GIS BASED ACCESSIBILITY ASSESSMENT FOR PUBLIC SERVICES: ISTANBUL CASE

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INTRODUCTION

Accessibility can be considered as one of the prior needs of the urban functions in the growing and developing cities.

A city becomes accessible, if urban function and transportation infrastructure integrated city population and urban dynamics.

There is no single definition and explanation of the concept of accessibility. For, number of fields and study use accessibility definitions are different.

INTRODUCTION

Accessibility is commonly defined as;

- ✓ potential for interaction
- ✓ freedom of individuals to participate in different activities
- ✓ the ease of an individual to pursue an activity of a desired type, at a desired location, by a desired mode, and at a desired time
- ✓ the ease with which any land – use activity can be reached from a location using a particular transport system
- ✓ interaction with the activity or activities of time and location and its access quality
- ✓ The ease with which activities at one place may be reached from another via a specific travel model

INTRODUCTION

Accessibility of public transportation becomes more important because of *two* reasons.

1. The first is *high level of usage private car* and its unwanted results (Increasing greenhouse gas, Emission, Traffic congestion, Physical inactivity and obesity e.g.).
2. The second is the principle of *equality*. Equality issue is about the fact that whole society can be use equal level of travel in view of comfort, price, and time.

INTRODUCTION

In the city of Istanbul, the daily journey is very high and a large part of this journey is made by road. This causes considerable traffic congestion in Istanbul. The most important reason of traffic congestion is excessive use of private car and train system (Metro) does not meet with the current demand of city dwellers

In addition the transportation problem of Istanbul is;

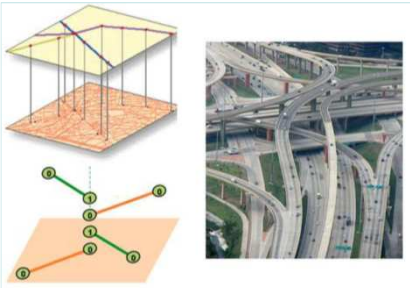
- increasingly number of the private car,
- rapid urbanization,
- lack of traffic safety.

A public survey applied to 9132 people shows that transportation and traffic (18%) are the primary problems of Istanbul.

In this study, by considering the concept of accessibility, Geographic Information Systems (GIS) in the scope of applicability of network analysis techniques were examined. Accessibility of subway was mapped in the case study of Istanbul province.

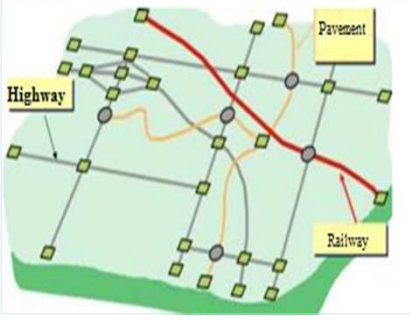
Network Analyst in GIS

A network is a system of interconnected elements, such as edges (lines) and connecting junctions (points) that describe possible routes from one location to another.



The line based geographic data such as highway network, water and sewerage system, electric and triangulation line network and etc. are interconnected with each other and they show continuity.

A network analysis can be defined as; making decision as a result of analyzing line based on geographic connections

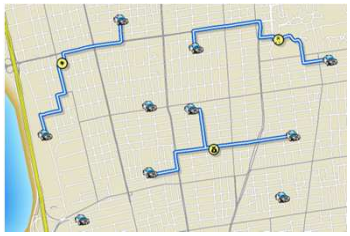


In network analysis decision maker or user need to use two factors:
These are impedance and supply – demand values.

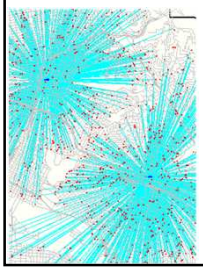
Network Analyst in GIS

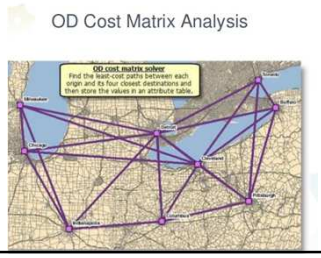
There are four important steps to create a network :

- Establishment of a data set and layers.
- The role setting of layer and connection values will be determined; travel time, Z values, and direction of data will be defined in attribute table.
- Returning data will be added to network.
- Network will be created.



Network analysis has various functionalities such as finding the best route, finding closest facility, service area, location – allocation, O – D cost Matrix, and vehicle routing problem.





Accessibility Components

Accessibility consists of use of land use, transportation systems, temporal and individual components;

Land Use Component: Land use components investigated in 3 groups:

Number, quality and spatial distribution of opportunities such as work places, stores, and health and recreation facilities in destination. At the end of the journey there is a direct ratio between the number of the places, level of importance it's for person and closeness between them.

Need for facilities: In network analysis origin and destination locations are important. In this way workplace – employee, student - school can be given as an example.

Capacity restriction of the facilities: Facilities with limited supply affect accessibility level. Even if a person reaches the destination, facility may not meet the demands of the person. As an example, there is not enough bed capacity in the hospital or no more movie tickets in a theatre when you reach the required facility.

