure 3. *Pedestrian movement rates in the case areas.*

In Bakırköy, the main pedestrian axis, İstasyon Street, starting from the Özgürlük (Liberty) Square at the north end of the study area and continuing until it connects to the coastal road (Kennedy Street) in the south, displays a dense pedestrian flow throughout the day. İstanbul Street, which follows an east-west direction, is the second busiest street used by pedestrians despite its vehicle traffic, the illegal parking that occupies two lanes and the narrow sidewalks. The colonnade system on one of the sidewalks the potential to provide a nice walk for pedestrians, but the low physical quality, advertising signs of local shops at every step and poor solutions for height differences along the sidewalk make it unpleasant (Figure 5).

Movement seems to be concentrated on the northern part of İstanbul Street and the distribution shows large numbers of pedestrians in the surrounding areas of the square, where there is a main bus station, and in the nearby streets at the intersection of two busy arterial streets. On the southern side of İstanbul Street, movement is concentrated only on the main arterial road and does not spread to the secondary roads. The amount of movement is reduced until it reaches the seaside, where there is a sea-bus port, and it is reduced a little more after the port and before the marina, which is a newly renovated entertainment and service zone (Figure 5).

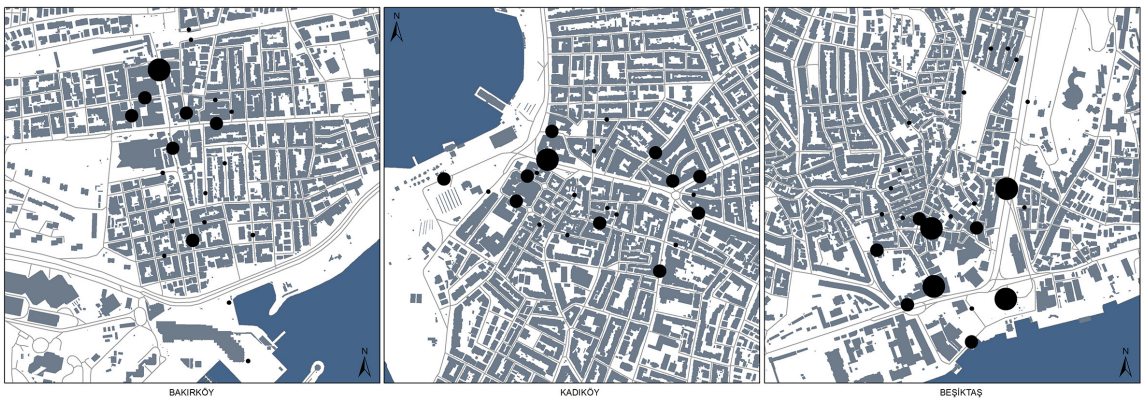


Figure 4. *Distribution of movement throughout the case areas.*

In Kadıköy, the main thoroughfare, Söğütlüçeşme Street, is not a pedestrian way; on the contrary, it is a main traffic artery with three lanes of one-way traffic and another lane for public transport which runs in the opposite direction, which runs together with a “nostalgic” tramway. Similar to İstanbul Street in Bakırköy, there is a colonnade system on one sidewalk, but with a better layout, and the sidewalk on the other side of the street is wide enough to enable a safe and pleasant walk (Figure 6).

Figure 5. *İstanbul Street, sidewalks with colonnade system (left) (source: http://www.yandex.com/) and Marina Park in the seaside of Bakırköy (right) (source: http://www.atakoymarina.com.tr/).*

The east end of Söğütlüçeşme Street is occupied by Altıyol Square. Its name means “six-points”, and it is the intersection point of six streets. The square has a statue of a bull, which is a very well-known reference point for the whole city. Söğütlüçeşme Street starts with a high amount of movement from the seaside. At the east end of the street, movement is dispersed towards the secondary arteries from Altıyol Square, all of which lead to destinations such as the main metro-bus station or the quieter residential and recreational neighbourhood of Moda (Figure 6).

Figure 6. *Söğütlüçeşme Street, Kadıköy (left) and Altiyol Square, Kadıköy (right) (source: http://www.flickr.com/).*

In the inner parts of Kadıköy, there are little urban squares on busy streets. These inner areas are all pedestrian-only streets which provide comfortable access for pedestrians.

The third case area, Beşiktaş, encloses a part of the coastal road, named Dolmabahçe Street, and its continuation to Barbaros Boulevard. This connects to the Bosphorus Bridge, and on a usual day it occupied by heavy vehicle traffic. Having such an active relationship with the main transportation system of the city pushes pedestrian movement into the background on the main arterial roads of Beşiktaş. Barbaros Boulevard has wide sidewalks but the sidewalks of Dolmabahçe Street are too narrow to allow more than two people to walk side by side (Figure 7).

