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The influence of architectural configuration on the pedestrian network in Büyük Beşiktaş market

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Abstract

A study of trading can help us understand a wider range of organizations and building types. Many shopping centers have been built in Istanbul over the past twenty years. Although these privately owned places serve as social spaces and provide an area for many public activities, their size and close proximity separate them from the urban environment and choke off daily urban street life. Buyuk Besiktas Market, which is selected as the subject of the case study has a specific architectural form. Multiple entrances and a conductive interface converts the building and especially the ground floor into a common area and urban domain that hosts concerts, urban activities and special meetings.

The study seeks to understand how does the architectural form and syntactic pattern of the outer layer play a role in changing the pedestrian network inside the building and how do basic architectural elements such as inner courtyards and open spaces affect pedestrian flow and preferences?

The research procedure is based on two main steps. The first step comprises a gate count of the people passing through the gates and a density analysis. The second step is to analyze the architectural configuration using Syntax 2D program developed by scientists at the University of Michigan.

The results of the study support the idea that particularly for multi-entrance buildings, the urban environment can be more dominant or at least effective in manipulating the natural movement in buildings. Independent from the structure of the building, the configuration which was set by urban dynamics is so dominant.

Keywords
Architectural layout, Pedestrian movement, Syntactical configuration.

1. Introduction

Many shopping centers have been built in Istanbul over the past twenty years. Although these privately owned places serve as social spaces and provide an area for many public activities, their size and close proximity separate them from the urban environment and choke off daily urban street life. Yet, from the perspective of commercial land use patterns, shopping spaces should be able to integrate urban spaces in a continuous way. In this manner, this study examines the syntactic character of the market places that affect people's movement, particularly the interface between architectural layout and urban form that affects that movement.

Istanbul's Buyuk Besiktas Market is selected as the subject of the case study. It has a specific architectural form that can be characterized as a semi-open, interior courtyard shopping building with multiple entry points that is located in a dense shopping district in Istanbul. The configuration of the building will be structurally analyzed considering the architectural layout, pedestrian flow and integration. The study seeks to answer the questions below:

- How does the architectural form and syntactic pattern of the outer layer play a role in changing the pedestrian network inside the building?
- How do basic architectural elements such as inner courtyards, open spaces and store allocation affect pedestrian flow and preferences?

2. Retail pattern and pedestrian movement

A study of trading can help us understand a wider range of organizations and building types. Trading has a pervasive effect on urban form and land use patterning as well as building interiors and appears in one form or another in every society and in every period of history (Penn, 2005). As Hillier (2005) noted, buildings and cities exist for us in two ways: as the physical forms that we build and see and as the spaces that we use and move through. In a situation where movement, configuration, and attraction are all in agreement, logic strongly suggests configuration as the primary 'cause' of movement. Logically, the presence of attractors can affect the presence of people; however, these attractors cannot affect the fixed configurational parameters that describe the spatial location. Similarly, configuration may affect movement; however, configurational parameters cannot be affected by movement; see Figure 1, (Hillier et al., 1993). Differences in layout affect movement independently from the attractors.

As Hillier (1993) illustrated in Figure 2, attractors and movement may affect each other; however, the other two relations are asymmetrical. Configuration may affect the location of attractors, but the location of attractors cannot affect configuration. Likewise, configuration may affect movement, but movement cannot affect configuration. If strong correlations are observed between movement and both configuration and attractors, the only possible lines of influence are from configuration to both movement and attractors, with the latter two influencing each other.

We can better understand how cities work if we draw a distinction between movement 'to' or 'from' spaces and movement 'through' spaces. Movement 'to' or 'from' spaces is primarily

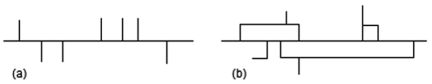

Figure 1. *(a) The more central segments of the 'main street' are likely to be the most frequently used.*
(b) The two most central vertical elements, one above and one below the 'main street,' would be on shorter routes than the more peripheral vertical elements (Hillier, et. all., 1993).

