

Identification of central business district (CBD) boundaries by Space Syntax analysis and the case of Elazığ (Turkey)

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Abstract

The central business district is a phenomenon used in many sciences, especially in geography. Various techniques have been developed to define the boundaries of this area. While the boundaries of CBD generally depend on the observation and experiences of the researcher conducting the study, individuals working in different fields of science try to determine the boundaries with various simple calculations. This situation may cause researchers to identify different CBDs in the same area. In this research study, the integration calculation provided by the Space Syntax Analysis method was used to determine the specific locations of the Central Business Districts. The city's global integration analysis (Segment / Integration HH), local integration analysis (Segment / Integration R800) were conducted using the DeptmapX program. As a result of the study process, it was observed that it is possible to determine the location, size and potential expansion of the central business area with the integration analysis of the Space syntax analysis method. Although it was possible to determine CBD boundaries of a city with this method, it is necessary to evaluate the study's analysis results by comparing them with field studies in order to reach the most accurate result.

Keywords

Central business district, Central business area, Elazığ city, Space Syntax analysis, Spatial analysis, Urban geography.

1. Introduction

Cities are one of the most significant places where humans and nature intertwine and where people try to establish dominance over nature. For this reason, these places attract the attention of different branches of science and a variety of studies about the urban areas have been carried out by different disciplines. Cities have an important role to serve their environment and people living in them. One of the most basic characteristics that distinguish urban places from rural areas is the service they provide to their environment. Some studies conducted in this context focus on determining the service characteristics of cities.

The CBD map is one of the basic maps used in the geographical city studies aiming at determining the qualities and limits of the service provided in a city. However, the boundaries of CBD are usually based on the field observations of the person who conducts the study. For this reason, it is possible to see that there are different boundaries of the very same specific area determined by different observers.

Although there have been some attempts to identify CBD boundaries by special methods in previous periods, these initiatives have been limited to the areas studied. Namely, it was possible to apply a specifically created method to a different city.

2. Concepts of central business district and centralisation in geographical studies

Centralization has emerged as a very important factor in understanding a complex network structure. It is also related to various spatial factors affecting social activity in cities. Centralization, in other words, central and perimeter levels, represents the topological hierarchy scale of the access within a system. Namely, the number of streets in a place indicates the level of access; the higher the level of access, the more central the place is.

The etymological origin of the word central is "centrum" in Latin or "kentron" in Greek which means thorn. It also means the tip of a compass and the middle point of a circle. In other words, the peak point of a city is

the space where socio-space units are stacked the most. There are different types of centralization in the areas of urban agglomeration. It is important to distinguish spatial and social notions (concepts). Therefore, the topological centrality applied in space syntax theory implies a spatial integration of a field. It can also be described as the configurational structure of the street network (Czerkauer-Yamu, 2010:24).

The Central Business Area issue was first discussed by American geographers Murphy and Vance (1959) and the Swiss geographer Carol (1960) (Uğur, Aliğaoğlu, 2015:157). Several definitions have been made by different scientists on the Central Business Site:

Real central business site functions are the retail sales of goods and services for profit and the fulfillment of different bureau services (Murphy and Vance, 1959:429).

The centralized workplaces of the cities have been described with the terms like *Cité* or *City* by the writers in Europe for a long time; according to Schwartz, although there may be some exceptions, these places are usually formed in cities with populations over 100,000 (Schwarz, 1966:451).

In general, the CBD is a place where informing, managing and profit-making activities are brought together. Central Business District can be defined as the central part of the cities, which have a collective shape, where commercial activities reach high density and increase in a vertical direction (Beaujeu-Garnier and Delobez, 1983:325-6).

The most important functional area of all small or large urban centers is the so-called "commercial core" or the Central Business District (CBD). This section is located in or near the geographical center of the cities, except those on the coast. In coastal cities, it is definitely close to the shore and mainly developed on the basis of recreation. The central business areas in the cities can range from small groups of four to five shops, and they can be in different scales, including shopping centers without traffic and with free parking lots (Tümertekin, Özgüç, 2002:475).