Figure 7. *Narrow sidewalks on Dolmabahçe Street (coastal road), Beşiktaş (left) and Barbaros Boulevard with its Bosphorus Bridge connection, Beşiktaş (right) (source: http://www.yandex.com/).*

The inner areas of Beşiktaş are both spatially and visually disjointed from the major roads. Although the entrance from Barbaros Boulevard is wide and remarkable, the route leading towards the centre is not a linear way. Therefore, the main centre of Beşiktaş is not recognizable from the major roads, nor can it be seen directly. There is a small-scale urban square with a huge statue of a black eagle (the symbol of Beşiktaş Sports Club, the local football team) in the centre. Unlike Kadıköy, this is known through its symbolic meaning, rather than its being a strong reference point. The statue is located very close to the fish market of Beşiktaş which is another symbolic and historical element of this area (Figure 8).

Figure 8. *Eagle Statue at the main center of Beşiktaş (up-left) (source: http://www.yandex.com/) and the fish market of Beşiktaş (bottom left and right) (source: https://acdn.architizer.com/).*

Since local people and frequent users of Beşiktaş are used to this complicated layout, the high amount of movement in this central area continues throughout the day. The streets which connect to the square are all pedestrian ways and it is one of the main reasons for the high levels of movement in this centre.

Instead of linear main arteries, the movement distribution in Beşiktaş displays a core which encircles the central area, the south parts of Barbaros Boulevard, the bus stop on Dolmabahçe Street, the main bus stop on the seaside, the pier and the very close surroundings. This distribution indicates that, in addition to spatial layout, there are multiple factors affecting pedestrian movement.

In all three case areas, movement distribution throughout the day displayed a very similar pattern during the week day and weekend.

2.2 Spatial analyses

The space syntax method has been used for spatial analyses. The road-centre lines map of the İstanbul Metropolitan Area generated by the Greater Municipality of İstanbul is an up-to-date representation of the street network of the entire city. In order to utilize this map for spatial analyses, it has been revised to include pedestrian-only connections that are not part of the street network. The three case areas were extracted from the map to create three separate files each of which covers a 2x2 km area. The angular segment analysis tool was run to calculate global and local measures. Global analyses are found to be better for the representation of the characteristics of the case areas for both integration and choice.

In Bakırköy, the global integration analysis emphasizes the two main arterial roads, İstanbul and İstasyon streets. In addition to those, Iskele Street, which has a north-south direction, is distinguished with its high integration values. The connections to the coastal Kennedy Street are limited either because of access control or height differences (Figure 9). Iskele Street is one of the few routes that have a connection to Kennedy Street. It works as a collector road and completes the circulation of the road network in the vicinity of the study area.

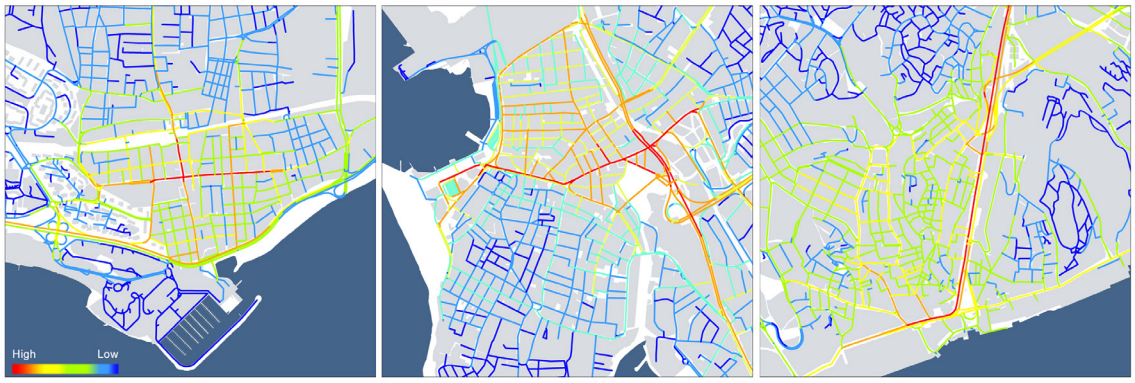


Figure 9. *Integration analyses of the case areas.*

Looking at the integration map from a distance, it can be clearly seen that the entire study area is separated from its surroundings by Kennedy Street in the south, by two main roads on its east and west sides, and more dramatically by the suburban train line in the north.

The only connection with the southern side of Kennedy Street is provided by a pedestrian bridge. The port for the sea-bus ensures a pedestrian flow to the area and Marina Park makes use of this flow. As mentioned before, this area has been recently renovated and its pleasantness also attracts people. However, the need for renovation emerged as a result of its disconnected layout. It had degraded and had become run down mainly due to poor links with the more lively neighbourhoods. As the sea-bus transportation system of the city expanded, more people started to use the port. Although the location of the port is inconvenient, it offers a fast and comfortable access to the Anatolian side, which would otherwise take much more time to reach.