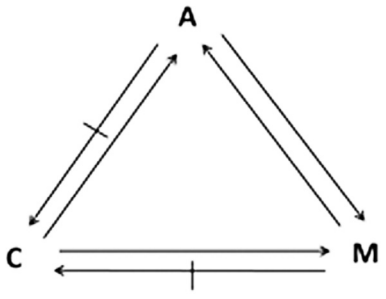

Figure 2. *Attraction, configuration and movement (Hillier, et. all., 1993).*

a function of land use, whereas movement 'through' spaces is primarily a function of configuration. More importantly, urban configuration creates an interface between those two types of movement. Thus, these two types of movement can be evenly balanced in some spaces and unevenly emphasized in others. Liveness, however, appears to require that both components be present and mutually supportive (Peponis, Ross, Rashidi, 1997).

The actual patterns of agglomeration and differentiation of retail functions that we observe in urban property use patterns appear to be strongly related to both the geometry and network topology of the urban street system. Two theories have sought to account for this phenomenon from a space syntax perspective. The first theory is the theory of natural movement (Hillier et al., 1993), which proposes that the configuration of the street grid accounts for a substantial proportion of pedestrian movement in urban areas. Retail land use is demonstrated to affect movement patterns by acting as a multiplier, transforming a linear relationship between spatial integration and pedestrian flows in mono-functional residential areas into an exponential relationship in mixed-use areas. The thesis is that the primary factor is urban spatial configuration, which then causes a pattern of space use that makes certain locations more attractive than others for retail. Retail occupies these locations preferentially and then becomes an attractor of new trips in its own right. The result is a multiplier in which configurationally strategic through routes become dominant retail aggregations. The result is an emergent correlation between land use, pedestrian movement and configuration that demonstrates immense stability over time. The second theory is the theory of the movement economy (Hillier & Penn, 1992; Hillier, 1996; 1997), which proposes that as a by-product of every trip between an origin and a destination, one passes opportunities for interaction and transaction in spaces along the way. We propose that this phenomenon allows for multi-purpose trips and is the link between urban spatial configuration and movement flows that provides logic for the disposition of land uses. An additional phenomenon exists, however, which is recognizable in many different city forms and cultures. This phenomenon involves how land use patterns remain roughly similar as one travels along a street but change radically as one turns a corner.

The traditional 'gravity' model employed by shopping mall developers attempts to create an artificial 'flow' of pedestrian movement between two known attractors. Shopping malls generally work on the premise of the classic dumb-bell concept; the large competing 'anchor' stores at two ends working as 'magnets' spaced between a two sided mall of smaller multi-cellular units (Fong, 2003) . Although Hillier (1993, 1996) has argued that movement is determined mainly by the configuration of space, a case study that was done on seven super regional shopping centres (Fong, 2003) shows that variables of attraction could best predict movement distribution rather than variables of configuration. In cases where the functional attractors like big stores do not exist, the interface of the building must be examined by considering that some environmental relational or urban links may serve as urban attractors that can affect pedestrian flow.

3. Conductive interface

Building surfaces play a significant role in the relationship between buildings and the urban environment. Especially at the ground floor level, building surfaces act as a "membrane" that serves as an interface between the building and the urban environment.

As more of these surfaces enable the transition, the buildings become urban interiors and their gates become the nodes of the urban environment.

The Buyuk Besiktas Market (BBM), which is examined in this study, is a three-story building with 184 stores selling accessories, shoes and clothing, in addition to other facilities like a post office and pay offices. Multiple entrances and a conductive interface converts the building and especially the ground floor into a common area and urban domain that hosts concerts, urban activities and special meetings

(Figure 3). This provides us with an opportunity to study the architectural characteristics affecting the pedestrian flow and preferences.

The surface of the BBM can be described as a conductive interface with multiple entrances that connect the building to its urban environment. The entrances demonstrate several common attributes that can be categorized and gives us the opportunity to discuss how the pedestrian flow is affected by architectural characteristics and the urban interface.

Although the entrances that connect the building to the urban grid are defined as "street based," the entrances located on the periphery and that activate the surface of the building act as a "periphery." Further, the connections with other shopping areas can be defined as "transition based" (Fig. 4). This predefinition of gates allows us to compare and discuss the role of the interface of the building in pedestrian movement and preference.