The Central Business Site is a phe-

nomenon that needs to be determined only in the studies on urban areas as cities are commercially much more developed than rural areas. In addition, as CBDs serve the surrounding settlements, they have significant functional positions.

Cities are the commercial service centers of the settlements in there are of influence. For this reason, the trade function is one of the most important ones that ensure the continuity of cities (Özçörekçi, 1944:71). CBD is analyzed under the title of trade function in most studies. In this context, the most intensive trade area of the city is determined and the map is accordingly produced; the commercial shops or places in the CBD are then classified into daily, periodic and long-term maps. The greater the variety of these qualities, the greater the attractiveness of that area is. For example, while the pedestrian traffic is more intense in the area that serves the daily needs, the pedestrian traffic is less intense in areas that serve the periodic needs. For this reason, the level of attractiveness at the center decreases towards the surrounding areas.

The solution to various infrastructure problems in regional planning and the identification of economic centers accordingly is the most important step. The developed centers distribute services to their surroundings: they thus need to have a variety of functions. The demands of people living in a region ranging from daily necessities to luxury consumption needs, cannot be fully equally satisfied everywhere. The most necessary services for the population in a settlement are provided in the economic center, which is specifically formed in a central location. This central location undertakes the specific functions of other settlements around it; in addition to responding to the needs of its local population, such locations are important in terms of providing services to its surroundings. The centrality is made of the plurality and a variety of central functions gathered in an urban location and based on one or several transportation systems in that location (Karaboran, 1989:94-5-7).

In urban settlements, the land becomes useful for different purposes. Shops, houses, and factories in cities

are placed in the order; there is a spatial differentiation. As the population of the settlement increases and evolves in such settlements, the “commercial sites” and “residential areas” are firstly separated. An increase in the business activities in a specific area leads to the creation of a Commercial Core.

Commercial sites are one of the most significant types of usage in urban lands. There are generally four types of commercial sites in cities:

1. Centralized Trade Areas or Central Business Sites.
2. Commercial Lanes.
3. Scattered Workplaces.
4. Shopping Centers (Tümertekin, 1967:18).

Trade is one of the traditional functions of city settlements. In fact, one of the reasons for the creation of the first city settlements is short or long-distance commercial relations. Cities are the trade centers of their people and surroundings. Some of the essential functions that cities have performed throughout history are to market agricultural products of a certain region and sell goods and urban services to the same region (Akçura, 1971:192). The main reason for manufacturing in cities is not the ease in production in the city, but the advantages of the city in terms of trade (Jacobs, 2011:354-5).

3. Methods used in determining central business district (CBD)

Different methods have been used to determine the CBD boundaries. The first of these methods is the classification of Zurich by Carol. In the first phase of this method, activities with and without central business site functions are distinguished. The building scale is evaluated in the second stage. According to the system, if an activity serves the city or a wider area, it is considered as a central business site function; on the other hand, if it serves a small area, it is out of this scope.

If three or more floors in a building are occupied by facilities with CBD function, then the building is considered to be a construction with a CBD function. If one or two floors of a building are occupied by the CBD function, then it is considered to be a semi-CBD function building. If less than one floor

rangements, the D260 highway passing through the city was removed from the system. D260 highway was specifically removed from the system until the point that the area intertwined with the city (until Elazığ, Tofaş junction) (Figure 1); as such long roads are located over a wide and long plane, they cause errors in urban integration.

Another arrangement was the removing settlements, non-residential polygons, and routes from the parcels within the zoning border in the system. If the parcels and routes that have not become settlements yet are removed from the system, they lead to a calculation error.

After the arrangements, the global integration analysis (Segment / Integration HH) of the city was conducted by using the DeptmapX program; the local integration analysis (Segment / Integration R800) was performed after this analysis process. The R800 value was used after a series of analyses (R200, 400, 600, 800, 1000, 1200) as it was determined that it gave the most accurate result regarding the integration of the workplace. CBD maps were generated from local integration analysis. Field studies were conducted to test the accuracy of the obtained maps and the routes were photographed (Figure 5-6-7-8).