The construction of a rail system project that will renovate existing suburban train lines and connect the rail systems of two sides of the city with a railroad

under the Bosphorus started in 2004 (Marmaray). With the completion of this construction, sea-bus transportation will have an equally fast and comfortable alternative. This will most probably reduce the number of passengers using the sea-bus and will affect the use of Marina Park area as well. It has been proven by experience that this area needs an intervention on its spatial layout to minimize the dividing effect of Kennedy Street and prevent its possible degradation.

The Kadıköy case area also has a disjointed pattern. It is divided by Söğütlüçeşme Street which connects to Bağdat Street in the east, the predominance of which is clearly seen on the integration map. Although the length and linear structure of these two streets were expected to be defined by high integration values, it is interesting to see that Söğütlüçeşme Street reaches the seaside on the west, thereby preserving its integration. It also continues to have high values beyond the boundaries of the neighbourhood on the east. An integrated core enclosed by these two streets is noticeable in the northern side of the area, while the southern side displays a disconnected structure.

In the Bakırköy case, coastal road creates a dividing effect because of its unconnected system as a result of its height difference and because of the limited crossing points. In the Kadıköy case, Söğütlüçeşme Street is a highly connected street, which collects traffic from all the neighbouring streets. This feature was expected to make it more accessible. However, the traffic regulations imposed upon it create a dividing effect by not allowing a connection between the two sides. Pedestrian crossings on Söğütlüçeşme Street are represented correctly on the road centre lines map, and are shown with two parallel lines. The actual situation is close to what is represented, but of course there are informal crossings as well. On the eastern parts of Söğütlüçeşme Street, there are height differences between the inner parts which are resolved by stairs.

The integration analysis of the Beşiktaş case area verifies the significance of Barbaros Boulevard and Dolmabahçe Street. Barbaros Boulevard is represented by two parallel lines because the connections between the streets on either side are limited by the geometric arrangement of the boulevard. The heavy traffic makes informal crossings nearly impossible, but there are a number of pedestrian crossings to prevent a disconnection between the two sides which are properly shown on the road centre lines map. Thus, the integration map does not display a completely disconnected pattern. The central area is also encircled by integrated lines.

The main differences between the two sides are that the street density is higher in the western section and there are unconnected lines causing dead-ends in the eastern section. Low integration values on the eastern side are mostly a result of the low density of the street network caused both by the hilly topography and by land uses that occupy large parcels. In the northern side, a similar situation is observed. There are dead-end streets caused by the inclines and which are defined with low integration values.

The global choice analysis of the Bakırköy case area shows that the İstanbul and İstasyon streets are defined with the highest choice values. Unlike the integration analysis, choice values do not show a hierarchical order. The streets with high choice values are clearly distinguished and they tend to form

a grid. These lines show a balanced system as they continue in both the north-south and east-west directions (Figure 10).

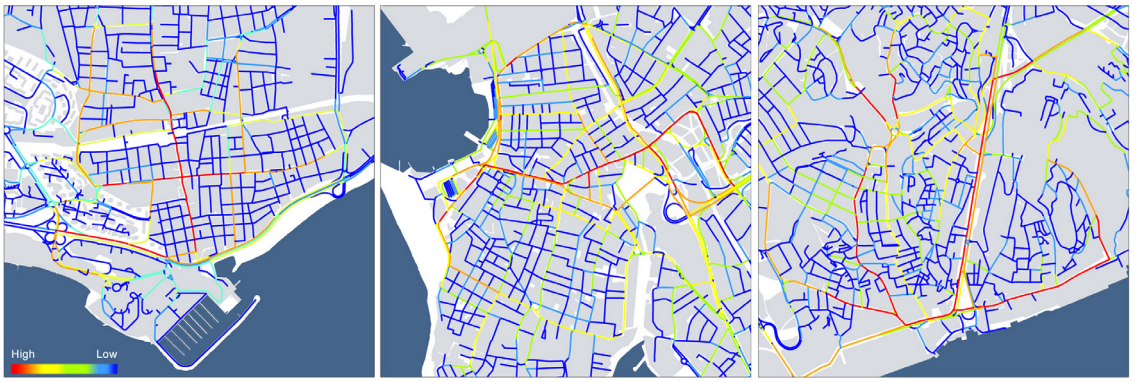


Figure 10. *Choice analyses of the case areas.*

The global choice values of Kadıköy emphasize the importance of Söğütlüçeşme Street. High choice values continue through this street and a three-section partition can be observed. On the north side of Söğütlüçeşme Street there is a hierarchy of choice values. The south side has two sections separated by Moda Street. In these sections, no continuing route can be observed.

The global choice analysis of Beşiktaş shows that streets with high values surround the central market area, which is defined with low choice values. Unlike the integration analysis, Barbaros Boulevard displays a stronger connection with the eastern part of the coastal road. In both Bakırköy and Kadıköy, choice values tend to form a grid, which cannot be seen in Beşiktaş because of its grift street network. In Beşiktaş, streets with higher choice values are all in the north-south direction and there is no continuing route in the east-west direction.