Figure 3. *Image showing the open courtyard and ground floor level as urban use.*

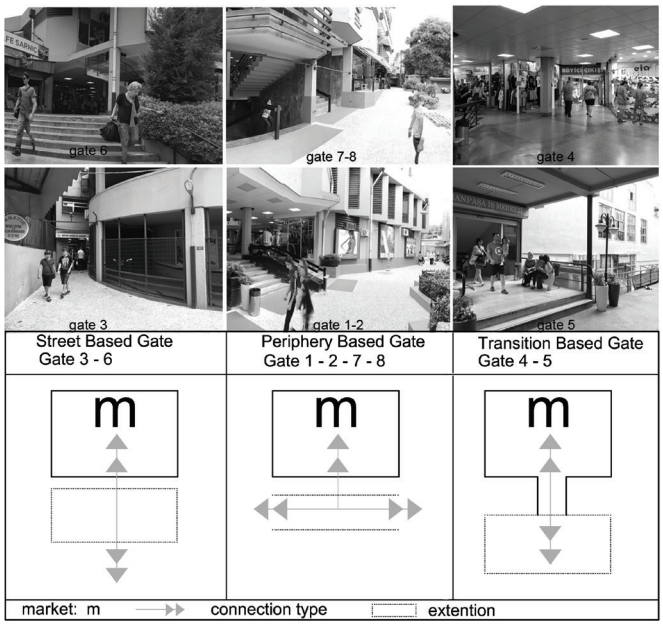

Figure 4. *Representation of each gate.*

4. Method

BBM is selected for the case study. The research procedure is based on two main steps. The first step comprises a gate count of the people passing through the gates and a density analysis, which provides the distribution of people inside the building. To understand the tendency of movement, people leaving or entering the market are calculated separately. These observations provide information about the preferences and distribution of pedestrians according to their choices of roles. In other words, this analysis will provide clues about how the conductive interface of the buildings affects public movement and how the existence of the inner courtyard manipulates that movement.

The second step is to analyze the architectural configuration. This will help us understand the syntactic pattern of the building and its basic architectural characteristics such as galleries, corridors and shop layout. Furthermore, analyzing the configuration will provide significant data about integration, which is known to have an effect on natural movement. The space syntax method, a key theory used to define the structural environment, will provide significant data in terms of analysis.

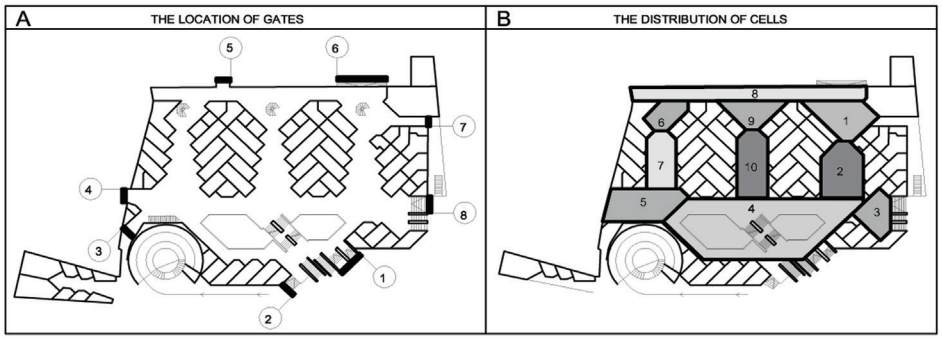

Figure 5. *Locations of entrances (A) and convex spaces (B).*

The Syntax 2D program developed by scientists at the University of Michigan provides data about the level of integration between convex spaces considering their spatial properties.

4.1. Analog method

- Gate count: Recording the number of people passing through the gates (frequency) for 10 minutes synchronically on weekdays and weekends during the morning, midday, and afternoon.
- Density: Mapping the distribution of pedestrians, considering the cells defining the convex space.

4.2. Syntactic analysis

There are two basic architectural components characterizing the market: the gate composition that gives the building multiple entrances and the open inner garden that makes the configuration unique. Integration is evaluated by considering the inner garden as a connective space regulating the pedestrian movement around it. We therefore seek to understand whether the open garden serves as an edge that distributes movement or as a perceptive continuity that attracts pedestrians.

Syntax 2D creates a grid fragmentation that enabled us to compare the plan integration and depth comparison values through different convex spaces. The mean integration (Figure 6) and mean depth data (Figure 7) are generated as a result of the analyses. These are two main concepts addressed in space syntax theory that can help us understand how some convex spaces are more integrated and shallow than others. For gates, the calculation uses the arithmetic average of entrance lines, whereas the calculation of convex space uses the arithmetic average of homogeneously divided equal areas.

