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WALKABILITY:
Perceived and measured qualities in action

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Abstract

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

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

In order to do this comparison, three case areas have been selected, all of which are central retail districts from Istanbul, with similar socio-economic user profile, similar public and private transportation links with the city and similar relations with the waterfront. All the three case areas have been limited to cover a 1kmx0.5km area. The similar qualities of the three case areas are expected to reset the effects of land use, user profile, transportation links and recreational qualities.

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

The data recorded in this study is 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 by urban design proposals.

Keywords: *walkability, space syntax, semantic differential, urban design*

Theme: *Urban Space and Social, Economic and Cultural Phenomena*

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 (Litman, 2011). Although urban designers have supported creating 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 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 has the meanings of being in short distance, not having barriers that would restrain pedestrians, being safe in terms of both traffic safety and security, 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 have started to serve high-speed traffic; they have lost their human scale (Forsyth and Southworth, 2008). Researches on types of transportation usually overlook the part of the trips that include walking. It is found easier to collect data on vehicle movement such as traffic flow rates and speed, and run tests for transportation models. Walking is an invisible type of transportation for most of the transportation planners (Litman, 2011).

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

To explain 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 like imagebility or enclosure, which are difficult to measure, are significant factors affecting the livelihood on the streets (Ewing et al., 2006; Ewing and Handy, 2009). Research on the effects of urban space on walking behaviour have developed techniques to operationalize perceptual qualities like enclosure, complexity, human scale and have suggested using measurable attributes of 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). 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, building it merely on physical measurements and disregarding human aspect would not give robust results.

One of the techniques developed to understand how physical environment affects feelings is Semantic Differential Scale. Semantic Differential Scale uses pairs of opposite words and usually a 7-level evaluation scale. This technique of using pairs of polar concepts grounds on research about 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 visualizing 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 in semantic differential technique; within the scope of the research, it can be adopted to the concepts that need to be measured (Osgood, et al., 1957).

METHODOLOGY

The analyses of this research is designed as three basic steps, those are pedestrian counts, syntactic analyses and questionnaires.
Three case areas have been selected, all of which are central retail districts from Istanbul, with similar socio-economic user profile according to the land values acquired from Istanbul Directorate of Tax Administration, similar public and private transportation links with the city, similar relations with the waterfront and similar topography elevating from sea level towards inner parts. The selected case areas are main centres of Bakirkoy, Kadikoy and Besiktas (Figure 1).