2.3 User perception

This phase of the study has been constructed on questionnaires that use the semantic differential scale. The semantic differential technique is preferred because it requires minimum levels of literacy and it allows a fast and simple evaluation.

At each observation point, at least 10 questionnaires were made. Randomly selected subjects were required to fill questionnaire forms comprising 25 pairs of polar adjectives. The questionnaire form was designed to have 7 units between each polar term. Subjects were asked to define the exact location that the questionnaire was being carried out by marking the box that best fits their feelings about that location.

(3) Extremely X
(2) Very X
(1) Slightly X
(0) Neither X nor Y; equally X and Y
(-1) Slightly Y
(-3) Extremely Y
(-2) Very Y

Responses were quantified following below assessment:

The final table consisted of 678 rows each having 25 columns showing the results of questionnaires made at 65 observation points. Using the SPSS

Table 3. *Results of the factor analysis.*

Attraction	Attractive - Unattractive Decent – Inferior Rich – Plain Special – Ordinary Nice – Bizarre Modern – Old style Surprizing – Dull Clean – Dirty
Beauty	Peaceful – Disturbing Good – Bad Beautiful – Ugly Safe – Dangerous Comfortable – Uncomfortable Consistent – Inharmonious
Liveliness	Lively - Spiritless Diverse – Monotonous Functional – Dysfunctional Central – Disconnected (segregated)
Intelligibility	Defined – Undefined Memorable – Unimpressive Clear – Complicated
Novelty	New – Old Maintained – Neglected
Openness	Open – Confined Spacious – Overcast

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

software, a factor analysis was applied to the final table to identify interrelated variables and reduce the number of variables by grouping those related. Factor analysis returned 6 factors defined with the given variables (Table 3).

When three case areas are examined comparatively, it can be seen that the Beşiktaş area is distinguishable from other case areas in almost all the factors. In particular, the Kadıköy and Beşiktaş areas display a completely reverse graphic. The general user perception in Beşiktaş indicates a weakly satisfied user profile in attraction, liveliness, intelligibility and novelty factors, while there is an average sense of beauty and a relatively higher feeling of openness (Figure 11). On the other hand, the highest attraction and liveliness values among the three areas are observed in Kadıköy. Bakırköy has close values to Beşiktaş for attraction and beauty factors and has close values to Kadıköy for intelligibility, novelty and openness factors.

Liveliness values of each case area are illustrated in Figure 12.