5. Assessment of centrality in space syntax analysis

Urban integration can be understood and analyzed by following the transportation networks in the cities. Space syntax is a method that analyzes how micro and macro spatial layers are shaped, how they work, develop and change (Hillier, 2005: 10). Today, this theory that connects space with social life is one of the most effective scientific approaches in architecture and urban design (Kubat et al., 2007:1).

Hillier argues that the concept of density center in a city means the combination of land uses and activities at an important center (Hillier, 2007:127). The concept of being central can also be defined by the intensive flow of pedestrians. Movement economics is a component of "live Centralization", which is one of the key ingredients of Centralization; this means the so-

cio-spatial effect. Live centralization is an element of centralization managed by the activities that bring unexpected benefits resulting from retailing, shopping, entertainment and mobility. Life centers that manage living centers also necessitate spatial requirements of other central functions such as management, office employment or religion. The theory of motion economics is based on investigations of the flow of motion in a street network, which affects the mobility of the street, the spatial configuration of the network itself.

The highest density of motion in a city system exists in urban centers. Low and high motion intensities occur through mobility and this process is in a hierarchy. Generally, different centers can host different functions. For example, while there are many more shops and offices in a historic area, there can be more residences in a residential area which is far from the city center (Czerkauer-Yamu, 2010:25).

In fact, the centralization structure becomes functional through the spatial configuration of the route selection within a street network. This has an effect on the selection of the area to be used. These elements seen in the whole city plan are called "attractors". Understanding Centralization is not very problematic because, for example, if we think of living centers in historical centers, we can see that the concept is very clear and stable.

In conclusion, where there is a center, there is also centrality. The topological center is linked to the urban fabric and its accessibility. Space Syntax Analysis provides a tool called "integration" to examine centralization in cities. Integration is a highly important factor in the space syntax method (Özbek, 2007:47,49,51).

The axial map is the representation of a space drawn according to certain rules, where the legibility, accessibility and street systems of a space can be classified as hierarchical. The integration contains several measures such as "step", "depth", and "radius". These measures represent "movement from one axial line to another line", "steps to go from any area to all other areas" (Klarqvist, 1993:11-2) and "maximum number of accessible steps". If the

whole map included in the calculation, it is called “global integration” or Radius “n” (Rn). If steps from aksiyel line is smaller than the total number of axial lines, this limited calculation is called “local integration” (Turner, 2007:540-5).

Integration: The degree of accessibility from the whole system. “It describes the average depth of space to all other spaces in the system” (Klarqvist, 1993). Integration can be calculated as a global or local measure. Global measures (Rn: global integration) calculate integration for the whole system whereas a local measure (local integration) is restricted to finite syntactic steps and therefore a specific spatial neighbourhood. Basically, Integration is used for a syntactic analysis. Integration enables measurements of the relative accessibility of a space within a system.

The first step of integration is to calculate the depth of each axial line,

$$D_i = \sum_{j=1}^N d_{ij}$$

D: Total depth for the given node i
dij: depth between two spaces of i and j
(Volchenkov and Blanchard, 2008)

N is the total number of nodes in the axial map

The average number of syntactic steps from a given node i to any other node is called “mean depth” (MD):

$$MD = D_i / (N - 1)$$

Mean depth can be defined as the minimum number of syntactic stages that will be required when moving from one place to another on the chart, however, since the size of the axial map affects the MD value, it is not possible to compare different networks thoroughly which have unequal number of nodes. To solve this problem, two concepts have been developed: Relative asymmetry (RA) and Real Relative Asymmetry (RRA).