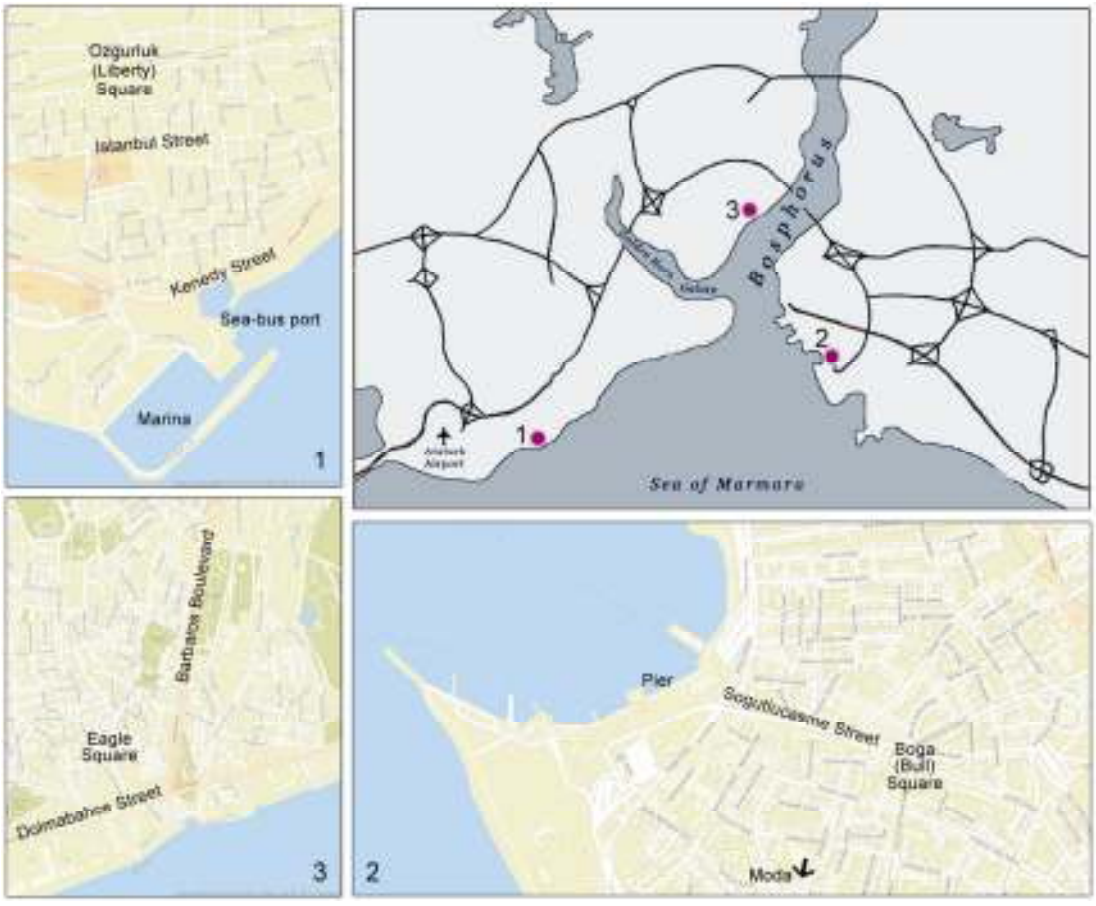

Figure 1 Study areas

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 reset the effects of land use, user profile, transportation links and recreational qualities.

To get a fulfilling 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 Bakirkoy, 22 locations from Kadikoy and 23 locations from Besiktas, making a total of 65 observation points.

Observing Pedestrian Movement

The most significant step of the walkability research is pedestrian flow rates. To distinguish different movement patterns generated by people who use the area for working purposes and by those using the area for recreational or entertainment purposes, pedestrian counts were carried out on one week day and a day on the weekend. Each location was observed for five minutes in two-hour time periods, from 08:00 to 20:00, and pedestrians moving in both directions were recorded separately.

Since the observed locations were sampling points from the case areas, observations have not recorded all the pedestrian movement within the study areas, which means there were more people than recorded.

Findings show that, highest level of movement throughout the day has been recorded in Kadıköy area and it is nearly twice as much as the movement in Besiktas area. Bakirkoy has a relatively higher level of movement than Besiktas but still quite lower than Kadikoy (Table 1, Figure 2, 3).

Table 1: Pedestrian movement rates in the case areas

	Weekday	*Weekend*
Bakirkoy	*264,144*	*323,496*
Kadikoy	*430,800*	*557,664*
Besiktas	*201,768*	*199,920*

