DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

MEASURING THE VARIATION IN URBAN ACCESSIBILITY LEVELS AT THE NEIGHBOURHOOD LEVEL IN İZMİR, TURKEY USING GIS

by
Edward BOAMPONG

June, 2015
İZMİR

MEASURING THE VARIATION IN URBAN ACCESSIBILITY LEVELS AT THE NEIGHBOURHOOD LEVEL IN İZMİR, TURKEY USING GIS

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We have read the thesis entitled "**MEASURING THE VARIATION IN URBAN ACCESSIBILITY LEVELS AT THE NEIGHBOURHOOD LEVEL IN İZMİR, TURKEY USING GIS**" completed by **EDWARD BOAMPONG** under supervision of **ASSOC. PROF. DR. K. MERT CUBUKCU** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

Assoc. Prof. Dr.K. Mert CUBUKCU

Supervisor

Assoc. Prof. Dr. Selman D. Dündar

(Jury Member)

Yrd.Doç.Dr. Muhammed Aydoğan

(Jury Member)

Prof.Dr. Ayşe OKUR

Director

Graduate School of Natural and Applied Science

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ABSTRACT

Urban areas have been studied for decades to cluster sectors or parts of the urban structure into distinguishable social areas. These studies have focused on the use of socio-economic data for conclusions in urban studies especially in comparative urban research. This study seeks to bridge the gap between the socio-economic characteristics and the spatial organization components of urban residential neighborhoods. The main aim of the study is to explore whether differences exist in the accessibility within residential neighborhoods in İzmir with prior emphasis on the socio-economic dynamism of the city's residential neighborhoods. Hierarchical cluster analysis is used to group the 340 neighborhoods in İzmir, Turkey, into eleven distinguishable and homogenous groups in terms of social and economic indicators. A simple random sampling is conducted to select a neighborhood from each of the eleven groups. The randomly selected eleven neighborhoods are Yildiz, Onur, Camlikoyu, Ugur, Altinordu, Ataturk (Narlidere), Namazgah, Bahcelerarasi, Dokuz Eylul, Ataturk (Cigli), and Yenigun. Centrality based accessibility indexes were used to measure the levels of accessibility in selected representative neighborhoods in İzmir, Turkey.

Reach centrality, gravity centrality, betweenness centrality, closeness centrality and straightness centrality indexes were determined for each building in the residential neighborhoods. The indices were calculated for each building in each neighborhood based on a 600-meter radius on the street network using network centrality tools developed by MIT's City Form Research Group. Hypotheses were formulated to measure the variations in neighborhoods accessibility using the centrality indices identified for the study. A One-way analysis of variance (ANOVA) was used to ascertain the differences or otherwise of the selected neighborhoods. The results of ANOVA for the indexes showed that all the neighborhoods have variations in terms of accessibility measured from the street networks and location of buildings for the neighborhoods. The results are statistically significant at alpha equal to 0.05. It is observed that the accessibility levels at the neighborhoods level varies with the social and economic characteristics.

The findings provide grounds for concluding that, a combination of the socio-economic factors and the spatial organization provide a good alternative for the comparative studies of the structure of urban neighborhoods.

Keywords: Accessibility, spatial structure, comparative studies, one-way analysis of variance.

İZMİR DE KENTSEL ULAŞILABİLİRLİK DÜZEYLERİNDEKİ FARKLILAŞMANIN MAHALLE ÖLÇEĞİNDE CBS İLE ÖLÇÜLMESİ

ÖZ

Kentsel alanların sosyal alanlara ya da parçalara ayrıştırılmalarına yönelik olarak uzun süredir çalışmalar yapılmaktadır. Söz konusu çalışmalar son yıllarda sosya-ekonomik verinin kullanımına dayanan karşılaştırmalı araştırmalara yoğunlaşmıştır. Bu çalışma, kentsel alanda sosyo-ekonomik parametreler ile mahalle düzeyinde mekânsal örgütlenme arasındaki ilişkiyi kurmaya yönelik olarak kurgulanmıştır.

Çalışmanın amacı İzmir örneğinde farklı sosyo-ekonomik karakterdeki mahallelerin mekânsal erişilebilirlik düzeyleri arasında fark olup olmadığının test edilmesidir. Bu amaçla İzmir'de bulunan 340 mahalle hiyerarşik küme analizi yöntemi ile 11 homojen gruba ayrılmıştır. Bu 11 homojen grup içerisinden basit rastlantısal örnekleme ile birer mahalle seçilerek 11 mahalle ile örneklem kümesi oluşturulmuştur. Seçilen mahalleler: Yıldır, Onur, Çamlıkoyu, Uğur, Altınordu, Atatuük (Narlıdere), Namazgahh, Bahçelerarası, Dokuz Eylül, Ataturk (Çiğli) ve Yenigün şeklindedir.

Mahalle ölçeğinde erişilebilirliği ölçülmesi için beş farklı erişilebilirlik endeks değeri kullanılmıştır: erişim (*reach*), yer çekimi (*gravity*), aradalılık (*betweenness*), yakınlık (*closeness*) ve düzlük (*straightness*). Endeks değerleri her mahalle için bina ölçeğinde, mahalle merkezinden ulaşım ağı üzerinden 600 metre mesafedeki yapıların tümü için MIT City Form Research Group tarafından geliştirilmiş olan program kullanılarak hesaplanmıştır. Hesaplanan endeks değerlerinin her ölçüt için mahalleler arasında farklılaşıp farklılaşmadığı tek yönlü varyans analizi ile (ANOVA) sınanmıştır.

Elde edilen sonuçlar, farlı sosyo-ekonomik yapıdaki mahallelerin mekansal yapısının da farklı olduğu sonucunu ortaya koymuştur. Elde edilen sonuçlar α eşittir 0.05 düzeyinde istatistiksel açıdan anlamlıdır. Çalışmanın sonuçları, sosyo-ekonomik faktörler ve mekansal yapının bir arada incelenmesinin sadece sosyo-ekonomik

faktörleri dikkate alan karşılaştırmalı çalışmalar için iyi bir alternatif olabileceğini ortaya koymuştur.

Anahtar kelimeler: Erişilebilirlik, mekansal yapı, karşılaştırmalı çalışmalar, tek yönlü varyans analizi.

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CHAPTER ONE
INTRODUCTION

The study of cities to capture the relationships between social processes and urban spatial configuration has received consideration attention without clear-cut breakthrough to understanding this phenomenon. City planners have studied the urban configuration in diversified ways to understand the processes behind the ways the cities function especially the structure of settlements and their connections to the social lives of the inhabitants of the cities. Some researchers in the past years have studied the urban structure patterns and social processes to expound the hidden relationships between the structure of urban areas and socio-economic processes within these urban areas. A study in Milan by Camagni et al (2002) suggested that emergence of new land consumption and urban growth is partly due to the changes in lifestyle patterns and spatial developments, which are both influenced by the social and economic characteristics of the city of Milan, Italy (Camagni et al., 2002).

The progression and the expansion of housing and residential structures in towns and villages had some influence from the cultural background of these settlements. Megacities, Metropolitan areas, cities, urban centres, towns and rural areas throughout the history of man have been the intervention of human activities on the natural environment. The classification of urban areas into sub-groups became noticeable in the 1920's when Burgess developed the Concentric Model of the urban structure to classify the city of Chicago (Burgess & Park, 1925). Hoyt used rent values to classify the urban space into sub-divisions popularly known as the sectors (Hoyt, 1939). The sectors were mainly based on the rent values which segregated the population into low class residential, medium class residential and high class residential (Hoyt, 1939). The classification of the cities into groups was conducted at the macro level without detail consideration to the elements at the neighborhood level. These differentiations were accounted for on the grounds of variables that did not take the spatial configurations of the settlements into consideration. The street networks, the location of buildings, the relevance of land uses and the social processes at the neighborhood level were not merited the needed attention.

Some studies along the course of time, studied cities to classify them into areas based on the social and economic variables (Bell, 1953; Haggerty 1982; Mack & McElrath, 1964; McElrath, 1965). Social Areas theory was used to cluster the urban neighborhoods, using socio-economic data from census tracts, into what he termed as social areas became prominent in the middle part of the 20th Century. This theory has contributed to the study of comparisons between cities and within cities and served as a comparative measure of urban residential patterns. There has been considerable research in urban studies to partition the urban space based on the pattern of social and economic growth. The growth of urban cities and urban settlements indirectly provides heterogeneity in the population as well as provide different life-styles of residents that breed variation in residential neighborhoods.

Cities serve as centres of economic and social development of the population in an important way to provide the opportunities for human wellbeing, economic development and equitable distribution of resources. Urban areas have been studied for decades to partition the urban structure into distinguishable social areas. These studies have over the years focused on the use of socio-economic data for making inferences in urban studies especially in comparative urban research. Cities have invariable differences in the internal availability of resources, the levels of social status and the levels of infrastructure and service distribution. Some studies over the past decades have grouped areas in the cities under social and economic classifications (Bell, 1953; Van Arsdol et al, 1958; Anderson & Egeland, 1961).

The linkage between the urban spatial structure and the social processes has received some considerable literature that has illuminated this study. There have been different aspects of urban spatial structure in connection to the social, demographic and economic characteristics of inhabitants in residential and urban neighborhoods (Camagni et al, 2002; Omer & Goldblatt, 2011; Cohen et al., 2013). Studies of the urban variations suggest that there exits relationships between poverty and physical accessibility to land uses such as parks, recreational facilities etc. The measure of variations in urban settlements has not indicated a clear and cutting-edge approach to measure the relationships in social and physical structures of urban settlements. This challenge has led to the emergence of variably consistent approach to examine the variations in social structure, spatial structure and a combination of social structure and spatial structure of urban settlements.

This thesis is centered on the measure of variations in the levels of accessibility in İzmir residential neighborhoods with the disparities of socio-economic factors of the neighborhoods at the background. The study sought to test the hypothesis that, there are no statistically significant differences in the accessibility in the residential neighborhoods. Two levels of variations were used to measure the Variations in the accessibility in İzmir. The first was the classification of the residential neighborhoods into distinguishable clusters and the second was the objective measure of differences in accessibility using Geographic Information Systems.

The study primarily focuses on the identification of the differences that exist between and among neighborhoods in the areas of physical accessibility using geographic information systems. Accessibility of residential neighborhoods with primary emphasis on neighborhood transport modes has become a very important area of concern for city planner and mangers.

The differences between urban residential neighborhoods in terms of distribution of resources such as economic and social infrastructure, roads, employment opportunities, social services, and security have prompted the study of variations in urban residential settings. Comparative urban studies contributed to the study of urban residential differentials to identify areas that are lacking in resource distributions and areas that have abundance. Identifying the uniqueness of areas permit planners, architects and city authorities to review and revise their planning interventions in cities. Planning and urban management is a continuous process which demands continuous research into how urban residential areas are evolving over time. The determination of these changes is dependent on both the social and economic characteristics of the residential areas as well the spatial structure altogether. Distinguishable social and economic areas ought to be determined not just by the socio-economic characteristics of the residential neighborhoods but must include the important and critical spatial configuration components.

The accessibility has become an important tool that serves as a yardstick in the measurement of transport systems, the distribution and redistribution of land uses. The accessibility within residential areas in the context of walking, as a mode of transport, has become relevant indicator to assess the effectiveness and efficiency of the street systems especially to researchers who are championing the compact city ideology.

Urban life is broken into two main elements in the context of *accessibility*. The two main elements are *activity areas* (land uses) and *channels or linkages* (transport system) to these land use areas. These two components of accessibility enhance and detract the potential of movement in urban areas (Geurs & Van Wee, 2004; Handy & Clifton, 2001). Implicitly, the land use zoning in urban areas and the effectiveness of its associated transport system directly or indirectly affect residents' potential of interaction in the metropolitan and urban neighborhoods. The ease with which urban dwellers are able to access shopping malls, shopping centers, education facilities, hospitals, industrial sites, working areas, recreational centers and open spaces is a combination of adequate land use planning and transportation system in urban areas. The understanding of the differences in neighborhood accessibility with prior emphasis on the social and economic diversity of residential areas in İzmir is the major hypothetical question that seeks to be examined.

The study of differences in settlements over the years has to some extent put a huge amount of relevance on the use of social and economic indicators. Qualitative methods of measuring variations have been used on several comparative studies to examine variations within and between urban settlements. This thesis seeks to broaden the scope of variables that are used in comparative urban studies. The comparative analysis of residential areas within the scope of this study has both qualitative and quantitative data that are used to determine the variances in the neighborhood accessibility.

The contextual scope of the study involves the use of social and economic data to classify the residential neighborhoods in İzmir into clusters. The Hierarchical cluster analysis process was used to group the residential neighborhoods of İzmir into unique clusters. These clusters formed the basis to compare the accessibility within the city.

Centrality-based accessibility measures were used to capture unique accessibility values for each of the buildings in the residential areas. Five different centrality-based accessibility indices were used to measure accessibility in each residential neighborhood. The ***reach, gravity, closeness, betweenness*** *and* ***straightness*** centrality indices were applied to the residential neighborhoods to capture the accessibility levels of each building on the spatial network of streets.

The Analysis of Variance (ANOVA) statistical tool was used to test whether there are differences in the neighborhood accessibility. The Welch test and the Brown-Forsythe test were used to test the null and alternative hypotheses for centrality accessibility indices. The Games-Howell pairwise comparisons tests were used to compare the representative neighborhoods of İzmir. This study is important to test the hypothesis that the spatial structure differs with socio-economic structure. Considering only the social processes such as social and economic factors when studying differences between residential areas, does not provide adequate coverage of the urban structure of cities and towns. The accessibility within neighborhoods provides the means to ensure in part, the social and economic wellbeing of the population staying in urban settlements.

This thesis provides theoretical and practical means to understanding the differences in urban residential structure, not only in the social and economic sense but also the effectiveness and the efficiency of the transport systems and the distribution of land uses (residential apartments).

The study revealed that social processes and spatial structure when examined could provide a very important tool to urban planners and urban researchers to understanding the urban spatial structure. The study has provided methods and means to understanding the methods of differentiating urban residential areas using practical and simple methods. This research work suggests that further studies can be conducted to study the relationships between specific socio-economic factors and their manifestation in the spatial aspects of the urban structure.

The rest of the study is organized as follows. The chapter two is made up of the literature review. Chapter three represents the methodology and the processes used for the study. Chapter four contains the data used for the thesis. Chapter five consists of the analysis and the results of the study. Chapter six entails the conclusion of the study and recommendations for future research.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The literature review section of this study has been categorized into five main parts. The first part deals with literature on the use of socio-economic data to classify urban space. The second part entails the literature on urban spatial structure and models that have been developed by earlier researchers on the classification of the urban space. The third part of the literature review section, consists of the relationship that negligibly exist between the socio-economic characteristics and the urban spatial structure. The fourth part of the literature review section comprises of a review of accessibility measures and the final section is concluded by the conceptual framework that forms the abstract element of the study.

2.2 The Social-Economic Classification of the Urban Space

The application of social and economic data in the study of settlements began even before the development of urban structure models by researchers in the early parts of the 20th Century. The evolution and the development of housing and residential structures in towns and villages had some influence from the cultural backdrop of these habitats. Megacities, metropolitan areas, cities, urban centres, towns and rural areas throughout the history of man have been the intervention of human activities on the natural environment. The classification of urban areas into sub-groups became prominent in the 1920’s when Burgess developed the Concentric Model of the urban structure to classify the city of Chicago (Burgess & Park, 1925). Some of his assumptions were purely based on economic and social indicators; the heterogeneous nature of cultural and social aspects of the urban space, commercial and industrial base of the city, rapidly growing population, the city centre of the city as the main point of employment and the economic competition for space(Burgess & Park, 1925). Although the concentric model has been criticized extensively, the model has provided some form of basis for the study of urban areas till today.

Homer Hoyt was one of the first critics of the Burgess Concentric concept. Hoyt used rent values to classify the urban space into sub-divisions popularly known as the sectors (Hoyt, 1939). The sectors were mainly based on the rent values which segregated the population into low class residential, medium class residential and high class residential (Hoyt, 1939). The Hoyt Sector concept applied social and economic data to build upon the Burgess concept but represented the classification of the urban space into sectors instead of rings. The definition of urban space into seeming clusters cannot be readily achieved without much concentration on the social and economic characteristics of the population in the urban setting.

Social Areas theory developed by Eshref Shevky to group the urban neighborhoods using socio-economic data from census tracts into what he termed as social areas became prominent in the middle part of the 20th Century. This theory has contributed to the study of comparisons between cities and within cities and served as a comparative measure of urban residential patterns. The theory was applied to Los Angeles and San Francisco Bay region to classify these cities into social areas (Bell, 1953). The research was conducted to understand how best to use social and economic indicators to group the population in these cities for adequate resource allocation and planning as well as to develop a working theory for the study of comparative urban structures. There has been extensive testing and re-application of the Social Areas to study the organization of urban neighborhoods and cities (Bell, 1953).

Different studies and researchers have used the Social Area concept to study urban neighborhoods and some of them made various modifications to the theory to suit their purposes (Bell, 1953; Van Arsdol et al, 1958; Anderson & Egeland, 1961). The Social Area theory comprises of three main indices propounded by Shevky to categorize urban neighborhood into social patterns. The indices were the urbanization index, the social rank index and the segregation index. The social rank index was derived from the education and occupation indicators of census tracts; the urbanization index was obtained from the measure of fertility, women in labor and single family dwelling units; the segregation index was captured from the ethnicity measures of the census tracts.

Van Arsdol et al in 1958 tested the generality of the indices of the social area theory using empirical data of census tracts from Akron, Birmingham, Louis-ville, Minneapolis, Portland, Providence, Rochester, Seattle, Atlanta and Kansas in the United States. They conceded that these measures serve the purpose of comparative yardstick if the indices are combined in a specific fashion. They argue statistically that at least three factors are very important to account for variations in the structure of the selected cities (Van Arsdol et al, 1958).

Anderson and Egeland statistically tested the sector concept (Homer Hoyt) and the concentric zone concept (Burgess) hypothesis of urban residential structure, using the social area analysis developed by Shevky and Bell (Anderson & Egeland, 1961). Apart from segregation which is one of the components of the measure of residential patterns developed by Shevky and Bell, all the other elements were applied in their study. The urbanization indices and the social rank indices were used for the analysis of the census track from four cities in the United States. They apply the same indices that were essentially practical in the works of Arsdol, Camilleri and Schmids (Anderson & Egeland, 1961). They used the prestige (social rank) values and urbanization indices to test the concentric hypothesis and the sector hypothesis. They established that based on the Shevky-Bell Social area; urbanization index and prestige value index using the selected cities, the sectors and ranked distances as variables for ANOVA, there was an inverse relationship between the two urban residential classification concepts (Anderson & Egeland, 1961). The urbanization index supports the concentric zone residential pattern, while the prestige index supports the sector concept based on the selected cities (Akron, Dayton, Indiana and Syracuse). This was because prestigious residents stayed at the sectors in the periphery and as such did not vary in the concentric residential patterns, but the urbanization index varied in terms of distances as residents with low socio-economic status tended to be found mostly in the central parts of the American cities (Anderson & Egeland, 1961).

The social Area theory, upon it general applicability in the comparative study of inter-city and intra-urban, has been criticized by some researchers. These critics of the theory argued that, the theory had no strong and convincing theoretical foundation and failed an empirical test altogether (Van Arsdol et al, 1961; Abu-Lughod, 1969). Van Arsdol et al undertook an empirical investigation of the Shevky Bell theory of "Social Area Analysis" comparing three independent variables and two identified criterion. They argued that the "social area" concept has no strong theoretical background and as such tested the empirical validity of the concept (Van Arsdol et al, 1961). The results of their statistics test indicated that, the six census tract measures used produced more significant results than when they are combined into social rank index, urbanization index and the segregation index. They conclude that, based on their empirical study, the Shevky concept of social area definition is not a good measure of urban residential structure variation (Van Arsdol et al, 1961). They therefore suggest that urban researchers should rather search for a more theoretically and empirically feasible measure for comparative urban studies (Van Arsdol et al, 1961).

Abu-Lughod (1969) tested the Social Area theory in Cairo, Egypt. The study was conducted to recommend new workable propositions; identify efficient method that was supported by empirical evidence and more enhanced than social area for the study of urban ecology. She identified three main propositions which she suggested would be the appropriate way for urban studies when combined efficiently with the use of factor analysis (Abu-Lughod, 1969). These new factors she proposed were that, residential segregation should be based on modern social rank measures, the thorough consideration of social rank and family association as well as the relationship between family type and housing specialization (Abu-Lughod, 1969). Abu-Lughod proposed that using these variables in a well-ordered amalgamation with factor analysis for urban comparative studies would be proficient to study urban ecologies of the cities (Abu-Lughod, 1969).

Haggerty (1982) explored the impact and the variations in the patterns of social contacts in urban neighborhoods considering the social-economic and environmental characteristics of the urban neighborhoods. The results of the study indicated that frequency of interaction has no relationship with local environment, how long neighboring persist was based on the socio-economic characteristics instead of environmental characteristics (Haggerty, 1982). The participation in organization were found out not to be influenced by the local environment. He postulated that neighborhood physical form contributed to some level of influence on the social contact of residents in the study but the most prominent set of factors involved were the socio-economic characteristics in the neighborhood (Haggerty, 1982).

Some researchers studied the urban ecology by considering the impacts of urbanization and the manner it has polarized the residential structure into socio-economic patterns (Mack & McElrath, 1964; McElrath, 1965). McElrath (1965) looked into the process of urbanization in a wider perspective and how it has impacted on the distribution of choice and constraints in urban areas. The results of the investigation, according to McElrath, were that industrialization and urbanization had led to the establishment of four social differentiation measurements of the urban residential landscape (McElrath, 1965). These measurements formed the basis along which resources and rewards are distributed in the urban areas. Individual opportunities are limited by economic status (based on skills); family status (based on lifestyle option); migration status (based on migration experience) and ethnic status (based on social visibility). These dimensions work in tandem to restrict urbanites from taking full advantages of opportunities in the urban areas (McElrath, 1965).

Mack and McElrath (1964) studied the process of urbanization in a wider perspective and how it impacted distribution of choice and constraints in urban areas. Mack and McElrath suggested that, ethnic and migrant, occupational and life-style differentiation all occur at different points in the urbanization process in urban settlements (Mack & McElrath, 1964). They conclude that urbanization breeds heterogeneity in population concentration, creates differences in occupation choices (variations in training, number of hours people work, choices of recreation, create different norms per class) and eventually differences in style of life (Mack & McElrath, 1964). They proposed that urbanization as a process, groups the urban population into three different status groups (occupational differentiations, ethnic and migrants differentiations and life style differentiations) in the urban environment. They argued that most of the urban cultural resources were distributed in the lines of ethnic and migrant differentiation, occupational differentiation and life-style differentiation systems (Mack & McElrath, 1964).

2.3 The Urban Spatial Structure

The atomic structure of a large city began from the community structure, which forms the basis of individual neighborhoods that combine into a large city. The urban structure has been examined by different researchers from different disciplines, ranging from social scientist, architects, city planners, urban managers, and urban economists to ecologists and anthropologists. The generic urban structure can loosely be described as the building structures and the transportation systems available in human habitations. The development of urban spatial structure models, were some of the early research which aimed at understanding the spatial structure of the urban sphere (Burgess, 1925; Homer, 1939; Harris & Ullman, 1945). Burgess developed the concentric model of urban spatial structure which was later criticized by Homer Hoyt (1939).

The multi nuclei urban spatial model propounded by Harris and Ullman became the most prominent model in 1945 to explain the pattern of land uses in the middle part of the 20th Century. The concentric model by Burgess was based on the notion that the city will develop from the central business district in a radial form. The Sector model classified the urban structure into sectors based on rent values beginning from the central business districts and following the primary transportation and accessibility routes, and the Multi Nuclei model removed the complexities of the Concentric and the Sector models by introducing more than one central business district in cities. A careful observation of these models revealed that they seek to order the arrangement of private and public land uses as well as the level of connectivity and accessibility (transportation systems) in the urban spatial arena. Researchers have used basic land use data to describe the urban spatial structure in terms of its regularities and irregularities. Transportation and accessibility to land uses have been the major actors to have led to changes in the growth of the urban structure. The urban spatial structure, sometimes referred to as the urban form has many elements. Urban form can be described as the spatial imprint of transportation and accessibility land uses including the adjacent infrastructure and the socio-economic activities.

The urban roads, highways, streets, the underground transport systems, and the location of houses, shops, malls and public spaces have in variable ways contributed to the form and organization of land uses in cities.

Researchers have studied the urban form in different dimensions and angles and relate the urban structure to how it has impacted human socio-economic activities, health and environment and made predictions on how the urban forms will appear in the future. Generally urban form is measured through urban residential density. The urban spatial structure is not limited to only residential density, but contain other important characteristics such as roads (levels), land uses, accessibility, geometrical shape of the urban structure to mention but a few. Urban researchers such as planners, architects, sociologist, ecologists, anthropologists, economists and engineers have studied aspects of the urban structure to contribute to the knowledge of urban studies.

Hansen developed a gravity-based model on his quest to understand how accessibility shape land uses in urban areas. Hansen studied the relationship between highways and urban land use empirically with the view to improving the planning in urban and city planning (Hansen, 1959). He concluded that residential development patterns portray that accessibility and developable lands in urban areas can be used to develop a model for the distribution of population growth in urban areas (Hansen, 1959).

The concept of urban morphology which comprises the study of human physical habitats and the processes of their formation, development and formation human settlements have led to differing research in the field of urban studies. Perkins (1962) provided a brief account of the formation of cities and the failures of early planning strategies and policies to solve the challenges of urban planning in the areas of human habitation and the natural environment. Perkins (1962) concludes that the promotion of social values, the individual dignity in their freedom of choice, the tendency and management of urban change and the utmost significance of the spatial relationship between man and nature would all provide the basis to offer a livable, efficient, and safe, opportunistic urban form and social structure for human habitation (Perkins, 1962).

Boarnet and Greenwald (2000) tested the influence of urban structure at the neighborhood level on the choices of decisions by urbanites regarding non-working trips purposes. The results of the study indicated that walking as a travel mode is affected by the urban structure considerably (Boarnet & Greenwald, 2000).

Grazi et al (2008) researched to determine the magnitude at which urban form affects individual travel behavior and consequently the transport-induced aspect of CO2 emissions. They argue that improvement in accessibility in urban neighborhood through a more energy-efficient transport modes for instance walking and biking could contribute to a reduction in transport related GHG emissions. Grazi et al (2008) analyzed the potential effects of urban spatial organization on carbon dioxide emission abatement. The results of the study indicated that urban spatial organization has the tendency to reduce the emission of CO2 when spatial planning and transport planning are considered in the debate of the procedures to reduce CO2 emission (Grazi et al, 2008).

Vojnovic (2006) examined the relationship between moderate physical activity and the built environment with major interest on the impact of accessibility on travel behavior at the regional level, city-wide level and the neighborhood block level. He suggests, per the study, that cities in USA should develop urban built environments that are more advantageous in providing a balance between the desires of different modes of transport (auto-mobile transport, public transport, and walking and bicycling) for the residents (Vojnovic, 2006).

The urban structure has been studied in different context by different researchers with the view to understanding the content, the characteristics, the formation, the layout, the problems and challenges. These studies have provided a series of conclusions that have contributed to urban quality of life as well protecting the environment.

2.4 The Relationship between Socio-economic Characteristics and Urban Spatial Structure

The human interventions in space have contributed to the development and the exploitation of the natural environment all over the world. These human interventions were made in relation to the social and cultural characteristics associated with the people in specific geographic areas. The concept of urban structure denotes a combination of the build environment and the social structure. The social aspect of the urban structure consists of the individuals and the activities they partake in the built up environment (Adolphson, 2011). The built environment and the social structure come together to form the urban structure. The social structure denotes the relationships that exist among individuals in a geographic area.

The urban spatial structure has passed through several phases of change due to the socio-economic changes in human society. The modern day urban structure has been shaped by developments in transportation and communication infrastructure especially considering the case of North America (Glaab & Theodore, 1967; Barrett, 1983; Cronon, 1991). These researchers gave a brief account of how transportation and communication systems developed over the centuries, in the areas of how they have contributed to the expansion and patterns of development in North America (Barrett, 1983; Cronon, 1991).