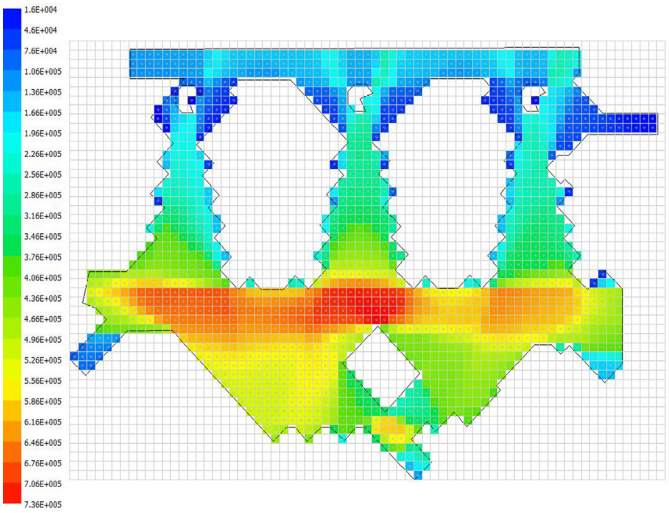

Figure 6. *Image of the integration analysis, completed using Syntax 2D to find the syntactic scores for gate count nodes and convex spaces.*

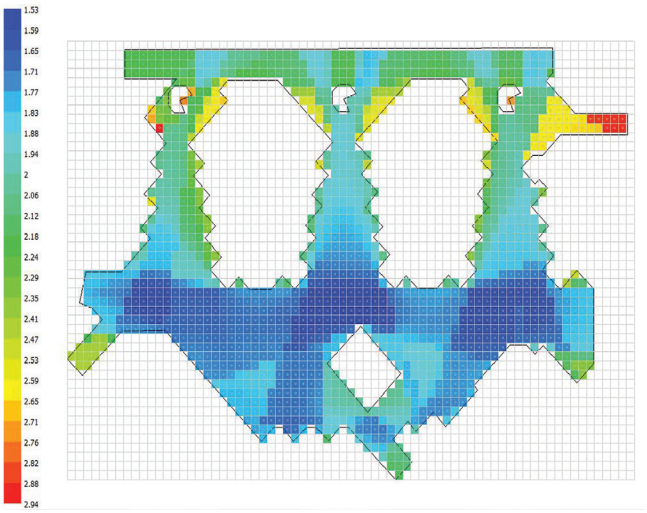

Figure 7. *Image of the mean depth analysis.*

5. Syntactic comparisons and analysis

Matching the syntactic data (integration and depth value) with the gate count will help us to explore the influence of architectural configuration on the people passing through the gates. Additionally, the comparison of the syntactic data and people located in convex spaces helps us to explore how integrated or segregated locations influence pedestrian movement, and whether there is any correlation between the architectural configuration of the market and the distribution of movement.

A schematic shown in Table 1 and Table 2 examines the relationship between the syntactic values (integration and mean depth) of the market gates and the frequency of people passing through the gates during weekdays and weekends, counted at regular hourly intervals.

As previously defined in the space syntax literature, convex spaces have distinctive properties that characterize each space as unique and common (Hillier et al., 1987). The comparison shown below in Table 3 and Table 4 indicates the relationship between the

Table 1. *Syntactic values and the number of people passing through each gate on weekdays.*

Weekday							
Gate	Gate Integration	Gate Mean Depth	10.00 am	11.45 am	13.30 pm	15.15 pm	17.00 pr
G 1	363173	1,82	14	38	66	60	63
G 2	177066	2,1	18	29	85	69	63
G 3	94062	2,44	48	36	92	92	96
G 4	484443	1,82	9	20	29	51	35
G 5	156590	2,07	36	39	73	77	78
G 6	245900	1,87	42	64	108	132	105
G 7	27709	2,89	5	4	8	8	5
G 8	466642	1,84	18	10	11	20	15

Table 2. *Syntactic values and the number of people passing through each gate on weekends.*

Weekend							
Gate	Gate Integration	Gate Mean Depth	10.00 am	11.45 am	13.30 pm	15.15 pm	17.00 pr
G 1	363173	1,82	25	19	44	59	57
G 2	177066	2,1	13	25	50	54	56
G 3	94062	2,44	40	45	72	139	127
G 4	484443	1,82	17	14	45	61	77
G 5	156590	2,07	25	34	63	131	107
G 6	245900	1,87	38	41	108	120	128
G 7	27709	2,89	3	2	9	5	23
G 8	466642	1,84	5	14	22	31	18