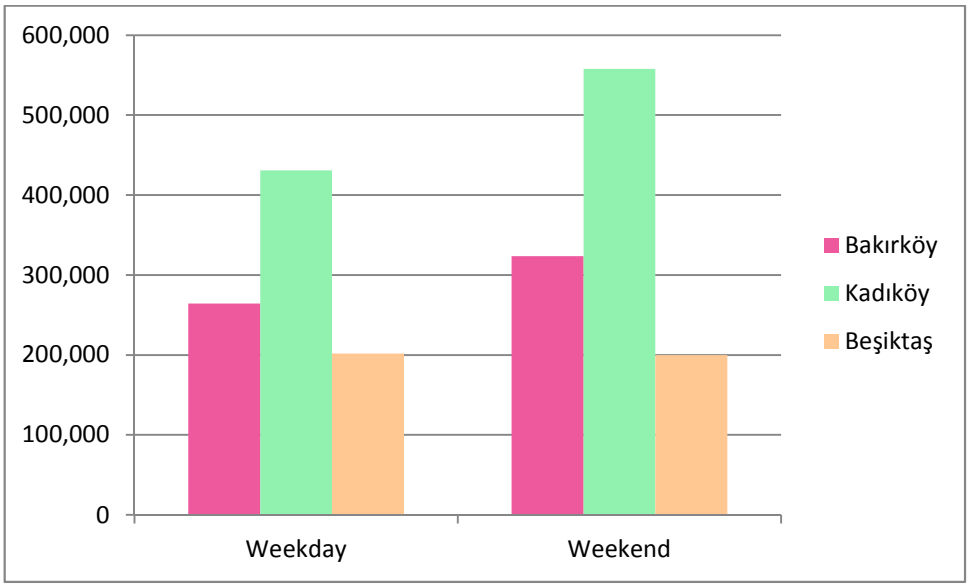

Figure 2 Pedestrian movement rates in the case areas

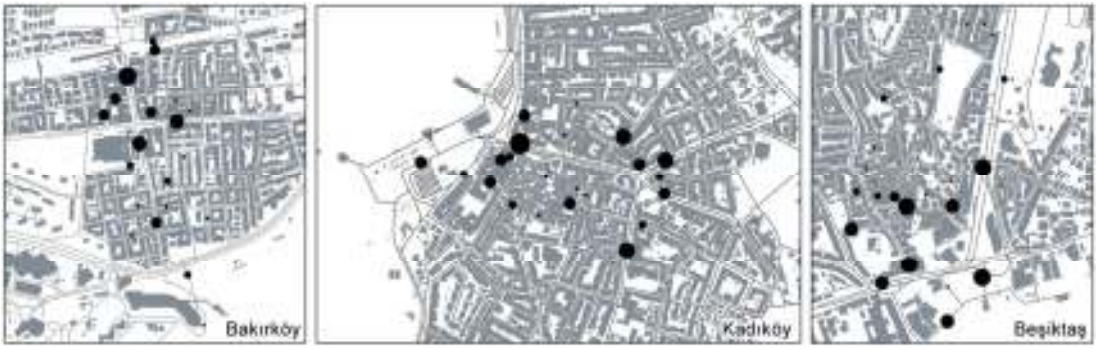

Figure 3 Distribution of movement throughout the case areas

In Bakirkoy, the main pedestrian axis, Istasyon Street, starting from the Ozgurluk (Liberty) Square in 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 all day long. Istanbul Street in east-west direction is the second busiest street used by pedestrians despite its vehicle traffic, illegal parking that occupies two lanes and narrow sidewalks. The colonnade system on one of the sidewalks provides 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 makes it unpleasant (Figure 4).

Movement seems to be concentrating on the northern part of Istanbul Street and the distribution show high amounts of pedestrians in the surrounding areas of the square, where there is a main bus station, and in the nearby streets of the intersection of the two busy arterial streets. On the southern side of Istanbul Street, movement concentrates only on the main arterial road and does not spread to the secondary roads. Amount of movement melts until it reaches the sea side where the port for sea-bus is and it melts a little more after the port before reaching the marina, which is a newly renovated entertainment and service zone (Figure 4).

Figure 4 Istanbul Street, sidewalks with colonnade system (left) (source: http://www.yandex.com/) and Marina Park in the seaside of Bakirkoy (right) (source: http://www.atakoymarina.com.tr/)

In Kadikoy, the main street, named Sogutlucesme Street, is not a pedestrian way; on the contrary, it is a main traffic artery with three lanes of one way traffic and one lane for public transport on the opposite direction, which runs together with the nostalgic tramway. Similar to Istanbul Street of Bakirkoy, there is a colonnade system on one sidewalk, but with a more proper layout, and the sidewalk on the other side of the street is wide enough to enable a safe and pleasant walk (Figure 5).

East end of Sogutlucesme Street is called Altiyol Square, meaning “six-points”, named after the intersection point of six streets. The square is symbolized with a statue of a bull, which is a very well-known reference for the inhabitants of not only Kadikoy but also the whole city. Sogutlucesme Street starts with a high amount of movement from the seaside. At the east end of the street, movement is dispersed towards secondary arteries from Altiyol Square, all of which lead to significant destinations such as main metro-bus station or the quiet recreational neighbourhood named Moda (Figure 5).

Figure 5 Sogutlucesme Street, Kadikoy (left) (source: http://www.yandex.com/) and Altiyol Square, Kadikoy (right) (source: http://www.flickr.com/)

In the inner parts of Kadikoy, there are little urban squares on busy streets. These inner areas are all pedestrian-only streets, providing comfortable access to pedestrians.

The third case area, Besiktas, encloses a part of the coastal road, named Dolmabahce Street, and Barbaros Boulevard in its continuance. It connects to the Bosphorus Bridge and on a usual day it shelters heavy and fast vehicle traffic. Having such an active relation with the daily transportation of the city pushes pedestrian movement into the background in the main arterial roads of Besiktas. Barbaros Boulevard has wide sidewalks but the sidewalks of Dolmabahce Street are too narrow to allow more than two people to walk side by side.

Inner parts of Besiktas 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, main centre of Besiktas is not recognizable from the major roads, nor can it be seen directly. There is a small scale urban square in the centre emphasized with a huge statue. Unlike Kadikoy, this one is known rather because of its symbolic meaning than being a strong reference. This statue of a black eagle is the symbol of Besiktas Sports Club. The statue is located very close to the fish market of Besiktas which is another symbolic element of this area with historical value.

Since local people and frequent users of Besiktas are used to this complicated layout, the high amount of movement in this central area continue throughout the day. Streets connecting to the square are all pedestrian ways and it is one of the main reasons of the high levels of movement in this centre.

Instead of main arteries, movement distribution in Besiktas displays a core circling the central area, south parts of Barbaros Boulevard, bus stop on Dolmabahce Street, main bus stop on the

seaside, pier and 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.