The emergence of the automobile contributed to transit with its associated privacy, speed and convenience. The seaports, the streets, the railways and public transport systems have all contributed to the development of the urban landscape in terms of structural developments which are instigated by mass societal social and economic changes in cities and settlements. The development of residential areas at the suburban and the fringes of metropolitan areas represented one of the growth phases of the urban structure due to improvements in transportation systems (Garreau, 1991). These kinds of development entail high concentration of retail spaces and offices, business centers as well as other land uses not limited to residential area which develop at the points of major highways in North America (Garreau, 1991).

Alex et al. (1998) have argued that the changes in residential development in Western European cities have undergone minimal changes due to their rich cultural amenities including the fact that most cities in Europe evolved as Medieval Towns. This created a great mixture of land uses in the core of these cities because of the relevance of public transport and the popularity of Apartment buildings (Alex et al, 1998).

There have been different aspects of the study of urban spatial structure in connection to the social, demographic and economic characteristics of residents in residential and urban neighborhoods (Roberto et al, 2002; Omer & Goldblatt, 2011: Cohen et al, 2013). Cohen et al (2013) examined the possibility of autonomous correlation between socio-economic statuses of two distinguishably identified low and high poverty neighborhoods, and their participation in park based physical activity with the same level of access to the parks. Their study was based in Philadelphia, Pennsylvania (PA); Columbus, Ohio (OH); Chapel Hill/Durham, North Carolina (NC); and Albuquerque, New Mexico (NM) areas (Cohen et al, 2013). They concluded that although there has not been an objective measurement of accessibility to park based physical activity geographically and physically their findings indicated that there was no significant differences in the use of park based physically as per the level of poverty in neighborhoods (Cohen et al, 2013).

Roberto et al (2002) hypothesized that in terms of relative generic socio-economic and income levels of residential areas differences in mobility patterns, time and mode could slightly be influenced by the urban physical form upon which growth occurs. They concluded that the emergence of new land consumption and urban growth is partly due to the changes in lifestyle patterns and landed developments which are both influenced by the social and economic characteristics of the city of Milan, Italy (Roberto et al, 2002).

Omer and Goldblatt (2011), studied how the socio-economic residential differentials depicted in Tel Aviv, Israel, correlates with the spatial configuration in terms of variations and similarities between areas as well as the linkages and breakages between spatial organizations of these areas. They studied the influence of spatial configuration on the creation of different social areas in urban areas. They suggested that complexity, visibility and differentiation are the three main physical characteristics of urban spatial structure that bring about the different social areas. They applied the space syntax methodology for their study of Tel Aviv in Israel. They studied the relationship between urban spatial structure and social differentiations in the Tel Aviv. They concluded that, social and economic differentiation of areas connects with the spatial separation or segmentation of those areas (Omer & Goldblatt, 2011).

Socio-economic characteristics such as education, occupation, gender, income, ethnicity, race, political orientation, religion to mention but a few has contributed to some extent, the residential location choice of inhabitants of today's cities directly or indirectly. The built environment comprises of the buildings, their volume, the color, geographical position, transport systems, land use configuration and the density of a built up area (spatial configuration). The relationship between the built structure and the social structure of neighborhoods in cities have been structured in relation to the social, cultural, climatic, political, economic and environmental factors that pertain to specific geographical regions. The role of planning over the years has been to manage spatial and non-spatial developments before and after the 20th Century, but since development started before the emergence of the planning discipline, spatial developments have been done without prior development planning and urban growth control processes. The planning and control of development in human settlements were aimed at ensuring impartiality in the distribution of a society's resources as well as the management of growth of human settlements. Unfortunately, because development of settlements took off before the introduction of the planning discipline, differences exists in the character, form and distribution of resources in urban settlements. This phenomenon has contributed to differences in neighborhood in terms of both physical accessibility and social capital (neighborliness) in neighborhoods.

Perkins (1962) provided a brief account of the formation of cities and the failures of early planning strategies and policies to solve the challenges of urban planning in the areas of human habitation and the natural environment. Perkins (1962), argued that the promotion of social values, individual dignity in their freedom of choice, tendency and management of urban change and the utmost significance of the spatial relationship between man and nature would provide the basis to offer a livable, efficient, and safe, opportunistic urban form and social structure for human habitation (Perkins, 1962). The growth of interest in the desire to become part of a neighborhood and the available means of movement (mobility) improves the formation of larger communities that share public goods such as community centers, local pubs, schools, local public spaces e.t.c. This is termed as local loyalties and can survive in large cities reflecting the felt needs of the residents. The formation of communities (social structure) in neighborhood of large cities is dependent averagely on the compounded systems of streets, roads and highways that shape the structure or the form of the neighborhood. The streets and roads in neighborhoods have contributed invariably to formation and maintenance of strong community urban social relations.

2.5 Accessibility Measurement

The concept of accessibility has extensive literature with two main elements in its application in research, in the context of urban accessibility measurement. The elements that are cardinal to the concept of accessibility are land use (activity areas) and transport systems (the links to the activity areas). Accessibility is an important characteristic of metropolitan areas and is often revealed in transportation and land use planning goals. What keeps residents in metropolitan areas is accessibility, the potential for interaction, both social and economic, the possibility of getting from home to a multitude of destinations offering a spectrum of opportunities for work and play (Ingram, 1971; Morris et al, 1979; Handy & Niemeier, 1997; Handy & Clifton, 2000). Accessibility is an important concept for urban planners in that, it reflects the possibilities for activities, such as work or shopping, available to residents in a neighborhood or a city or a metropolitan area. Accessibility is determined by attributes of both the activity patterns and the transportation system in the area.

The land use element of the measurement of accessibility is concerned with the distribution of the various land use destinations which are alternatively termed *attractions* in the urban areas. The transportation component of accessibility measure is concerned with the ease of movements between points in space and is determined by the character and quality service provided by the transport measured in terms of travel time, distance or monetary cost.

Accessibility measure can be lightly categorized into three main types. These are cumulative opportunities measures, gravity-based measures and utility-bases measures. All these types incorporate the elements of land use and transport systems in their determination of accessibility (Sandy & Niemeier, 1997). Accessibility has been argued as broad application indicators to measure the evaluation of transport or land use systems, modeling travel choice situations, modeling urban development and summarizing spatial structures (Morris et al, 1978).

Accessibility measures assess the potential of opportunities for interactions. The elements of accessibility measure incorporate the spatial distribution of destinations (attractions), the ease of reaching these destinations considering the quality and characteristics of the transport systems and the quality of these attraction areas (destinations). There are several forms of accessibility measures from convention point of view. Five main general forms of accessibility measures are Cumulative opportunities; Gravity based measures; spatial separation; utility measures and time space measures of accessibility (Bhat et al, 2002). In addition, accessibility has been categorized into two main classifications. The ***relative*** and ***integral*** accessibility which puts accessibility in two classes (Ingram, 1971). Relative accessibility describes the relation or degree of connection between any two points, whereas integral accessibility describes the relation or degree of interconnection between a given point and all others within a spatial set of points (Ingram, 1971).

Four basic perspectives on measuring accessibility have been identified in the applicability of accessibility (Geurs & Van Wee, 2004). These perspectives are described in brief: ***Infrastructure based measures*** which are typically used in transport planning where performance (observed and simulated) or service levels of transport infrastructure such as congestion levels and average travel speed on network are analyzed.

The second is the ***location based measures*** which are applied typically at the macro level, where accessibility to locations are analyzed. The location base measure considers the distribution of activities spatially and the travel time or other cost associated with getting to the opportunities. This measure explains the level of accessibility to spatially distributed phenomenon such as count of jobs within 30 minutes travel time from the origin of location. Location-based measures are typically used in urban planning and geographical studies. ***Person-based measures*** measure of accessibility considers the individual participation in accessing an activity within a given time. This measure explores the limitation on an individual's freedom of action in the environment. In other terms, the location and duration of compulsory activities influence the time that has been budgeted for flexible activities and travel speed that is permitted by the transport system.

The ***Utility-based measures*** consider the economic benefits that people derive from access to spatially distributed activities. This measure is based on some economic studies which ignores some basic components of accessibility. Infrastructure base ignore the land use component of accessibility in that, they are insensitive to changes in the spatial distribution of activities if service levels such as travel speed, travel times or costs remain constant.

Another important development in the concept of accessibility measurement is the network approach that uses networks to measure accessibility. Spatial network research to date has represented networks using two types of network elements; nodes and edges. The case of urban street networks, however, edges typically represent street segments, and nodes denote the junctions where two or more edges intersect (Porta et al. 2005; Sevtuk & Mekonnen, 2011). Network measures provide a very conducive platform for measuring accessibility using Geographic Information Systems (G.I.S).

2.6 Conceptual Framework

The differences in urban areas in the context of neighborhood have provided a very stimulating topic of debate in the 21st Century. The differences in urban neighborhoods have been studied by different researchers from varied disciplines who have interest in the urban structure. The earlier researchers provided several methods to classify the urban structure into homogeneous assemblies. Considering the importance of variations in population distribution in urban areas especially cities, some studies were conducted to classify the urbanites into groups based on social and economic variables. The justification for the categorization of urban population into groups has been; to improve the understanding of the structure of urban population pattern; to ensure the equitable distribution of urban public spaces such as streets, housing, health infrastructure, recreation centers, education infrastructure, and urban equitable distribution of the opportunities; distribution of population growth and employment opportunities; the improvement in the social structure of urban neighborhoods; and to provide a yardstick for inter and intra-urban comparative analysis for regional development and planning. The social area theory has been very useful in the study of urban population distribution pattern although the concept has received considerable criticism as a theory and a practicable tool for urban research.

The relationship between the socio-economic factors and the spatial characteristics of urban areas has not received adequate attention in the area of literature. The pattern of distribution of urban population to some extent is related to the social and economic dynamics of the population. The literature reviewed portrayed that, there have been different forms of research in the case of urban studies but the relationship between the urban spatial organization and the socio-economic dynamics of the inhabitants of urban areas has not been explored. This study seeks to measure the differences in the spatial organization of neighborhoods with emphasis on the socio-economic characteristics of the population. The study seeks to explore the variations in the neighborhoods in the context of accessibility which has the socio-economic factors of these neighborhoods at the background.

The research will be conducted principally to measure the variations in the spatial organization of the city of İzmir, Turkey. The neighborhoods will be classified into different categorizations based on the socio-economic dynamics of the neighborhoods. The classification of the various neighborhoods in the city will be used as the basis to define the clusters. The unique clusters will then be used as the background to measure the variances in the accessibility levels of the neighborhoods in each cluster. Analysis of variance (ANOVA) will be used to test whether there are statistically significant differences in accessibility for the neighborhoods representing the clusters. Hypotheses are going to be formed based on the accessibility indicators selected to measure accessibility within the neighborhoods spatial structure. The tests will be the basis upon which to determine the differences in accessibility in İzmir Province.

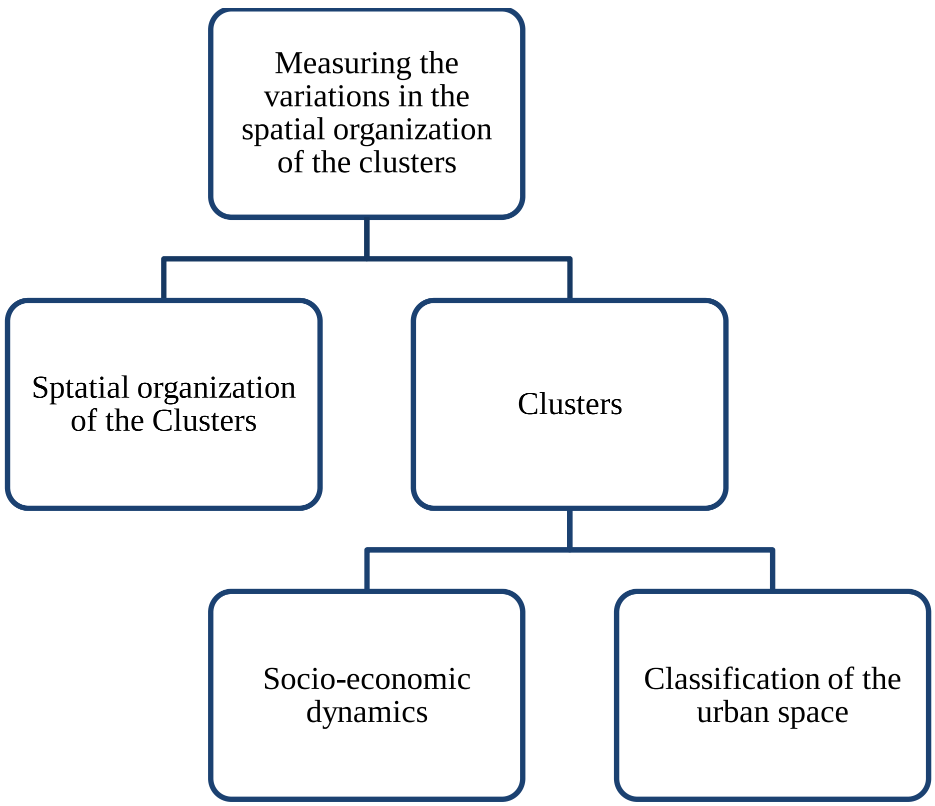

Figure 2. 1 Conceptual Framework for the study

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This research was conducted using a set of procedures to achieve the results. The methods for the research began with the classification of the neighborhoods into clusters using hierarchical cluster analysis. The neighborhoods were grouped based on similarities pertaining to the social and economic indicators for each neighborhood. The huge number of neighborhoods in the city necessitated the use of simple random sampling to select a neighborhood from each cluster. The selected neighborhoods from the eleven clusters were used to represent the clusters for the city. The spatial organizations of the selected were represented in a GIS format through digitizing the streets and the buildings. Network accessibility measures were selected for the measure of the accessibility from each building based on the street networks. Five different accessibility measure indices were used to derive accessibility values for each building in each neighborhood. Analysis of variance was conducted to test five different null hypotheses to determine statistically that there are no variations in the neighborhoods in terms of the accessibility measures. The neighborhoods were compared to each other in term of the accessibility indices to ascertain whether there are statistically significant differences between the pairs using the Games-Howell post anova statistical tests.

These procedures are in connection with the conceptual framework of the study in the literature section of this report. The methods used are social economic classification of the İzmir province, random sampling from the classification, digitizing the selected neighborhoods using Geographic Information Systems, derivation of accessibility measures using GIS considering spatial organization of the neighborhoods, evaluating the differences between and among the neighborhood structures and finally drawing inferences from the results. These procedures have been expounded in detail in this chapter.

3.2 Classification (Cluster Analysis)

Cluster analysis is the prominent method of data classification in socio-economic studies. Clustering has been described by many researchers in so many perspectives but the main idea has been to group like terms together in a homogeneous fashion in a form of subsets (Bailey, 1975; Ketchen & Shook, 1996; Golder & Yeomans, 1973; Hansen & Delattre, 1978). Cluster analysis as a means of drawing boundaries within a set of data in a multidimensional form. Clustering involves grouping of a set of data into clusters considering their similarities on chosen variables instantaneously. The basic idea is to maximize homogeneity within clusters as well as to maximize heterogeneity between clusters. In other words, the process of clustering involves maximizing variations between clusters whiles reducing the variations within clusters. In cluster analysis the concept of exhaustiveness and mutual exclusiveness is paramount. The grouping of the elements should be such that each element is grouped under one and only one cluster alone. Cluster analysis involves making decisions about the method to use and the form of linkage as well as the type of distance or similarity measure to be used.

In cluster analysis the two main methods according to Bailey (1975) are the agglomerative and the divisive methods. Agglomerative method of cluster analysis starts by regarding each element as a separate cluster and recombines these elements into larger and larger clusters until two main clusters are derived. The divisive method considers the grouping of all the elements into a single cluster and later breaks this large cluster into different clusters. The agglomerative and the divisive methods have been described as “classification from below” and “classification from above” respectively. Naturally seeking clusters do not involve the specification of a predetermined number of clusters but the number of clustered is left in the hands of nature. Agglomerative methods are usually in this category of naturally grouping cluster process and the divisive method is the opposite in this direction.

Single level and hierarchical clustering are some of the factors to consider in cluster analysis. The single level method of cluster analysis performs the classification of the elements on the same level. The hierarchical method uses a sequential clustering and replication of the clustering to define the clusters. The end result of the hierarchical method mostly contains two large clusters with sub-clusters. Hierarchical clusters are mostly displayed in a tree-like graph known as dendrogram to aid the visual display of the formed clusters. The purpose of the research determines the point at which the cluster will be selected.

One important decision to consider in cluster analysis is the form of linkages, in another sense how the elements become parts of a cluster. Bailey (1975) postulated that there are three general forms of linkages in cluster analysis. These are the single-linkage, the complete-linkage form and the other intermediate forms such as average-linkage form.

The single-linkage method operates on the premise that, an element becomes a part of a particular cluster if that element has correlation with at least one member in that particular cluster with which such a correlation is higher than its relationship with any object that is not part of that cluster in question. This form of linkages defines a cluster in such a manner that each member in that cluster is like one another unlike those other members that are not in the cluster.

In the complete-linkage methods of cluster analysis, a member is admitted to a cluster if and only if that member or element has correlation with all the members in that cluster than a correlation with other elements not in the cluster of interest. The relationship is more symmetric in a cluster when the complete-linkage method is used to admit members into a cluster. Compactness of clusters formed by the complete-linkage methods is one of the strength of the complete linkage over the Single-linkage clusters. The complete-linkage method increases the distance between objects that are not in the same groups. The method produces condensed clusters.

The third method of forming clusters is the average-linkage method. This method operates on the premise that a member is admitted to a cluster if the member does not contribute to the reduction of the average similarity values of the cluster as higher than a particular extent.

3.2.1 Classification of İzmir Neighborhoods into Clusters

The classification of the neighborhoods of the İzmir province involves the use of social-economic data obtained from the European Union Internal Migration Integration Project (IGEP) in cooperation with İzmir, Ankara, Bursa and İstanbul Metropolitan Municipalities completed in May, 2010. The data was prepared and inputted into the SPSS software for the statistical analysis and the classification. The cluster analysis tool in the SPSS package was used for the analysis of the acquired socio-economic data. The neighborhoods in the province totaled 340. These neighborhoods data made up of ; the education score for neighborhoods; Density of people who are not in the workforce; density of unemployment; density of unemployed people with no occupation; density of literates without any school; density of illiterate women; and density of unpaid family workers.

The Agglomerative cluster method was applied with the aim of seeking a natural group of elements (neighborhoods) principally based on the socio-economic data. The hierarchical cluster analysis method was considered for this study because it permits the grouping of the elements into in a sequential manner. The data furthest neighbor method was used for the cluster analysis to group the neighborhoods into similar and dissimilar taxonomies. The reason for the choice of the complete-linkage method was to have group or a cluster made up of members who share a very strong relationship in terms of their correlations. The distance measure used for the cluster analysis is the interval distance measure with the squared Euclidean distance. The values of the data were transformed using z- values. Dendrogram was used to display the results of the cluster. See Appendix A for dendrogram of the cluster analysis

The dendrogram displayed the clusters in a graphical format for easy and efficient representation of the results. A decision was made to determine the fusion point or the distance at which to determine the number of clusters. The first fusion point or distance point was selected and the results of the clusters displayed. This was a subjective decision with an objective consideration. The first fusion point was chosen for the purpose of ensuring adequate representation of neighborhoods in the study.

3.3 Simple Random Sampling

The clusters formed at the first fusion point of the dendrogram totaled up to eleven clusters. These clusters contained all the 340 neighborhoods that make up the İZMIR city. The limited time for the research, inadequate resources and the nature of the data for the study necessitated the need for a simple random sampling of the neighborhoods in each of the eleven clusters. This brings to light the importance of the selected fusion point, to provide a chance for each of the neighborhoods in each cluster of being selected for the study. The random sampling was done by representing each neighborhood in cluster on a piece of paper. The neighborhoods that form each cluster put together and one of the pieces of paper with a neighborhood name is selected. This was repeated separately for all the nine clusters. In the end, each cluster was represented by a randomly selected neighborhood. The study was then conducted based on the results of the simple random sampling. Nine neighborhoods were used to represent the city of İzmir. The following table summarizes the process that was involved in the simple random sampling of the data (neighborhoods).

Table 2. 1 Results of the simple random sampling from the clusters

Clusters	Number of Neighborhoods	Randomly Selected Neighborhoods	Districts
Cluster 1	165	Yildiz	Buca
Cluster 2	141	Onur	Balcova
Cluster 3	8	Camlicay	Guzelbece
Cluster 4	1	Ugur	Konak
Cluster 5	2	Altinordu	Konak
Cluster 6	3	Ataturk (Cigli)	Cigli
Cluster 7	1	Namazgah	Konak
Cluster 8	1	Bahcelerarasi	Balcova
Cluster 9	6	Dokuz Eylul	Gaziermir
Cluster 10	9	Ataturk (Narlidere)	Narlidere
Cluster 11	2	Yenigun	Konak

3.4 Accessibility Measures

Accessibility is a broad field of research which encompasses three main broad areas which include transportation systems, land uses and mobility. These broad themes of accessibility have been investigated separately or a combinations by researchers over the years to assess accessibility in urban areas. Accessibility measures can be used to examine feedback effects between transport systems and modal participation as well as to evaluate urban form and the spatial distribution of activities. There are several measures of accessibility developed over the years. The general categories of accessibility measures in use are spatial separation measures, gravity measures, the contour measures, the competition measures, the space-time measures and the network measures (Scheurer & Curtis, 2007).

The positive relationship between geographic and graph entities prompted the use of the primal approach to the representation of street networks where nodes and edges are made of junctions and street segments respectively. This provides a very objective, feasible and realistic means of measuring accessibility as compared to the space syntax analysis based on an indirect representation of street networks based on topological measures. The space syntax concept provides efficient way of measuring how socio-economic relationships correspond to the spatial structure of geographic areas. The use of the space syntax is not very efficient when studying social systems when distances (meters) are applied such as urban street systems (Porta et al, 2005; 2006). The measure of the spatial organizations of the neighborhoods necessitated the use of the network measures of accessibility. The network measures consider of networks for the study of the organization of the urban forms. Centrality measures were considered to measure the differences in the spatial organization of the neighborhoods. Network centrality measures of accessibility were used to measure the variations in the levels of accessibility in İzmir.

3.4.1 Network Representation of Built Environments

Porta et al (2005, 2006) take the study of accessibility to the level of analyzing entire movement networks. Two approaches are distinguished: the primal approach and the dual approach. Each approach is based on the identification of nodes and edges as the indistinguishable components of any network: in the primal approach, street segments are considered as edges and street intersections are considered as nodes. In the dual approach street are considered as nodes and street intersections are considered as edges. They classified the primal approach as a ‘simple, intuitive representation of networks’ (2005) used in most studies on subjects, including those on aspatial structures such as social networks. They maintain that the primal approach is most suited to capture distance, as ‘one of the most crucial components of the spatial studies in geographic context, as it is designed to include a measure proportional to the physical distance, or other impediment, of movement paths.

The dual graph approach is derived from the space syntax methodology first developed by Hillier and Hanson (1984). The idea is to identify the continuity of streets over a multiplicity of intersections as a key attribute of the legibility and functionality of movement networks.

Sevtuk and Mekonnen (2012) argued that the representation of streets and intersections of these streets as edges and nodes respectively simplifies the findings and conclusions of most studies in urban studies making the interpretations very difficult. They contend that buildings in urban settlements are places where most daily travels or trips starts and ends. The movement of people from homes through the streets and intersections to their destinations begins from the buildings and after their activities return to the buildings. They also argue that buildings are places where important urban decisions are taken.

The inadequate representation of built environments with edges and nodes ignores the local variations in built settlements. They cited an instance where a building located at the edge of a street is accorded the same level of accessibility to a building located at the middle of a block. Finally, they argued that buildings have different attributes and as such the representation of nodes and edges on unweighted networks does not provide a true picture of the local variances in a network of built environments. They suggested that the use of unweighted networks accords the same level of accessibility to for instance commercial areas, residential areas and industrial areas in a built environment of networks (Sevtuk & Mekonnen, 2012).

Sevtuk and Mekonnen (2012) postulate that buildings should be an integral part of network representation of built up areas where activities take place. They provide a tripartite representation of the built environment made up buildings, streets and junctions in a network. This representation of space in a network provides a good basis to measure the local differences in the location of buildings (Sevtuk & Mekonnen, 2012). The unit of analysis is the buildings (not the streets and nodes) where most activities starts and ends. This allows for uneven trends in the cities to be accounted for in the study of urban areas. The urban network analysis tool uses points or polygons to represent the buildings in the computations of the five accessibility indexes developed for spatial analysis. They provide the ground for measurement of variations on weighted networks as opposed to most studies that considered only unweighted networks (Sevtuk & Mekonnen, 2012). Attributes of buildings as well as various characteristics of the streets and junctions can be incorporated in the network to measure the actual characteristics of spatial locations on the spatially represented network.

3.4.2 Network Centrality Measures

Centrality has been described as the mathematical methods used to show how centrally located a node is on a graph. Five main network centrality indexes which use graph theoretic representation of the built up environments were used for the study. These accessibility measures use a network representation of the built environment to evaluate accessibility in urban areas. The streets and the junctions are represented by the edges and the nodes of the network. The edges are the line segments and the nodes are the junctions where two or more segments meet. The five centrality indexes used for the evaluation of the spatial organizations of the neighborhoods are reach index, gravity index, closeness index, betweenness index and the straightness index. These tools were developed into geographic based application commonly known as the Urban Network Analysis by Sevtsuk and Mekonnen in 2012. These tools are discussed in detail as follows:

A. Reach Measure

The reach index measures the number of buildings that are reached on the network based on the chosen radius on the network (3.1). The reach centrality, ${C^r}_R[i]$, of a node ***i*** in a graph G at a search radius ***r***, describes the number of nodes in the graph that are reachable from ***i*** hand within a distance of less than or equal to the radius. The equation is written below

$$ {C^r}_R[i] = |\{j\epsilon G - \{i\}: d[i,j] \leq r\}| \tag{3.1} $$

Where ${C^r}_R[i]$ is the Reach centrality, $[i,j]$ is the shortest path distance between nodes ***i*** and ***j*** in the graph G. Another equation denotes the application of the reach centrality with weighted attributes. The equation (3.1) was developed by Sevtuk and Mekonnen (2012)

The Reach centrality can be weighted by attributes such as population, residents, floor numbers etc. The reach measure can be assumed to be a measure of density for activities on street network.

When the equation is weighted

$$ {C^r}_R[i] = \sum_{j\epsilon G-\{i\}:d[i,j]\leq r} W[j] \tag{3.2} $$

Where the addition to formula (3.1) is the weight component of formula (3.2) denoted by $W[j]$.

The reach centrality can be seen as the number of elements in a graph that are reachable by one element within a specified distance radius. The elements can be weighted to measure the elements coverage based on the set weights.

B. Gravity centrality

Gravity measures consist of three main elements. The attractiveness of a place, the destination of the places and the impedance factor are the elements of the gravity measure. The gravity measure in accessibility measurement was first introduced by Hansen (1959) when he developed a land use based on vacant land and accessibility to accommodate population growth within metropolitan areas. This model developed by Hansen has been restructured in various ways by different researchers for different purposes. Andre Sevtsuk and Michael Mekonnen (2012) have developed the gravity measure into a centrality index using a graph theoretic concept. They define the gravity centrality, ${C^r}_G[i]$ of a node ***i*** in a graph , with a radius of ***r*** is considered on the premise that centrality is inversely proportional to the shortest path distances it covers from the node ***i*** to every other node in the graph G that are reachable from ***i*** at a radius of ***r***. Mathematically is denoted as (Hansen, 1959; Sevtuk and Mekonnen, 2012):

$$ {C^r}_G[i] = \sum_{j \epsilon G-\{i\}:d[i,j]\leq r} \frac{1}{e^{\beta - d[i,j]}} \ . \qquad (3.3) $$

Where β is the exponent that controls the distance decay consequences on each of the shortest path distances on the network between ***i*** and ***j***. By making the β=0, then gravity centrality produces results equivalent to the reach centrality (Sevtsuk and Mekonnen, 2012). The formula (3.3) and (3.4) were developed by Sevtuk and Mekonnen (2012) after initially developed by Hansen (1959)

The gravity centrality index can be weighted to measure accessibility of buildings in the graph. The gravity centrality will provide results that are proportional to the weights of the buildings specified in the graph$G$. The formula for gravity centrality is as follows:

$$ {C^r}_G[i] = \sum_{j,k \epsilon G-\{i\}:d[j,k]\leq r} \frac{W[j]}{e^{\beta - d[i,j]}} \, . \qquad (3.4) $$

The gravity is directly proportional to the weights of each attribute $W[j]$ in graph$G$. Where $W[j]$ are the weights of ***j*** that are reachable from ***i*** within the catchment radius of ***r.***

The gravity centrality measures the buildings that can be reached subject to the impedance and the selected radius on the network by each building on the graph. This can be weighted by other factors such as jobs, population, gender, etc.