The relative asymmetry or relative mean depth expressed as a “fraction of the maximum possible range of depth values for any node in a graph with the same number of nodes as the system” (Bafna, 2003):

$$RA = 2 \frac{MD - 1}{(N - 2)}$$

Real Relative Asymmetry is calculated by adding a normalization parameter (DN) to the formula of RA for each node i (Volchenkov and Blanchard, 2008):

$$RRA = 2 \frac{MD - 1}{D_N (N - 2)}$$

Basically, DN in this formula is the RA values of the central node of a diamond graph (or the normal distribution of nodes) with the same number of nodes as the system and it is extended as (Volchenkov and Blanchard, 2008):

$$D_N = 2 \frac{N(\log_2 \left(\frac{N+2}{3}\right) - 1) + 1}{(N - 1)(N - 2)}$$

Integration is a measure of depth and focuses on the correlation of movement and mean depth. It has to be noted, that researchers assume the integration measure with regard to centrality as an indicator of how people move around. In the urban system, some space may be more accessible or have higher integration than other areas. The syntax that connection and structural features of the transportation systems in the cities greatly affect the spatial integration. The diversity in integration calculations gives ideas about variations on the integrity of settlements. Therefore, the spatial integration map can also be assumed to represent the topological configuration and location of the CBD. As a result, the usability of global analysis, which is one of the integration accounts in the case of Elazığ, was tested in determining the central business area.

Hillier and Hanson describe integration as a global measure of depth and think that systems with different sizes can be directly compared with another; formulated as “Integration = 1 / RRA” (Hillier, Hanson, 1984:1089)

In terms of space syntax, centrality is defined as the accessibility which is appropriate for the minimum possible change in local and global urban settlements. Therefore, the integration of central locations is much higher than the whole system (Czerkauer-Yamu, 2010:25).

The most important concept of the Space Syntax method is the “integra-

tion” phenomenon. Integration is a method that is formed by overlapping the smallest and largest potential movement lines in the structure island system, which is transformed into the grid form of cities. By calculating the integration of each line into the local system and into the whole system, an urban grid system can be analyzed, mobility can be predicted, and data can be produced to explain its current mobility. This relationship will be effective in many areas of urban functions as it constitutes the most fundamental subject of design (Autors, 2015: 13).

Integration is used in syntactic analyses. It allows relative accessibility measurements of space within a system.

6. Identification of boundaries of central business district in Elazığ

The city of Elazığ stretches out from the east towards the west. Today, the development of the city is mostly in a west-northwest direction. For this reason, Elazığ has a linear structure, especially towards the west. The linear structure of the city caused the integration value to increase more in the middle of the settlement area (Figure 2).

In the global integration analysis, the most prominent routes were mostly boulevards in the city. Ahmet Ka-

baklı Boulevard, which connects the roads in the central part of the city to the north, and Atatürk-Cahit Dalokay Boulevard, which provide transportation to the east side of the city, are among the leading systems. In addition to the aforementioned boulevards, Zübeyde Hanım Street, Elazığ Street, and the following Governor Fahribey Street are the routes with the highest integration values in the city.

When the local integration analysis is examined, two clustering areas attract attention. This proves that the city has two different central business districts. However, the area identified as the second cluster corresponds to the area where the city's auto industrial site is located (Figure 3). Auto industry sites are not considered as CBD. For this reason, the second cluster area should be considered as a space used when necessary, not as a CBD.

The area identified as the first cluster area shows the most intense area of integration at the local scale. This area is also part of the city's CBD.

The CBD boundaries of the study area are the spaces between Muammer Çorbacioğlu Street in the north, Şehit Polis Kamil Gökçeer Street in the south, Bahçeli Street in the west, Şire Square and the Covered Bazaar in the east. When Figure 4 is analyzed, it can be seen that Şire Square and the Grand Bazaar form a small cluster area within the boundaries of the CBD.

The CBD area in Elazığ was classified according to a hierarchy according to the level of significance. The first-order important routes indicate the most intensive part of the economic activities in CBD. The other routes are the secondary parts of the CBD.

The aforementioned secondary parts are not often included in the studies. However, as a result of the field observations, it was concluded that the location of these streets and avenues in the economic cycle is important. In addition, these secondary routes fulfill the task of connecting the first-order routes. In this context, secondary and third-order routes should be studied within the boundaries of CBD.