Spatial Analyses

Space syntax method has been used for spatial analyses. Road-centre lines map of Istanbul Metropolitan Area generated by Greater Municipality of Istanbul 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 have been extracted from the map to create three separate files each of which covers 2x2 km of area, smoothly covering the case areas. The maps have been analysed using Depthmap software and angular segment analysis tool has been run.

In Bakirkoy, global integration analysis emphasizes the two main arterial roads, Istanbul and Istasyon streets. In addition to those, Iskele Street in the north-south direction is distinguished with its high integration values. Connections to Kennedy Street on the coastal line are limited either because of access control or height differences (Figure 6). Iskele Street is one of the few lines that have 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 6 Integration analyses of the case areas

Looking at the integration map from a distance, it is clearly seen that, the entire neighbourhood of the study area is separated from its surroundings by Kennedy Street in the south, by two main roads on 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. 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 attracts people too. However, the need for renovation had emerged as a result of its disconnected layout at the first place. It had degraded and had run down mainly because of the poor links with the lively neighbourhood. As the sea-bus transportation system of the city grew, more people started to use the port. Although the location of the port was inconvenient, it offered a fast and comfortable access to the Anatolian side, which would otherwise take much more time to reach.

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 has 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 affect the use of Marina Park area as well. It is 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.

Kadikoy case area also has a disjointed pattern divided by Sogutlucesme Street. It connects to Bagdat Street on the east, 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 with high integration values, it is interesting to see that Sogutlucesme Street reaches the seaside on the west preserving its integration. It also continues to have high values beyond the boundaries of the neighbourhood on the east. An integration core enclosed by these two streets is noticed in the northern side of the area, while the southern side displays a disconnected structure.

In Bakirkoy case, coastal road was creating a dividing effect because of its unconnected system as a result of height difference and because of the limitations in crossing it. In Kadikoy case, Sogutlucesme Street is a highly connected street, collecting all the neighbouring streets. This feature was expected to be the reason for making it more accessible. However, the traffic regulations on it create the dividing effect, not allowing connection between the two sides. Pedestrian crossings on Sogutlucesme Street are represented correctly on the road centre lines map, where it is shown with two parallel lines. Actual situation is pretty close to what is represented, but of course there are informal crossings as well. On the eastern parts of Sogutlucesme Street, there are height differences between the inner parts, resolved by staircases.

Integration analysis of Besiktas case area verifies the significance of Barbaros Boulevard and Dolmabahce Street. Barbaros is represented with two parallel lines because the connection between the streets on the two sides is limited by the geometric arrangement of the boulevard. Heavy traffic it holds makes informal crossings nearly impossible but there are a number of pedestrian crossings enough 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 encircled by integrated lines as well.

Main differences between the two sides are street density being higher on the west section and unconnected lines causing dead-ends on the east section. Low integration values on the eastern side are mostly a result of the low density of the street network caused both by 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 inclined surface, defined with low integration values.

User perception

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

On 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.

Responses were quantified following below assessment:

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

The final table consisted of 678 rows each having 25 columns showing the results of questionnaires made on 65 observation points. Using the SPSS 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 2).

Table 2 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.

When three case areas are examined comparatively, it is seen that Besiktas area is distinguished from other case areas in almost all the factors. Especially Kadikoy and Besiktas areas display a completely reverse graphic. General user perception in Besiktas 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 7). On the other hand, the highest attraction and liveliness values among the three areas are observed in Kadikoy. Bakirkoy has close values to Besiktas for attraction and beauty factors and has close values to Kadikoy for intelligibility, novelty and openness factors.