C. Betweenness Centrality

The Betweenness centrality measures on the graph the number of times each building lies on the graph in the context of other buildings. The earliest conception of the point centrality in the area of communication was based on the structural property of *betweenness*. The betweenness centrality is based fundamentally on the notion that a point becomes relevant and gains control in a network of communication when the location of the point facilitates, impedes or bias communication on the network (Freeman, 1977). This centrality measure is based on the earlier works of researchers such as Freeman. Sevtuk and Mekonnen, the developers of the Urban Network Analysis tools postulates that the betweenness measure can be used to measure the number of passerby of buildings in the network limited by a chosen radius. Betweenness estimates the potential traffic that passes by the building in a graph. Mathematically, the Betweenness centrality is

$$C^{r}{}_{B}[i] = \sum_{j,k \epsilon G-\{i\}:d[j,k]\leq r} \frac{n_{jk}[i]}{n_{jk}} \quad . \tag{3.5}$$

Where $C^{r}{}_{B}[i]$ is the betweenness centrality of i on a graph Gat radius of $\boldsymbol{r}$, n_{jk} is the number of shortest path distances between j and k on the network, $n_{jk}[i]$ is the number of shortest path distances between j and k on the network that passes i on the network.

If the buildings in the graph G are waited then the betweenness centrality is formulated as

$$C^{r}{}_{B}[i] = \sum_{j,k \epsilon G-\{i\}:d[j,k]\leq r} \frac{n_{jk}[i]}{n_{jk}} . W[j] \quad . \tag{3.6}$$

Where the weight of the building i is denoted as $W[j]$. The betweenness centrality can be applied in different scenarios depending on the context of the study. This can be applied in urban studies to measure the number of times certain locations are traversed on a street network or communication channels. The number of times a particular location is passed by can be determined by the betweenness centrality measure. This can be weighted to suit specific needs such the demography of an area. The formula (3.5) and (3.6) were developed based on idea from Freeman (1977) and later modified by Sevtuk & Mekonnen (2012)

D. Closeness Centrality

The closeness centrality measures in general terms the nearness of a place on a network of streets in urban street of networks. The closeness centrality, ${C^r}_B[i]$, of a building i in a graph G is an inverse of the distance from i to all other buildings or locations in the graph limited by the radius of r in the graph G. The closeness centrality is defined as follows

$$ {C^r}_B[i] = \frac{1}{\sum_{j \epsilon G-\{i\}:d[i,j] \leq r} d[i,j]} \quad . \tag{3.7} $$

The closeness centrality measure can be weighted to measure specific variables in urban spatial studies. The closeness centrality measures proximity of each location to all other surrounding locations in a defined radius on a network. When weights are applied the closeness measure is defined as follows

$$ {C^r}_c[i] = \frac{1}{\sum_{j \epsilon G-\{i\}:d[i,j] \leq r} (d[i,j].W[j])} \quad . \tag{3.8} $$

Where the weight is denoted by $W[j]$

The formula (3.7) and (3.8) were developed based on idea from Freeman (1977) and later modified by Sevtuk & Mekonnen (2012).

E. Straightness Centrality

The straightness measure captures the extent of a networking route from a node to all other nodes in the graph of networks considering how the route deviates from a virtual straight route (Porta et al, 2005). The straightness centrality, ${C^r}_S[i]$, of a building i in a graph G calculates how closely the shortest path distances between i and all other paths in the graph G looks like Euclidean distances. The straightness centrality is defined below.

$$ {C^r}_S[i] = \sum_{j \epsilon G-\{i\}:d[i,j]\leq r} \frac{\delta[i,j]}{d[i,j]} \quad . \tag{3.9} $$

Where $[i, j]$, represents as a crow-flies-distance between locations i and j in the network and $d[i, j]$is the shortest path distances between the same locations. As a ratio between the Euclidian distance and the geodesic distance from each location i and j to the surrounding locations Straightness centrality can only be estimated if the units of impedance are in linear distance (e.g. miles), not topological distance (e.g. turns). The formula (3.9) was initially developed by Porta et al. (2005) and later modified by Sevtuk & Mekonnen (2012)

3.5 Application of the Centrality Index Tools to Neighborhoods of İzmir

The measurements of the variations in the accessibility to the buildings in the neighborhoods were undertaken by developing a network of streets and subsequently running the centrality indexes using the Arc GIS package. The neighborhood buildings were the unit of analysis and the street networks provided the framework upon which trips were conducted. The research considered a radius of 600 meters of walking distance from each of the buildings in the network of the built up environment. The 600 meters represented an average obtained from Survey of walking distance used in North America, ranging between 300 meters and 900 meters for Canada and 400 meters to 800 meters in United States (Dittmar and Ohlandes, 2004). The 600 meter radius represented approximated 10 minutes of walking in the considered neighborhoods for the study. The interface of the used is displayed below for a brief practical interpretation of the tool.

3.5.1 The Buildings Used for Centrality Computation

The calculation of the centrality is based on the buildings on the networks. The buildings provide the basis for the measurement of accessibility in urban areas as postulated by Sevtuk & Mekonnen (2012). A chunk of trips originate and ends with entry into buildings in the urban space. The neighborhood buildings are inputted into the Urban Network Analysis tool (UNA) for the computation of the accessibility indices. The buildings must have unique identities in order to ensure that buildings are accounted for in the analysis. The buildings could have been weighted by attributes but for limited resources the relevant attributes were not obtained.

3.5.2 Digitized Streets from the Neighborhoods

Network of streets for the neighborhoods were determined for each neighborhoods using ArcGIS 10.1 package. The network analyst extension was used to develop the street networks used for neighborhoods in the study. The network was created by right clicking on the street center lines shape files used to represent the streets in the neighborhoods. The create network tool was selected and a pop up showing the network creation window. The network was configured to simply without complications as the impedance factor is distance in meters. The streets were considered to have pavement as observed in the neighborhoods in the İzmir Province, Turkey. The networks created were all tested using network analyst tools such as ‘new routes’ and ‘service area’ tools. This was undertaken to evaluate the networks before they were used in the UNA tool.

3.5.3 Output of the Urban Network Analysis Tool

The output of the urban network analysis tool is based on the neighborhood spatial data for the determining the accessibility levels of buildings in the neighborhood considering the social and economic status of the neighborhoods. The radius used for analysis was set at 600 meters representing 10 minutes of walking distance. The output of the centrality calculations were displayed in map and the attribute data of the reach, betweenness, gravity, closeness and straightness for each building were used for variation analysis of the neighborhoods. The output of the centrality indexes are showed in the results of the report on the research.

3.6 Evaluating the Variations in the Neighborhood's Accessibility

The evaluation of the differences in the accessibility in the neighborhoods in İZMIR was determined by Analysis of variance (ANOVA) of the means of the centrality indexes. The choice of ANOVA was principally based on the ability of this statistical tool to estimate the variations in the "means" of groups of centrality measures as per the neighborhoods in the city of İZMIR, Turkey. The aim was to measure statistically the differences in accessibility measures in the Province. This section of the report provides a brief account on ANOVA, the hypothesis that were formed, the methodology and the parameters used for the analysis.

3.6.1 Analysis of Variance

Analysis of variance (ANOVA) simply can be described as a statistical technique used to obtain discrete estimates of the population variances; where one of the estimates is calculated from the difference between group means and the grand mean commonly known as "between group variance" or "among group variances" and the determination of the variances calculated by estimating the differences between the observations in each group and the means' of their corresponding groups popularly referred to as "within group variance". The ratio of the between groups and the within group variances provides the F-statistics that determines the relationships between the groups in question (Whellams, 1973). Analysis of variance is a statistical tool that permits the evaluation of the differences between sets of scores. The tool can be used to answer questions by taking into account the differences between two or more groups; the differences in the scores among members in each group; the results of the difference in means and the differences in scores in each group can be used to determine the effects of a variable on another independent variable. The statistical procedures can be applied to the scores to provide the results desired by the researcher (Gamst et al, 2008). The tool has been applied in a series of disciplines in estimating the variances in a population set. The development of the ANOVA tool started in the 20th Century by Sir Ronald Aylmer Fisher in 1921 during a research he conducted on Agriculture fields in England (Gamst et al, 2008). In modern times, for instance in urban studies; the two-way ANOVA was used to test the hypothesis of the two urban residential structure based on the four cities, their selected sectors and their distances (Anderson & Egeland, 1961). The components of ANOVA can be classified into six main categories. These are the total sum of squares, the between group sum of squares, the within group sum of squares, the degree of freedoms, the mean squares and finally the F-statistics.

A. ***Total sum of Squares***: is the total sum of the deviations of the squares of each group mean from the grand mean of the scores. This can simply be explained as the sum of deviations of all the observations from the population mean without considering the existence of groups. Mathematically it is represented as follows:

$SS_{Total} = \sum(X - \overline{X_T})^2$ (Gamst et al, 2008), where SS $_{Total}$ is the total sum of squares; X is a number of observations from the study and $\overline{X_T}$ represents the mean of all the observations in the study. In this case we deal with the variability of the each observation from the population mean.

B. ***Between-Groups Sum of Squares***: mostly the between-groups sum variances provide the underlying effects of the independent variables. The between-group sum of squares is based on the group means and the grand mean of the scores for the analysis. The group means summarizes the scores by providing an average value that represents each group in the distribution therefore serving as substitute variables for the scores that gave rise to the average value. Mathematically is defined as***;***

SS $_{A}$ = $\sum(\overline{Y} - \overline{Y}_T)^2$ (Gamst et al, 2008),

Where SS $_{A}$ represents the sum of squares for the between-group variances; $\overline{Y}$ represents the means of the groups and $\overline{Y}_T$ represents the grand mean of the entire distribution. The between-groups variance provides grounds to explain to an extent whether the variations in the grand mean is associated to the groups with which the scores belong. How much of the total variance can be explained to an extent by considering the relationship between the total sum of squares and the between-groups sum of squares.

C. ***Within-Group Sum of Squares:*** the within group variance also known as the 'error variance' measures the factors other than the dependent variables that contributed to variances within each of the groups for comparisons. The point is that none of the unknown factors can be statistically measured but the effects of the known measures can be statistically determined.

SS$_{S/A}$ = $\sum(Y_i - \overline{Y}_j)^2$ (Gamst et al, 2008), where $SS_{S/A}$ is the within-group sum of squares; Y_i is the observations in each group;

$\overline{Y}_j$ is the mean of a particular group.

D. ***Degrees of Freedom:*** The degrees of freedom for the mean squares were applied in the computation of the F-statistics for the study. The degree of freedoms divided the means squares for the Means squares of the study. The degree of freedom for the Total sum of squares is the total observations minus one. The degree of freedom for the between-group sum of squares is number of independent variables minus one. The within-group variance is the summation of the degree of freedoms for each group. The number of observations in each group minus one gives the within-group sum of squares' degree of freedom (Gamst et al, 2008).

E. ***Mean Squares:*** the mean squares are the variance statistics determined by the dividing the sum of squares by their corresponding degrees of freedom. The Total sum of squares, between-groups sum of squares and the within-group sum of squares were divided by their matching degrees of freedoms (Gamst et al, 2008).

F. ***F-Statistics:*** the F-statistics is determined by simply dividing the Between-group mean squares by the Within-group mean squares. This is determined for the study by the SPSS software upon which conclusions are based. The F-statistics is the basis upon which to test the null hypothesis that there are no significant differences among the groups' means for comparisons. One important characteristic of the F-statistics is that it uses the known variances of the independence variables to determine the level of variations in the dependent variables (Gamst et al, 2008).

3.6.2 The Independent Variables and Null Hypotheses for the Study

The One-Way between subjects ANOVA design was used for the study. The variables used for the independent variables are the accessibility measures of each building. The buildings have five main scores in terms of their level of accessibility in each neighborhood. Neighborhoods represent the groups upon which their means' are compared to identify differences in accessibility in İzmir Province, Turkey. ANOVA was used to determine the variability of the groups (neighborhoods) in terms of reach, gravity, closeness, straightness and betweenness. In all five different ANOVA were computed and the variations were identified based on the F-statistics and the Welch and Brown Forsythe tests.

The null hypothesis for ANOVA is that all the groups are equal implying that there are no differences in the groups as far as the independent variable is concerned and they are selected from the same population. Five different hypotheses were used for the study to measure the variations in accessibility in the study area. These null hypotheses were based on the accessibility measures used for the study.

The following are the null hypotheses tested in the study:

Reach centrality denoted by *R* for all the groups (neighborhoods) was written as

H_{0R} : Namazgah $_{R\,\mu}$ = Yenigun $_{R\,\mu}$ = Bahcelerarasi $_{R\,\mu}$ = Ataturk $_{R\,\mu}$ = Dokuz Eylul $_{R\,\mu}$ = Ugur $_{R\,\mu}$ = Camlicay $_{R\,\mu}$ = Ataturk $_{R\,\mu}$ = Yildiz $_{R\,\mu}$ = Onur $_{R\,\mu}$ = Altinordu $_{R\,\mu}$,

where H_{0R} is the null hypothesis for reach centrality in neighborhoods and R µ is the mean of each group. H_{AR} is the alternative hypothesis that would be accepted if the Null hypothesis is rejected;

H_{AR} : Namazgah $_{R\,\mu} \neq$ Yenigun $_{R\,\mu} \neq$ Bahcelerarasi $_{R\,\mu} \neq$ Ataturk $_{R\,\mu} \neq$ Dokuz Eylul $_{R\,\mu} \neq$ Ugur $_{R\,\mu} \neq$ Camlicay $_{R\,\mu} \neq$ Ataturk $_{R\,\mu} \neq$ Yildiz $_{R\,\mu} \neq$ Onur $_{R\,\mu} \neq$ Altinordu $_{R\,\mu}$, The gravity centrality is the denoted by G µ is mean of the groups and the $H_{G\mu}$ is the null hypothesis of the gravity centrality:

H_{0G} : Namazgah $_{G\mu}$ = Yenigun $_{G\mu}$ = Bahcelerarasi $_{G\mu}$ = Ataturk (Cigli) $_{G\mu}$ = Dokuz Eylul $_{G\mu}$ = Ugur $_{G\mu}$ = Camlicay $_{G\mu}$ = Ataturk (Narlidere)$_{G\mu}$ = Yildiz $_{G\mu}$ = Onur $_{G\mu}$ = Altinordu $_{G\mu}$,

The alternative hypothesis for the gravity centrality measure is denoted as; Where H_{AG} is the alternative hypothesis for gravity centrality measure:

H_{AG} : Namazgah $_{G\mu}$ ≠ Yenigun $_{G\mu}$ ≠ Bahcelerarasi $_{G\mu}$ ≠ Ataturk $_{G\mu}$ ≠ Dokuz Eylul $_{G\mu}$ ≠ Ugur $_{G\mu}$ ≠ Camlicay $_{G\mu}$ ≠ Ataturk $_{G\mu}$ ≠ Yildiz $_{G\mu}$ ≠ Onur $_{G\mu}$ ≠ Altinordu $_{G\mu}$.

The closeness centrality, in terms of the null hypothesis is written as:

H_{0C} : Namazgah $_{C\mu}$ = Yenigun $_{C\mu}$ = Bahcelerarasi $_{C\mu}$ = Ataturk $_{C\mu}$ = Dokuz Eylul $_{C\mu}$ = Ugur $_{C\mu}$ = Camlicay $_{C\mu}$ = Ataturk $_{C\mu}$ = Yildiz $_{C\mu}$ = Onur $_{C\mu}$ = Altinordu $_{C\mu}$.

where H_{0C} is the null hypothesis of closeness centrality for the neighborhoods and the C $_{\mu}$ is the mean of the closeness values for each neighborhood. The alternative hypothesis for the closeness centrality measure is denoted as H_{AC}:

H_{AC} : Namazgah $_{C\mu}$ ≠ Yenigun $_{C\mu}$ ≠ Bahcelerarasi $_{C\mu}$ ≠ Ataturk $_{C\mu}$ ≠ Dokuz Eylul $_{C\mu}$ ≠ Ugur $_{C\mu}$ ≠ Camlicay $_{C\mu}$ ≠ Ataturk $_{C\mu}$ ≠ Yildiz $_{C\mu}$ ≠ Onur $_{C\mu}$ ≠ Altinordu $_{C\mu}$.

The betweenness centrality as one of the measures of variations in accessibility has its null hypothesis denoted by $H_{B\mu}$ and the mean of the betweenness centrality for each neighborhood is represented by B_{μ}

H_{0B} : Namazgah $_{B\mu}$ = Yenigun $_{B\mu}$ = Bahcelerarasi $_{B\mu}$ = Ataturk $_{B\mu}$ = Dokuz Eylul $_{B\mu}$ = Ugur $_{B\mu}$ = Camlicay $_{B\mu}$ = Ataturk $_{B\mu}$ = Yildiz $_{B\mu}$ = Onur $_{B\mu}$ = Altinordu $_{B\mu}$.

The alternative hypothesis is represented as follows:

H_{AB} : Namazgah $_{B\,\mu} \neq$ Yenigun $_{B\,\mu} \neq$ Bahcelerarasi $_{B\,\mu} \neq$ Ataturk $_{B\,\mu} \neq$ Dokuz Eylul $_{B\,\mu} \neq$ Ugur $_{B\,\mu} \neq$ Camlicay $_{B\,\mu} \neq$ Ataturk $_{B\,\mu} \neq$ Yildiz $_{B\,\mu} \neq$ Onur $_{B\,\mu} \neq$ Altinordu $_{B\,\mu}$.

The null hypothesis of the straightness centrality is denoted by H_{0S} and the mean of the each neighborhood is represented by S_{μ} . The equation is given as follows:

H_{0S} : Namazgah $_{S\,\mu}$ = Yenigun $_{S\,\mu}$ = Bahcelerarasi $_{S\,\mu}$ = Ataturk $_{S\,\mu}$ = Dokuz Eylul $_{S\,\mu}$ = Ugur $_{S\,\mu}$ = Camlicay $_{S\,\mu}$ = Ataturk $_{S\,\mu}$ = Yildiz $_{S\,\mu}$ = Onur $_{S\,\mu}$ = Altinordu $_{S\,\mu}$.

The alternative hypothesis for the straightness centrality for the study is shown as:

H_{AS} : Namazgah $_{S\,\mu} \neq$ Yenigun $_{S\,\mu} \neq$ Bahcelerarasi $_{S\,\mu} \neq$ Ataturk $_{S\,\mu} \neq$ Dokuz Eylul $_{S\,\mu} \neq$ Ugur $_{S\,\mu} \neq$ Camlicay $_{S\,\mu} \neq$ Ataturk $_{S\,\mu} \neq$ Yildiz $_{S\,\mu} \neq$ Onur $_{S\,\mu} \neq$ Altinordu $_{S\,\mu}$.

3.6.3 Application of Statistical Packages for Social Sciences (SPSS) in the Variation Analysis

The first step in SPSS was to examine the data exported from excel to make sure that the data was representative such that all missing values and anomalies were corrected. The descriptive analysis tool was used to examine the data using mean, standard deviation, plots, variance, minimum, maximum, skewness, kurtosis, outlier analysis and histograms to ensure that all anomalies in the data were taken care of in the study. The explore tool was used in the examination of the data for any unidentified anomalies.

3.6.3.1 ANOVA Assumptions and the Null Hypothesis Tests

The two common assumptions for ANOVA computation were considered in the application of ANOVA for the measurement of variations in İzmir Province, Turkey. The test of homogeneity and the test of Normal distribution of the data were computed to consider the assumptions of ANOVA (Gamst et al, 2008).

The homogeneity test and normality analysis was undertaken with to ensure that the means of the groups (neighborhoods) are significantly varied. The results aided the calculation of the F-statistics. The violation of these assumptions implies that assumption of heterogeneity of the variance is assumed in the analysis. A more robust analysis of variance when heterogeneity of the variance is assumed is the Welch and Brown Forsythe Analysis (Gamst et al, 2008; Jan and Shieh, 2014).

The null hypotheses were tested to determine whether the means are the same for all the neighborhoods in the study. The results of the statistics test are shown in the results section of this report. The alpha level used for the study was 0.05.

3.6.3.2 Multiple Comparisons of Means

The next phase and equally important aspect of the Analysis of variance for the accessibility in the İzmir Province is the comparisons of the means. The purpose of this was to determine the neighborhoods that have very significant accessibility characteristics in relation to the centrality measures used for the study. Ideally the Tukey test is the robust method to compare means, principally when the variance is assumed to be equal and normality test is satisfied. The sample sizes and the unequal nature of the variances do not permit the use of Tukey comparison analysis. A pairwise comparison test that is sometimes liberal. This test is appropriate when the variances are unequal (Games and Howell, 1976; Tamhane, 1979).

The chosen comparative statistics tool was the Game Howell test comparison which is liberal and uses a pair-wise procedure to compare the group means, in this situation the neighborhood accessibility values. The neighborhoods' centrality means were compared to each one of the neighborhoods to identify statistically significant neighborhoods in relation to accessibility in the İzmir province. The group means are compared separately with each other group in the analysis of the variance.

3.7 Limitations of the Study

The challenges to a successful implementation of the study have been basically access to geographic data with various attributes. The data needed for the study included the various neighborhoods shapefiles such the residential buildings of each neighborhood; the attributes of the buildings such as heights and alternative uses of the buildings; the size of streets, the locations of commercial facilities in each neighborhood. These sets of data were not acquired due to limited financial resources. This was overcome by manually digitizing the residential buildings at radius of 500 meters for the center of each selected neighborhood. The attributes were not obtained for the study.

CHAPTER FOUR
DATA

4.1 Introduction

This section of the study focuses on the data used for the study. This chapter provides a brief account of the geographic location of the city of İzmir. The section then delves down to provide information on the data and how the data was obtained for the research. The data has been classified into two main categories. The socio-economic data and the spatial data are the two main data categories upon which the measures of accessibility were conducted for the city. A descriptive statistics was undertaken based on the socio-economic data including a statistical representation of the formed clusters. The study of variations in accessibility was principally based on the neighborhoods drawn from the clusters using the simple random sampling conducted. The naturally formed clusters were analyzed to understand the social and economic characteristics of the formed clusters based on the variables used for the cluster analysis.

The spatial organizations of the selected neighborhoods are shown in maps showing the streets and buildings in the residential areas. The measures of accessibility for the study were based on the locations of buildings, the street and the networks developed using GIS packages (ArcGIS 10.1). These relevant sources of data provided the yardstick to capture the accessibility values for each building in the residential neighborhoods. All the buildings in the study served as important sources of data for the measure of variations in accessibility in the city of İzmir, Turkey. The streets in the neighborhoods served as a very important component for the accessibility measures in the sense that all movements in the neighborhoods were conducted on the networks. Residents traverse along the streets within neighborhoods from and to their buildings.

4.2 Location and Brief Summary of Izmir

İzmir is the third largest city in Turkey after Istanbul and Ankara and is situated at the Western-most part of Turkey (Figure 4.1). The city of Izmir is situated by the gulf and has the second largest sea port in Turkey, situated by the Aegean sea in the West of the Anatolian Peninsula. Izmir has a population of approximately 4 million people and a total built up area of roughly 12,012 square meters. The average temperature for the summer and the winter months are 27.5 and 12 degree Celsius respectively. Izmir has 21 districts and over 340 neighborhoods as at 2014. The satellite image is provided showing the location of Izmir and the randomly selected neighborhoods from the clusters that were formed from the neighborhoods. There are 11 neighborhoods representing the eleven clusters that form Izmir.

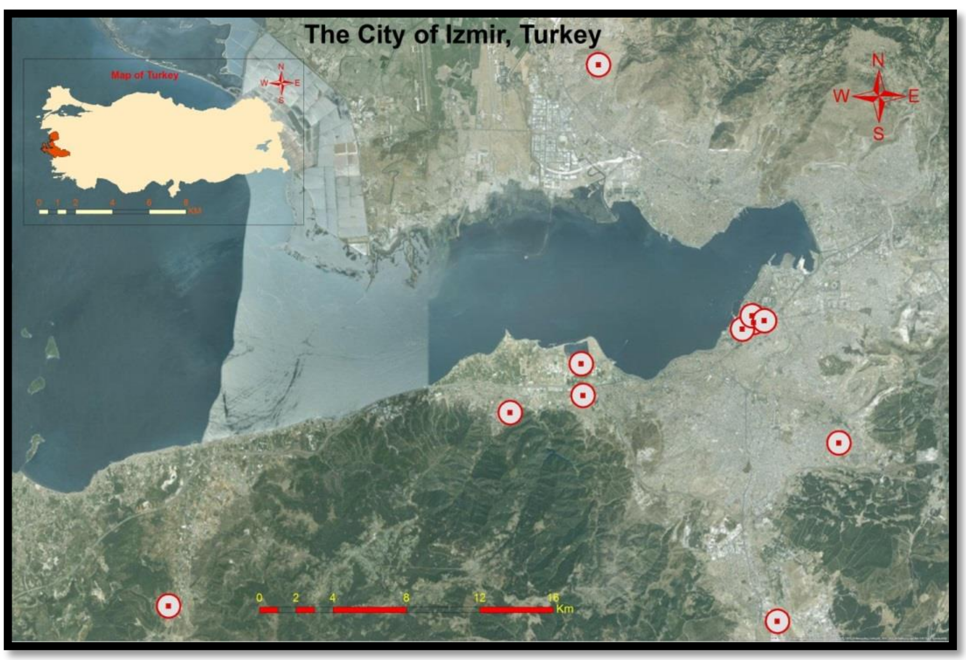

Figure 4.1 Satellite imagery of the location of the areas of study. (Accessed on the 12/03/2014 at ArcGIS online and edited by the Author, 2014)

4.3 Socio-Economic Data

This study is predominantly focused on the measurement of the differences in the accessibility patterns in the neighborhoods of Izmir. These neighborhoods are unique and made up of a mix of socio-economic variables that distinguishes each neighborhood from the other. Neighborhood level socio-economic data was acquired from the Internal Migration Integration Project (IGEP), Izmir. The data is made of an empirical averaging of the individual residents' perceptions from the respective neighborhoods that have been combined into indexes for each administrative neighborhood in Izmir.

4.3.1 Socio-economic Variables

The variables for the research were computed at the neighborhood level during a research by Izmir Metropolitan Municipality Culture and Social Affairs Department conducted in 2008. The variables include Education scores, density of people not in the work force, density of unemployment, unemployment density of people without any occupation, density of literates, illiterate women score, density of handicapped and density of unpaid family workers. The variables were computed on neighborhood levels making these variables objectively viable to provide basis for grouping the neighborhoods into clusters. There were 340 neighborhoods registered as the number of neighborhoods in the city of İzmir. The variables served as the basis for the cluster analysis in the grouping of the neighborhoods into taxonomies. The procedure for the determination of the variables has been briefly described in this section of the report.

A. Education Scores

The education scores obtained for the neighborhoods were computed by computing the resident educational level of attainment in the respective neighborhoods. These averages per neighborhood were computed based on the data gathered from the residential neighborhoods.

Table 4.1 Education score in Izmir per neighborhoods

	Neighborhoods	Minimum	Maximum	Mean	Std. Deviation
Education Score	340	-8.181	7.884	-0.851	2.800

B. Density of People Not in the Work Force

The density of people not in the work force was computed by dividing the total number of people who are not in the work force by the size (area) of each of the neighborhoods. This can be loosely termed as the density of dependent population in each residential neighborhood in the city.

Table 4.2 Descriptive statistics of the density of dependent population in Izmir

	Neighborhoods	Minimum	Maximum	Mean	Std. Deviation
Not in the Workforce (Dependent Population)	340	0.120	1.240	0.988	0.146

C. Density of Unemployment

The density of unemployment was calculated as a result of dividing the total number of unemployed people in the work force by the total land area of the respective neighborhoods. The unemployment density was calculated on neighborhood basis for all the 340 neighborhoods in the city.

Table 4.3 Descriptive statistics of the density of unemployed in Izmir

	Neighborhoods	Minimum	Maximum	Mean	Std. Deviation
Density of Unemployment	340	No data	4.160	1.072	0.369

D. Density of Unemployment without Occupation

The density of unemployment without occupation is the number of people who are unemployment and have no defined or professional occupation. This was calculated by dividing the number of unemployed without occupation by the area of each neighborhood. The calculation was conducted for all the 340 neighborhoods in the City.

