ACCESSIBILITY OF HEALTH CARE INSTITUTIONS: A CASE
STUDY BY GIS

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ABSTRACT

In this study, the accessibility of health care institutions within the boundaries of Istanbul’s Buyukcekmece district was examined with the help of GIS. First of all, health care institutions located within the boundaries of research area were identified, and, later on, these health care institutions were transferred in a GIS environment. Then, road network, within the boundaries of the district, was digitized with the help of “street” base map of Arc Map 10.1 software and Google Earth. This road network was also later in the determination of settlement areas. In addition, the topographical condition of research area was determined with the help of Digital Elevation Model (DEM) with 30 m resolution obtained from the images of ASTER satellite, and it was discovered that the lowest elevation within the boundaries of the district was 0, and the highest altitude was 221 m. First of all, with the help of data obtained and produced, buffer zones were created around health care institutions and it has been concluded that 20.88% of research areas were 1 km away from health care institutions and 56.33% of them were 3 km away from those facilities. In the shortest distance analysis, it has been discovered that health care institutions could be reached from the most distant residential areas within a short period of 20 minutes. As a result, it was concluded that both online data that GIS provided and tools that it used were proved to be very efficient in the measurement of accessibility of health care institutions, and the efficiency of GIS would increase by developing new technologies and methods.

Keywords: Health care institutions, accessibility, geographic information systems, network analysis.

1. INTRODUCTION

Public health and health services are among the biggest problems in developing countries as well as the accessibility of health care institutions are being among the most important factors in constituting healthy communities. Measuring the accessibility of health care institutions is one of the most significant indicators of measuring the efficiency of health care system. Many factors affect people’s access to health care institutions of necessary level. These factors can be divided into 3 groups (Penchansky and Thomas, 1981; Oliver and Mossialos, 2004):

- Compliance – availability
- Socio-economic convenience (ethnic origin, religion, gender, age, salary)
- Geography

Accessibility was divided into two in the literature of medical geography as potential and realized (Aday and Andersen, 1974; Joseph and Phillips, 1984). Potential accessibility refers to the spatial relationship between health care institutions and the people who reside around these institutions. As can be seen, potential accessibility is a concept mostly related to the “geography” of habitation and can also be perceived as “geographical accessibility.” Geographical accessibility is generally defined as the spatial separation of the population and the spatial or physical accessibility which include the complex relationship between the services that health care institutions provide (Black et al, 2004). The accessibility of public to the health care institutions can be affected negatively by the multitude of distance (Black et al., 2004). The multitude of distance is a significantly negative effect especially on elderly patients of over certain age and physically-limited people who have difficulties in walking.

There are many studies and criticisms conducted in literature of medical geography and planning in order to measure the
geographical accessibility. These studies are generally complex models that give away the number of health care institutions within a certain geographical locations, facilities of these institutions and the total number of people these facilities provide service for. These studies were chiefly conducted by Koenig (1980), Joseph and Bantock (1984) and Love and Lindquist (1995).

One of the most efficient tools used in measuring the accessibility of health care institutions is GIS. GIS, just like other data management systems (DMS), is an information system used for obtaining, organizing, storing and analyzing large-scale data (Aronoff, 1989; Burrough, 1986). The difference of GIS from other DMSs is its possession of information on the location of data it analyzes, and the capability of GIS software to perform a wide variety of assessments related to geographical locations by means of its high spatial analyzing ability. GIS software receives this ability from “topological” properties it possesses. Topology is defined as the geometric relationships of objects found in GIS environment to each other and relationship (such as proximity and inclusion) between one object and the other object is determined due to this property. This constitutes the basis of spatial analysis.

Health services planning and GIS are two interconnected concepts that require spatial data. The location of health care institutions, distribution and characteristics of patients are primary spatial data that should be considered during the planning of local health care services (Murad, 2004). Spatial querying tools and related GIS capabilities such “buffer” and “overlay” make GIS a very efficient tool in querying the accessibility of health care institutions both for today and in the future (Love and Lindquist, 1995).

There are many available studies in which GIS were used as a tool in querying the physical (geographical) accessibility of health care institutions (Love and Lindquist, 1995; Wilkinson et al. 1998; Albert et al. 2000; Phillips et al. 2000; Black et al. 2004; Murad, 2004). In addition to these, World Health Organization (WHO) also developed a GIS-based model for physical accessibility of health care institutions. Analysis, such as price efficiency and total number of patients who have ability to reach hospitals, can be performed by means of this model. The subject of this study is to analyze the accessibility of health care institutions located in Istanbul’s Buyukcekmece district by using the high ability of GIS in analyzing spatial data.

2. DATA AND METHOD

Figure 1: Buyukcekmece sub-province.

Buyukcekmece gained the characteristic of district by separating from Catalca in 1998 and was included within the boundaries of Metropolitan Municipality in 2008. Today, there are 23 neighborhoods located within the boundaries of Buyukcekmece (figure 2) and 201,077 inhabitants reside here according to address-based population registration system (ABPRS) in 2012.
While Batikoy becomes the most crowded neighborhood of Buyukcekmece with the population of 30703, Ahmediye is the neighborhood having the lowest population with 1327 persons. In terms of population density, Batikoy, Dizdariye, Fatih and Ataturk neighborhoods are in the position of the most densely-populated neighborhoods (figure 3). The population density of the district, which has 158 km$^2$ of area (only land), is 1277 persons/km$^2$. 