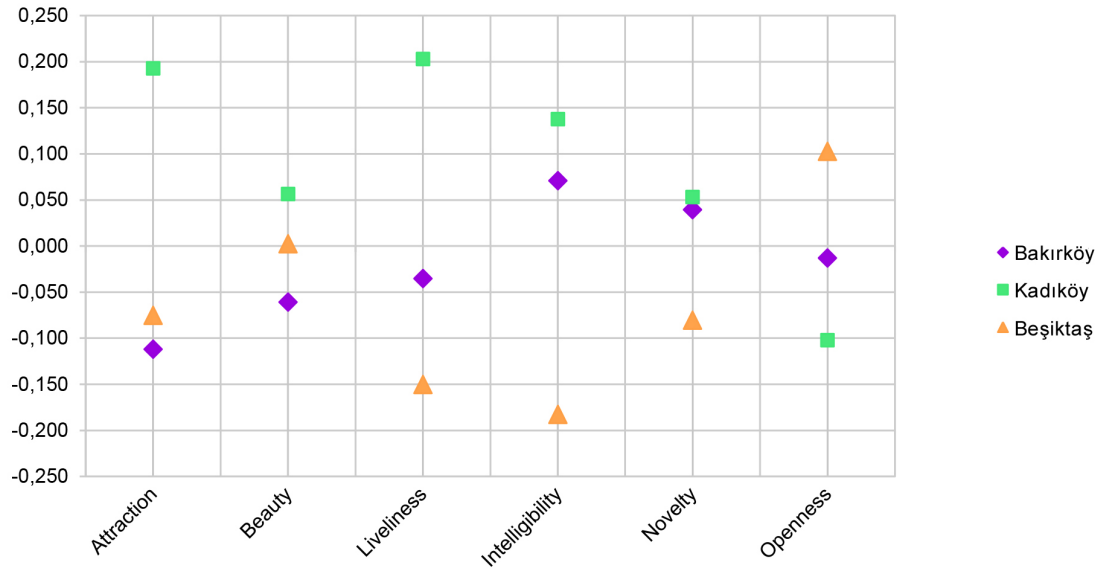


Figure 11. *User perception graphics of the case areas.*

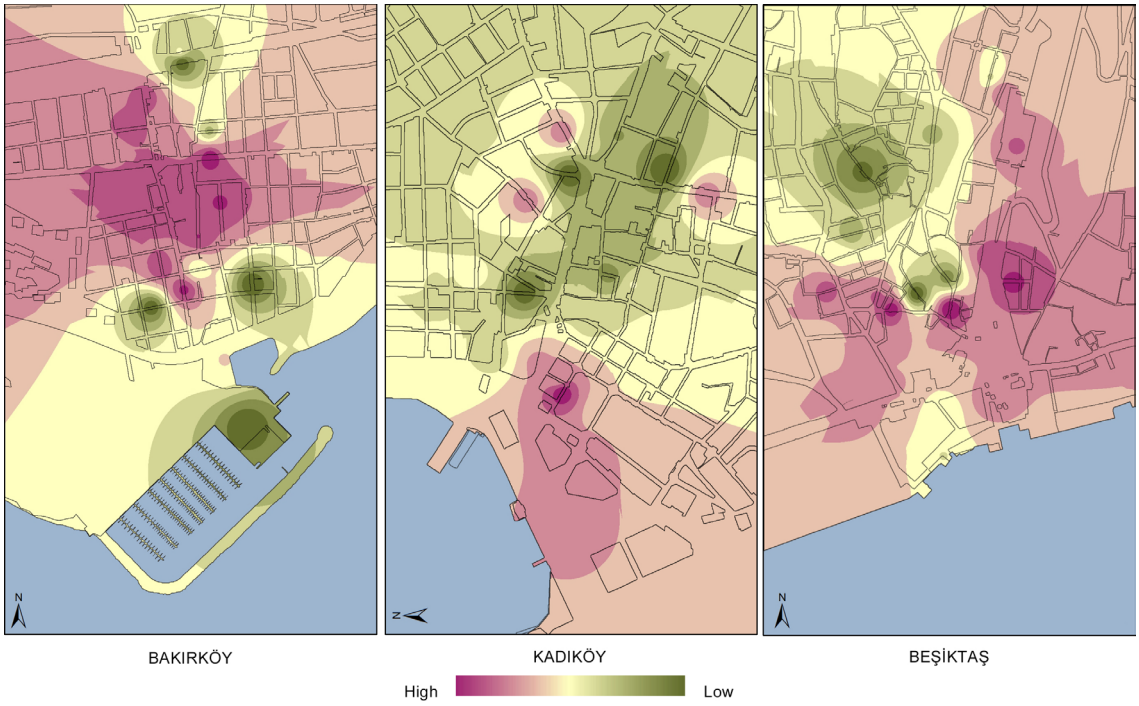


Figure 12. *Liveliness values of the case areas.*

3. Results

For a comparative evaluation, all the gathered data have been combined as a single database table. The final table consists of three basic types of data: 1) pedestrian counts as total values for week day and weekend separately, 2) space syntax integration and choice measures and 3) user perception data under six headings which are: attraction, beauty, liveliness, intelligibility, novelty and openness.

The first step of the evaluation was to statistically analyse the correlation between these variables. Correlations between pedestrian movement levels and spatial values show a significant and strong relationship in the Bakırköy and Kadıköy case areas, while there is no significant relationship in the Beşiktaş area (Table 4 and 5). As mentioned before, the spatial organization of Beşiktaş gives primacy to vehicle traffic. Streets defined with the highest integration or choice values are actually the main arterial roads of the city. Even with wide sidewalks, these roads are not the heart of pedestrian movement. The eagle statue and fish market in the central area have the highest rates of pedestrian movement, and these areas are defined with relatively lower integration and choice values.

Table 4. *Correlation between pedestrian movement and integration in the case areas.*

Correlations		Bakırköy		Kadıköy		Beşiktaş	
		Week Day	Weekend	Week Day	Weekend	Week Day	Weekend
Integration (n)	Pearson Correlation	**,666****	**,704****	**,530***	**,430***	,312	,218
	Sig. (2-tailed)	,001	,001	,011	,046	,148	,318

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 5. *Correlation between pedestrian movement and choice in the case areas.*

Correlations		Bakırköy		Kadıköy		Beşiktaş	
		Week Day	Weekend	Week Day	Weekend	Week Day	Weekend
Choice (n)	Pearson Correlation	**,865****	**,885****	**,601****	**,528***	,363	,281
	Sig. (2-tailed)	**,000**	**,000**	**,003**	**,011**	,089	,194

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

The correlations between pedestrian movement and user perception data did not return any meaningful results in the Bakırköy case area. In the Kadıköy case area, the only significant correlation was found between the total number of pedestrians and liveliness of the area. The correlation coefficient is r=0,504 for the week day total and liveliness, and r=0,502 for the weekend total and liveliness with a significance at the 0,05 level (Table 6).