Table 4.4 Descriptive statistics of the density of unemployed people without occupation

	Neighborhoods	Minimum	Maximum	Mean	Std. Deviation
Density of Unemployed People with no Occupation	340	No data	3.630	1.015	0.432

E. Density of Literates Not from Any School

Density of literates was made up of people who have not attended any school but can read and write and understand the Turkish language. The neighborhood average of literates not from any school is divided by the size of the neighborhood geographical built up area. This was conducted for all the neighborhoods in the city.

Table 4.5 Descriptive statistics of the density of literates without any formal school attendance

	Neighborhoods	Minimum	Maximum	Mean	Std. Deviation
Density of Literates that are not graduated from any school	340	No data	2.010	1.036	0.296

F. Illiterate Women Score

The illiterate women score is the average of the number of illiterate women in each neighborhood. The score show the magnitude of illiterate women in each neighborhood per the population of the women in the respective neighborhood. This variable was conducted for all the 340 neighborhoods in the city.

Table 4.6 Descriptive statistics of density of illiterate women in Izmir

	Neighborhoods	Minimum	Maximum	Mean	Std. Deviation
Density of Illiterate Women	340	-1.429	5.610	0.360	1.159

G. Density of Handicapped

Density of handicapped is the number of disabled people who have been rendered incapable in any aspect of their human physical form, economic problems and poverty. This was determined by the total number of handicaps for each neighborhood divided by the area size of the neighborhood. The variable was calculated for all the neighborhoods that form Izmir city.

Table 4.7 Descriptive statistics of the density of handicapped in Izmir

	Neighborhood	Minimum	Maximum	Mean	Std. Deviation
Density of Handicapped	340	No data	403.150	5.202	29.863

H. Density of Unpaid Family Workers

Unpaid family workers comprise the number of family workers per each neighborhood who work but do not receive any remuneration for their labor. The average for each neighborhood is divided by the area size of the neighborhood to determine the density of unpaid family workers.

Table 4.8 Descriptive statistics of the density of unpaid family workers in Izmir

	Neighborhood	Minimum	Maximum	Mean	Std. Deviation
Density of Unpaid Family Workers	340	No data	6.760	1.095	0.598

4.4 Cluster Analysis

The results of the Hierarchical cluster analysis yielded 11 different clusters based on the variables used for the classification. The socio-economic data used for the analysis comprised of two main categories. Density data and scores calculated for the respective neighborhoods in the Izmir Province. The results of the classification of the data into cluster have been displayed in dendrogram at the appendices section of the report (Appendix 4.1). The table provides a summary of the number of neighborhoods classified under each cluster.

Table 4.9 Hierarchical Cluster analysis results

Clusters	Number of Neighborhoods
Cluster 1	165
Cluster 2	141
Cluster 3	8
Cluster 4	1
Cluster 5	2
Cluster 6	3
Cluster 7	1
Cluster 8	1
Cluster 9	6
Cluster 10	9
Cluster 11	2
Total	340

4.4.1 Descriptive Statistics of the Clusters

The clusters naturally formed were described in relation to the socio-economic data that were used to undertake the cluster analysis. The clusters were formed in SPSS by using the hierarchical cluster analysis (the cluster method was the furthest neighbor; the measure used was squared euclidean distance; and the transformation was the standard z-values). The descriptive statistics of the clusters are expressed based on the variables used for the classification. These variables are education scores, density of people not in the work force, density of unemployment, unemployment density of people without any occupation, density of literates, illiterate women score, and density of handicapped and density of unpaid family workers. The tables show the clusters, the number of neighborhoods in each cluster, the minimum and the maximum values in each cluster, the mean and the standard deviations for each of the clusters.

Table 4.10 Descriptive statistics of cluster one (n=166)

	Minimum	Maximum	Mean	Std. Deviation
Education Score	-6.500	4.025	-2.398	1.620
Illiterate Women Score	-1.180	3.95	0.793	0.944
Density of People Not in the Workforce	0.880	1.160	1.016	0.047
Unemployment Density of People with no Occupation	0.400	2.160	1.110	0.291
Density of Unpaid Family Workers	0.000	2.610	1.11	0.395
Density of Unemployment	0.720	1.950	1.120	.2123
Density of Literates that are not graduated from any school	0.790	1.720	1.198	0.175
Density of Handicapped	0.000	31.210	1.796	3.472

Table 4.11 Descriptive statistics of cluster two (n=141)

	Minimum	Maximum	Mean	Std. Deviation
Illiterate Women Score	-1.429	3.650	-0.293	0.777
Unemployment Density of People with no Occupation	0.000	1.580	0.825	0.271
Density of Literates that are not graduated from any school	0.330	1.2100	0.870	0.162
Density of Unemployment	0.470	1.470	0.928	0.175
Density of Unpaid Family Workers	0.000	2.590	0.994	0.343
Density of People Not in the Workforce	0.640	1.2400	1.003	0.092
Education score	-5.029	7.8840	1.322	2.404
Density of Handicapped	0.000	68.670	2.726	8.386

Table 4.12 Descriptive statistics of cluster three (n=8)

	Minimum	Maximum	Mean	Std. Deviation
Education Score	-6.973	0.709	-2.431	3.090
Unemployment Density of People with no Occupation	0.280	1.280	0.900	0.325
Density of People Not in the Workforce	0.980	1.150	1.050	0.051
Density of Unemployment	0.570	1.740	1.158	0.394
Density of Literates that are not graduated from any school	0.710	2.010	1.188	0.447
Illiterate Women Score	-0.584	4.357	1.571	1.836
Density of Unpaid Family Workers	0.930	3.930	2.795	0.921
Density of Handicapped	0.640	19.670	4.268	6.452

Table 4.13 Descriptive statistics of cluster four (n=1)

	Minimum	Maximum	Mean	Std. Deviation
Illiterate Women Score	0.000	0.000	0.000	.
Density of Unpaid Family Workers	0.000	0.000	0.000	.
Education Score	0.000	0.000	0.000	.
Unemployment Density of People with no Occupation	0.000	0.000	0.000	.
Density of People Not in the Workforce	0.690	0.690	0.690	.
Density of Literates that are not graduated from any school	0.970	0.970	0.970	.
Density of Unemployment	4.160	4.160	4.160	.
Density of Handicapped	19.430	19.430	19.430	.

Table 4.14 Descriptive statistics of cluster five (n=2)

	Minimum	Maximum	Mean	Std. Deviation
Education Score	-4.012	-2.023	-3.017	1.406
Density of Unpaid Family Workers	0.490	0.610	0.550	0.084
Density of People Not in the Workforce	0.460	0.870	0.665	0.289
Density of Literates that are not graduated from any school	0.260	1.200	0.730	0.664
Illiterate Women Score	0.118	1.732	0.925	1.140
Unemployment Density of People with no Occupation	1.200	2.050	1.625	0.601
Density of Handicapped	0.810	3.260	2.035	1.732
Density of Unemployment	2.270	2.560	2.415	0.205

Table 4.15 Descriptive statistics of cluster six (n=3)

	Minimum	Maximum	Mean	Std. Deviation
Illiterate Women Score	-1.218	0.000	-0.766	0.667
Density of Unpaid Family Workers	0.000	0.150	0.050	0.086
Density of Literates that are not graduated from any school	0.000	0.150	0.086	0.077
Density of People Not in the Workforce	0.120	0.410	0.223	0.161
Density of Unemployment	0.000	1.150	0.740	0.642
Unemployment Density of People with no Occupation	0.000	2.250	1.413	1.230
Education Score	0.000	3.736	2.177	1.943
Density of Handicapped	0.000	11.380	3.903	6.477

Table 4.16 Descriptive statistics of cluster seven (n=1)

	Minimum	Maximum	Mean	Std. Deviation
Density of Unemployment	0.000	0.000	0.000	.
Illiterate Women Score	0.000	0.000	0.000	.
Density of Unpaid Family Workers	0.000	0.000	0.000	.
Education Score	0.000	0.000	0.000	.
Unemployment Density of People with no Occupation	0.000	0.000	0.000	.
Density of Literates that are not graduated from any school	0.580	0.580	0.580	.
Density of People Not in the Workforce	1.120	1.120	1.120	.
Density of Handicapped	185.130	185.130	185.130	.

Table 4.17 Descriptive statistics of cluster eight (n=1)

	Minimum	Maximum	Mean	Std. Deviation
Education Score	-2.152	-2.152	-2.152	.
Illiterate Women Score	0.455	0.455	0.455	.
Density of Handicapped	0.570	0.570	0.570	.
Density of People Not in the Workforce	0.780	0.780	0.780	.
Unemployment Density of People with no Occupation	0.860	0.860	0.860	.
Density of Literates that are not graduated from any school	0.920	0.920	0.920	.
Density of Unemployment	1.660	1.660	1.660	.
Density of Unpaid Family Workers	6.760	6.760	6.760	.

Table 4.18 Descriptive statistics of cluster nine (n=6)

	Minimum	Maximum	Mean	Std. Deviation
Education Score	-0.736	0.233	-0.202	0.413
Illiterate Women Score	-0.344	0.285	-0.049	0.220
Density of Unpaid Family Workers	0.000	0.790	0.255	0.323
Density of People Not in the Workforce	0.170	0.570	0.360	0.175
Density of Literates that are not graduated from any school	0.000	0.620	0.366	0.232
Density of Unemployment	0.210	0.890	0.525	0.218
Unemployment Density of People with no Occupation	0.000	1.860	0.873	0.876
Density of Handicapped	0.630	47.940	9.375	18.962

Table 4.19 Descriptive statistics of cluster ten (n=9)

	Minimum	Maximum	Mean	Std. Deviation
Education Score	-8.181	0.709	-4.547	2.536
Density of People Not in the Workforce	0.970	1.120	1.046	0.055
Density of Unpaid Family Workers	0.920	1.910	1.265	0.369
Density of Literates that are not graduated from any school	0.850	1.840	1.424	0.322
Density of Unemployment	0.920	2.000	1.473	0.352
Unemployment Density of People with no Occupation	0.900	3.280	2.047	0.685
Illeterate Women Score	0.477	5.609	2.793	1.493
Density of Handicapped	0.060	26.060	5.147	8.600

Table 4.20 Descriptive statistics of cluster eleven (n=2)

	Minimum	Maximum	Mean	Std. Deviation
Illiterate Women Score	0.000	0.000	0.000	0.000
Education Score	0.000	0.275	0.137	0.194
Density of Unpaid Family Workers	0.000	0.940	0.470	0.664
Density of People Not in the Workforce	0.220	0.740	0.480	0.367
Unemployment Density of People with no Occupation	0.000	1.000	0.500	0.707
Density of Literates that are not graduated from any school	0.980	1.060	1.020	0.056
Density of Unemployment	0.920	3.350	2.135	1.718
Density of Handicapped	0.750	403.150	201.950	284.539

The scarcity of data paved the way for the use of simple random sampling for the selection of the representative neighborhoods for the study. Eleven neighborhoods were selected from each of the clusters that were formed as an outcome of the cluster analysis. These neighborhoods were used as the basis to assess the variations in physical structure of the neighborhoods and the socio-economic factors.

Table 4.21 Results of simple random sampling

Clusters	Number of Neighborhoods	Randomly Selected Neighborhoods	Districts
Cluster 1	165	Yildiz	Buca
Cluster 2	141	Onur	Balcova
Cluster 3	8	Camlicay	Guzabece
Cluster 4	1	Ugur	Konak
Cluster 5	2	Altinordu	Konak
Cluster 6	3	Ataturk	Cigli
Cluster 7	1	Namazgah	Konak
Cluster 8	1	Bahcelerarasi	Balcova
Cluster 9	6	Dokuz Eylul	Gaziermir
Cluster 10	9	Ataturk	Narlidere
Cluster 11	2	Yenigun	Konak

4.5 Spatial Configuration of Neighborhood Built Environment

The built environment is a composition of human interventions on the natural environment by architects, planners, building engineers, transport planners and urban designers. The urban management and planning policies have significant impact on the pattern and direction of growth of the physical aspects of urban centers. The measure of neighborhood accessibility objectively contains mostly geographic locations and transportation systems. The buildings and the streets in the selected neighborhood are used to measure how accessible the residential areas are and have been configured. The buildings and streets in the neighborhoods are represented in geometric format for easy interpretation by the GIS application used for the analysis of the data. The shapefiles in the form of polygons and lines are used to represent the buildings and the streets respectively. The streets and the buildings of the selected neighborhoods were digitized with the use of ArcGIS 10.1 in connection with images captured from Google Earth application. The buildings of the neighborhoods and the streets form the database for the application of the accessibility measurement tools. These datasets were needed for an objective assessment of the level of accessibility within the neighborhoods in Izmir.

The accessibility values for each neighborhood is dependent on the way the neighborhood are configured in terms of the location of the building and how they are connected and inter-connected with the streets. The streets in the neighborhoods were used for the development of the spatial networks upon which the centrality measures are applied. The main components of the accessibility are land uses and transportation systems which are represented in the study by the buildings and the streets respectively. The data for the accessibility measurement are obtained from the buildings in the neighborhoods based on the spatial network of streets. The buildings are considered very essential because most trips in cities largely begin and end in buildings.

4.5.1 Digitizing of the Selected Neighborhoods from the Clusters

The spatial organization of the selected neighborhoods is one of the main components of the study upon which the analysis of the variations in accessibility will be based. The digitizing of the neighborhoods' buildings and street system are the primary geographical and physical data needed for the objective measurement of the differences in accessibility in the neighborhoods. The shapefile of the neighborhoods was obtained from the Izmir Buyuk Belediyesi Geographic Information Systems Department. The neighborhood shapefile formed the basis upon which the boundaries of the neighborhoods were determined.

4.5.1.1 The Digitizing Standards Set for the Study

The representation of the spatial organization of the selected neighborhood included buildings and the street systems at the neighborhood levels. Some digitizing guidelines and the procedure that were used are described in this section. These include the software package used, the digitizing scale and the coordinate system used.

a. The software package: the ArcGIS 10.1 software package was used to digitize the streets and the buildings of the neighborhoods used for the study..
b. The scale used for the digitizing was set to ensure that all the data used for analysis were devoid of biases which may be inherent in the process of digitizing. A scale of 1:2000 was used in connection with the projected coordinate of the neighborhoods shapefile from the GIS department of Izmir Province.
c. The coordinate system used was the projected coordinate system. This was done because of the measurement of distance at the neighborhood level. The characteristics of the coordinate system is listed below:

Projected Coordinate System:ITRF96

Projection: Transverse Mercator

False Easting: 500000.00000000

False Northing: 0.00000000

Central Meridian: 27.00000000

Scale Factor: 1.00000000

Latitude of Origin: 0.00000000

Linear Unit: Meter

Geographic Coordinate System: GCS_WGS_1984

Datum: D_WGS_1984

Prime Meridian: Greenwich

Angular Unit: Degree

This coordinate system represents the location of Izmir province geographically and was obtained from the Izmir Province Geographic Information Systems Department.

4.5.1.2 Digitizing the Neighborhoods

The digitizing of the selected neighborhoods was done principally using Arc Map 10.1. The first step was the set up the coordinate system of the data frame using the working projected coordinate system stated above. The neighborhood shapefile was added to the data frame in Arc Map and the eleven neighborhoods representing Izmir, according to the cluster analysis and the random sampling, were selected and exported individually. A 500 meter radius buffer was determined using the mean centers from the neighborhoods according to their built up areas. This was done to ensure that all the neighborhoods were considered objectively irrespective of the size of the neighborhoods. The size of the neighborhoods in terms of built up areas were delineated equitably using the 500 meter radius. Some of the neighborhoods were larger than the buffers set at the centre of the built up areas whiles others were lesser than the set buffer. The map below shows the spatial location of the selected of the neighborhoods and the buffers of 500m from the respective neighborhood mean centers. The mean centers were determined for each neighborhood using the mean center tool in ArcGIS map 10.1 under the spatial statistics tool set. The results of each neighborhood mean center was merged using the geo-processing tool in ArcGIS map 10.1. The completion of the merge operation permitted the use of the buffer operation on the data. The results are presented in Figure 4.2.

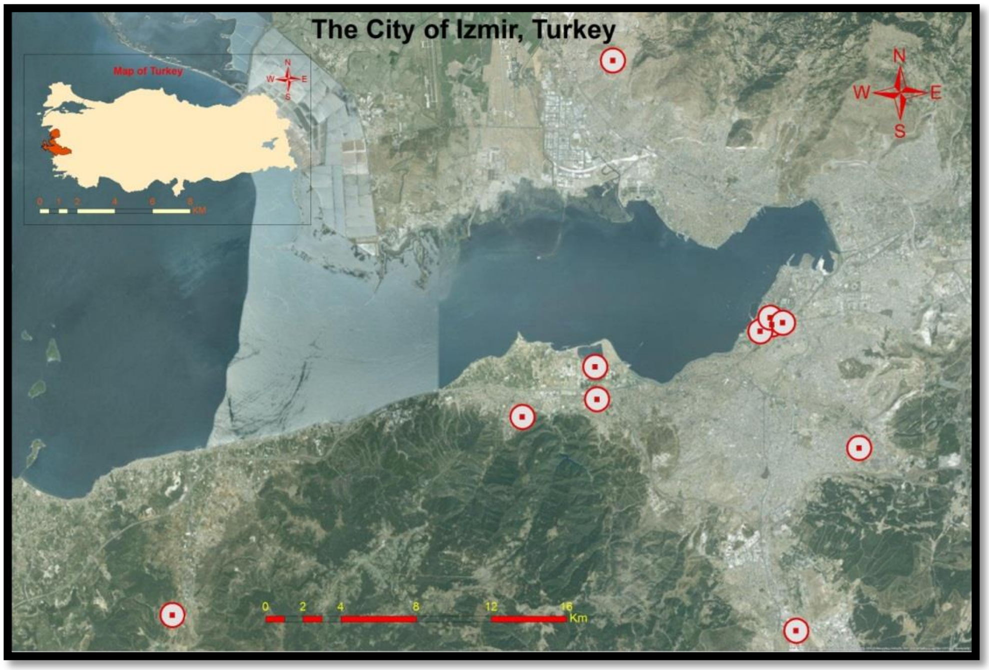

Figure 4.2 Map showing the built up areas of the neighborhoods selected for the study**.**

The digitizing was done by first, setting the data frame coordinate system to the working coordinate system for the study. The next step was adding the shapefiles of the randomly selected neighborhoods. A satellite base map of the areas was added from the ArcGIS map online map resources. The buildings were digitized for each neighborhood considering the 500 meters radius. The Open street online ArcGIS map resource was also accessed to digitize the streets that were within the catchment area of the buffers for the neighborhoods.

The results of the digitizing of the streets and the buildings within the set buffer radius formed the data representing the spatial organization of the neighborhoods for the study. The building and streets of the selected neighborhoods are presented in Figure 4.3 and Figure 4.4.

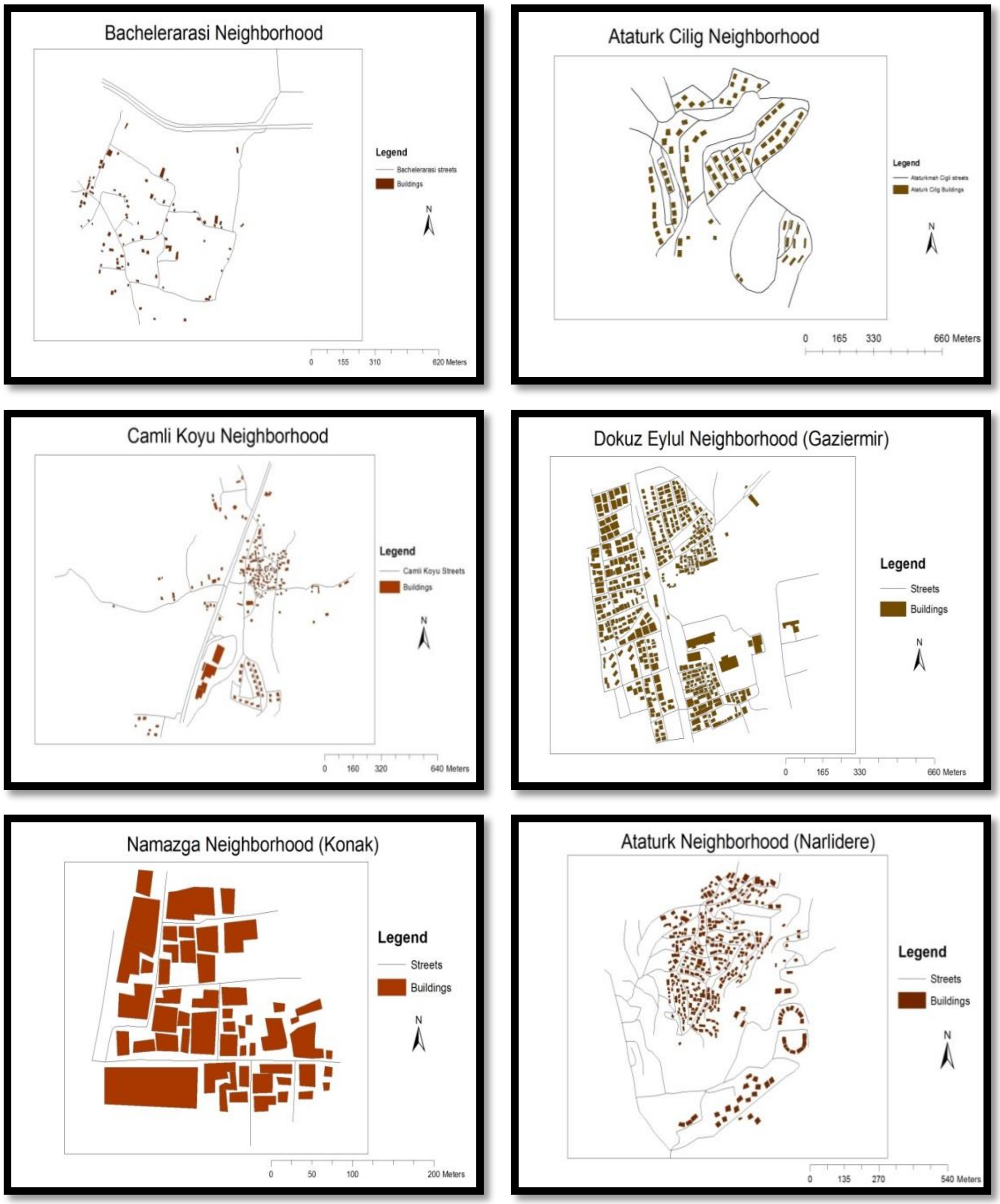

Figure 4.3 Buildings and streets digitized from the selected neighborhoods

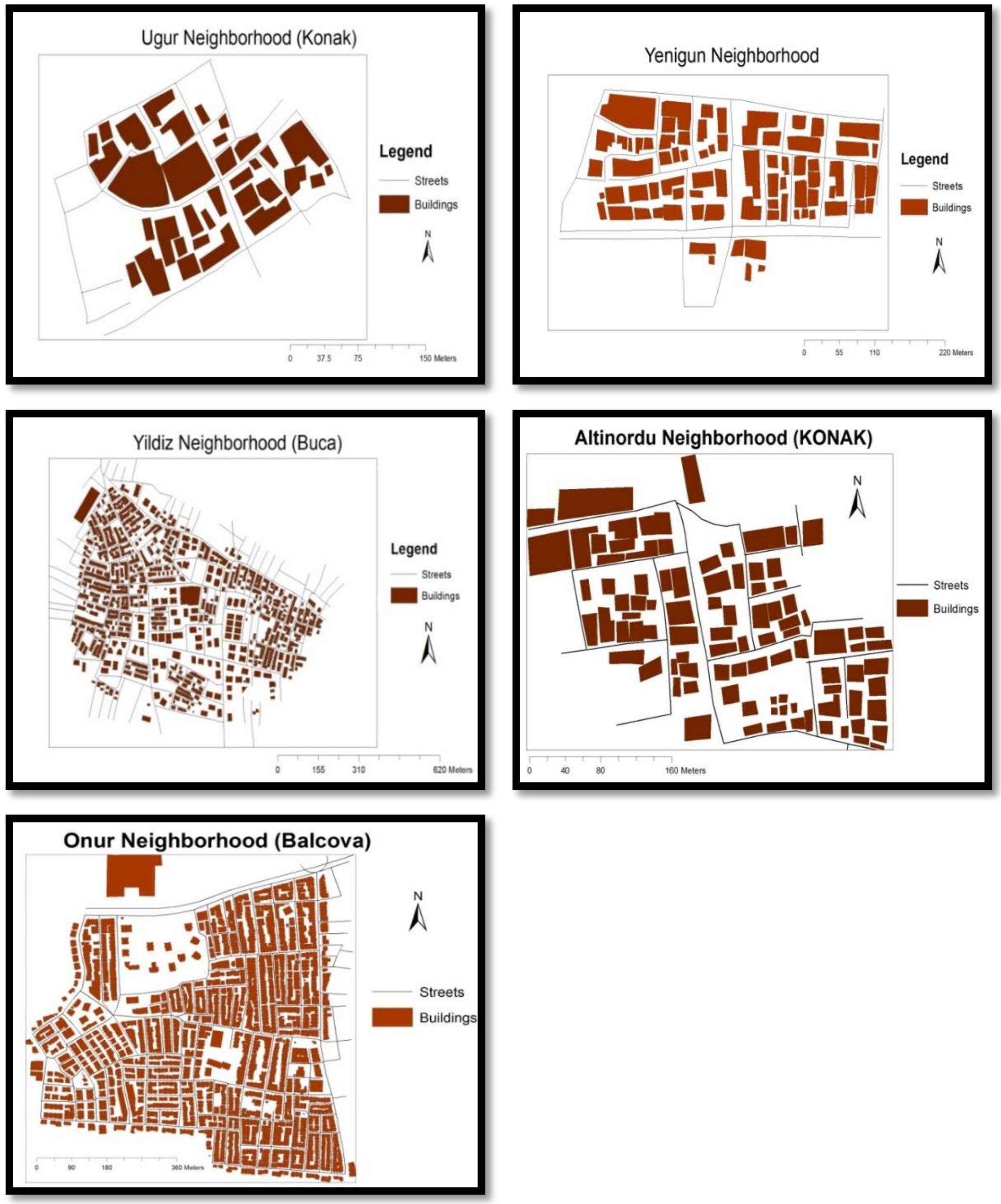

Figure 4.4 Buildings and Streets digitized from the selected neighborhoods

The buildings and the street data sets were the basis upon which the accessibility in the neighborhoods was measured. The buildings served as the objects of the measure from which accessibility based on different centrality measurements are obtained. The streets were converted to networks with edges and nodes on which the people traverse for their normal daily lives. One important characteristic of the streets in Izmir is that, all the streets in residential neighborhoods have pavements to facilitate walking in the neighborhoods. The above data sets are considered with relevance to the fact that these neighborhood facilitate walking and a means of commuting. The differences in the levels of accessibility are measured based on the neighborhood spatial configuration. The determination of centrality-based accessibility for the buildings was conducted without the use of any weights on the buildings.

CHAPTER FIVE
ANALYSIS AND RESULTS

5.1 Introduction

The measures of accessibility used to assess the spatial organization of the representative neighborhoods were identified to be the network centrality indices. A set of hypotheses were tested to find out whether differences exist in the accessibility in the neighborhoods using the network based accessibility indicators. The results of accessibility of each building were obtained using the network centrality indices. The data was entered into SPSS for analysis of the variances in the neighborhoods with regards to accessibility. The results of the analysis of variance (ANOVA) are presented in this section of the report. The section has been organized based on the network centrality measures used to measure the variations in the neighborhoods located in the Province of Izmir, Turkey.

Descriptive statistics, assumption test, ANOVA test, Welch test, Brown-Forsythe test of variation, post hoc analysis of variance were determined based on each network centrality measure. The accessibility indices were treated independently for the neighborhoods. Reach, gravity, betweenness, closeness and straightness centrality measures are used to provide the results for the neighborhoods' spatial organization differences.