Table 3. *Syntactic values and frequencies of people in each convex space on weekdays.*

Weekday							
Convex Space	Mean Integration	Mean Depth	10.00 am	11.45 am	13.30 pm	15.15 pm	17.00 pr
CS1	115314	2,4	1	2	1	2	0
CS2	322856	1,9	1	3	2	2	1
CS3	381625	1,92	0	0	0	1	2
CS4	542524	1,77	9	13	18	20	22
CS5	571266	1,69	0	4	4	4	6
CS6	149271	2,15	1	3	0	1	0
CS7	301049	2	1	0	2	0	3
CS8	163844	2,06	4	3	5	2	5
CS9	132862	2,34	3	2	1	4	4
CS10	418188	1,79	3	4	5	3	4

Table 4. *Syntactic values and frequencies of people in each convex space on weekends.*

Weekend							
Convex Space	Mean Integration	Mean Depth	10.00 am	11.45 am	13.30 pm	15.15 pm	17.00 pr
CS1	115314	2,4	2	3	3	2	4
CS2	322856	1,9	0	1	6	3	5
CS3	381625	1,92	1	2	1	1	1
CS4	542524	1,77	6	6	14	30	15
CS5	571266	1,69	3	0	3	6	8
CS6	149271	2,15	2	0	1	1	1
CS7	301049	2	4	3	7	2	5
CS8	163844	2,06	4	0	6	7	8
CS9	132862	2,34	1	1	4	4	6
CS10	418188	1,79	3	2	7	7	6

syntactic value of predefined convex spaces and the frequency of people passing or spending time in the following convex space. For consistency, the analysis is made over the same time intervals used for the gate count.

The statistical analysis was performed using SPSS software considering the gate count numbers (people passing through the gates) and convex number (people located in convex space) as the dependent variables and syntactic values (integration and depth) as the dependent variables. All regression analyses are shown in Figure 8.

First, the regression analysis of the gate count and syntactic value using both the integration and mean depth was performed for each time interval and day shown in the figure. Interestingly, no significant relationship was found between the syntactic values of the ground floor and the people

passing through the gates. The same result was investigated both for weekdays and weekends. For instance at the 15.15 time interval, the regression between the integration and gate count yields no significant result (Weekday: R=0.145; p=0.732>0.05, Weekend: R=0.220; p=0.6>0.05); nevertheless, for the same time interval, no significant relationship was found between the mean depth and gate count (Weekday: R=0.145; p=0.732>0.05, Weekend: R=0.220; p=0.6>0.05). Almost parallel results were seen for every time interval, as shown in Figure 8.

Second, a regression analysis was performed to examine the relationship between the syntactic values and convex space frequency. At the 17.00 time interval, no positive relationship was found between the integration value and convex space frequency (Weekday: R=0.507; p=0.680>0.05, Weekend: R=0.518; p=0.125>0.05). Although there was no significant relationship between the syntactic value and convex space frequency (Figure 10), the values were higher than the results of the gate count analyses. The negative results for the comparison of both the gate count – syntactic value and convex space frequency – and the syntactic value invite a different perspective for the research. These findings encourage us to discuss the architectural layout of the market in terms of the urban context and immediate surroundings.

6. Discussion and conclusions

Considering the trends in the number of people entering and leaving the market, every gate shows different patterns. For example, more people tend to enter than leave through Gates 3 and 6, whereas more people leave through Gates 4 and 5. At Gates 1, 2, 6 and 8, the number of people entering and leaving is almost equal.

Referring to Hillier's "through-to movement" theory and considering the data gathered from BBM, it is clear that street-based movement character-