Table 6. *Correlation between pedestrian movement and perceived qualities.*

Pearson Correlation	Attraction	Beauty	Liveliness	Intelligibility	Novelty	Openness
Bakırköy - Weekday	,352	,250	,428	,294	-,142	-,410
Sig. (2-tailed)	,128	,287	,059	,209	,551	,073
Bakırköy - Weekend	,353	,211	,443	,247	-,122	-,399
Sig. (2-tailed)	,127	,373	,050	,293	,609	,081
Kadıköy – Weekday	,273	-,253	**,504***	,057	-,177	,364
Sig. (2-tailed)	,220	,256	,017	,800	,431	,095
Kadıköy – Weekend	,347	-,187	**,502***	,002	-,095	,356
Sig. (2-tailed)	,114	,406	,017	,992	,675	,103
Kadıköy – Weekday	,292	**-,450***	**,484***	-,008	,243	-,170
Sig. (2-tailed)	,177	,031	,019	,972	,264	,438
Beşiktaş - Weekday	,292	**-,450***	**,484***	-,008	,243	-,170
Sig. (2-tailed)	,177	,031	,019	,972	,264	,438
Beşiktaş - Weekend	,330	-,510*	,524*	-,087	,144	-,138
Sig. (2-tailed)	,124	,013	,010	,693	,512	,529

*. Correlation is significant at the 0.05 level (2-tailed).

In Beşiktaş, which is the only case area with no significant correlation between spatial measures and pedestrian movement, there is a significant correlation between movement and perceived liveliness. The correlation coefficient for movement and liveliness is r=0,484 for the week day and r=0,524 for the weekend. Accordingly, it can be concluded that the movement characteristics of Beşiktaş are shaped by the perceived liveliness, which is explained as diverse, functional and central in this study. When integrated streets cannot ensure comfortable walking, there has to be other factors which affect the distribution of pedestrian movement. These factors can be secondary in ordinary situations and becoming primary factors in the absence of proper access to integrated streets.

In the cases of Beşiktaş and Kadıköy, liveliness is found to be related with movement levels. Since this is not a causal relationship, it would not be right

to claim that liveliness is affecting movement levels. Both movement levels and perceived qualities can be affected from each other. Liveliness, apart from everything else, means having other people around. Thus, in a rather complicated area, getting lost can be an issue but getting lost in a silent place would outweigh that issue. In the case of Beşiktaş, this may be the reason behind the relationship between liveliness and number of people, which is worth analysing further in detail.

Correlations between spatial analyses and user perception data did not return any meaningful results in the Bakırköy case area. However, in Kadıköy, a significant correlation has been found between perception of intelligibility and integration values; r=0,429. Hillier (2007) describes intelligibility as the degree to what can be seen from the spaces of a spatial system. He states that in an intelligible system, well-connected spaces also tend to be well-integrated spaces (Hillier, 2007). In the case of Kadıköy, the intelligibility of the spaces perceived by the users supports this idea. This can be considered as a contribution to studies that aim to develop measurements for urban design qualities.

4. Discussion

This paper presents the initial findings of an on-going research on walkability. The methodology of this research was built on the collection of three types of data for three case areas, Bakırköy, Kadıköy and Beşiktaş, and comparatively evaluating them for each case area. The three types of data are 1) levels of pedestrian movement, 2) data on spatial configuration and 3) urban design qualities.

From a total of 65 observation points, pedestrian movement levels were recorded on one week day and one weekend day. The spatial analyses were carried out using the space syntax method and integration and choice maps were prepared for each case area. In order to operationalize urban design qualities, the semantic differential technique was utilized and 678 questionnaires were made. These qualities were grouped under 6 headings: attraction, beauty, liveliness, intelligibility, novelty and openness. The final database including all the data has been summarized to have 65 rows and several statistical correlation analyses have been run on this table.

The Bakırköy area gives the highest correlation between pedestrian movement and space syntax values. In the Kadıköy area there is also a significant relation between these variables. The only case area that does not provide comfortable walking for pedestrians along its main axes is Beşiktaş. Accordingly, Beşiktaş was also the only case area with no significant relationship between spatial values and pedestrian movement levels.

Among the perceived urban design qualities, only liveliness was found to be significantly related with levels of pedestrian movement and only in the Kadıköy and Beşiktaş areas. Since the highest correlation between pedestrian movement and integration and choice values were obtained in the Bakırköy area, it is possible to say that when there is significant relationship between levels of movement and spatial configuration, other factors remain secondary or tertiary. However, when there is no significant relationship between levels of movement and spatial configuration, those other factors start to take effect. According to the findings, the primary factor affecting pedestrian movement levels is spatial configuration. The layout of space is the main indicator which

shapes the flow of movement, unless there are any powerful factors to prevent this relationship. The spatial values that are obtained using space syntax methodology are strong predictors of pedestrian movement levels. However, there are situations where the design of spaces negatively affects the benefits of their natural movement potential.
The relationship between perceived intelligibility and integration in the Kadıköy area is also considered to be an important outcome of this study as it supports the idea that objectively measured spatial intelligibility is in line with the perception of the users.

It is believed that the results of this study contribute to a better understanding not only of the walkability measures, but also of the level of the relationship between the space syntax methodology and pedestrian perception. Factors affecting the walkability of an area and how the degree of walkability changes when the effect of one of the factors is blocked can be considered to be worthy of more detailed analysis. The pedestrian profile should also be further analysed in terms of gender, age group and purpose for walking. The method and the findings of this study constitute an analytical model that could shed fresh light on future research into walkability as well as on controlling the levels of use within urban design proposals.