5.2 Accessibility Variations Based on Reach Centrality Measure

The Reach centrality essentially measures the number of buildings that can be reached on the street of networks within a 600-meter from each building in each neighborhoods. The results of reach from each building were ascertained, upon which the means' of Reach from each neighborhood was determined. The descriptive statistics provides a brief overview of the accessibility levels that exist in the neighborhoods representing the clusters in the study. The means, standard deviations and the total number of buildings are shown in the tables below. This gives a firsthand view of condition in the neighborhoods in the context of accessibility for the study. The test of homogeneity of the variances proved that there is heterogeneity in the data and as a result the assumption of homogeneity has been violated. The unequal sample sizes and the unequal variance provided the basis to use a robust test of equality of means. The Welch and Brown-Forsythe test were used to test the null hypothesis.

Table 5.1 Descriptive statistics of Reach centrality for the neighborhoods in Izmir

		Number of Buildings	Mean	Std. Deviation
Reach Centrality	Yildiz	1158	704.720	190.576
	Onur	1517	1049.590	239.797
	Camli Koyu	198	77.180	55.363
	Ugur	34	16.180	8.685
	Altinordu	95	33.410	22.703
	Ataturk	87	9.450	7.894
	Namazgah	53	10.680	6.076
	Bahcelerarasi	84	13.190	10.314
	Dokuz Eylul	470	51.620	40.027
	Ataturk Nar	341	59.770	34.356
	Yenigun	77	49.170	14.769
	Total	4114	602.390	464.770

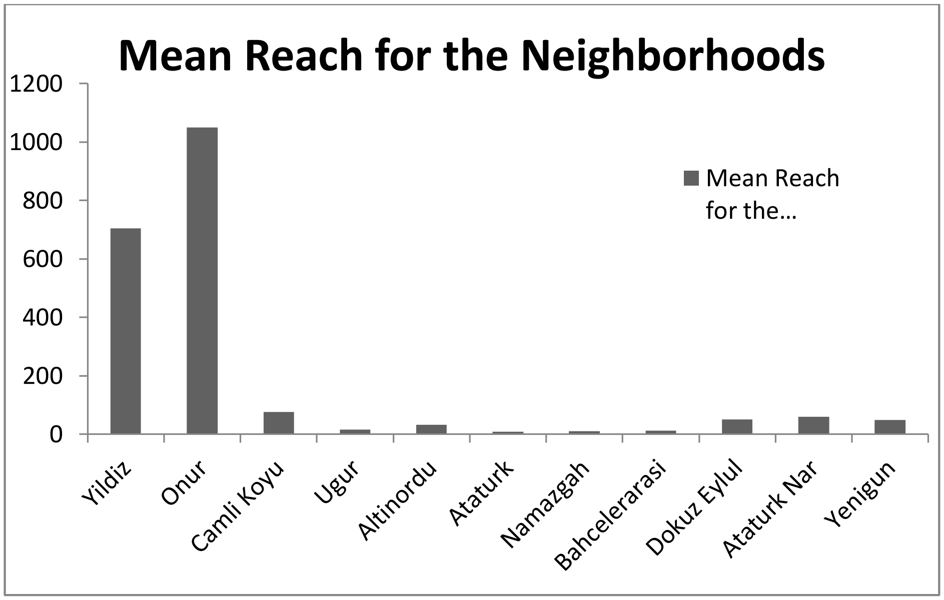

Figure 5.1 Statistical means determined for the reach centrality index for the neighborhoods.

5.2.1 Test of Homogeneity of Variance for Reach Centrality

One important assumption for the analysis of variance is the test of homogeneity of the variances. This assumption provides the background upon which the ANOVA analysis can be undertaken using the F-statistics. The results from the Reach centrality in relation to the neighborhoods are expounded below statistically.

Table 5.2 Results of homogeneity of the variances for the reach index for neighborhoods

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Reach	250.827	10	4103	0.000

The test was conducted at an alpha level of 0.05 and the results indicated that there is a statistically significant heterogeneity of the variances in the reach variances for the neighborhoods. The assumption for the homogeneity of variance is violated for the reach centrality for the neighborhoods. The use of the F-statistics was deemed statistically unrealistic because there is inequality of variances on the reach centrality index for the representative neighborhoods.

5.2.2 Examining the Variations in the Reach Centrality for the Neighborhoods

The main thrush of the study is to measure accessibility variations in the neighborhoods in Izmir Province, Turkey. The test was conducted using ANOVA. The null hypothesis and the alternative hypothesis are stated. Reach centrality denoted by ***R*** for all the groups (neighborhoods) was written as

H_{0R} = Namazgah $_{R\ \mu}$ = Yenigun $_{R\ \mu}$ = Bahcelerarasi $_{R\ \mu}$ = Ataturk $_{R\ \mu}$ = Dokuz Eylul $_{R\ \mu}$ = Ugur $_{R\ \mu}$ = Camlicay $_{R\ \mu}$ = Ataturk $_{R\ \mu}$ = Yildiz $_{R\ \mu}$ = Onur $_{R\ \mu}$ = Altinordu $_{R\ \mu}$

Where H_{0R} is the null hypothesis for reach centrality in neighborhoods and R µ is the mean of each group. H_{AR} is the alternative hypothesis that would be accepted if the null hypothesis is rejected;

H_{AR} = Namazgah $_{R\ \mu}$ ≠ Yenigun $_{R\ \mu}$ ≠ Bahcelerarasi $_{R\ \mu}$ ≠ Ataturk $_{R\ \mu}$ ≠ Dokuz Eylul $_{R\ \mu}$ ≠ Ugur $_{R\ \mu}$ ≠ Camlicay $_{R\ \mu}$ ≠ Ataturk $_{R\ \mu}$ ≠ Yildiz $_{R\ \mu}$ ≠ Onur $_{R\ \mu}$ ≠ Altinordu $_{R\ \mu}$

The analysis of variance for the means of the neighborhoods provided the F-statistics for the test of the variations in the reach centrality. The results of the ANOVA and the complementing Welch and Brown-Forsythe are discussed below. The ANOVA results for the reach centrality for the neighborhoods in the Izmir Province, Turkey, was conducted at $\alpha = 0.05$.

Table 5.3 Anova results of reach centrality index for the neighborhoods

		Sum of Squares	df	Mean Square	F	Sig.
Reach	Between Groups	757419124.698	10	75741912.470	2371.640	0.000
	Within Groups	131035538.591	4103	31936.519		
	Total	888454663.289	4113			

Table 5.4 Welch and Brown-Forsythe robust test of equality of means for reach index

		Statistic[a]	df1	df2	Sig.
Reach	Welch	4350.113	10	481.609	0.000
	Brown-Forsythe	11007.666	10	3130.595	0.000
a. Asymptotically F distributed.					

The results of the ANOVA indicated that there was statistically significant differences between the neighborhoods' reach centrality means as determined by one-way anova [F (10, 4113) = 2371.640, p = 0.000)] as well as the Welch and Brown-Forsythe test showing a statistically significance value of 0.00 at α = 0.05. Welch and Brown-Forsythe robust test of equality of means at α = 0.05 produced statistically significant results. The results provide statistical evidence to reject the null hypothesis and therefore the alternative hypothesis for the reach centrality index is accepted for the neighborhoods.

H_{AR} = Namazgah $_{R\,\mu} \neq$ Yenigun $_{R\,\mu} \neq$ Bahcelerarasi $_{R\,\mu} \neq$ Ataturk $_{R\,\mu} \neq$ Dokuz Eylul $_{R\,\mu} \neq$ Ugur $_{R\,\mu} \neq$ Camlicay $_{R\,\mu} \neq$ Ataturk $_{R\,\mu} \neq$ Yildiz $_{R\,\mu} \neq$ Onur $_{R\,\mu} \neq$ Altinordu $_{R\,\mu}$

The alternative hypothesis (H_{AR}) is accepted for reach centrality indicating that in terms of accessibility in the representative neighborhoods in Izmir, Turkey, there exist statistically significant differences in the average number of buildings that can be reached from 600 meter radius from each building in the neighborhoods.

5.2.3 Post hoc Analysis of the Variance for Reach Centrality

The observation that, there exist statistically significant differences between the means of the neighborhoods in term of reach centrality index does not provide a very strong statistical basis to measure the variations in the accessibility of the neighborhoods. The Post Hoc analysis test provided a good way to identify neighborhood pairs with statistically significant differences and those without significant differences. The Games-Howell test was used to perform pairwise comparisons of the neighborhoods variances relating to the reach accessibility index. The significance level was set at α = 0.05 for the comparisons. The table below presents pairwise comparisons between the means where 1 denotes statistical significance between two neighborhoods at α = 0.05 and 0 denotes statistical insignificance between the pairs being compared at α = 0.05. See Appendix 5.1 for details of the Games-Howell multiple comparisons results

Table 5.5 Games-Howell pair-wise comparison for reach centrality index where 1 represents statistical significance and 0 represents statistical insignificance at α = 0.05 in terms of differences and similarities respectively for the neighborhoods.

Neighborhoods	Yildiz	Onur	Camlicay	Ugur	Altinordu	Ataturk	Namazgah	Bahcelerarasi	Dokuz Eylul	Ataturk	Yenigun
Yildiz	--										
Onur	1	--									
Camlicay	1	1	--								
Ugur	1	1	1	--							
Altinordu	1	1	1	1	--						
Ataturk (Cigli)	1	1	1	1	1	--					
Namazgah	1	1	1	0	1	0	--				
Bahcelerarasi	1	1	1	0	1	0	0	--			
Dokuz Eylul	1	1	1	1	1	1	1	1	--		
Ataturk (Narlidere)	1	1	1	1	1	1	0	1	1	--	
Yenigun	1	1	1	1	1	1	0	1	0	1	--

The results of the Game-Howell test indicated that there exist statistically significant differences between the neighborhoods. Some pairs of neighborhoods from the analysis were statistically insignificant. These pairs are (Namazgah: Ugur), (Bahcelerarasi: Ugur), (Ataturk: Namazgah), (Namazgah: Bahcelerarasi), (Dokuz Eylul: Yenigun) and (Yenigun: Namazgah). These results show that there are similarities in these pairs of neighborhoods in terms of reach centrality index.

5.3 Accessibility Variations Based on Betweenness Centrality Measure

The betweenness centrality index takes into consideration the relevance of locations serving as intermediary between other locations in a network of streets. The Betweenness centrality explains the relative importance of buildings in the neighborhoods controlling accessibility between and among other buildings based on a specified threshold. The threshold defined for the study represent a 10 minutes walking distance from each building in the neighborhood. The descriptive statistics and the accompanying tests are discussed.

Table 5.6 Descriptive statistics of the Betweenness centrality measures for the neighborhoods

		Number of Buildings	Mean	Std. Deviation
Betweenness Centrality	Yildiz	1158	15170.508	15050.546
	Onur	1517	35304.305	32315.334
	Camlicay	198	1197.161	1420.147
	Ugur	34	47.470	55.861
	Altinordu	95	345.178	428.743
	Ataturk (Cigli)	87	25.977	37.465
	Namazgah	53	36.943	42.750
	Bahcelerarasi	84	56.880	94.065
	Dokuz Eylul	470	579.519	725.274
	Ataturk (Narlidere)	341	881.982	1206.120
	Yenigun	77	245.194	194.055
	Total	4114	17500.371	25831.261

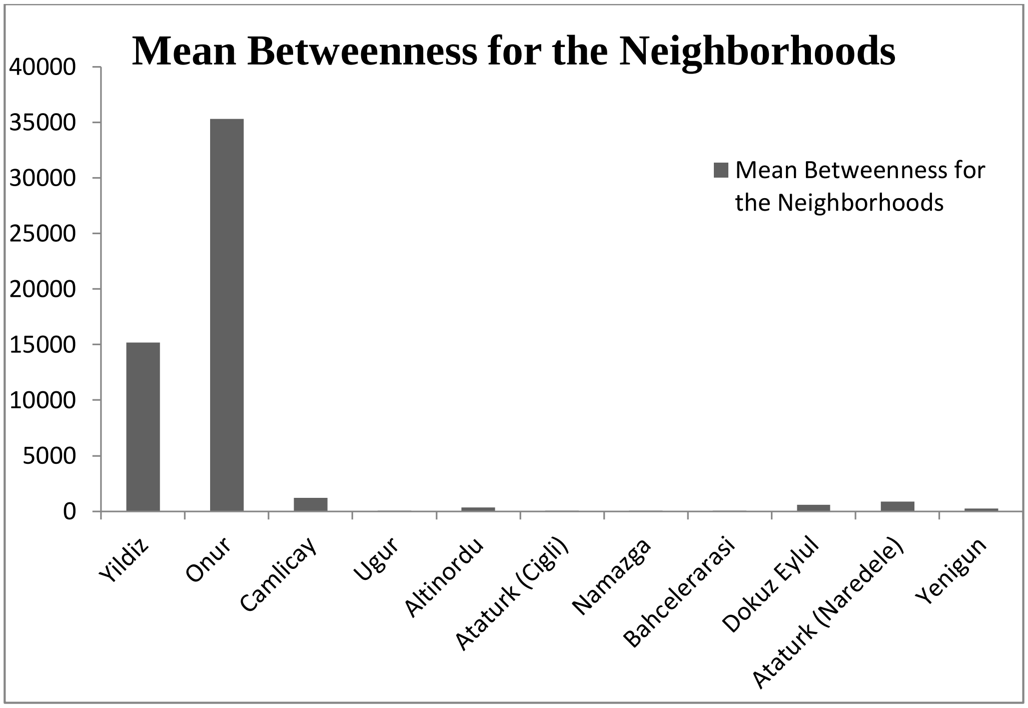

Figure 5.2 Statistical means determined for the betweenness centrality index for the neighborhoods.

5.3.1 Test of Homogeneity of Variance for Betweenness Centrality

The homogeneity assumption for the Betweenness centrality was tested at α = 0.05 with aim of finding out that, the variances are homogeneous. The results of the test are has been summarized.

Table 5.7 Test of homogeneity of variance for the Betweenness centrality for the neighborhoods

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Betweenness	223.031	10	4103	0.000

The test results signify that there is statistically significant heterogeneity in the variance at α = 0.05 at a significance of 0.000. The unequal sample sizes and the unequal variance assumptions violate the use of the F-statistics as a robust statistical tool for the comparisons of the means in the measure of variations in the accessibility with emphasis on Betweenness. The Welch and the Brown-Forsythe tests provide a very robust assessment of the differences between the neighborhood means.

5.3.2 Examining the Variations for Betweenness Centralities for Neighborhoods

The set null hypothesis for the betweenness centrality index was tested using the ONE-anova statistical tool. The Welch and the Brown-Forsythe tests were used principally for the test because unequal variances and unequal sample sizes were assumed. The betweenness centrality as one of the measures of variations in accessibility has null hypothesis denoted by $H_{B\mu}$ and the mean of the betweenness centrality for each neighborhood is represented by B_{μ}

H_{B0} = Namazgah $_{B\,\mu}$ = Yenigun $_{B\,\mu}$ = Bahcelerarasi $_{B\,\mu}$ = Ataturk $_{B\,\mu}$ = Dokuz Eylul $_{B\,\mu}$ = Ugur $_{B\,\mu}$ = Camlicay $_{B\,\mu}$ = Ataturk $_{B\,\mu}$ = Yildiz $_{B\,\mu}$ = Onur $_{B\,\mu}$ = Altinordu $_{B\,\mu}$

The alternative hypothesis is represented as follows

H_{B1} = Namazgah $_{B\,\mu}$ ≠ Yenigun $_{B\,\mu}$ ≠ Bahcelerarasi $_{B\,\mu}$ ≠ Ataturk $_{B\,\mu}$ ≠ Dokuz Eylul $_{B\,\mu}$ ≠ Ugur $_{B\,\mu}$ ≠ Camlicay $_{B\,\mu}$ ≠ Ataturk $_{B\,\mu}$ ≠ Yildiz $_{B\,\mu}$ ≠ Onur $_{B\,\mu}$ ≠ Altinordu $_{B\,\mu}$

Table 5.8 ANOVA for betweenness centrality index in the neighborhoods

ONE- WAY ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Betweenness	Between Groups	898044010027.595	10	89804401002.759	199.563	0.000
	Within Groups	1846371936274.186	4103	450005346.399		
	Total	2744415946301.780	4113			

Table 5.9 Robust test of Equality of means using Welch and Brown-Forsythe tests

Robust Tests of Equality of Means					
		Statistic[a]	df1	df2	Sig.
Betweenness	Welch	363.395	10	481.426	0.000
	Brown-Forsythe	1087.323	10	2203.533	0.000
a. Asymptotically F distributed.					

The test signifies that there are significance differences between the neighborhood means. H_{B1} is accepted and H_{B0} is rejected. The one-way anova tests conducted suggest statistically that at [F (10, 4103) = 199.663 at $\alpha = 0.05$] there exist statistically significant differences between the neighborhood means for how "between" the buildings are on a street network at a radius of 600 meters from each building in the neighborhoods. The alternative hypothesis is accepted based on the test statistics of the Welch and Brown-Forsythe results.

5.3.3 Post hoc Analysis of the Betweenness Centrality for the Neighborhoods

The Games-Howell comparisons of the means was undertaken to determine which of the neighborhoods in the city of Izmir have statistical accessibility differential significance from the others. The analysis was conducted using at $\alpha = 0.05$ for the significance in SPSS. A pair-wise comparison of the neighborhoods has been conducted and the results are displayed below. The comparison with a significant statistical value has been denoted by 1 and the comparison without statistical significance has been represented by 0 at $\alpha = 0.05$. See Appendix 5.1 for Game-Howells multiple comparisons results.

Table 5.10 Games-Howell pair-wise comparison for betweenness centrality index, where 1 represents statistical significance and 0 represents statistical insignificance at α = 0.05 in terms of differences and similarities respectively for the neighborhoods.

Neighborhoods	Yildiz	Onur	Camlicay	Ugur	Altinordu	Ataturk	Namazgah	Bahcelerarasi	Dokuz Eylul	Ataturk	Yenigun
Yildiz	--										
Onur	1	--									
Camlicay	1	1	--								
Ugur	1	1	1	--							
Altinordu	1	1	1	1	--						
Ataturk (Cigli)	1	1	1	0	1	--					
Namazgah	1	1	1	0	1	0	--				
Bahcelerarasi	1	1	1	0	1	0	0	--			
Dokuz Eylul	1	1	1	1	1	1	1	1	--		
Ataturk (Narlidere)	1	1	0	1	1	1	0	1	1	--	
Yenigun	1	1	1	1	0	1	1	1	1	1	--

Pair-wise comparisons of the neighborhood betweenness means' showing the statistically significant differences between neighborhoods. 1 represents statistical significance and 0 represents statistical insignificance at α = 0.05 respectively. There is statistically significant differences between the neighborhoods using the Games-Howell multiple comparisons at α = 0.05. Some neighborhood pairs have similarities in relation to the betweenness centrality calculated as presented in Table 5.10. There exist similarities between some pairs of neighborhoods such as (Ataturk-Narlidele: Camlicay), (Ataturk-Narlidele: Namazga), (Ataturk-Cigli: Ugur), (Namazgah: Bahcelerarasi) as can be observed from Table 5.10.

5.4 Accessibility Variations based on Closeness Centrality Index

The closeness centrality index can be loosely explained as how close buildings in the neighborhoods are, within a defined threshold on a spatial street network. The Closeness centrality for the neighborhoods was determined for the buildings within a 600 meter radius from each building in each neighborhood. The mean of each neighborhood for the Closeness centrality is defined in the table below.

Table 5.11 Descriptive statistics of closeness centrality for the representative neighborhoods of Izmir, Turkey

		Number or Buildings	Mean	Std. Deviation
Closeness Centrality	Yildiz	1158	0.000	0.000
	Onur	1517	0.000	0.000
	Camlicay	198	0.005	0.027
	Ugur	34	0.002	0.006
	Altinordu	95	0.051	0.312
	Ataturk (Cigli)	87	0.005	0.012
	Namazgah	53	0.004	0.007
	Bahcelerarasi	84	0.005	0.009
	Dokuz Eylul	470	0.011	0.145
	Ataturk (Narlidere)	341	0.002	0.006
	Yenigun	77	0.001	0.002
	Total	4114	0.0031	0.069

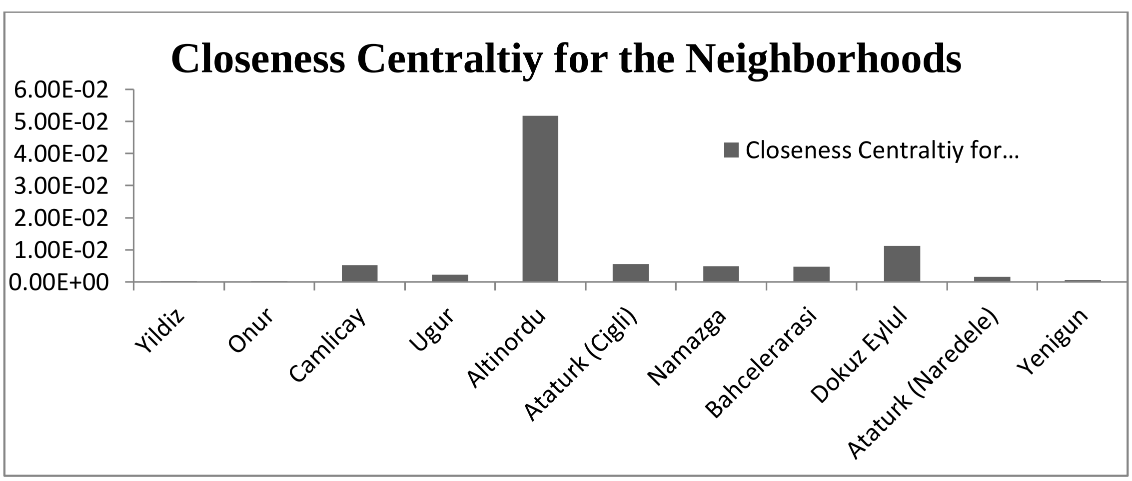

Figure 5.3 Statistical means determined for the closeness centrality index for the neighborhoods.

5.4.1 Test of Homogeneity of Variance for the Closeness Centrality

The homogeneity of variance test for the closeness centrality of the neighborhood portrayed that there is significant heterogeneity in the variances of the Closeness centrality. The test was conducted at $\alpha = 0.05$ for the determination of the assumption of homogeneity of variance.

Table 5.12 Homogeneity test of variance for the means for closeness centrality

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Closeness	21.560	10	4103	0.000

The results indicated that there is heterogeneity in the variances of the closeness index determined on the street networks of the neighborhoods. This permitted the use of Welch and Brown-Forsythe tests for the null hypothesis for the closeness centrality index for the neighborhoods means.

5.4.2 Examining the Variations for Closeness Centralities for Neighborhoods

One of the means of measuring the accessibility differences is the use of the closeness centrality values for the buildings in the neighborhoods for this study. The closeness measures for the neighborhoods were obtained from each building to other surrounding buildings on the street networks of the respective neighborhoods. A 600-meter radius for each building was used for the calculations of accessibility within each neighborhood on the spatial street networks. The means of these neighborhoods are tested using ANOVA statistics tools in conjunction with Welch and Brown-Forsythe tests of variations in means. The null and the alternative hypothesis for the means of neighborhoods are defined below:

H_{0C} = Namazgah $_{C\ \mu}$ = Yenigun $_{C\ \mu}$ = Bahcelerarasi $_{C\ \mu}$ = Ataturk $_{C\ \mu}$ = Dokuz Eylul $_{C\ \mu}$ = Ugur $_{C\ \mu}$ = Camlicay $_{C\ \mu}$ = Ataturk $_{C\ \mu}$ = Yildiz $_{C\ \mu}$ = Onur $_{C\ \mu}$ = Altinordu $_{C\ \mu}$

Where H_{0C} is the null hypothesis of closeness centrality for the neighborhoods and the C $_{\mu}$ is the mean of the closeness values for each neighborhood. The alternative hypothesis for the closeness centrality measure is denoted as H_{AC};

H_{AC} = Namazgah $_{C\ \mu}$ ≠ Yenigun $_{C\ \mu}$ ≠ Bahcelerarasi $_{C\ \mu}$ ≠ Ataturk $_{C\ \mu}$ ≠ Dokuz Eylul $_{C\ \mu}$ ≠ Ugur $_{C\ \mu}$ ≠ Camlicay $_{C\ \mu}$ ≠ Ataturk $_{C\ \mu}$ ≠ Yildiz $_{C\ \mu}$ ≠ Onur $_{C\ \mu}$ ≠ Altinordu $_{C\ \mu}$

Table 5.13 One-way anova for the test of variations between the means for the closeness centrality for the neighborhoods

ONE-WAY ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Closeness	Between Groups	0.285	10	0.029	6.101	0.000
	Within Groups	19.190	4103	0.005		
	Total	19.475	4113			

Table 5.14 Welch and Brown-Forsythe robust test of equality of means for the closeness centrality measure for accessibility differences in the neighborhoods at α = 0.05

Robust Tests of Equality of Means					
		Statistic[a]	df1	df2	Sig.
Closeness	Welch	132.271	10	370.984	0.000
	Brown-Forsythe	2.477	10	135.411	0.009
a. Asymptotically F distributed.					

The results of the one-way anova for the test of equality means for the closeness centrality at [F (10, 4103) = 6.101 at α = 0.05)] suggest that statistically there are significant differences between the means of the neighborhoods in relation to closeness centrality accessibility measure. The F-statistics therefore, is not a good measure in terms of robustness for the test of differences between the means because of the violation of the homogeneity assumption. The Welch and the Brown-Forsythe (significance at 0.000) suggest statistically that there are significant differences between the means of the neighborhoods with regards to closeness centrality.

5.4.3 Post Hoc Analysis of the Closeness Centrality for the Neighborhoods

The unequal variance and the violation of the homogeneity of variance assumption permitted the use of the Games-Howell post hoc analysis of the means. The comparison was made between all the pairs of the neighborhood means concerning the Closeness of the building on the network of streets. The alpha level was set at α = 0.05 and statistical significance between pairs of neighborhood was represented by 1 and the statistically insignificant comparison between any pairs has been represented by 0. See Appendix 5.1 for details of the multiple comparisons

The results of the Games-Howell statistics signifies that generally in the context of accessibility in neighborhoods based on closeness centrality, there are no statistically significance between the neighborhoods in the city.

Table 5.15 Games-Howell pair-wise comparison for closeness centrality index, where 1 represents statistical significance and 0 represents statistical insignificance at α = 0.05 in terms of differences and similarities respectively for the neighborhoods.

Neighborhoods	Yildiz	Onur	Camlicay	Ugur	Altinordu	Ataturk	Namazgah	Bahcelerarasi	Dokuz Eylul	Ataturk	Yenigun
Yildiz	--										
Onur	1	--									
Camlicay	0	0	--								
Ugur	0	0	0	--							
Altinordu	0	0	0	0	--						
Ataturk (Cigli)	1	1	0	0	0	--					
Namazgah	1	1	0	0	0	0	--				
Bahcelerarasi	1	1	0	0	0	0	0	--			
Dokuz Eylul	0	0	0	0	0	0	0	0	--		
Ataturk (Narlidere)	1	1	0	0	0	0	0	0	0	--	
Yenigun	0	0	0	0	0	1	1	1	0	0	--

The post hoc analysis (Table 5.15) for the closeness index indicates that, generally, there are no statistically significant difference between most of the neighborhood pairs. The pairs of neighborhoods showing significant differences in statistical terms are (Ataturk-Narlidele: Onur), (Ataturk-Narlidele: Yildiz), (Namazgah: Yildiz), (Namazgah: Onur) and all the pairs of neighborhoods represented by 1 in the Table 5.15.

5.5 Accessibility Variations based on Gravity Centrality Index

The gravity centrality is an improvement over the reach centrality considering the distance decay effect of the moving from one building on the network of streets to other buildings within a specified threshold. The reach centrality index only measures the count of buildings on a network of streets but the gravity centrality index incorporates the distance that is covered to reach other buildings in addition to the count. This is calculated within a defined threshold or walking distance for the buildings. The gravity explains the number of buildings that are reached by a particular building with a 600 meters radius within a neighborhood but taking into account the distance it takes to move between the two buildings in question.