Important first-order routes in CBD in Elazığ are; Gazi and Hürriyet streets in the north, Yakup Şevki Street which

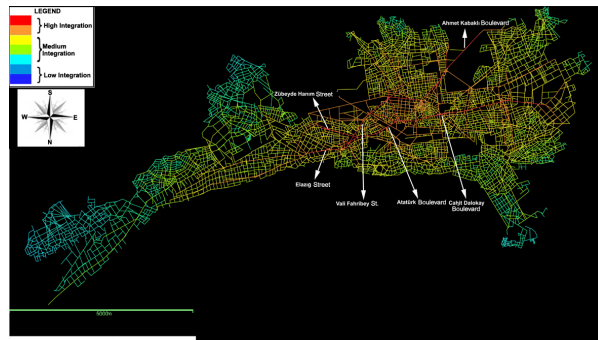


Figure 2. Analysis of Global Integration in Elazığ (Integration HH).



Figure 3. Cluster Areas in Elazığ (Local Integration R800).

is the follow-up of these streets, Şehit Polis Kamil Gökçeer in the South and General Abdullah Alpdoğan streets which cut CBD in the northeast-south-west direction. In the area where Şire Square and the Grand Bazaar are located, the east-west direction Atatürk School Street and the north-south direction Aksaray Street are the first degree CBD routes of Elazığ. The route with the highest integration value is Gazi Street (Figure 4-5).

At the beginning of the second order of CBD routes is Muammer Çorbacıoğlu Street, which intersects with Gazi Street in the west, extends parallel to Gazi Street and Vali Fahribey Street, located at the south of the street. The proximity to Gazi Street, which has the highest integration value, has a big share of the increase in the importance of these two avenues. This importance of these routes is followed by General Hakay Talay Street, which extends in the east-west direction (Figure 6-7).

There are three basic routes in the study field that have the second-degree integration value. They connect the first-degree integration routes to either one another or to the other streets and avenues. The first route is Akın Street that connects Gazi and Vali Fahribey Streets and extends towards north-south direction. The second is İstasyon Street that starts at the intersection of Hürriyet and Gazi Streets and extends towards the north. İnönü Street, starting from the intersection of Hürriyet and Yakup Şevki Streets extending towards the north (Figure 7).

There is a common point of the third degree important routes; all of these routes are made of lines that cut the other avenues in the north-south direction. Yenice Street, Tuncay Street, Şire Square and Sakarya Street in the Grand Bazaar are the third-order important routes (Figure 3-8).

7. Conclusion and findings

SpaceSyntax Analysis provides the identification of the most integrated axes of a city's transportation network in a specific space or in the whole urban area. An area where axes with high integration values, located at the center of the city, attracts commercial functions as it provides the advantages of being



Figure 4. Routes of Central Business District (CBD) in Elazığ.



Figure 5. a) Gazi Street, b) Yakup Şevki Street, c) Hürriyet Street.

together in terms of trade; such areas with high trade activity and capacity form the main trade area of the city called CBD. In this context, it is possible to determine the position, size and potential span of the central business area by integration analysis of the space syntax method. The analyses conducted in the city of Elazığ indicate that the spatial alignment method can be used as a tool for determining CBD.



Figure 6. a) Vali Fahribey Street, b) Muammer Çorbacıoğlu Avenue, c-d) Bahçeli Avenue.



Figure 7. a) İstasyon Street, b) İnönü Street, c) Akın Avenue, d) General Hakkı Talay Street.



Figure 8. a-b) Şire Square, c) Bankalar Street (going down from Gazi Street to Şire Square), d) Nalburcular Avenue, e) The Grand Bazaar (West Entrance), f) The Grand Bazaar (South Entrance).

Although there are two clustering areas in Elazığ, there is only one CBD. Although there is a rapid urban development towards the west due to the continuity of the linear structure of the city, and despite the fact that some of the official institutions have been moved to the west of the city, no CBD has been developed in this area yet.