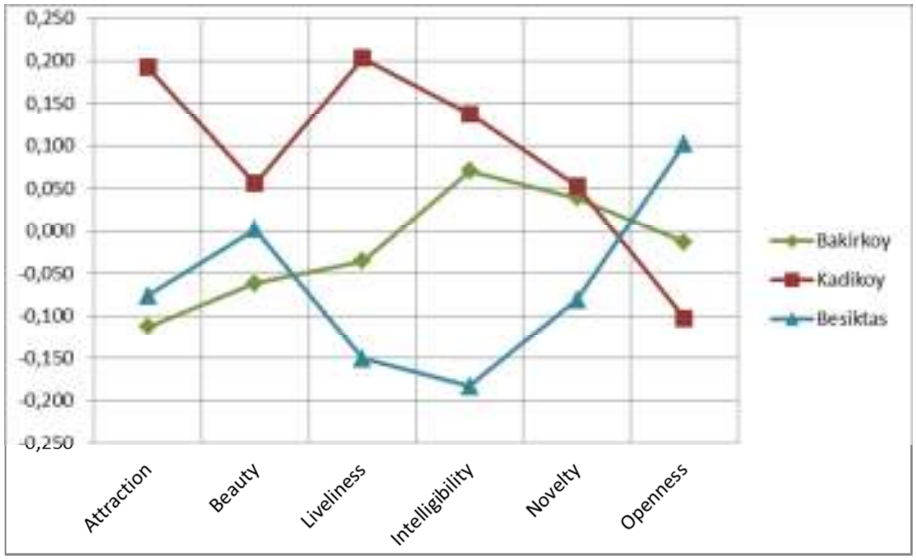

Figure 7 User perception graphics of the case areas

The general liveliness values of each case area are illustrated in Figure 8.

Figure 8 Liveliness values of the case areas

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 measures and 3. user perception data under six headings which are attraction, beauty, liveliness, intelligibility, novelty and openness.

The first step of evaluation was to statistically analyse the correlation between these variables. Correlations between pedestrian movement levels and integration values show a significant and strong relation in Bakirkoy and Kadikoy case areas, while there is no significant relation in Besiktas area (Table 3). As mentioned before, spatial organization of Besiktas privileges vehicle traffic. Streets defined with the highest integration values are actually main arterial roads of the city. Even with wide sidewalks, these roads are not the heart of the movement. The eagle statue and fish market in the central area have the highest rates of movement and these areas are defined with relatively lower integration values.

Table 3 Correlation between pedestrian movement and integration in the case areas

Correlations		Bakirkoy		Kadikoy		Besiktas	
		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).

Correlations between pedestrian movement and user perception data did not return any meaningful results in Bakirkoy case area. In Kadikoy case area, the only significant correlation has been found between the total number of pedestrians and liveliness of the area. Correlation coefficient is r=0,504 for week day total and liveliness, and r=0,502 for weekend total and liveliness with significance at the 0.05 level.

In Besiktas, 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. Correlation coefficient for movement and liveliness is r=0,484 in the week day and r=0,524 in the weekend. Accordingly, it can be concluded that the movement characteristics of Besiktas are shaped by the perceived liveliness, which is explained as being diverse, functional and central in this study. When integrated streets cannot ensure a comfortable walking, there has to be other factors affecting distribution of pedestrian movement. These factors can be acting as secondary in ordinary situations and becoming primary factors in the absence of proper access to integrated streets.

In the case of Besiktas and Kadikoy, 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 Besiktas, this may be the reason behind the relation 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 Bakirkoy case area. However, in Kadikoy, 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 says, in an intelligible system, well-connected spaces also tend to be well-integrated spaces (Hillier, 2007). In the case of Kadikoy, the intelligibility of the spaces that is perceived by the users, support this idea. This can be considered as a contribution to the studies that aim to develop measurements for urban design qualities.

DISCUSSION

This paper presents the initial findings of an on-going research on walkability. Methodology of this research has been built on collecting three types of data for three case areas those are Bakirkoy, Kadikoy and Besiktas, and comparatively evaluating them for each case area. These three types of data are 1. levels of pedestrian movement, 2. data on spatial configuration and 3. urban design qualities.

For a total of 65 observation points, pedestrian movement levels have been recorded on one week day and on a day on the weekend. Spatial analyses have been done using the space syntax method and integration maps have been prepared for each case area. In order to operationalize urban design qualities, semantic differential technique has been utilized and 678 questionnaires have been made. These qualities are grouped under 6 headings which are 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.

According to the findings, Bakirkoy area gives the highest correlation between pedestrian movement and integration values. In Kadikoy area there is also a significant relation between these variables. The only case area that is not providing a comfortable walking to pedestrians on main axes is Besiktas. Accordingly, it was also the only case area with no significant relation between integration values and pedestrian movement levels.

Among perceived urban design qualities, only liveliness was found significantly related with the levels of pedestrian movement and only in Kadikoy and Besiktas areas. Since highest correlation between pedestrian movement and integration values were obtained in Bakirkoy area, it is possible to say that, when there is significant relation between levels of movement and spatial configuration, other factors remain secondary or tertiary. However, when there is no significant relation between levels of movement and spatial configuration, those other factors start to take effect.

Factors affecting the walkability of an area and how the degree of walkability changes when the effect of one of the factors is blocked should be analysed in detail. Pedestrian profile should also be further analysed in terms of gender and age group differences.

The correlation between perceived intelligibility and integration in Kadikoy area is also considered as 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 of not only the walkability measures, but also 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 by urban design proposals.

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