Table 5.16 Descriptive statistics of the gravity centrality index for the neighborhoods

		Number of Buildings	Mean	Std. Deviation
Gravity	Yildiz	1158	358.012	97.728
	Onur	1517	507.687	123.040
	Camlicay	198	48.275	34.701
	Ugur	34	12.199	6.417
	Altinordu	95	23.729	14.900
	Ataturk (Cigli)	87	5.458	3.877
	Namazgah	53	7.914	3.722
	Bahcelerarasi	84	8.329	5.748
	Dokuz Eylul	470	30.397	20.704
	Ataturk (Narlidere)	341	36.109	20.447
	Yenigun	77	30.078	7.234
	Total	4114	298.365	225.571

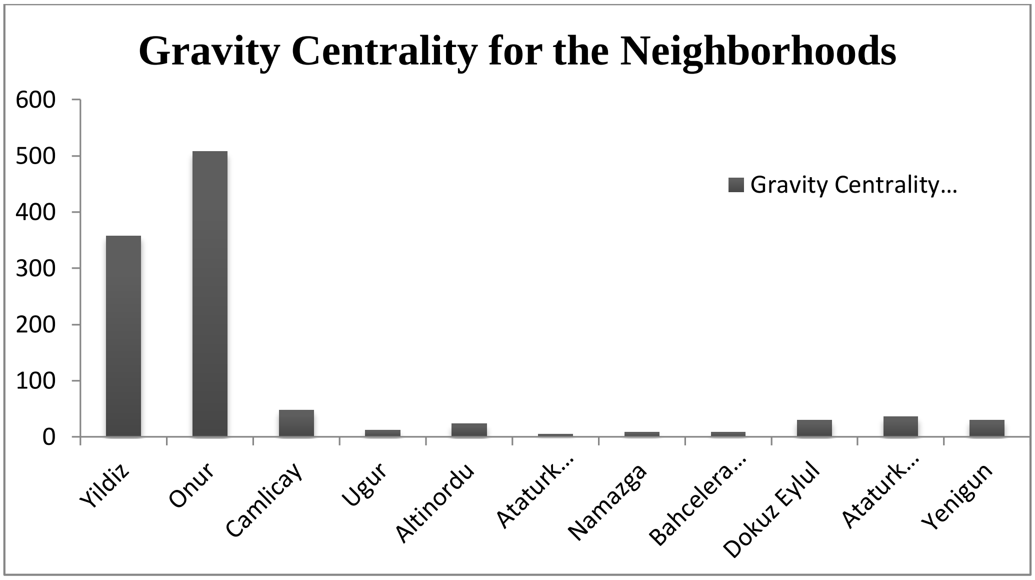

Figure 5.4 Statistical means determined for the gravity centrality index for the neighborhoods

5.5.1 Test of Homogeneity of Variance for the Gravity Centrality Index

The homogeneity of variance test conducted showed that there is significant heterogeneity in the variance of the means for closeness centrality index of the neighborhoods. The results as conducted at $\alpha = 0.05$ provided the following the results.

Table 5.17 Homogeneity assumption test for ANOVA at $\alpha = 0.05$ and the assumption has been violated

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Gravity	249.975	10	4103	0.000

The Welch and the Brown-Forsythe robust test of equality of means were used to test the null hypothesis and the alternative hypothesis for the study. The heterogeneity of the variance and the unequal sample sizes warranted the use of the F-statistics, statistically misleading for the tests. The Welch and the Brown-Forsythe robust test were used for the test of the equality of means for the gravity centrality index for the neighborhoods.

5.5.2 Examining the Variations for Gravity Centrality Index for Neighborhoods

The gravity centrality of the buildings in neighborhoods determined and was tested using the one-way anova statistical tool. The means of the neighborhoods in relation to gravity were tested for equality between the neighborhoods. The null and alternative hypotheses formulated are stated below.

The gravity centrality is the denoted by G, µ is mean of the groups and the $H_{G\,\mu}$ is the null hypothesis of the gravity centrality:

H_{0G} = Namazgah $_{G\,\mu}$ = Yenigun $_{G\,\mu}$ = Bahcelerarasi $_{G\,\mu}$ = Ataturk (Cigli) $_{G\,\mu}$ = Dokuz Eylul $_{G\mu}$ = Ugur $_{G\mu}$ = Camlicay $_{G\mu}$ = Ataturk (Narlidere) $_{G\,\mu}$ = Yildiz $_{G\,\mu}$ = Onur $_{G\,\mu}$ = Altinordu $_{G\mu}$

The alternative hypothesis for the Gravity centrality measure is denoted as follows; Where H_{AG} is the alternative hypothesis for gravity centrality measure

H_{AG} = Namazgah $_{G\,\mu}$ ≠ Yenigun $_{G\,\mu}$ ≠ Bahcelerarasi $_{G\,\mu}$ ≠ Ataturk $_{G\,\mu}$ ≠ Dokuz Eylul $_{G\,\mu}$ ≠ Ugur $_{G\,\mu}$ ≠ Camlicay $_{G\,\mu}$ ≠ Ataturk $_{G\,\mu}$ ≠ Yildiz $_{G\,\mu}$ ≠ Onur $_{G\,\mu}$ ≠ Altinordu $_{G\,\mu}$

Table 5.18 One-way anova of the difference between means of the neighborhoods in terms of gravity centrality

ANOVA						
		Sum of Squares	Df	Mean Square	F	Sig.
Gravity	Between Groups	174667718.117	10	17466771.812	2070.532	0.000
	Within Groups	34612434.626	4103	8435.885		
	Total	209280152.743	4113			

Table 5.19 Robust test of equality of means of gravity centrality index for the neighborhoods

Robust Tests of Equality of Means					
		Statistic[a]	df1	df2	Sig.
Gravity	Welch	3991.565	10	470.173	0.000
	Brown-Forsythe	9341.336	10	3208.767	0.000
a. Asymptotically F distributed.					

The robust test of equality of means for gravity centrality per the neighborhoods means' suggest that, statistically there are significant differences between the neighborhood means at $\alpha = 0.05$. The results from the robust tests of equality of means serve as the basis for comparing statistical significance for gravity centrality in the representative neighborhoods. The null hypothesis H_{G0} is rejected and the alternative hypothesis H_{G1} is accepted for the gravity centrality accessibility difference in the neighborhoods. There is a statistically significant variation in the means of the neighborhoods with respect to gravity centrality measure.

5.5.3 Post Hoc Analysis of the Gravity Centrality for the Neighborhoods

The gravity centrality means of the neighborhoods were compared to each other using the Games-Howell multiple comparisons statistical tool. The pair-wise comparison was made between all the pairs of neighborhoods in terms of their gravity centrality means. The comparison was undertaken at $\alpha = 0.05$ where pairs with significant statistical differences in their means were denoted by '1' and comparisons with statistically insignificant differences in their means were represented by '0'. See Appendix 5.1 for details of the multiple comparisons

Table 5.20 Games-Howell pair-wise comparison for gravity centrality index, where 1 represents statistical significance and 0 represents statistical insignificance at α = 0.05 in terms of differences and similarities respectively for the neighborhoods.

Neighborhoods	Yildiz	Onur	Camlicay	Ugur	Altinordu	Ataturk	Namazgah	Bahcelerarasi	Dokuz Eylul	Ataturk	Yenigun
Yildiz	--										
Onur	1	--									
Camlicay	1	1	--								
Ugur	1	1	1	--							
Altinordu	1	1	1	1	--						
Ataturk (Cigli)	1	1	1	1	1	--					
Namazgah	1	1	1	0	1	1	--				
Bahcelerarasi	1	1	1	0	1	1	0	--			
Dokuz Eylul	1	1	1	1	1	1	1	1	--		
Ataturk (Narlidere)	1	1	1	1	1	1	1	1	1	--	
Yenigun	1	1	1	1	1	1	1	1	0	1	--

Pair-wise comparisons of neighborhood gravity centrality means using the Games-Howell post hoc analysis for unequal variance assumed at α = 0.05. The 1 and 0 represents statistical significance and insignificance of the comparisons at α = 0.05.

Generally comparing the statistical differences between the neighborhoods showed that there are significant difference between most the neighborhoods at α = 0.05. Accessibility variances between the neighborhoods in terms of gravity centrality measure show that there are significant differences between and among the neighborhoods statistically.

5.6 Accessibility Variations based on Straightness Centrality Index

The straightness measure captures the extent of a networking route from a node to all other nodes in the graph of networks considering how the route deviates from a virtual straight route. The straightness measure measures how central a feature based on the idea that it is more reachable directly by other features in a network (Porta et al, 2005). In the study, the straightness is captured from the buildings to other surrounding buildings on a 600 meter walking distance, serving as the threshold. The straightness centrality index measures how buildings on the network can be reached directly from other buildings compared to a Euclidean distance. The means of Straightness captured form the neighborhoods are displayed below.

Table 5.21 Descriptive statistics of the Straightness centrality for the neighborhoods

		Number of Buildings	Mean	Std. Deviation
Straightness	Yildiz	1158	537.876	155.092
	Onur	1517	801.541	179.075
	Camlicay	198	52.186	37.432
	Ugur	34	11.624	5.756
	Altinordu	95	24.661	15.792
	Ataturk	87	7.199	5.507
	Namazgah	53	7.642	3.660
	Bahcelerarasi	84	10.541	7.675
	Dokuz Eylul	470	35.351	25.702
	Ataturk	341	35.623	19.622
	Yenigun	77	31.592	9.090
	Total	4114	458.187	357.235

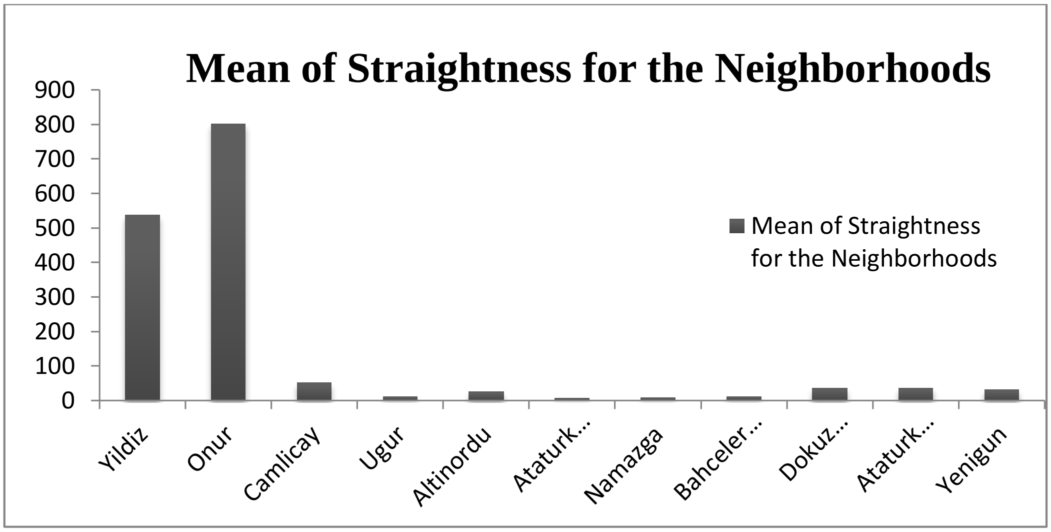

Figure 5.5 Statistical means determined for the straightness centrality index for the neighborhoods

5.6.1 Test of Homogeneity of Variance for the Straightness Centrality

The assumption for one-way anova was evaluated for the straightness centrality for the neighborhoods. The test was conducted at $\alpha = 0.05$ using the SPPS package. The result of the test is displayed in the table below.

Table 5.22 Homogeneity of variances of the straightness centrality index for the neighborhoods

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Straightness	259.810	10	4103	0.000

The homogeneity assumption for the one-way anova test of equality of the means was violated at significance of 0.000 at $\alpha = 0.05$. The F-statistics could not be used as the statistical basis to compare the equality of the means. Another factor that does not permit the use of the F-statistics in traditional one-way anova is the unequal sample sizes of the neighborhood buildings. The Welch and the Brown-Forsythe test were used as the basis to compare the equality of the means due to the robustness of the tests.

5.6.2 Examining the Variations for Straightness Centrality Means for Neighborhoods

The null and alternative hypotheses set are tested using the one-way anova but more relevance is placed on the robust test of equality of means using the Welch and Brown-Forsythe tests. The null hypothesis of the straightness centrality is denoted by H_{0S} and the mean of the each neighborhood is represented by S_{μ}. The equation is given as follows;

H_{0S} = Namazgah $_{S\ \mu}$ = Yenigun $_{S\ \mu}$ = Bahcelerarasi $_{S\ \mu}$ = Ataturk $_{S\ \mu}$ = Dokuz Eylul $_{S\ \mu}$ = Ugur $_{S\ \mu}$ = Camlicay $_{S\ \mu}$ = Ataturk $_{S\ \mu}$ = Yildiz $_{S\ \mu}$ = Onur $_{S\ \mu}$ = Altinordu $_{S\ \mu}$

The alternative hypothesis for the straightness centrality for the study is shown as

H_{AS} = Namazgah $_{S\ \mu}$ ≠ Yenigun $_{S\ \mu}$ ≠ Bahcelerarasi $_{S\ \mu}$ ≠ Ataturk $_{S\ \mu}$ ≠ Dokuz Eylul $_{S\ \mu}$ ≠ Ugur $_{S\ \mu}$ ≠ Camlicay $_{S\ \mu}$ ≠ Ataturk $_{S\ \mu}$ ≠ Yildiz $_{S\ \mu}$ ≠ Onur $_{S\ \mu}$ ≠ Altinordu $_{S\ \mu}$ where H_{S1} is the Alternative hypothesis

Table 5.23 One-way anova for the test of equality of means of the Straightness centrality for the representative neighborhoods of Izmir at α = 0.05.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Straightness	Between Groups	447687535.890	10	44768753.589	2379.311	0.000
	Within Groups	77201407.509	4103	18815.844		
	Total	524888943.399	4113			

Table 5.24 Robust test of equality of means using the Welch and Brown-Forsythe tests at α = 0.05.

Robust Tests of Equality of Means					
		Statistic[a]	df1	df2	Sig.
Straightness	Welch	4320.500	10	482.420	0.000
	Brown-Forsythe	11120.806	10	3004.360	0.000
a. Asymptotically F distributed.					

The Welch and the Brown-Forsythe robust test of equality of means indicated that there are statistically significant differences between the neighborhoods means with respect to Straightness centrality. The null hypothesis H_{0S} is rejected at Welch and

Brown Forsythe equal to 0.000 at α = 0.05. The alternative hypothesis, H_{AS}, is accepted for the comparison of the equality of means for the straightness centrality for the buildings in the neighborhoods. There was statistically significant difference between the means of the neighborhoods for the straightness centrality index.

5.5.3 Post hoc analysis of the straightness centrality for the neighborhoods

The unequal variance and the violation of the homogeneity test permitted the use of the Games-Howell multiple comparisons test of significance between all the pairs of the neighborhoods. The pair-wise test was conducted at α = 0.05 for all the comparisons using the Games-Howell post hoc analysis tool in SPSS. The comparisons with statistical significance are represented by '1' and the comparisons with no statistical significance are denoted by '0'.

Table 5.25 Games-Howell pair-wise comparison for straightness centrality index, where 1 represents statistical significance and 0 represents statistical insignificance at α = 0.05 in terms of differences and similarities respectively for the neighborhoods.

Neighborhoods	Yildiz	Onur	Camlicay	Ugur	Altinordu	Ataturk	Namazgah	Bahcelerarasi	Dokuz Eylul	Ataturk	Yenigun
Yildiz	--										
Onur	1	--									
Camlicay	1	1	--								
Ugur	1	1	1	--							
Altinordu	1	1	1	1	--						
Ataturk (Cigli)	1	1	1	1	1	--					
Namazgah	1	1	1	1	1	0	--				
Bahcelerarasi	1	1	1	0	1	0	0	--			
Dokuz Eylul	1	1	1	1	1	1	1	1	--		
Ataturk (Narlidere)	1	1	1	1	1	1	1	1	0	--	
Yenigun	1	1	1	1	1	1	1	1	0	0	--

Games-Howell post hoc test showing the level of significance between pairs of neighborhood Straightness centrality means at α = 0.05. '1' and '0' represents statistical significance and insignificance at α = 0.05. The generic view of the results indicates that there are statistically significant differences in the pairs of the neighborhoods with relevance to Straightness centrality. There are statistically significant differences in the neighborhoods in the context of how buildings are directly reached on the street networks when routes are considered as euclidean distance. See Appendix 5.1 for details of the multiple comparisons.

The post hoc analysis of the centrality-based accessibility showed statistically the similarities between some pairs of neighborhoods and the differences in other pairs of neighborhoods.

CHAPTER SIX
DISCUSSION AND CONCLUSION

This study focused on the measurement of the levels of variations in the residential neighborhoods of Izmir with geographic information system. The aim of the research was to examine the relationship between residential neighborhoods in terms of the spatial organization and socio-economic characteristics. The measurement of accessibility in the residential neighborhoods of Izmir, Turkey, was conducted based on the location of buildings (land use) and the transport systems in the residential neighborhoods after a classification of the residential neighborhoods using socio-economic factors. The purpose of this research was to explore the gap that has been left unattended in the study of variations in urban residential areas with much emphasis on the spatial structure component of the urban structure.

The classification of urban areas into distinguishable groups was conducted by several researchers without considering the spatial components of the neighborhoods. In previous studies such as the social areas theory, the classification of the urban areas into the so called social areas neglected spatial component of the urban structure (Bell, 1953; Van Arsdol et al, 1958; Anderson & Egeland, 1961). Some urban researchers in previous studies approximated the relationship between the socio-economic and spatial structure by considering the abstract relationships that exist in the urban areas, using the space syntax accessibility measure (Omer & Goldblatt, 2011). Literature revealed that some studies of the relationship between urban spatial environment and their relationship was conducted based on the perceptions and view of the inhabitants on the urban structure, without considering an objective measure of the impact of the urban spatial structure (Haggerty,1982).

There have been different aspects of the study of urban spatial structure in connection to the social, demographic and economic characteristics of residents in residential and urban neighborhoods (Burgess, 1925; Homer, 1939; Harris & Ullman, 1945; Mack &

McElrath, 1964; McElrath, 1965; Greenwald & Boarnet 2000; Camagni et al, 2002; Grazi et al, 2008; Omer & Ram, 2011; Cohen et al, 2013). These studies approximated the spatial structural components with a biased outlook of the urban geographic space without an objective observation of the components, the structure, the form and the functionality of the urban spatial structure.

There has been a concerted effort by urban researchers to establish a relationship between social processes and the urban spatial structure but these provided conclusions and theories which were not easy to understand, complex and impracticable in reality.

This research is an empirical examination of the differences that exist not exclusively in the socio-economic sense but the urban spatial differences as well. This empirical research contains two significant components that complement each other in the study of urban structure variations. The urban structure is categorized into two main components; the social processes and the spatial structure.

The first part of the study involved the classification of the residential neighborhoods that form Izmir, Turkey, into naturally formed groups. The result of a cluster analysis was that eleven distinguishable and unique groups were formed. These groups represented how the urban structure is divided into various groups based on some socio-economic indicators. This analysis showed that there are differences in the socio-economic components of the urban structure. Eleven neighborhoods were drawn from the different neighborhood groups referred to as clusters. The selected neighborhoods were Yildiz(Buca district), Onur(Balcova district), Camlikoyu(Guzelbece district), Ugur(Konak district), Altinordu(Konak district), Ataturk(Cigli district), Namazgah(Konak district), Bahcelerarasi(Balcova district), Dokuz Eylul(Gaziermir district), Ataturk(Narlidele district) and Yenigun(Konak district) all in Izmir Province, Turkey.

The thrust of this thesis involved the inclusion of the spatial variations in the urban variation studies. Geographic information system was used to measure the differences in accessibility using the buildings and the street network in each neighborhood. Network-based centrality indices served as the benchmark to measure the potential of interaction centered on the spatial organizations of the neighborhoods as well as measure the variances in accessibility between the neighborhoods. The streets were converted into a spatial network of streets and different network centrality measures were used to measure the differences in accessibility for the neighborhoods. Accessibility of each building was determined using different network based accessibility centrality indices.

The reach, betweenness, gravity, closeness and straightness centrality tools were used to capture the levels of accessibility in each representative neighborhood.

In a bid to measure the differences in accessibility per each spatial structure of the neighborhoods, a One-way analysis of variance (ANOVA) was used. Different hypotheses were formulated to test the differences in the neighborhoods in the context of the centrality indices. The results indicated that, statistically, there exist significant differences in the accessibility levels in Izmir, Turkey.

Understanding the level of difference between individual neighborhoods, the Games-Howell pair-wise comparison test was used to statistically test the differences between neighborhoods with regards to the accessibility indices. The results indicated that, statistically, there are significant differences in neighborhoods with regards to four centrality accessibility indices. Generally, there are significant statistical differences between neighborhoods considering the reach, gravity, straightness and betweenness centrality. The closeness centrality yielded insignificant statistical differences between the neighborhoods.

The results of this study provide the grounds for the conclusion that, the accessibility levels at the neighborhood level varies with the social and economic characteristics. The neighborhoods selected vary from each other based on selected social and economic indicators. Similarities between some of the neighborhoods with respect to closeness index indicates that although there are differences in social and economic factors of the respective neighborhoods they are similar with respect to spatial organization.

Socio-economic classification studies in urban settlements and cities conducted (Burgess & Park, 1925; Hoyt, 1939; Bell 1953; Van Arsdol et. al, 1958; Anderson & Egeland, 1961; Mark & Mc Elrath, 1964; Mc Elrath, 1965; Abu-Lughod, 1969) pay little or no importance to the differences in spatial organization of neighborhoods. Subsequently, studies conducted with the view to understanding the urban structure relationships with socio-economic are very minimal (Hansen, 1959; Perkins, 1962; Alex et al, 1998; Boarnet & Greenwald, 2000; Roberto et al, 2002; Grazi et al, 2008; Adolphson, 2011; Cohen et al, 2013).

This study was conducted to throw more light on the relationship between socio-economic processes and the urban structure of residential neighborhoods. The results of the study indicates that differences in socio-economic factors generally influence differences in the spatial structure of residential neighborhoods.

The results of this study, further, affirms the suggestion that, there could be differences in social and economic characteristics of neighborhoods but the spatial structure of neighborhoods can be similar, the case of closeness centrality index for the neighborhoods. Consequently, variations in neighborhood socio-economic factors, could vary with the spatial organization structure of residential neighborhoods, the case of reach, gravity, betweenness and straightness indices analysis for the residential neighborhoods in Izmir, Turkey. Network-based centrality measures and socio-economic classification methods can provide a practical and theoretical basis in urban comparative studies.

The formation of policies and development plans should focus not only on the socio-economic variations but also on the spatial structure which shapes the lives of the inhabitants. The ease at which people traverse the residential neighborhoods and the cities to other areas provides a base to measure differences in accessibility.

In future the measure of accessibility can be based on the physical accessibility to specific infrastructure. For instance schools, hospitals, industrial areas, shops, malls, recreational facilities, market centres and other land uses. This will provide very pragmatic and practical methods for comparative urban studies when complemented with socio-economic indicators. This will help identify pragmatic and theoretically supported methods that can be used to establish the relationship between social processes and urban settlement structure.

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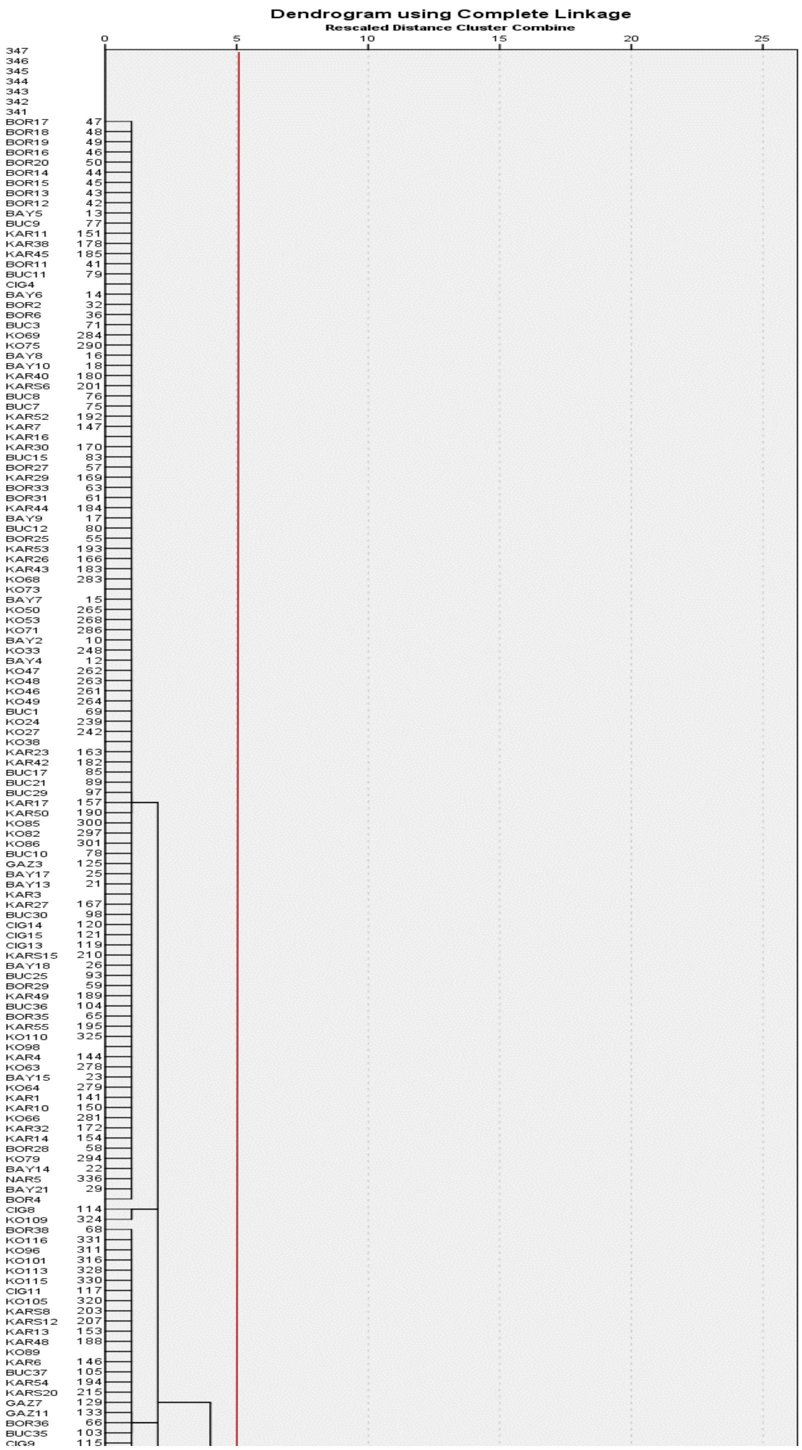
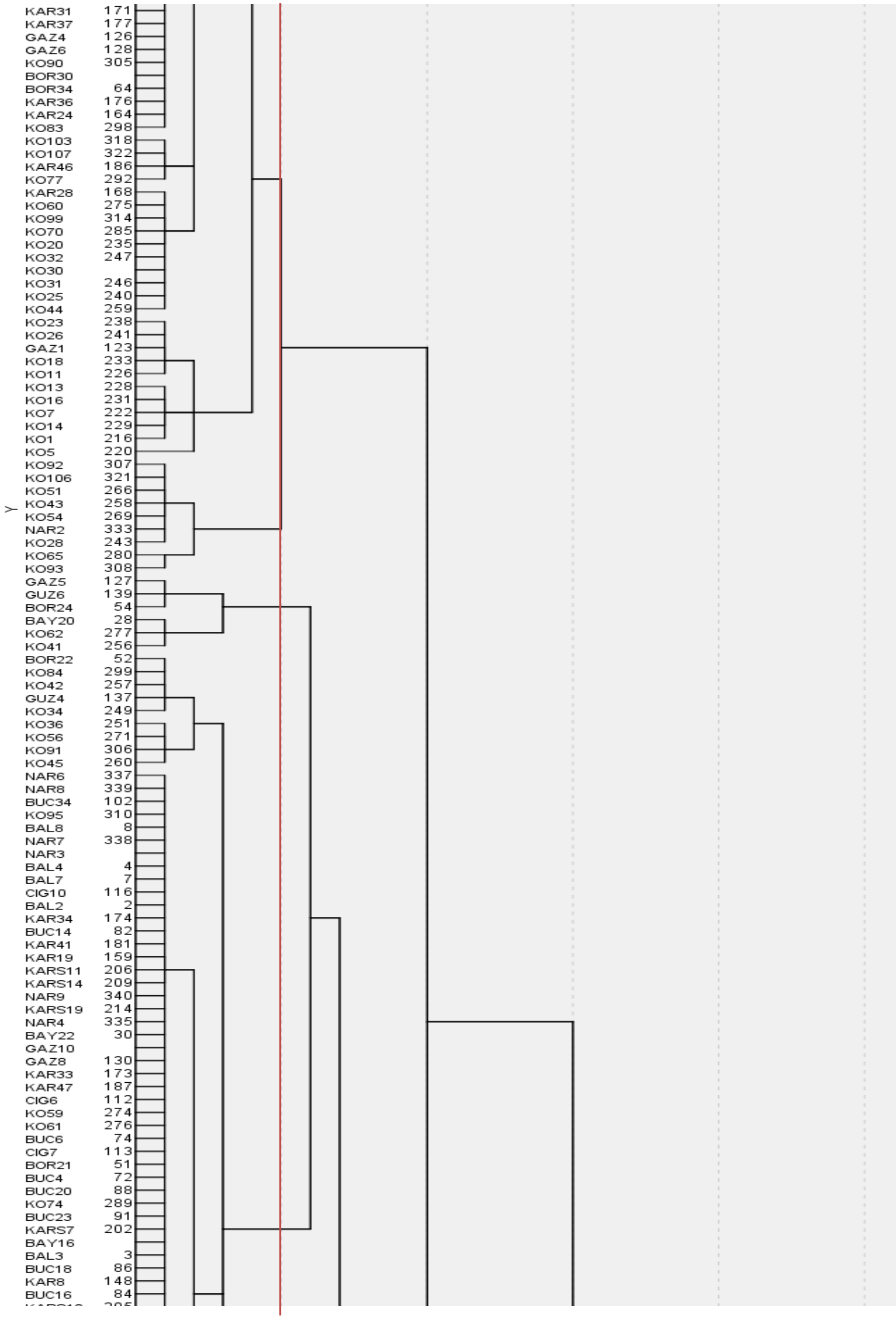
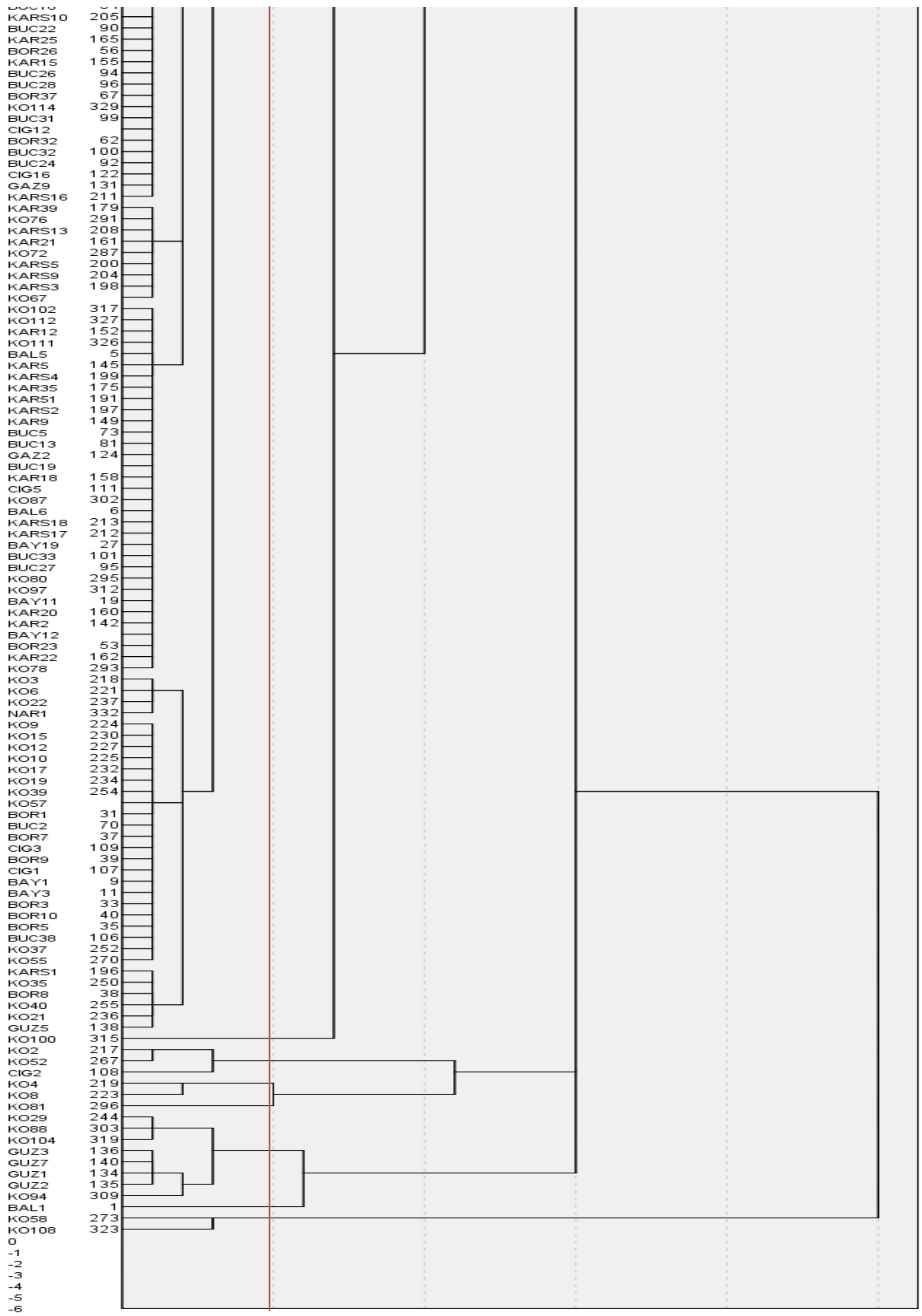
APPENDICES