Accessibility Components

Transportation Component: It includes activities causing losses during the journey depending on the type of transport. The activities are divided into 3 groups. First: **the waste of time during the journey**. It consists of travelling, parking, and waiting time for the transport. The second one is **cost of journey** and the third one is **journey attractions** such as safety, comfort, and accident risk.

These activities are related to supply and demand. Supply is concerned with the location and properties of the person, like speed of transportation and variety of transportation vehicle. Demand are concerned with both the person and cost of journey.

Time component: It refers to **the time constraints** in terms of access to the facilities. Time dimension of accessibility depends on the usability and available time of facilities during the day.

Person Component: Accessibility depends on needs, capacity, and opportunities of the person. Personal needs depend on the age, education level or incomes whereas the capacity depends on the physical conditions and availability of transportation system. Opportunities depends on the incomes and budget for travelling.

Accessibility Measures and Public Transits

The availability of the public transportation system is one of the main issues for both local government and researches.

Public transportation system contributes to social equality and decreases emission damages. Using public transportation decreases the level of carbon dioxide released to atmosphere, physical inactivity and related diseases such as obesity, cardiac disease, and cholesterol.

In this study, the availability of transportation is divided into 3 groups:

1. Access to transit stops,
2. Public transit travel time,
3. Access to destination by public transportation

Access to Transit Stops

In many studies the power of access to transit stops was researched in GIS. These studies summarized the proximity of first location and destination. Using this proximity, accessibility will map the accessibility of transit stops.

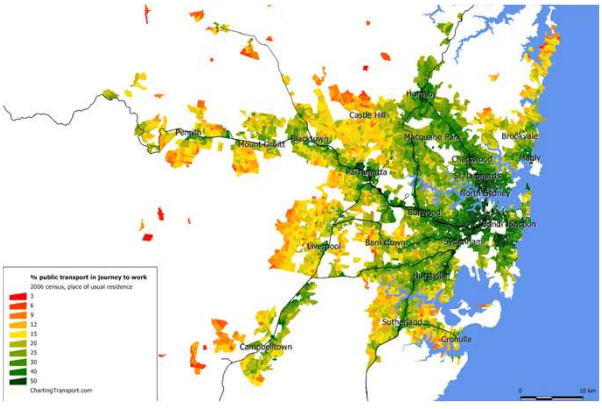
The accessibility of transit stops was calculated by ***using Euclidean and Network analysis tools***. Another way for calculating this accessibility is to determine number of step to walk to the transit stop. This calculation is generally based on survey results.

Duration of Public Transit Journey

Beside access to transit stops, the duration of public transit journey is also an important factor for accessibility measure.

Time interval between first and target destination affects the quality of accessibility.

Making **isochrones analysis**, calculating the public transit travel time, and making models to show transit service frequencies calculate this accessibility.



Access to Destination by Public Transport

The transit stops and duration of journey as much as route options and activity diversity will affect the accessibility. Researches showed that access to destination varies depending on using different transportation options.

For example, Huang and Wei, Wei (Huang & Wei, 2002) calculated access via public transit. In their study, access to destination was calculated by using public transit model, GIS based Land and Public Transport Accessibility Index (LUPTAI).

The LUPTAI combines accessibility calculated for walking distances, transit service frequencies, and public transit travel time.

CASE STUDY

Istanbul metropolitan area was chosen as a pilot area. According to Turkish Statistical Institute, Istanbul is **the most crowded city** of Turkey with 14.160.467 population. Istanbul contributes to Turkish economy more than any other city in Turkey. Thanks to geopolitical position of Istanbul, it has numerous transportation modes. The transportation demand of Istanbul is increasing day by day.

The railroad system of Istanbul started to be used in 1989 firstly and 993.742 people were carried by railway line.

There are 9 subway networks now in Istanbul and they serve to 112.046.120 people in 2014

CASE STUDY

This case study can illustrate walkability from the transit stops for each location as seen on Figure 2.
If the walking distance to metro or railroad station is less than 600 meters, it is considered at a high accessible level; between 600 - 800 meters considered as medium accessible level; between 800 -1000 meters considered as low accessible level; and lastly 1000-1200 meters as a poor accessible level.

Public Transportation	Train
High	Up to 600 m. walk
Medium	Up to 800 m. walk
Low	Up to 1000 m. walk
Poor	Up to 1200 m. walk

TRAIN	Service Frequency (min)			
Walking Distance (m)	≤15	30	60	>60
>0	H	M	L	P
100	H	M	L	P
200	H	M	L	P
300	H	M	L	P
400	H	M	L	P
500	H	M	L	P
600	H	M	L	P
700	M	M	L	P
800	M	M	L	P
900	L	L	L	P
1000	L	L	L	P
1100	P	P	P	P
1200	P	P	P	P
1300+	N	N	N	N

DATA COLLECTION

In this presentation, the data based on social-economic information depend on the transportation, construction, county, neighborhood, and traffic analyze zone under the scope of application of Istanbul Metropolitan Department was used.

