Effect of land use to minimize urban transportation

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Abstract
The matter of transportation in cities specially in mega-cities cover various aspects of residents's life and inefficiency of transportation system may threat efficiency urban system and effect adversely on urban economic. Locating of land use in one of the robust tools to decrease expenditure of transportation. Using this powerful means, the optimal place can be determined to locate different kind of urban land uses and also minimize the demands of travel to or from the these land uses.

Close relationship of land use and transportation makes control and development of transportation facilities as powerful means to be use by manages,in order to direct urban development. Therefore land use activities deeply affects on improvement of transportation infrastructure. Finding the best place for utilization of land use is one of the main factors for reducing time of travel , that consequently decreases request of travel in cities and finally cost of transportation. Appropriate locating of a hospital, high school, police office, shopping center or another service center make access to these places more comfortable and provide least travel time.

With this respect in this paper a new method is presented for evaluation of reduction of demand due to land use and it's resulted economic effect. Finally this method is implanted for a shopping center in 9 region of Tehran city using Alfred Weber's locating algorithm and programming linear software. The result of locating this land use in optimal regions is evaluated and then comprise to other places of this region based on travel demand.

Keyword: Linear Programming, Travel demand, land-use Locating, Weber's problem, Shopping center

Introduction
Finding the best places to deploy User types of in land uses in the urban networks is one of the factors that reduce the length of travel and thus reducing of demand for travel within the city and ultimately will help for reducing the cost of transportation.

Urban land use planning is the locative and spatial organizing of the urban activities and functions and classify and will locate types of land uses (Ziari.2002). Urban land use system, is specifying the type of land use in the city, conducting the urban spatial organizing, determining the building and how to conform them with each other and with urban systems

and it create a Framework for optimum land use plan. and based on this framework we should prevent inappropriate using of land and economic objectives - social, physical limitations and environmental policy must be respected. in this article, we use the locating land use tool to optimize the urban transportation system to reduce additional urban transportation, that will lead to reduce the traffic.

The region 9of Tehran Municipality has been selected as the study area and a shopping center is selected as a specified land use.

Research Methodology

In this paper, the library studies and harvest of field has been used for analysis. In this way By studying the optimal locating model and using linear programming and QSB software and attention to field harvest of access Network for region 9 of Tehran municipality and restrictions of transportation was performed. Finally, the optimal location of shopping center in region 9 of Tehran is determined by analysis that we done

Transportation Planning

Proper transportation planning needs to study problems at different levels. decision Policies in a level may be have complications and significant effects on the transportation process. In fact, the most difficult conditions is that a transportation project has impact on its environment during their development. These changes on the environment will change demands on system and make it possible to change used criteria and data in the original model of plan. For example, a question that has been discussed for a long time this is: whether creating a new road creates excess capacity or will produce additional demand?

Mutual communication of transportation facilities and land use are shown in below figure. (Afandi Zade.2003)

![Fig 1 Cycle of transport and land](image)

Land use is the main and determinant factors in activity of travel production. Level of activity, the travel production and determining the travel directions in the district create the need of facilities. The provision of this facilities, changes accessing to land; this issue cause potential determining of land
Transportation Model

Travel is done mainly for utilization of educational, recreational, social and business opportunities. In fact, close relationship between land use and transportation can control or expand transportation facilities and make them one of the strongest geographic tools for planners until they can use it for conducting the urban development. (Suematsu, 2006)

Important changes which appears in land use, with changing the population size and distribution of residential population or changing industrial sites will changes the pattern of transportation demand.

so the primary goal of transportation planning is to create an efficient balance between land use activities and potential capacity of relationship between this activities.

Select the appropriate transportation route

In transportation planning selecting among paths to reach the specified center is very important that should be decided on clear criteria. The main variable in this decision is duration of travel.

Because in natural and normal conditions, passengers choose the shortest way among possible ways. In general we can claim that if there are no different constraints such as: crossing capacity for transportation facility, the shortest route between two region or neighborhood is used. But really the routes between two region may be very different on this lines such as: terrafic density, waist the time and used structures on it. That these factors impact on duration of travel.