APPENDIX 4.1 DENDROGRAM OF THE CLUSTER ANALYSIS



DENDROGRAM…..………………CONTINUED





APPENDIX 4.1 NEIGHBORHOOD CODES DESIGNATED TO THE NEIGHBORHOODS

NEIGHBORHOOD	NEIGHBORHOOD CODES	NEIGHBORHOODS	NEIGHBORHOOD CODES
BAHÇELERARASI	BAHÇELERARASI	GÜRPINAR	BOR11
ÇETİN EMEÇ	BAL2	IŞIKLAR	BOR12
EĞİTİM	BAL3	IŞIKLAR	BOR13
FEVZİ ÇAKMAK	BAL4	IŞIKLAR	BOR14
İNCİRALTI	BAL5	IŞIKLAR	BOR15
KORUTÜRK	BAL6	IŞIKLAR	BOR16
ONUR	BAL7	IŞIKLAR	BOR17
TELEFERİK	BAL8	IŞIKLAR	BOR18
ADALET	BAY1	IŞIKLAR	BOR19
ALPASLAN	BAY2	IŞIKLAR	BOR20
BAYRAKLI	BAY3	İNÖNÜ	BOR21
CENGİZHAN	BAY4	KARACAOĞLAN	BOR22
ÇAY	BAY5	KAZIM DİRİK	BOR23
ÇİÇEK	BAY6	KEMALPAŞA	BOR24
DOĞANÇAY	BAY7	KIZILAY	BOR25
EMEK	BAY8	KOŞUKAVAK	BOR26
FUAT EDİP BAKSI	BAY9	MERİÇ	BOR27
GÜMÜŞPALA	BAY10	MERKEZ	BOR28
MANAVKUYU	BAY11	MEVLANA	BOR29
MANSUROĞLU	BAY12	NALDÖKEN	BOR30
MUHİTTİN ERENER	BAY13	RAFETPAŞA	BOR31
NAFIZ GÜRMAN	BAY14	SERİNTEPE	BOR32
ONUR	BAY15	TUNA	BOR33
OSMANGAZİ	BAY16	ÜMİT	BOR34
POSTACILAR	BAY17	YEŞİLÇAM	BOR35
REFİK ŞEVKET İNCE	BAY18	YEŞİLOVA	BOR36
SOĞUKKUYU	BAY19	YILDIRIM BEYAZIT	BOR37
TURAN	BAY20	ZAFER	BOR38
YAMANLAR	BAY21	ADATEPE	BUC1
YETMİŞBEŞİNCİYIL	BAY22	AKINCILAR	BUC2
ATATÜRK	BOR1	ATATÜRK	BUC3
BARBAROS	BOR2	AYDOĞDU	BUC4
BİRLİK	BOR3	BARIŞ	BUC5
ÇAMKULE	BOR4	CUMHURİYET	BUC6
ÇINAR	BOR5	ÇAĞDAŞ	BUC7
DOĞANLAR	BOR6	ÇALDIRAN	BUC8
ERGENE	BOR7	ÇAMLIK	BUC9

NEIGHBORHOODS	CODES	NEIGHBORHOOD	CODES
ERZENE	BOR8	ÇAMLIKULE	BUC10
EVKA-3	BOR9	ÇAMLIPINAR	BUC11
GAZİOSMANPAŞA	BOR10	DİCLE	BUC12
DUMLUPINAR	BUC13	ATIFBEY	GAZ2
EFELER	BUC14	BEYAZEVLER	GAZ3
FIRAT	BUC15	BİNBAŞIREŞATBEY	GAZ4
GAZİLER	BUC16	DOKUZEYLÜL	GAZ5
GÖKSU	BUC17	EMREZ	GAZ6
GÜVEN	BUC18	GAZİ	GAZ7
HÜRRİYET	BUC19	GAZİKENT	GAZ8
İNKILAP	BUC20	IRMAK	GAZ9
İNÖNÜ	BUC21	SEVGİ	GAZ10
İZKENT	BUC22	YEŞİL	GAZ11
KARANFİL	BUC23	ATATÜRK	GUZ1
KOZAĞAÇ	BUC24	ÇAMLIÇAY	GUZ2
KURUÇEŞME	BUC25	ÇELEBİ	GUZ3
LALELİ	BUC26	KAHRAMANDERE	GUZ4
MENDERES	BUC27	MALTEPE	GUZ5
MURATHAN	BUC28	YAKA	GUZ6
MUSTAFA KEMAL	BUC29	YALI	GUZ7
SEYHAN	BUC30	ABDİ İPEKÇİ	KAR1
ŞİRİNKAPI	BUC31	ADNAN SÜVARİ	KAR2
VALİRAHMİBEY	BUC33	ALİ FUAT CEBESOY	KAR3
YAYLACIK	BUC34	ALİ FUAT ERDEN	KAR4
YENİGÜN	BUC35	ARAPHASAN	KAR5
YEŞİLBAĞLAR	BUC36	AŞIK VEYSEL	KAR6
YILDIZ	BUC37	AYDIN	KAR7
YİĞİTLER	BUC38	BAHAR	KAR8
AHMET TANER KIŞLALI	CIG1	BAHÇELİEVLER	KAR9
AYDINLIKEVLER	CIG3	BAHRİYE ÜÇOK	KAR10
BALATÇIK	CIG4	BARIŞ	KAR11
ÇAĞDAŞ	CIG5	BASINSİTESİ	KAR12
EGEKENT	CIG6	BOZYAKA	KAR13
EVKA 2	CIG7	CENNETÇEŞME	KAR14
GÜZELTEPE	CIG8	CENNETOĞLU	KAR15
İSTASYONALTI	CIG9	ÇALIKUŞU	KAR16
İZKENT	CIG10	DEVRİM	KAR17
KÖYİÇİ	CIG11	DOĞANAY	KAR18
KÜÇÜKÇİĞLİ	CIG12	ESENLİK	KAR19

NEIGHBORHOOD	CODES	NEIGHBORHOOD	CODES
MALTEPE	CIG13	ESENTEPE	KAR20
ŞİRİNTEPE	CIG14	ESENYALI	KAR21
UĞUR MUMCU	CIG15	FAHRETTİN ALTAY	KAR22
YENİ MAHALLE	CIG16	GAZİ	KAR23
AKTEPE	GAZ1	GENERAL ASIM GÜNDÜZ	KAR24
GENERAL KAZIM ÖZALP	KAR25	GONCALAR	KARS11
GÜLYAKA	KAR26	İMBATLI	KARS12
GÜNALTAY	KAR27	MAVİŞEHİR	KARS13
İHSAN ALYANAK	KAR28	NERGİZ	KARS14
KARABAĞLAR	KAR29	ÖRNEKKÖY	KARS15
KAZIM KARABEKİR	KAR30	ŞEMİKLER	KARS16
KİBAR	KAR31	TERSANE	KARS17
LİMONTEPE	KAR32	TUNA	KARS18
MALİYECİLER	KAR33	YALI	KARS19
METİN OKTAY	KAR34	YAMAÇ	KARS20
MUAMMER AKAR	KAR35	AKARCALI	KO1
OSMAN AKSUNER	KAR36	AKDENİZ	KO2
ÖZGÜR	KAR37	AKIN SİMAV	KO3
PEKER	KAR38	AKINCI	KO4
POLİGON	KAR39	ALİREİS	KO5
REFET BELE	KAR40	ALSANCAK	KO6
REİS	KAR41	ALTAY	KO7
SALİH OMURTAK	KAR42	ALTINORDU	KO8
SARIYER	KAR43	ALTINTAŞ	KO9
SELVİLİ	KAR44	ANADOLU	KO10
SEVGİ	KAR45	ATAMER	KO11
ŞEHİTLER	KAR46	ATİLLA	KO12
TAHSİN YAZICI	KAR47	AZİZİYE	KO13
UĞUR MUMCU	KAR48	BALLIKUYU	KO14
UMUT	KAR49	BARBAROS	KO15
UZUNDERE	KAR50	BİRİNCİKADRİYE	KO16
ÜÇKUYULAR	KAR51	BOĞAZİÇİ	KO17
VATAN	KAR52	BOZKURT	KO18
YUNUS EMRE	KAR53	CENGİZ TOPEL	KO19
YURDOĞLU	KAR54	ÇAHABEY	KO20
YÜZBAŞIŞERAFETTİN	KAR55	ÇANKAYA	KO21
AKSOY	KARS1	ÇINARLI	KO22
ALAYBEY	KARS2	ÇINARTEPE	KO23
ATAKENT	KARS3	ÇİMENTEPE	KO24

NEIGHBORHOODS	CODES	NEIGHBORHOODS	CODES
BAHARİYE	KARS4	DAYIEMİR	KO25
BOSTANLI	KARS5	DOLAPLIKUYU	KO26
CUMHURİYET	KARS6	DUATEPE	KO27
DEDEBAŞI	KARS7	EGE	KO28
NEIGHBORHOODS	NEIGHBORHOODS CODES	NEIGHBORHOODS	NEIGHBORHOOD CODES
DEMİRKÖPRÜ	KARS8	EMİRSULTAN	KO29
DONANMACI	KARS9	ETİLER	KO30
FİKRİ ALTAY	KARS10	FAİKPAŞA	KO31
FATİH	KO32	MEHTAP	KO73
FERAHLI	KO33	MERSİNLİ	KO74
FEVZİPAŞA	KO34	MİLLET	KO75
GÖZTEPE	KO35	MİMAR SİNAN	KO76
GÜNEŞ	KO36	MİRALİ	KO77
GÜNEŞLİ	KO37	MİTHATPAŞA	KO78
GÜNEY	KO38	MURAT	KO79
GÜNGÖR	KO39	MURATREİS	KO80
GÜZELYALI	KO40	NAMAZGAH	KO81
GÜZELYURT	KO41	NAMIK KEMAL	KO82
HALKAPINAR	KO42	ODUNKAPI	KO83
HASAN ÖZDEMİR	KO43	OĞUZLAR	KO84
HİLAL	KO44	ONDOKUZMAYIS	KO85
HURŞİDİYE	KO45	PAZARYERİ	KO86
HUZUR	KO46	PİRİREİS	KO87
HUZUR	KO47	SAKARYA	KO88
HUZUR	KO48	SELÇUK	KO90
HUZUR	KO49	SÜMER	KO91
İKİNCİKADRİYE	KO50	SÜVARİ	KO92
İMARİYE	KO51	ŞEHİT NEDİM TUĞALTAY	KO93
İSMETKAPTAN	KO52	TAN	KO94
İSMETPAŞA	KO53	TINAZTEPE	KO95
KADİFEKALE	KO54	TRAKYA	KO96
KAHRAMANLAR	KO55	TURGUTREİS	KO97
KAHRAMANMESCİT	KO56	TUZCU	KO98
KEMALREİS	KO57	TÜRKYILMAZ	KO99
KESTELLİ	KO58	UĞUR	KO100
KILIÇREİS	KO59	ULUBATLI	KO101
KOCAKAPI	KO60	UMURBEY	KO102
KOCATEPE	KO61	ÜLKÜ	KO103

NEIGHBORHOODS	CODES	NEIGHBORHOODS	CODES
KONAK	KO62	VEZİRAĞA	KO104
KOSOVA	KO63	YAVUZ SELİM	KO105
KUBİLAY	KO64	YENİ	KO106
KURTULUŞ	KO65	YENİDOĞAN	KO107
KÜÇÜKADA	KO66	YENİGÜN	KO108
KÜLTÜR	KO67	YENİŞEHİR	KO109
LALE	KO68	YEŞİLDERE	KO110
LEVENT	KO69	YEŞİLTEPE	KO111
MECİDİYE	KO70	YILDIZ	KO112
MEHMET AKİF ERSOY	KO71	YİRMİALTIAĞUSTOS	KO113
MEHMET ALİ AKMAN	KO72	ZAFERTEPE	KO114
ZEYBEK	KO115	LİMANREİS	NAR6
ZEYTİNLİK	KO116	NARLI	NAR7
ALTIEVLER	NAR1	SAHİLEVLERİ	NAR8
ATATÜRK	NAR2	YENİKALE	NAR9
ÇAMTEPE	NAR3	ATATÜRK	CIG2
ILICA	NAR4	UFUK	BUC32
İKİNCİİNÖNÜ	NAR5	SAYGI	KO89

APPENDIX 5.1 GAMES-HOWELL

Multiple Comparisons

Games-Howell

Dependent Variable	(I) cluster	(J) cluster	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Gravity	Yildiz	Onur	-149.674*	4.269	.000	-163.428	-135.921
		Camli Koyu	309.737*	3.785	.000	297.519	321.955
		Ugur	345.813*	3.076	.000	335.888	355.739
		Altinordu	334.283*	3.253	.000	323.786	344.780
		Ataturk	352.554*	2.902	.000	343.196	361.912
		Namazgah	350.098*	2.917	.000	340.690	359.505
		Bahcelerarasi	349.683*	2.940	.000	340.203	359.162
		Dokuz Eylul	327.615*	3.027	.000	317.857	337.373
		Ataturk Nar	321.903*	3.078	.000	311.980	331.826
		Yenigun	327.934*	2.988	.000	318.299	337.569
	Onur	Yildiz	149.674*	4.269	.000	135.921	163.428
		Camli Koyu	459.411*	4.008	.000	446.482	472.340
		Ugur	495.488*	3.345	.000	484.698	506.277
		Altinordu	483.957*	3.510	.000	472.640	495.275
		Ataturk	502.228*	3.186	.000	491.957	512.499
		Namazgah	499.772*	3.200	.000	489.456	510.087
		Bahcelerarasi	499.357*	3.221	.000	488.975	509.738
		Dokuz Eylul	477.289*	3.300	.000	466.653	487.926
		Ataturk Nar	471.577*	3.347	.000	460.789	482.366
		Yenigun	477.608*	3.265	.000	467.084	488.132
	Camli Koyu	Yildiz	-309.737*	3.785	.000	-321.955	-297.519
		Onur	-459.411*	4.008	.000	-472.340	-446.482
		Ugur	36.077*	2.701	.000	27.295	44.858
		Altinordu	24.546*	2.902	.000	15.131	33.961
		Ataturk	42.817*	2.501	.000	34.677	50.958
		Namazgah	40.361*	2.519	.000	32.165	48.557
		Bahcelerarasi	39.946*	2.545	.000	31.669	48.223
		Dokuz Eylul	17.878*	2.645	.000	9.289	26.468
		Ataturk Nar	12.166*	2.703	.001	3.392	20.941
		Yenigun	18.197*	2.600	.000	9.745	26.650
	Ugur	Yildiz	-345.813*	3.076	.000	-355.739	-335.888
		Onur	-495.488*	3.345	.000	-506.277	-484.698
		Camli Koyu	-36.077*	2.701	.000	-44.858	-27.295
		Altinordu	-11.530*	1.884	.000	-17.710	-5.351
		Ataturk	6.741*	1.177	.000	2.742	10.739
		Namazgah	4.284*	1.214	.034	.182	8.387
		Bahcelerarasi	3.869	1.267	.106	-.382	8.121
		Dokuz Eylul	-18.198*	1.457	.000	-23.002	-13.395
		Ataturk Nar	-23.910*	1.561	.000	-29.033	-18.788
		Yenigun	-17.879*	1.375	.000	-22.454	-13.305
	Altinordu	Yildiz	-334.283*	3.253	.000	-344.780	-323.786
		Onur	-483.957*	3.510	.000	-495.275	-472.640
		Camli Koyu	-24.546*	2.902	.000	-33.961	-15.131
		Ugur	11.530*	1.884	.000	5.351	17.710
		Ataturk	18.271*	1.584	.000	13.060	23.482
		Namazgah	15.815*	1.612	.000	10.519	21.111
		Bahcelerarasi	15.400*	1.652	.000	9.980	20.819
		Dokuz Eylul	-6.668*	1.803	.013	-12.547	-.789
		Ataturk Nar	-12.380*	1.888	.000	-18.526	-6.234
		Yenigun	-6.349*	1.737	.015	-12.032	-.666
	Ataturk	Yildiz	-352.554*	2.902	.000	-361.912	-343.196
		Onur	-502.228*	3.186	.000	-512.499	-491.957
		Camli Koyu	-42.817*	2.501	.000	-50.958	-34.677
		Ugur	-6.741*	1.177	.000	-10.739	-2.742

		Altinordu	-18.271*	1.584	.000	-23.482	-13.060
		Namazgah	-2.456*	.659	.013	-4.621	-.291
		Bahcelerarasi	-2.871*	.752	.009	-5.332	-.410
		Dokuz Eylul	-24.939*	1.042	.000	-28.305	-21.572
		Ataturk Nar	-30.651*	1.183	.000	-34.479	-26.823
		Yenigun	-24.620*	.923	.000	-27.653	-21.586
	Namazgah	Yildiz	-350.098*	2.917	.000	-359.505	-340.690
		Onur	-499.772*	3.200	.000	-510.087	-489.456
		Camli Koyu	-40.361*	2.519	.000	-48.557	-32.165
		Ugur	-4.284*	1.214	.034	-8.387	-.182
		Altinordu	-15.815*	1.612	.000	-21.111	-10.519
		Ataturk	2.456*	.659	.013	.291	4.621
		Bahcelerarasi	-.415	.809	1.000	-3.065	2.235
		Dokuz Eylul	-22.482*	1.083	.000	-25.988	-18.977
		Ataturk Nar	-28.195*	1.220	.000	-32.144	-24.245
		Yenigun	-22.164*	.970	.000	-25.347	-18.980
	Bahcelerarasi	Yildiz	-349.683*	2.940	.000	-359.162	-340.203
		Onur	-499.357*	3.221	.000	-509.738	-488.975
		Camli Koyu	-39.946*	2.545	.000	-48.223	-31.669
		Ugur	-3.869	1.267	.106	-8.121	.382
		Altinordu	-15.400*	1.652	.000	-20.819	-9.980
		Ataturk	2.871*	.752	.009	.410	5.332
		Namazgah	.415	.809	1.000	-2.235	3.065
		Dokuz Eylul	-22.067*	1.143	.000	-25.763	-18.371
		Ataturk Nar	-27.780*	1.273	.000	-31.898	-23.661
		Yenigun	-21.748*	1.036	.000	-25.137	-18.360
	Dokuz Eylul	Yildiz	-327.615*	3.027	.000	-337.373	-317.857
		Onur	-477.289*	3.300	.000	-487.926	-466.653
		Camli Koyu	-17.878*	2.645	.000	-26.468	-9.289
		Ugur	18.198*	1.457	.000	13.395	23.002
		Altinordu	6.668*	1.803	.013	.789	12.547
		Ataturk	24.939*	1.042	.000	21.572	28.305
		Namazgah	22.482*	1.083	.000	18.977	25.988
		Bahcelerarasi	22.067*	1.143	.000	18.371	25.763
		Ataturk Nar	-5.712*	1.462	.005	-10.434	-.991
		Yenigun	.319	1.262	1.000	-3.771	4.409
	Ataturk Nar	Yildiz	-321.903*	3.078	.000	-331.826	-311.980
		Onur	-471.577*	3.347	.000	-482.366	-460.789
		Camli Koyu	-12.166*	2.703	.001	-20.941	-3.392
		Ugur	23.910*	1.561	.000	18.788	29.033
		Altinordu	12.380*	1.888	.000	6.234	18.526
		Ataturk	30.651*	1.183	.000	26.823	34.479
		Namazgah	28.195*	1.220	.000	24.245	32.144
		Bahcelerarasi	27.780*	1.273	.000	23.661	31.898
		Dokuz Eylul	5.712*	1.462	.005	.991	10.434
		Yenigun	6.031*	1.380	.001	1.558	10.504
	Yenigun	Yildiz	-327.934*	2.988	.000	-337.569	-318.299
		Onur	-477.608*	3.265	.000	-488.132	-467.084
		Camli Koyu	-18.197*	2.600	.000	-26.650	-9.745
		Ugur	17.879*	1.375	.000	13.305	22.454
		Altinordu	6.349*	1.737	.015	.666	12.032
		Ataturk	24.620*	.923	.000	21.586	27.653
		Namazgah	22.164*	.970	.000	18.980	25.347
		Bahcelerarasi	21.748*	1.036	.000	18.360	25.137
		Dokuz Eylul	-.319	1.262	1.000	-4.409	3.771
		Ataturk Nar	-6.031*	1.380	.001	-10.504	-1.558
Closeness	Yildiz	Onur	.000*	.000	.000	.000	.000
		Camli Koyu	-.005	.002	.199	-.012	.001
		Ugur	-.002	.001	.570	-.006	.001
		Altinordu	-.052	.032	.873	-.158	.054