A second CBD is likely to develop in this area if the western part of the linear structure of the city is changed in the future. Considering the situation

in the global integration map and the current development process of the city, it is possible to say that due to its proximity to the center, Hazardağlı Intersection (Beyzade Efendi and İmam Efendi Boulevard), could become the intersection point of Sürsürü-Ataşehir and Cumhuriyet neighborhoods.

Most of the CBD routes with first and second-degree integration in the city are in the east-west direction, while all of the third-degree integration routes are in the north-south direction. This shows that the integration value of the roads in the direction of the general extension of the city is higher. Therefore, in the future, if a new CBD is formed in the future, we can foresee that the route will be on an east-west direction which is suitable for the city's development route.

Although the CBD boundaries of a city have been determined by the Space Syntax Analysis Method, it is useful to evaluate the results of the analyses by comparing them with the field studies in order to reach the most accurate results.

As a result of the field studies, it is determined that although Bağlar Street followed by Hacı Hayri Street, Martyr Police Kamil Gökçeer Street, and then Adnan Orakçıoğlu Street is within the boundaries of CBD, the ground floors of the buildings constructed on these streets are not allocated to any business firms. In other words, as all of the buildings are used as dwellings, there are no commercial shops or places on the streets. Therefore, these streets in Elazığ's CBD boundaries should be ignored in studies.

There are surely some streets and neighborhoods with business firms outside the CBD boundaries (Şehit İlhanlar Street, Şehit İdris Doğan Street, etc.); however, as they are not defined as specific fields that integrate with the other streets, they are not included in the system. As a matter of fact, the high number of business firms in an axis doesn't mean that it has the characteristics of CBD.

Elazığ's CBD boundaries start at Bahçeli street in the west and end at Şire Square in the east, while the northern part starts with Muammer Çorbacıoğlu street and extends until

General Hakkı Talay street in the south (General Hakkı Talay street is included in CBD). Within the system, General Abdullah Alpdoğan Street and İstasyon Street constitute the linear routes connected with the CBD area within the system.

In cases where it is not possible to obtain detailed land-use data in terms of time and cost, it can be possible to understand the city by analyzing the central business area via the transport network. It is also possible to analyze the changes in the location of the city's central business area over time by examining the change in the city's transport network.

Streets in the boundaries of the CBD including residences in terms of function should be carefully determined in the studies. On the other hand, the residential areas can be re-planned and CBD areas can be rearranged on this basis. It can thus be possible to transform such areas in the cities with increasing population into more proper locations for the people living in them. SpaceSyntax analysis may include residences in the axes within the boundaries of the CBD area. Similar to Elazığ example, although some streets in the area with central business activities have high integration values due to the transportation network, these locations have only housing functions. These areas, as Burgess points out, are extremely important for CBD which is the focus of commercial, social and urban life. The arrangement of these streets, which can be called as the transition area, is also important for the planning and harmonization of the CBD functions with the CBD development as well as for the residential areas and urban life in the center.

References

Akçura, T. (1971). Türkiye'de Şehirleşme ve Bazı Şehir Örnekleri (Urbanization in Turkey and Some Examples). *Türkiye Coğrafya ve Sosyal Araştırmalar*, Çağlayan Matbaası, İstanbul (in Turkish).

Bafna, S. (2003). Space Syntax: A Brief Introduction to Its Logic And Analytical Techniques. *Environment and Behavior Review*, 35(1): 17-29.

Battino, S., Borruso, G., and Do-

nato, C. (2012). *Analyzing the Central Business District: The Case of Sassari in the Sardinia Island*, In, editor, p.624-39. Berlin, Heidelberg: Springer Berlin Heidelberg.

Beaujeu- Garnier, J. Delobez, A. (1983). *Pazarlama Coğrafyası (Geography of Marketing)*. (Translated by : Erol Tümertekin) ,İstanbul Üniversitesi Yayınları, No:3111, İstanbul (in Turkish).