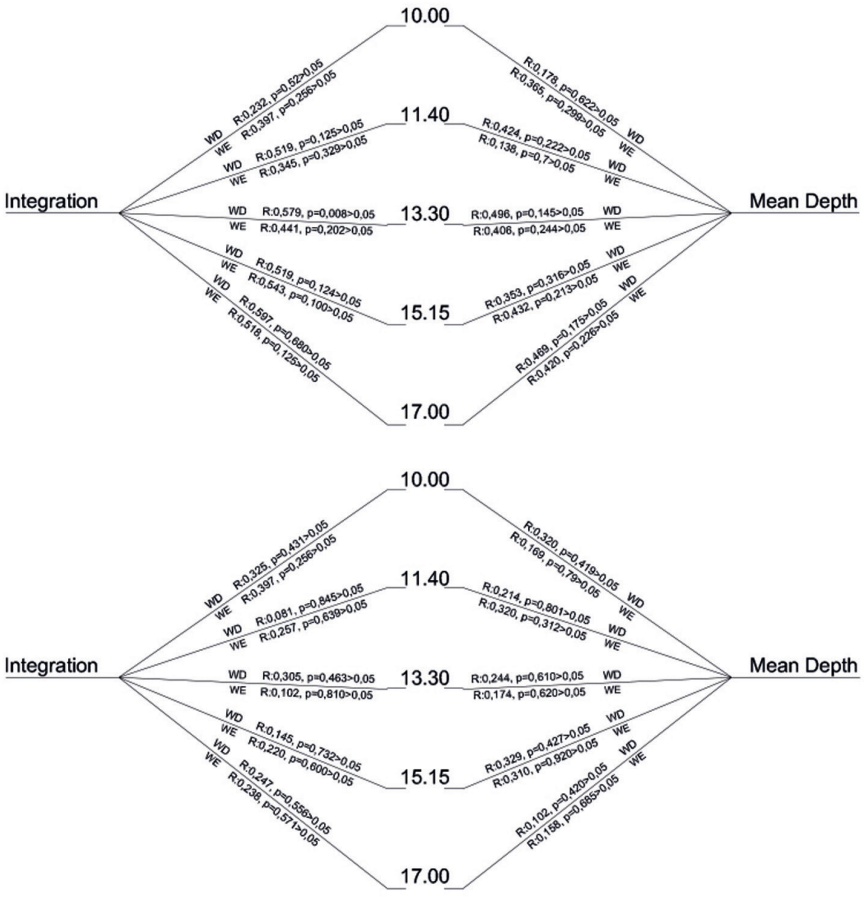

Figure 8. *Regression comparison results a. syntactic values-convex space (above), b. syntactic values-gate count (below). WD weekday; WE weekend.*

izes both through and to movement, where pedestrians move with intention and motivation (Gate 3, Gate 6). Transition-based movement characterizes "through movement," when people act with intention (Gates 4 and 5). On the other hand, peripheral-based movement is identified as "to movement," when people behave self oriented. By taking into account the people entering and leaving the marketplace, it is clear that every gate has a different character.

It was surprising to see clearly that there was no relationship between the architectural layout configuration and the distribution of people passing through the gates. Although the most significant characteristic of the market place is its multiple entrances, the importance of gate location stems not from local integration but from the urban context, which can be described as urban gravity. Moreover, a case study done by Zhang et al. (2012), compares the multilevel and single level shopping buildings to predict the accesibility and pedestrian flow. Related study suggests that multi-level commercial cases, measures of configuration can not explain the pedestrian flows well. Being a multilevel building, might be seen as another reason of uncorrelation between pedestrian flow and syntactic values of ground floor of Buyuk Besiktas Market.

Independent from the structure of the building, the configuration which was set by urban dynamics is so dominant. The gates have different frequencies due to these dynamics. Whether the building have an introvert occupancy its gates creates a new syntactical discussion on urban interfaces. The peripheral, transitional and street based flows are the main attractors in this discussion. The differentiations of these gates are independent from inner syntactical configuration however defines the movement patterns through urban interfaces.

The results of the study support the idea that particularly for multi-entrance buildings, the urban environment can be more dominant or at least effective in manipulating the natural movement in buildings. In particular, Istanbul's Büyük Beşiktaş Market has a very distinctive architectural layout that has the potential to connect the interior to its urban surroundings at almost every surface of the building. This design decision connects the building to its environment and makes the building indispensable to its environment.