		Ataturk	-.006*	.001	.003	-.010	-.001
		Namazgah	-.005*	.001	.000	-.008	-.002
		Bahcelerarasi	-.005*	.001	.000	-.008	-.002
		Dokuz Eylul	-.011	.007	.841	-.033	.010
		Ataturk Nar	-.002*	.000	.000	-.003	-.001
		Yenigun	-.001	.000	.599	-.001	.000
	Onur	Yildiz	.000*	.000	.000	.000	.000
		Camli Koyu	-.005	.002	.199	-.012	.001
		Ugur	-.002	.001	.569	-.006	.001
		Altinordu	-.052	.032	.873	-.158	.054
		Ataturk	-.006*	.001	.003	-.010	-.001
		Namazgah	-.005*	.001	.000	-.008	-.002
		Bahcelerarasi	-.005*	.001	.000	-.008	-.002
		Dokuz Eylul	-.011	.007	.841	-.033	.010
		Ataturk Nar	-.002*	.000	.000	-.003	-.001
		Yenigun	-.001	.000	.594	-.001	.000
	Camli Koyu	Yildiz	.005	.002	.199	-.001	.012
		Onur	.005	.002	.199	-.001	.012
		Ugur	.003	.002	.956	-.004	.010
		Altinordu	-.047	.032	.933	-.153	.060
		Ataturk	.000	.002	1.000	-.008	.007
		Namazgah	.000	.002	1.000	-.007	.007
		Bahcelerarasi	.001	.002	1.000	-.006	.008
		Dokuz Eylul	-.006	.007	.999	-.028	.016
		Ataturk Nar	.004	.002	.743	-.003	.010
		Yenigun	.005	.002	.348	-.002	.011
	Ugur	Yildiz	.002	.001	.570	-.001	.006
		Onur	.002	.001	.569	-.001	.006
		Camli Koyu	-.003	.002	.956	-.010	.004
		Altinordu	-.050	.032	.901	-.155	.056
		Ataturk	-.003	.002	.682	-.009	.002
		Namazgah	-.003	.001	.775	-.007	.002
		Bahcelerarasi	-.002	.001	.840	-.007	.002
		Dokuz Eylul	-.009	.007	.963	-.031	.013
		Ataturk Nar	.001	.001	1.000	-.003	.004
		Yenigun	.002	.001	.870	-.002	.005
	Altinordu	Yildiz	.052	.032	.873	-.054	.158
		Onur	.052	.032	.873	-.054	.158
		Camli Koyu	.047	.032	.933	-.060	.153
		Ugur	.050	.032	.901	-.056	.155
		Ataturk	.046	.032	.935	-.060	.152
		Namazgah	.047	.032	.928	-.059	.153
		Bahcelerarasi	.047	.032	.927	-.059	.153
		Dokuz Eylul	.041	.033	.977	-.067	.148
		Ataturk Nar	.050	.032	.893	-.056	.156
		Yenigun	.051	.032	.879	-.055	.157
	Ataturk	Yildiz	.006*	.001	.003	.001	.010
		Onur	.006*	.001	.003	.001	.010
		Camli Koyu	.000	.002	1.000	-.007	.008
		Ugur	.003	.002	.682	-.002	.009
		Altinordu	-.046	.032	.935	-.152	.060
		Namazgah	.001	.002	1.000	-.005	.006
		Bahcelerarasi	.001	.002	1.000	-.004	.006
		Dokuz Eylul	-.006	.007	.999	-.028	.016
		Ataturk Nar	.004	.001	.140	-.001	.009
		Yenigun	.005*	.001	.013	.001	.010
	Namazg	Yildiz	.005*	.001	.000	.002	.008

	ah	Onur	.005*	.001	.000	.002	.008
		Camli Koyu	.000	.002	1.000	-.007	.007
		Ugur	.003	.001	.775	-.002	.007
		Altinordu	-.047	.032	.928	-.153	.059
		Ataturk	-.001	.002	1.000	-.006	.005
		Bahcelerarasi	.000	.001	1.000	-.004	.005
		Dokuz Eylul	-.006	.007	.997	-.028	.015
		Ataturk Nar	.003	.001	.067	.000	.007
		Yenigun	.004*	.001	.002	.001	.008
	Bahcelerarasi	Yildiz	.005*	.001	.000	.002	.008
		Onur	.005*	.001	.000	.002	.008
		Camli Koyu	-.001	.002	1.000	-.008	.006
		Ugur	.002	.001	.840	-.002	.007
		Altinordu	-.047	.032	.927	-.153	.059
		Ataturk	-.001	.002	1.000	-.006	.004
		Namazgah	.000	.001	1.000	-.005	.004
		Dokuz Eylul	-.007	.007	.996	-.028	.015
		Ataturk Nar	.003	.001	.101	.000	.006
		Yenigun	.004*	.001	.003	.001	.007
	Dokuz Eylul	Yildiz	.011	.007	.841	-.010	.033
		Onur	.011	.007	.841	-.010	.033
		Camli Koyu	.006	.007	.999	-.016	.028
		Ugur	.009	.007	.963	-.013	.031
		Altinordu	-.041	.033	.977	-.148	.067
		Ataturk	.006	.007	.999	-.016	.028
		Namazgah	.006	.007	.997	-.015	.028
		Bahcelerarasi	.007	.007	.996	-.015	.028
		Ataturk Nar	.010	.007	.936	-.012	.031
		Yenigun	.011	.007	.877	-.011	.032
	Ataturk Nar	Yildiz	.002*	.000	.000	.001	.003
		Onur	.002*	.000	.000	.001	.003
		Camli Koyu	-.004	.002	.743	-.010	.003
		Ugur	-.001	.001	1.000	-.004	.003
		Altinordu	-.050	.032	.893	-.156	.056
		Ataturk	-.004	.001	.140	-.009	.001
		Namazgah	-.003	.001	.067	-.007	.000
		Bahcelerarasi	-.003	.001	.101	-.006	.000
		Dokuz Eylul	-.010	.007	.936	-.031	.012
		Yenigun	.001	.000	.182	.000	.002
	Yenigun	Yildiz	.001	.000	.599	.000	.001
		Onur	.001	.000	.594	.000	.001
		Camli Koyu	-.005	.002	.348	-.011	.002
		Ugur	-.002	.001	.870	-.005	.002
		Altinordu	-.051	.032	.879	-.157	.055
		Ataturk	-.005*	.001	.013	-.010	-.001
		Namazgah	-.004*	.001	.002	-.008	-.001
		Bahcelerarasi	-.004*	.001	.003	-.007	-.001
		Dokuz Eylul	-.011	.007	.877	-.032	.011
		Ataturk Nar	-.001	.000	.182	-.002	.000
Straightne	Yildiz	Onur	-263.665*	6.474	.000	-284.521	-242.809
		Camli Koyu	485.690*	5.277	.000	468.672	502.707
		Ugur	526.252*	4.663	.000	511.212	541.291
		Altinordu	513.215*	4.837	.000	497.617	528.813
		Ataturk	530.677*	4.596	.000	515.856	545.498
		Namazgah	530.235*	4.585	.000	515.447	545.022
		Bahcelerarasi	527.335*	4.634	.000	512.391	542.278
		Dokuz Eylul	502.525*	4.709	.000	487.340	517.709

		Ataturk Nar	502.253*	4.680	.000	487.163	517.344
		Yenigun	506.285*	4.674	.000	491.213	521.357
	Onur	Yildiz	263.665*	6.474	.000	242.809	284.521
		Camli Koyu	749.355*	5.312	.000	732.230	766.479
		Ugur	789.917*	4.703	.000	774.758	805.076
		Altinordu	776.880*	4.875	.000	761.166	792.594
		Ataturk	794.342*	4.635	.000	779.400	809.284
		Namazgah	793.900*	4.625	.000	778.990	808.809
		Bahcelerarasi	791.000*	4.673	.000	775.936	806.064
		Dokuz Eylul	766.190*	4.748	.000	750.886	781.493
		Ataturk Nar	765.918*	4.719	.000	750.708	781.128
		Yenigun	769.950*	4.713	.000	754.758	785.141
	Camli Koyu	Yildiz	-485.690*	5.277	.000	-502.707	-468.672
		Onur	-749.355*	5.312	.000	-766.479	-732.230
		Ugur	40.562*	2.837	.000	31.336	49.789
		Altinordu	27.525*	3.115	.000	17.418	37.633
		Ataturk	44.987*	2.725	.000	36.121	53.853
		Namazgah	44.545*	2.707	.000	35.734	53.356
		Bahcelerarasi	41.645*	2.789	.000	32.578	50.712
		Dokuz Eylul	16.835*	2.912	.000	7.382	26.288
		Ataturk Nar	16.563*	2.865	.000	7.261	25.866
		Yenigun	20.595*	2.855	.000	11.319	29.871
	Ugur	Yildiz	-526.252*	4.663	.000	-541.291	-511.212
		Onur	-789.917*	4.703	.000	-805.076	-774.758
		Camli Koyu	-40.562*	2.837	.000	-49.789	-31.336
		Altinordu	-13.037*	1.897	.000	-19.256	-6.817
		Ataturk	4.425*	1.150	.012	.571	8.279
		Namazgah	3.983*	1.108	.028	.248	7.717
		Bahcelerarasi	1.083	1.295	.999	-3.205	5.371
		Dokuz Eylul	-23.727*	1.543	.000	-28.760	-18.694
		Ataturk Nar	-23.999*	1.450	.000	-28.748	-19.250
		Yenigun	-19.967*	1.431	.000	-24.687	-15.247
	Altinordu	Yildiz	-513.215*	4.837	.000	-528.813	-497.617
		Onur	-776.880*	4.875	.000	-792.594	-761.166
		Camli Koyu	-27.525*	3.115	.000	-37.633	-17.418
		Ugur	13.037*	1.897	.000	6.817	19.256
		Ataturk	17.462*	1.724	.000	11.801	23.123
		Namazgah	17.020*	1.696	.000	11.444	22.595
		Bahcelerarasi	14.120*	1.824	.000	8.151	20.089
		Dokuz Eylul	-10.690*	2.008	.000	-17.224	-4.156
		Ataturk Nar	-10.962*	1.938	.000	-17.278	-4.646
		Yenigun	-6.930*	1.923	.018	-13.214	-.647
	Ataturk	Yildiz	-530.677*	4.596	.000	-545.498	-515.856
		Onur	-794.342*	4.635	.000	-809.284	-779.400
		Camli Koyu	-44.987*	2.725	.000	-53.853	-36.121
		Ugur	-4.425*	1.150	.012	-8.279	-.571
		Altinordu	-17.462*	1.724	.000	-23.123	-11.801
		Namazgah	-.442	.775	1.000	-2.981	2.096
		Bahcelerarasi	-3.342	1.025	.051	-6.692	.007
		Dokuz Eylul	-28.152*	1.324	.000	-32.433	-23.871
		Ataturk Nar	-28.424*	1.216	.000	-32.358	-24.490
		Yenigun	-24.392*	1.192	.000	-28.304	-20.480
	Namazgah	Yildiz	-530.235*	4.585	.000	-545.022	-515.447
		Onur	-793.900*	4.625	.000	-808.809	-778.990
		Camli Koyu	-44.545*	2.707	.000	-53.356	-35.734
		Ugur	-3.983*	1.108	.028	-7.717	-.248
		Altinordu	-17.020*	1.696	.000	-22.595	-11.444
		Ataturk	.442	.775	1.000	-2.096	2.981
		Bahcelerarasi	-2.900	.977	.114	-6.102	.302
		Dokuz Eylul	-27.710*	1.288	.000	-31.874	-23.546
		Ataturk Nar	-27.982*	1.176	.000	-31.788	-24.175
		Yenigun	-23.950*	1.152	.000	-27.738	-20.162

	Bahcelerarasi	Yildiz	-527.335*	4.634	.000	-542.278	-512.391
		Onur	-791.000*	4.673	.000	-806.064	-775.936
		Camli Koyu	-41.645*	2.789	.000	-50.712	-32.578
		Ugur	-1.083	1.295	.999	-5.371	3.205
		Altinordu	-14.120*	1.824	.000	-20.089	-8.151
		Ataturk	3.342	1.025	.051	-.007	6.692
		Namazgah	2.900	.977	.114	-.302	6.102
		Dokuz Eylul	-24.810*	1.452	.000	-29.507	-20.113
		Ataturk Nar	-25.082*	1.353	.000	-29.466	-20.697
		Yenigun	-21.050*	1.332	.000	-25.405	-16.695
	Dokuz Eylul	Yildiz	-502.525*	4.709	.000	-517.709	-487.340
		Onur	-766.190*	4.748	.000	-781.493	-750.886
		Camli Koyu	-16.835*	2.912	.000	-26.288	-7.382
		Ugur	23.727*	1.543	.000	18.694	28.760
		Altinordu	10.690*	2.008	.000	4.156	17.224
		Ataturk	28.152*	1.324	.000	23.871	32.433
		Namazgah	27.710*	1.288	.000	23.546	31.874
		Bahcelerarasi	24.810*	1.452	.000	20.113	29.507
		Ataturk Nar	-.272	1.592	1.000	-5.411	4.868
		Yenigun	3.760	1.574	.378	-1.345	8.865
	Ataturk Nar	Yildiz	-502.253*	4.680	.000	-517.344	-487.163
		Onur	-765.918*	4.719	.000	-781.128	-750.708
		Camli Koyu	-16.563*	2.865	.000	-25.866	-7.261
		Ugur	23.999*	1.450	.000	19.250	28.748
		Altinordu	10.962*	1.938	.000	4.646	17.278
		Ataturk	28.424*	1.216	.000	24.490	32.358
		Namazgah	27.982*	1.176	.000	24.175	31.788
		Bahcelerarasi	25.082*	1.353	.000	20.697	29.466
		Dokuz Eylul	.272	1.592	1.000	-4.868	5.411
		Yenigun	4.032	1.484	.198	-.789	8.852
	Yenigun	Yildiz	-506.285*	4.674	.000	-521.357	-491.213
		Onur	-769.950*	4.713	.000	-785.141	-754.758
		Camli Koyu	-20.595*	2.855	.000	-29.871	-11.319
		Ugur	19.967*	1.431	.000	15.247	24.687
		Altinordu	6.930*	1.923	.018	.647	13.214
		Ataturk	24.392*	1.192	.000	20.480	28.304
		Namazgah	23.950*	1.152	.000	20.162	27.738
		Bahcelerarasi	21.050*	1.332	.000	16.695	25.405
		Dokuz Eylul	-3.760	1.574	.378	-8.865	1.345
		Ataturk Nar	-4.032	1.484	.198	-8.852	.789
Betweenness	Yildiz	Onur	-20133.797*	940.212	.000	-23163.138	-17104.456
		Camli Koyu	13973.346*	453.650	.000	12510.499	15436.194
		Ugur	15123.037*	442.384	.000	13696.283	16549.792
		Altinordu	14825.329*	444.463	.000	13391.921	16258.736
		Ataturk	15144.531*	442.299	.000	13718.050	16571.012
		Namazgah	15133.564*	442.320	.000	13707.017	16560.112
		Bahcelerarasi	15113.627*	442.400	.000	13686.823	16540.430
		Dokuz Eylul	14590.989*	443.544	.000	13160.524	16021.454
		Ataturk Nar	14288.525*	447.077	.000	12846.751	15730.300
		Yenigun	14925.313*	442.833	.000	13497.122	16353.504
	Onur	Yildiz	20133.797*	940.2	.000	17104.45	23163.138

				12		6	
		Camli Koyu	34107.143*	835.806	.000	31412.942	36801.344
		Ugur	35256.834*	829.745	.000	32582.057	37931.610
		Altinordu	34959.126*	830.855	.000	32280.793	37637.459
		Ataturk	35278.328*	829.700	.000	32603.697	37952.958
		Namazgah	35267.361*	829.711	.000	32592.695	37942.027
		Bahcelerarasi	35247.424*	829.753	.000	32572.621	37922.226
		Dokuz Eylul	34724.785*	830.364	.000	32048.026	37401.545
		Ataturk Nar	34422.322*	832.257	.000	31739.498	37105.146
		Yenigun	35059.110*	829.985	.000	32383.566	37734.653
	Camli Koyu	Yildiz	-13973.346*	453.650	.000	-15436.194	-12510.499
		Onur	-34107.143*	835.806	.000	-36801.344	-31412.942
		Ugur	1149.691*	101.379	.000	819.570	1479.812
		Altinordu	851.983*	110.095	.000	494.424	1209.541
		Ataturk	1171.185*	101.005	.000	842.225	1500.144
		Namazgah	1160.218*	101.096	.000	830.977	1489.459
		Bahcelerarasi	1140.281*	101.446	.000	809.953	1470.609
		Dokuz Eylul	617.642*	106.326	.000	272.096	963.189
		Ataturk Nar	315.179	120.217	.241	-74.272	704.630
		Yenigun	951.967*	103.320	.000	615.791	1288.143
	Ugur	Yildiz	-15123.037*	442.384	.000	-16549.792	-13696.283
		Onur	-35256.834*	829.745	.000	-37931.610	-32582.057
		Camli Koyu	-1149.691*	101.379	.000	-1479.812	-819.570
		Altinordu	-297.708*	45.019	.000	-445.940	-149.476
		Ataturk	21.494	10.388	.604	-13.709	56.696
		Namazgah	10.527	11.237	.997	-27.137	48.191
		Bahcelerarasi	-9.410	14.040	1.000	-55.665	36.845
		Dokuz Eylul	-532.049*	34.799	.000	-644.578	-419.520
		Ataturk Nar	-834.512*	66.014	.000	-1048.396	-620.628
		Yenigun	-197.724*	24.101	.000	-277.139	-118.310
	Altinordu	Yildiz	-14825.329*	444.463	.000	-16258.73	-13391.921

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		Onur	-34959.126*	830.855	.000	-37637.459	-32280.793
		Camli Koyu	-851.983*	110.095	.000	-1209.541	-494.424
		Ugur	297.708*	45.019	.000	149.476	445.940
		Ataturk	319.202*	44.171	.000	173.524	464.880
		Namazgah	308.236*	44.378	.000	161.939	454.532
		Bahcelerarasi	288.298*	45.170	.000	139.626	436.970
		Dokuz Eylul	-234.340*	55.264	.002	-414.117	-54.563
		Ataturk Nar	-536.803*	78.747	.000	-791.701	-281.906
		Yenigun	99.984	49.234	.628	-61.208	261.176
	Ataturk	Yildiz	-15144.531*	442.299	.000	-16571.012	-13718.050
		Onur	-35278.328*	829.700	.000	-37952.958	-32603.697
		Camli Koyu	-1171.185*	101.005	.000	-1500.144	-842.225
		Ugur	-21.494	10.388	.604	-56.696	13.709
		Altinordu	-319.202*	44.171	.000	-464.880	-173.524
		Namazgah	-10.966	7.115	.902	-34.411	12.478
		Bahcelerarasi	-30.904	11.021	.171	-67.152	5.344
		Dokuz Eylul	-553.542*	33.695	.000	-662.520	-444.564
		Ataturk Nar	-856.005*	65.438	.000	-1068.068	-643.943
		Yenigun	-219.218*	22.476	.000	-293.670	-144.766
	Namazgah	Yildiz	-15133.564*	442.320	.000	-16560.112	-13707.017
		Onur	-35267.361*	829.711	.000	-37942.027	-32592.695
		Camli Koyu	-1160.218*	101.096	.000	-1489.459	-830.977
		Ugur	-10.527	11.237	.997	-48.191	27.137
		Altinordu	-308.236*	44.378	.000	-454.532	-161.939
		Ataturk	10.966	7.115	.902	-12.478	34.411
		Bahcelerarasi	-19.938	11.825	.840	-58.713	18.838
		Dokuz Eylul	-542.576*	33.966	.000	-652.418	-432.734
		Ataturk Nar	-845.039*	65.579	.000	-1057.544	-632.534
		Yenigun	-208.251*	22.881	.000	-283.907	-132.596
	Bahcelerarasi	Yildiz	-15113.627*	442.400	.000	-16540.430	-13686.823

		Onur	-35247.424*	829.753	.000	-37922.226	-32572.621
		Camli Koyu	-1140.281*	101.446	.000	-1470.609	-809.953
		Ugur	9.410	14.040	1.000	-36.845	55.665
		Altinordu	-288.298*	45.170	.000	-436.970	-139.626
		Ataturk	30.904	11.021	.171	-5.344	67.152
		Namazgah	19.938	11.825	.840	-18.838	58.713
		Dokuz Eylul	-522.638*	34.993	.000	-635.762	-409.514
		Ataturk Nar	-825.101*	66.117	.000	-1039.306	-610.897
		Yenigun	-188.314*	24.380	.000	-268.501	-108.127
	Dokuz Eylul	Yildiz	-14590.989*	443.544	.000	-16021.454	-13160.524
		Onur	-34724.785*	830.364	.000	-37401.545	-32048.026
		Camli Koyu	-617.642*	106.326	.000	-963.189	-272.096
		Ugur	532.049*	34.799	.000	419.520	644.578
		Altinordu	234.340*	55.264	.002	54.563	414.117
		Ataturk	553.542*	33.695	.000	444.564	662.520
		Namazgah	542.576*	33.966	.000	432.734	652.418
		Bahcelerarasi	522.638*	34.993	.000	409.514	635.762
		Ataturk Nar	-302.463*	73.384	.002	-539.732	-65.194
		Yenigun	334.324*	40.103	.000	204.567	464.081
	Ataturk Nar	Yildiz	-14288.525*	447.077	.000	-15730.300	-12846.751
		Onur	-34422.322*	832.257	.000	-37105.146	-31739.498
		Camli Koyu	-315.179	120.217	.241	-704.630	74.272
		Ugur	834.512*	66.014	.000	620.628	1048.396
		Altinordu	536.803*	78.747	.000	281.906	791.701
		Ataturk	856.005*	65.438	.000	643.943	1068.068
		Namazgah	845.039*	65.579	.000	632.534	1057.544
		Bahcelerarasi	825.101*	66.117	.000	610.897	1039.306
		Dokuz Eylul	302.463*	73.384	.002	65.194	539.732
		Yenigun	636.788*	68.957	.000	413.536	860.039
	Yenigun	Yildiz	-14925.313*	442.833	.000	-16353.50	-13497.122

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		Onur	-35059.110*	829.985	.000	-37734.653	-32383.566
		Camli Koyu	-951.967*	103.320	.000	-1288.143	-615.791
		Ugur	197.724*	24.101	.000	118.310	277.139
		Altinordu	-99.984	49.234	.628	-261.176	61.208
		Ataturk	219.218*	22.476	.000	144.766	293.670
		Namazgah	208.251*	22.881	.000	132.596	283.907
		Bahcelerarasi	188.314*	24.380	.000	108.127	268.501
		Dokuz Eylul	-334.324*	40.103	.000	-464.081	-204.567
		Ataturk Nar	-636.788*	68.957	.000	-860.039	-413.536
Reach	Yildiz	Onur	-344.875*	8.323	.000	-371.687	-318.064
		Camli Koyu	627.537*	6.844	.000	605.459	649.614
		Ugur	688.542*	5.795	.000	669.851	707.233
		Altinordu	671.308*	6.065	.000	651.746	690.870
		Ataturk	695.270*	5.664	.000	677.005	713.536
		Namazgah	694.039*	5.662	.000	675.779	712.299
		Bahcelerarasi	691.528*	5.712	.000	673.107	709.949
		Dokuz Eylul	653.101*	5.897	.000	634.090	672.113
		Ataturk Nar	644.953*	5.901	.000	625.927	663.980
		Yenigun	655.550*	5.848	.000	636.692	674.408
	Onur	Yildiz	344.875*	8.323	.000	318.064	371.687
		Camli Koyu	972.412*	7.307	.000	948.853	995.971
		Ugur	1033.417*	6.334	.000	1012.997	1053.838
		Altinordu	1016.183*	6.583	.000	994.963	1037.404
		Ataturk	1040.146*	6.215	.000	1020.113	1060.178
		Namazgah	1038.915*	6.213	.000	1018.887	1058.942
		Bahcelerarasi	1036.403*	6.259	.000	1016.229	1056.578
		Dokuz Eylul	997.977*	6.428	.000	977.261	1018.693
		Ataturk Nar	989.829*	6.432	.000	969.099	1010.558
		Yenigun	1000.425*	6.383	.000	979.851	1020.999
	Camli Koyu	Yildiz	-627.537*	6.844	.000	-649.614	-605.459
		Onur	-972.412*	7.307	.000	-995.971	-948.853
		Ugur	61.005*	4.207	.000	47.326	74.684
		Altinordu	43.771*	4.572	.000	28.934	58.608
		Ataturk	67.734*	4.024	.000	54.639	80.828
		Namazgah	66.503*	4.022	.000	53.415	79.590
		Bahcelerarasi	63.991*	4.092	.000	50.684	77.299
		Dokuz Eylul	25.565*	4.346	.000	11.462	39.667
		Ataturk Nar	17.416*	4.352	.004	3.294	31.539
		Yenigun	28.013*	4.279	.000	14.112	41.914
	Ugur	Yildiz	-688.542*	5.795	.000	-707.233	-669.851
		Onur	-1033.417*	6.334	.000	-1053.838	-1012.997
		Camli Koyu	-61.005*	4.207	.000	-74.684	-47.326
		Altinordu	-17.234*	2.765	.000	-26.298	-8.170
		Ataturk	6.728*	1.713	.010	.979	12.478
		Namazgah	5.497	1.707	.072	-.241	11.236
		Bahcelerarasi	2.986	1.867	.877	-3.219	9.191
		Dokuz Eylul	-35.441*	2.372	.000	-43.174	-27.707
		Ataturk Nar	-43.589*	2.383	.000	-51.363	-35.815
		Yenigun	-32.992*	2.247	.000	-40.396	-25.589
	Altinordu	Yildiz	-671.308*	6.065	.000	-690.870	-651.746
		Onur	-1016.183*	6.583	.000	-1037.404	-994.963
		Camli Koyu	-43.771*	4.572	.000	-58.608	-28.934
		Ugur	17.234*	2.765	.000	8.170	26.298

		Ataturk	23.962*	2.478	.000	15.827	32.098
		Namazgah	22.731*	2.474	.000	14.606	30.856
		Bahcelerarasi	20.220*	2.587	.000	11.749	28.691
		Dokuz Eylul	-18.206*	2.972	.000	-27.870	-8.543
		Ataturk Nar	-26.355*	2.981	.000	-36.049	-16.661
		Yenigun	-15.758*	2.874	.000	-25.141	-6.376
	Ataturk	Yildiz	-695.270*	5.664	.000	-713.536	-677.005
		Onur	-1040.146*	6.215	.000	-1060.178	-1020.113
		Camli Koyu	-67.734*	4.024	.000	-80.828	-54.639
		Ugur	-6.728*	1.713	.010	-12.478	-.979
		Altinordu	-23.962*	2.478	.000	-32.098	-15.827
		Namazgah	-1.231	1.189	.994	-5.126	2.664
		Bahcelerarasi	-3.742	1.408	.229	-8.343	.858
		Dokuz Eylul	-42.169*	2.031	.000	-48.734	-35.604
		Ataturk Nar	-50.317*	2.044	.000	-56.932	-43.702
		Yenigun	-39.721*	1.884	.000	-45.910	-33.531
	Namazgah	Yildiz	-694.039*	5.662	.000	-712.299	-675.779
		Onur	-1038.915*	6.213	.000	-1058.942	-1018.887
		Camli Koyu	-66.503*	4.022	.000	-79.590	-53.415
		Ugur	-5.497	1.707	.072	-11.236	.241
		Altinordu	-22.731*	2.474	.000	-30.856	-14.606
		Ataturk	1.231	1.189	.994	-2.664	5.126
		Bahcelerarasi	-2.511	1.401	.783	-7.099	2.077
		Dokuz Eylul	-40.938*	2.026	.000	-47.490	-34.385
		Ataturk Nar	-49.086*	2.039	.000	-55.689	-42.483
		Yenigun	-38.490*	1.879	.000	-44.667	-32.312
	Bahcelerarasi	Yildiz	-691.528*	5.712	.000	-709.949	-673.107
		Onur	-1036.403*	6.259	.000	-1056.578	-1016.229
		Camli Koyu	-63.991*	4.092	.000	-77.299	-50.684
		Ugur	-2.986	1.867	.877	-9.191	3.219
		Altinordu	-20.220*	2.587	.000	-28.691	-11.749
		Ataturk	3.742	1.408	.229	-.858	8.343
		Namazgah	2.511	1.401	.783	-2.077	7.099
		Dokuz Eylul	-38.427*	2.162	.000	-45.419	-31.434
		Ataturk Nar	-46.575*	2.174	.000	-53.613	-39.537
		Yenigun	-35.978*	2.025	.000	-42.609	-29.348
	Dokuz Eylul	Yildiz	-653.101*	5.897	.000	-672.113	-634.090
		Onur	-997.977*	6.428	.000	-1018.693	-977.261
		Camli Koyu	-25.565*	4.346	.000	-39.667	-11.462
		Ugur	35.441*	2.372	.000	27.707	43.174
		Altinordu	18.206*	2.972	.000	8.543	27.870
		Ataturk	42.169*	2.031	.000	35.604	48.734
		Namazgah	40.938*	2.026	.000	34.385	47.490
		Bahcelerarasi	38.427*	2.162	.000	31.434	45.419
		Ataturk Nar	-8.148	2.621	.071	-16.610	.313
		Yenigun	2.448	2.498	.996	-5.656	10.552
	Ataturk Nar	Yildiz	-644.953*	5.901	.000	-663.980	-625.927
		Onur	-989.829*	6.432	.000	-1010.558	-969.099
		Camli Koyu	-17.416*	4.352	.004	-31.539	-3.294
		Ugur	43.589*	2.383	.000	35.815	51.363
		Altinordu	26.355*	2.981	.000	16.661	36.049
		Ataturk	50.317*	2.044	.000	43.702	56.932
		Namazgah	49.086*	2.039	.000	42.483	55.689
		Bahcelerarasi	46.575*	2.174	.000	39.537	53.613
		Dokuz Eylul	8.148	2.621	.071	-.313	16.610
		Yenigun	10.597*	2.509	.002	2.454	18.739
	Yenigun	Yildiz	-655.550*	5.848	.000	-674.408	-636.692
		Onur	-1000.425*	6.383	.000	-1020.999	-979.851
		Camli Koyu	-28.013*	4.279	.000	-41.914	-14.112
		Ugur	32.992*	2.247	.000	25.589	40.396
		Altinordu	15.758*	2.874	.000	6.376	25.141
		Ataturk	39.721*	1.884	.000	33.531	45.910
		Namazgah	38.490*	1.879	.000	32.312	44.667
		Bahcelerarasi	35.978*	2.025	.000	29.348	42.609

		Dokuz Eylul	-2.448	2.498	.996	-10.552	5.656
		Ataturk Nar	-10.597*	2.509	.002	-18.739	-2.454
*. The mean difference is significant at the 0.05 level.							