Carol, H. (1960). The Hierarchy of Central Functions within the City. *Annals of the Associations of American Geographers*, Vol: 50 No:4: 419-438, London.

Czerkauer-Yamu, C. (2010). *Space Syntax Understanding, HILLIER's Concept of Spatial Configuration and Space Syntax Analysis*. Universite de Franche- Comte, University College London, England.

Davies D. H., (1960). The Hard Core of Cape Town's Central Business District: An Attempt at Delimitation. *Economic Geography*, Vol.36, No.1: 53-69, UK.

Hillier, B. (2007). *Space Is the Machine*. Cambridge University Press, London.

Hillier, B. (2005), The Art Of Place And The Science Of Space, *World Architecture* 11/2005, p 10,21.

Hillier, B., Hanson, J. (1984). *Social Logic of Space*. Cambridge University Press, London.

Jacobs, J. (2011). *Büyük Amerikan Şehirlerinin Ölümü (The Death and life of Great American Cities)*. (Translated by: Bülent Doğan) Metis Yayınları, İstanbul (in Turkish).

Karaboran, H. (1989). Şehir Coğrafyası ve Şehrsel Fonksiyonlar (Urban Geography and Urban Functions). *Fırat Üniversitesi Sosyal Bilimler Fakültesi Dergisi*, Vol. 3, No.1: 81-118,Elazığ (in Turkish).

Klarqvist, B. (1993). A Space Syntax Glossary. *Nordisk Arkitekturforskning*, 2th Edition, Norway.

Kubat, A.S., Güney, Y.İ., Özer, Ö. (2007), Space Syntax Üzerine. 6. *Space Syntax Sempozyumu*.

Murphy, R.E. Vance, J. E. (1954). Delimiting the CBD. *Economic Geography*, No:3, Vol:30:189-222,UK.

Özbek, M. (2007), *Fizik Mekan Kurularının Sosyal İlişkiler Üzerinden Ar-*

navutköy Yerleşimi Bütününde Mekan Dizimi Yöntemi İle İncelenmesi. Mimar Sinan Güzel Sanatlar Üniversitesi Fen Bilimleri Enstitüsü Doktora tezi.

Özçörekçi, H. (1944). Anadolu'da Küçük Şehir Araştırmaları (Small City Researches in Anatolia). *Ankara Üniversitesi Dil Tarih ve Coğrafya Fakültesi Dergisi*, Vol. 3, No. 1: 69-83, Ankara (in Turkish).

Schwarz, G. (1966). *Allgemeine Siedlungsgeography*. 3th edition, de Gruyter Verlag, Germany.

Taubenböck, H., Klotz, M., Wurm, M., Schmieder, J., Wagner B. and Esch T. (2013). Delimiting Central Business Districts – A Physical Approach Using Remote Sensing. *Proceedings of the JURSE*, April 21-23, Brazil.

Tümertekin, E. (1967). İstanbul'un Merkezi İş Sahaları (Central Business District of İstanbul). *İstanbul Üniversitesi Coğrafya Enstitüsü Dergisi*, Vol.8, No.16:18-37, İstanbul (in Turkish).

Tümertekin, E. Özgün, N. (2002). *Beşeri Coğrafya İnsan, Kültür, Mekan (Human Geography, Human, Culture, Location)*. Çantay Kitabevi, İstanbul (in Turkish).

Turner, A. (2007). From axial to road centre lines: a new representation for space syntax and a new model of route choice for transport network analysis. *Environment and Planning B: Planning and Design* 34.

Uğur, A., Aliağaoğlu, A. (2015). *Şehir Coğrafyası (Urban Geography)*. Nobel Akademik Yayıncılık Eğitim ve Danışmanlık Tic. Ltd. Şti, 4.Basım, Ankara (in Turkish).

Volchenkov, D. and Blanchard, P. (2008). Scaling and universality in city space syntax: Between Zipf and Mathew. *Physica A: Statistical Mechanics and its Applications*, 387(10): 2353-64.