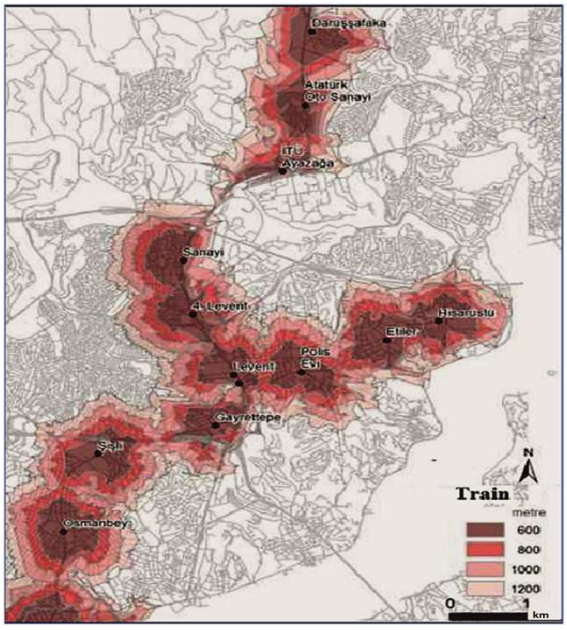
These data was integrated by using **ArcGIS10.1** software in a geographic database. Road systems and connections based on the arc - node topology rules were edited in order to make a network analysis.

The Snap tools were used to connect the available road data within **10 meters** of the area. After topologic corrections, network analysis was done to make the **assay of walking availability** of transport stops. In the network data representing road features, meter was used as a unit of length and minute as a unit of time. After finishing the network installation, the walking availability from the public transport stations to determined points was investigated.

APPLICATION

During the implementation phase of the study, Metro transportation is classified into their own in the group. In the grouping system, it is used **Transport Accessibility Index** (LUPTAI).

Figure demonstrates LUPTAI that is divided into high, medium, low, and poor area of subway transportation accessibility.



RESULT

Increasing accessibility levels improve the **quality of life** in metropolitan cities like Istanbul.

In addition, the accessibility of public transportation is the key of independence and equality of whole community.

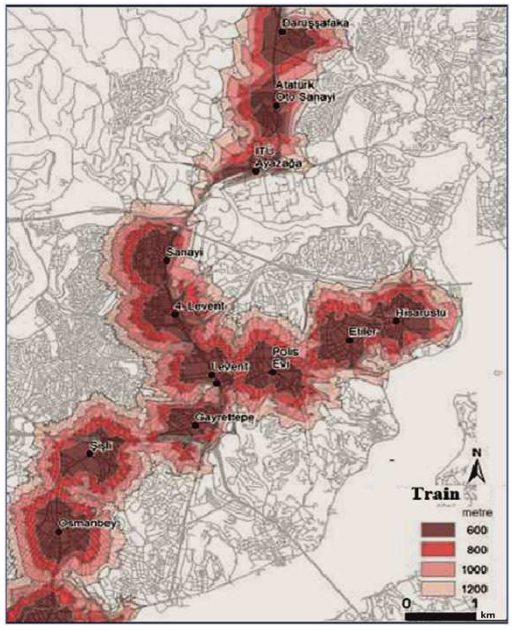
Subway public transportation is safe, modern; in addition, it is ecofriendly that protects the environment from gas emission and air pollution.

RESULT

Subway public transportation must be improved in highly populated neighborhoods of Istanbul.

Transportation problems may be reduced in this way.

As a consequence of the study, 371 out of 788 neighborhoods were determined at high accessibility level.

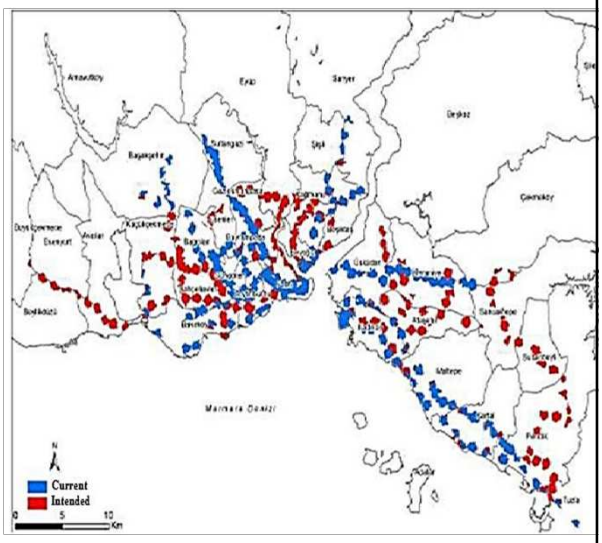


RESULT

The target of Istanbul Metropolitan Municipality for the period following **2023** is to increase the length of Rail System.

According to the Istanbul Transportation Master Plan, **615 km rail network** will be completed until the year 2023.

As a result of this evolution, **514 out of 788** neighborhoods will reach high accessibility level as illustrated on Figure (< 600m. walk).

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