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Yürünebilirlik: Kentsel mekanda ölçülen ve ölçülemeyen özellikler

Kentsel mekanda yaya hareketleri, ekonomik canlılığın ve sosyal etkileşimin merkezinde yer alması nedeniyle, kentsel tasarımın en önemli bileşenlerindendir. 1960 sonrasında önem kazanan bir konu olmasına rağmen, kentsel tasarımcıların gündemine ancak son yıllarda yapılan kamu sağlığı çalışmaları sayesinde gelmeye başlamıştır. Yaya hareketlerinin, ekonomik canlılık yaratan bir etken olması, bu konuya verilen önemi pekiştirmektedir.

Bu çalışmada, “morfolojik özelliklerin” ve “algılanan çevresel özelliklerin” yaya hareket düzeyleri üzerindeki etkileri ölçülerek, yaya hareketlerinin açıklanmasına ve kentsel tasarımla kontrol edilebilmesine yönelik tarafsız bir altlık oluşturmak amaçlanmıştır. Böylelikle, kentsel tasarımda yayalara yönelik önerilerin iyileştirilmesi sağlanabilecektir. Çalışma, yürünebilirlik araştırmalarında kullanılan iki farklı yaklaşımı bünyesinde birleştirmekte ve yürünebilirliği açıklamak üzere hem morfolojik yapıyı hem de çevresel algıyı ölçen ve karşılaştıran bir yöntem geliştirmektedir. Bu kapsamda, üç temel analiz gerçekleştirilmiştir. Bu analizler, gözlem yoluyla yaya hareket düzeylerinin tespiti, mekan dizim yöntemi ile mekansal ilişkilerin analizi ve semantik farklılaştırma yöntemi ile çevresel algı analizi olarak tanımlanmıştır.

Çalışmada, arazi kullanımı, kullanıcı profili, şehirle günlük ilişkiler, ulaşım olanakları ve denizle kurulan ilişkiler gibi özellikleri benzerlik gösteren üç farklı çalışma alanı belirlenmiştir. Belirlenen alanlar, Bakırköy çarşı alanı, Kadıköy çarşı alanı ve Beşiktaş çarşı alanıdır.

Çalışma kapsamında, belirlenen üç alanda, yapılan ön incelemeler neticesinde kullanım düzeyleri ve mekansal değerleri farklılık gösteren ve çalışma alanının bütününe dair fikir edinmeye yetecek sayıda gözlem noktası saptanmıştır. Bakırköy’de 20, Kadıköy’de 22 ve Beşiktaş’ta 23 olmak üzere toplam 65 gözlem noktası belirlenmiştir.

Çalışmanın en temel verisi yaya hareket düzeyleridir. Yaya hareket düzeylerinin tespiti, çalışma veya eğlenme/gezinti amaçlı kullanımları değerlendirebilmek amacıyla hafta içi bir gün ve hafta sonu bir gün olmak üzere toplam iki gün boyunca, gün içinde zirve saatlerdeki hareket yoğunluğunu ayırt edebilmek için sabah 08:00 ile akşam 20:00 arasında toplam 6 saat diliminde, kullanıcıların hareket düzeyleri her iki yönde ayrı ayrı kaydedilecek şekilde tasarlanmıştır. Yapılan tespitler, hem tablo hem harita olarak hazırlanmış ve yorumlanmıştır.
Çalışma alanlarındaki toplam yaya sayılarına bakıldığında, hem hafta içinde hem hafta sonunda en yüksek hareketliliğin Kadıköy’de tespit edildiği görülmektedir. Bakırköy ve

Kadıköy'de, hafta içi ve hafta sonu değerleri arasındaki fark göze çarpmaktadır; her iki alanda da hafta sonu değerleri, hafta içinden çok daha yüksektir. Özellikle Kadıköy'de, hafta içi ve hafta sonu, alanı kullanan yaya sayısı arasındaki farkın yüz binin üzerinde olduğu görülmektedir. Bakırköy'de bu fark daha düşük olmakla birlikte, hafta sonu alanı kullanan yaya sayısı belirgin bir şekilde artmaktadır. En düşük hareket oranlarına sahip olan Beşiktaş'ta ise hafta içi ve hafta sonu değerlerinin birbirine çok yakın olduğu, hatta hafta sonunda daha düşük değerlere sahip olduğu görülmektedir.
Çalışmada kullanılan ikinci veri, mekansal yapıya ait değerlerdir. Araştırma kapsamında, çalışma alanlarının her biri mekan dizim yöntemi kullanılarak analiz edilmiş ve yöntemin yaya hareketlerini tahmin etmekte en başarılı ölçümleri olan "bütünleşme" ve "tercih" değerleri hesaplanmıştır. Her üç alan için de, hem global hem lokal değerler açısal segment analizi tekniğiyle incelenmiştir. Lokal analizler için 50m, 100m ve 250m olmak üzere metrik yarıçap kullanılmıştır. Alanların karakteristiklerini en iyi yansıtan değerlerin global bütünleşme analizlerinde elde edildiği görülmüştür. Analizler sonrasında, her bir gözlem noktasına, üzerinde bulunduğu sokak parçasının mekansal değerleri atanmıştır.