Figure 2: Neighborhoods of Buyukcekmece

Figure 3: Population density map of Buyukcekmece Sub-province
Buyukcekmece district, whose area covers 3.35% of Istanbul, appears to be a flat center of settlement where elevation difference is generally less. The highest point of the district, situated in the south of the Marmara Sea, is 221m (figure 4).

The difference of elevation, in other words, the sparseness of geographic irregularities facilitated the road construction. It can be stated that there are sufficient amounts of roads within the boundaries of Buyukcekmece district. Asphalt roads are available in every area where settlement existed and their length is 1007 km. Again, there are 19 health care institutions located within the boundaries of the research area (figure 5).
3. RESULTS

Analyses performed in this section, as can be understood from the title of the study, are based on the measurement of the accessibility of people residing within the boundaries of the district to the health care institutions. Therefore, analyses rest upon the spatial relationship between centers of settlement and health care institutions.

In this regard, the proximity of residential regions to health care institutions within the research area was identified primarily by creating buffer zones around these facilities. First of all, buffer zones, with the length of 1 km were created (figure 6). The reason for selecting a distance of 1 km is the possibility of covering this distance on foot if necessary and, in addition, is the chance of reaching it in a few minutes by car.

As can be seen from the above map, health care institutions are centered in the southern part where the population is denser. In the district with a total of 158 km² area, an area of 33 km² (20.88%) is located within 1 km of distance from the hospitals. This figure can be said to be quite good given that the population was concentrated within this zone. This proximity is of great importance especially for emergency situations. The proximity plays a vital role in the patients who should be rushed to hospital as soon as possible and in cases that require immediate intervention.

Another buffer zone was drawn around 3 km of hospitals (figure 7). The reason behind for selecting this distance is the ability of covering this distance in a short time, like 10 minutes, in situations in which traffic in the city is not congested.
According to the results of analysis, in Buyukcekmece having an area of 158 km$^2$, 89 km$^2$ (56.33%) of district territories is located within the zone of 3 km. It can be stated that this figure is also quite high and Buyukcekmece is in a pretty good situation in terms of its proximity to health care institutions.

Another analysis performed with regard to spatial analysis of health care institutions is the “shortest distance” analysis. As stated earlier, health care institutions are centered in the south of Buyukcekmece (figure 5). Therefore, settlements in the south side of the district are very close to health care institutions and distance analyses were performed by selecting the spots in the northern part of the district.

As can be seen from the maps, there are two pieces of northward extensions in Buyukcekmece district and these extensions are located on the west and east of Buyukcekmece Lake, extend until the northern end of the lake, and, even, even pass it. First of all, a spot, on the northern most of the extension located in the west of the lake and nearby the housings, was chosen and the distance between this spot and the nearest health care facility and the shortest route were identified (figure 7). The length of this route is 11.9 km. This means that a person, who resides in the west of Buyukcekmece Lake, would be able to reach the closest health facility within a short time of 10-15 minutes in case of emergencies. It can be said that this distance would comfortably be covered in 15 minutes considering the sparseness of settlements in the west bank of the Lake and, therefore, the less congestion of the traffic. In cases requiring ambulance, this time can be considered to be longer if arrival and departure of a vehicle is calculated, but departure and arrival of ambulance vehicles will be again a time of 15 minutes in a distance of 12 km. As is known, ambulances, which are not restricted by speed limitations and to whom every vehicle in traffic would make way for, would be cover distances in short period of time.
The second spot selected for distance analysis is located in the northeast of the lake and this distance is the farthest distance to the health care institutions within the boundaries of the district (figure 8). This distance is 15 km and it can be said that it could be covered in a period of 20 minutes taking the traffic in the city into account. However, in cases requiring ambulance, it can be stated that ambulance could go and come back this distance in a period of approximately 20-25 minutes.

Other residential areas within the boundaries of the district are very close to health care facilities (figure 5) and people are able to reach health care facilities from, at least, one-third of these residential areas on foot within a period of 10 minutes.
4. CONCLUSION

After all these results, it can be said that 23 health care institutions, which Buyukcekmece district possesses, are sufficiently close to the inhabitants of the district. In other words, the residents of Buyukcekmece do not have any problems related to the proximity to the health care institutions. In addition, Buyukcekmece State Hospital, within the boundaries of the district, is a health care institution that can provide all types of health services to the patients. Considering the city of Istanbul, city has many respected health care institutions primarily university hospitals. Even some of these facilities are worldly-renowned institutions.

Another result of our study is that GIS proved to be quite a useful tool in its city applications. GIS has a variety of analysis tools in order to be used for many applications, such as transportation, health, and education and can provide a wide range of conveniences to researchers, who conduct research in the related areas and urban planners. Besides the conveniences it provides, GIS makes it possible to achieve better outcomes with its tools such as overlay and proximity.

Another feature of GIS is that it is a technology-driven system or science. In other words, benefits of GIS will increase with the emergence of new methods, application and techniques. There is a huge difference between the benefit obtained from GIS tools and software 20 years ago and the benefits obtained today. Arc Map, which we used, can be a very good example to this. Arc Map started to offer “base map” to its users together with its 10 software versions, and thus users found the opportunity to access to so many maps, satellite images and aerial photographs belonging to every part of the world. In this study, “shortest path” analyses were made via “street” base map.

REFERENCES