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Mimari konfigürasyonun Büyük Beşiktaş Çarşısı'ndaki yaya dolaşımı üzerindeki etkisinin irdelenmesi

İstanbul şehri, son 20 yıl içerisinde alışveriş merkezlerinin hızla çoğalması ile farklı bir morfolojik düzene doğru evrilmektedir. Bu yapılar, kendi içlerinde sosyal bir yaşam ve kamusal kullanımlar önerseler de, ölçekleri ve genellikle dışa kapalı özellik sergilemeleri dolayısıyla bulundukları çevreden ve kentsel süreklilikten kopuk özellik göstermektedir. Bu bağlamda yapı çeperleri, mimari kurguları ile beraber önem kazanmaktadır. Sunulan çalışma, mimari kurgu – yapı çeperi – ve kent ilişkisini İstanbul-Beşiktaş'ta bulunan Büyük Beşiktaş Çarşısı üzerinden irdelemektedir. Söz konusu çarşı, yukarıda sözü edilen kapalı alışveriş merkezlerinden farklı olarak, çok girişli, kent içerisine yayılan, yarı açık ve açık galerileri ile özgün bir mimari kimliğe sahiptir. Sahip olduğu dış çeper, çok girişli ve geçirgen yapısıyla giriş katını kentsel bir arayüze dönüştürmekte, iç mekanın dışarıya, dış mekanın da içeriye sızdığı bir kurgusal düzen sergilemektedir. Bu tespitlerden hareketle çalışma kapsamında gerçekleştirilen alan çalışmasının araştırma soruları aşağıdaki gibidir;

- Mimari form ve yapı çeperinin dizimsel özellikleri bina içindeki yaya akışı ve dağılımlarını etkiler mi?
- İç avlu, açık mekan ve dükkan dizilimi gibi mimari özellikler yayaların rota seçimlerini nasıl etkiler?

Büyük Beşiktaş Çarşısı'nın giriş noktaları, hem bina ile kurdukları ilişki hem de kent ile kurdukları ilişki bağlamında özgün özellikler sergilemektedir. Bu farklı karakteristikler, yapının dizimsel değerleri ve gözlemlerden elde edilen özellikler ile karşılaştırıldığında yayaların rota tercihleri, ve mekansal seçimleri hakkında bilgi verebilmektedir. Söz konusu analizler, yapı çeperinin kullanımı (frekans) ve mimari kurgu içindeki rota tercihlerini ortaya koymaktadır.

Araştırma prosedürü, iki aşamadan oluşmaktadır. İlk aşamada bir hafta sonu ve bir hafta içi olmak üzere gün içindeki 5 zaman diliminde ve 10 dakikalık aralıklarda giriş noktalarınındaki insan akışı gözlemlenmiş, bunun yanında aynı zaman aralıklarında mimari kurgu içerisinde tanımlanan konveks mekanlarda kullanıcı dağılımı not edilmiştir. İkinci aşamada mekanın dizimsel özellikleri Syntax 2D programı ile ortaya konmuş, binanın bütünsellik ve derinlik değerleri tanımlanmıştır. Giriş noktalarının dizimsel değerleri ile aynı noktalardaki insan akışının karşılaştırılması, bu akışın mimari kurgu kaynaklı olup olmdığı hakkında bilgi vermekte, iç mekan kurgusunun dizimsel değerleri ile konveks mekanlardaki insan dağılımlarının karşılaştırılması da bina içerisindeki yaya dağılımının sebeplerini ortaya koymaktadır.

Verilerin analiz edilmesi sonucunda, giriş noktalarının dizimsel değerleri ile bu noktalardan geçen insan yoğunluğu arasında net bir şeklde anlamlı bir ilişki tespit edilmemiş, aynı şekilde mimari kurgunun dizimsel değerleri ile iç mekandaki insan dağılımı arasında da güçlü bir anlamsal ilişkiye rastlanmamıştır. Bu sonuçlar, bina içindeki insan akışının mimari kurgudan çok, kentsel dinamiklerden kaynaklandığını, yakın çevredeki sokak, açık pazar, meydan gibi katalizörlerin yaya akışını domine edici özellik sergileyebileceğini ortaya koymaktadır. Sonuç yargı olarak, Büyük Beşiktaş Çarşısı, kendi mimari strüktüründen bağımsız olarak kentsel dinamiklerden etkilenmektedir.

Çalışma, kapalı ve çevresinden kopuk alışveriş merkezlerinden farklı olarak Beşiktaş Çarşısı'nın Kentsel dinamiklerden beslendiğini, kentin parçası haline geldiğini ve tekil olarak değil çevresi ile beraber bir bütün olarak var olduğunu ortaya koymakta, özellikle kamusal işlevler üstlenen yapılarda kentsel arayüzün önemini göstermektedir.