Bakırköy'ün global bütünleşme ve tercih analizleri, yaya hareketleri sonuçlarının da vurguladığı İstasyon ve İstanbul caddelerinin baskın olarak ortaya çıktığını göstermektedir. Kadıköy'ün global bütünleşme analizi, alan genelinde kopuk bir mekansal yapı olduğunu göstermektedir. Hem bütünleşme hem tercih değerlerinde Söğütlüçeşme Caddesi'nin önemli bir aks olarak ortaya çıktığı görülmektedir. Söğütlüçeşme Caddesi ile doğu-batı doğrultusunda kesintisiz bir güzergah çizen tercih değerleri, alanın genelinde üç temel bölünme tanımlamaktadır. Beşiktaş'ın global bütünleşme analizleri, Barbaros Bulvarı ve Dolmabahçe Caddesi'nin önemini ve baskın karakterini doğrulamaktadır. Beşiktaş'ta tercih analizinde, bütünleşme analizinden farklı olarak, Barbaros Bulvarı'nın, Dolmabahçe Caddesi yerine Çırağan Caddesi ile bir bütünlük arz ettiği görülmektedir. Bakırköy ve Kadıköy'de, yüksek tercih değerlerinin, gride yakın bir yapı oluşturduğu görülmektedir. Beşiktaş'ta ise, yol ağının girift yapısı itibariyle böyle bir durum gözlenememektedir.

Çalışmanın sonraki adımında, kullanıcıların çevresel algılarını ölçmek amacıyla, bir anket çalışması yürütülmüş ve semantik farklılaştırma ölçeği kullanılmıştır. Yapılan anket çalışmasında, gözlem noktalarında kullanıcı algısına yönelik 25 kavramı sorgulamak üzere, 25 ifade çifti belirlenmiştir. Anket çalışması sonucunda, 65 gözlem noktası için toplam 678 adet geçerli anket elde edilmiştir Anket sonuçlarının yer aldığı tabloda faktör analizi uygulanmış ve Çekicilik, Güzellik, Canlılık, Okunabilirlik, Yenilik ve Açıklık olarak ifade edilen 6 faktör elde edilmiştir. Çalışma alanları karşılaştırmalı olarak değerlendirildiğinde, Beşiktaş'ın, diğer alanlardan nerdeyse tüm faktörlerde ayrıştığı görülmektedir. Özellikle Kadıköy ve Beşiktaş'ın çizdiği grafikler, birbirinin tam tersidir. Beşiktaş'taki genel kullanıcı algısı çekicilik, canlılık, okunabilirlik ve yenilik faktörleri açısından yeterince tatmin olmayan bir kullanıcı profiline işaret etmekte, ortalama düzeyde bir güzellik ve nispeten yüksek bir açıklık algısı olduğu görülmektedir. Tamamı sayısal olarak elde edilen bu veriler, istatistiksel olarak karşılaştırılarak değerlendirilmiştir. Değerlendirme, üç adımda yapılmıştır; 1) yaya hareketleri ve mekansal analizlerin karşılaştırması, 2) yaya hareketleri ve kullanıcı algısının karşılaştırılması, 3) mekansal analizlerin ve kullanıcı algısının karşılaştırılması. Elde edilen bulgulara göre, yaya hareket düzeylerini etkileyen birincil etken mekansal yapıdır. Bu durumu değiştirecek başka bir etken olmadığı takdirde, mekansal yapı, hareketin dağılımında belirleyici etkendir.

Bu çalışma, yürünebilirlik araştırmalarında kullanılan iki farklı yaklaşımı bünyesinde birleştirerek yürünebilirliği açıklamak üzere hem mekansal yapıyı hem de çevresel algıyı ölçen ve karşılaştıran bir yöntem geliştirmiştir. Çalışma, yürünebilirlik araştırmalarına bu yöntemle yaklaşan ilk araştırma olma özelliğini göstermektedir. Araştırma yönteminin, sadece yaya hareketleri araştırmalarında değil, kentsel mekanda analiz yapan tüm çalışmalarda, kentsel tasarım niteliklerini ölçmek ve sayısal olarak değerlendirmek üzere semantik farklılaştırma tekniğinin kullanılması yönünde teşvik edici olacağı düşünülmektedir. Çalışmada elde edilen sonuçların, yürünebilirliğin mekansal ve algısal özelliklerle ilişkisinin anlaşılmasında katkı sağlayacağına inanılmaktadır.