Usually in consideration of planning three methods are used for this choice:
1) Selecting the path that minimize the duration of travel without limitations
2) conducting activities of transportation in the best route, with considering to related limitation with the density and capacity of roads
3) selection of different pieces of the route between the two regions according to the characteristics of each segment in terms of road considering to density and capacity constraints (Beizaei, 2003)

travel assignment method

In Transportation planning we must allocate travel demands to different links of transportation system. In fact, in the general case there are several ways to achieve from j region to i that each of them have own characteristics. (capacity, distance or duration of travel, etc.) (Tabibian, 2008). Loading of transportation system should be this way to minimize trip attempt (i.e., a combination of time, cost and lack of comfort, etc.) between the regions for all passengers. So the first step in the methods of travel allocation that is to determine the routes that minimize the attempt for travel in that routes and between regions. Of course, knowing the difficulty of each of the links, it can be done with shortest path method.

A network is composed by set of nodes in space that connect together by links in general mood. A network can be directed like a one-way streets or to be without. There is the extent that any link can support, or no capacity or complex. There are different ways for introducing a network. Network of graph is the graph expression of it. The following figure represents capacity and direction of communication network in region 9 of Tehran. Arrows represent direction of travel. Number of represent their capacity or the maximum amount of travel that can support.
Fig 2. Sample of communication network in region 9

Shortest path based on this way: from origin nodes and in a set of sequential steps, all nodes are marked. According to the shortest distance from the origin. in each step we determine a node that has minimum distance from the origin. This node is connected to origin directly or it is available through multiple marked nodes. In other words, the node that has the minimum distance should be connected by links directly or with routs that have multiple linkage to several nodes that are marked and then from that node to the origin. when all nodes were marked, mark of last node is the shortest path from origin, even the end node was marked before all nodes in the network.

We can not stop this process because it is possible that the shortest path from the origin that are not marked from the other nodes is available.

Dividing the region to neighborhoods and determining the network graph of region 9

The first step of the modeling is Dividing the region to neighborhoods and determining the graph of the network. In this paper, 13 neighborhoods in region 9 of Tehran is used for dividing. Then using GIS software, and using properties of population in statistical blocks in each neighborhood gravity Center of population in each neighborhood is derived. and then connector graph between the centers of gravity is achieved and Matrix of distance between centers of gravity is obtained based on actual data by miles.

Table 1.
Distance matrix

Estimation of minimum distance between the centers of gravity of population in neighborhood

Matrix of distance between centers of gravity is obtained by using two softwares: Network Modelling from QSB software and Netork analysis of Arc GIS software.

With Entering the network graph in Network Modeling software, minimum distance matrix is obtained. Optimal location of land use in the city is one of the major factors that leads to reduce the length of travel, reducing travel demand within the city, reducing air pollution and reducing costs resulting from transportation. Optimal locating of land use is important because that allocate large volumes of urban travel to itself. So, access to these centers or their services to existent network can be possible with minimum length of travel. Therefore, we will use Alfred Weber’s locating model for this purpose. And optimum location of shopping center will be determined by using the linear programming.

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Table 2 Minimum Distance Matrix

Estimation of the production or absorption of travel from any of the neighborhoods to specified land use

To calculate production rate of travel, we can calculate it with travel rate method. In this method, the number of produced or absorbed travel will be classified by different land uses, such as a shopping center or health facility. Which we can put the rate of producing or absorbing of travel in one group for different groups of land use, production rate of absorption of travel or travel in a group contract. For example, we can determine the number of travel that is done by a citizen to the shopping center and use its results for the entire city.

If we consider the population of the neighborhood (i) equal pi and if we consider Production and absorption rate of travel equal fi for a special land use, then we can show the amount of absorbed or produced travel as the following

\[ h_i = f_i \times \text{pop}_{(i)} \]  

(1)

The results of this process, will be used as input parameters of land use locating. These parameters include:

- \( d_{ij} \): Minimum distance matrix, Between each pair of origin - destination
- \( h_i \): Producing or absorbing the travel for any of the neighborhood to \( i \) from the specified land use

Locating the specified land use, Using the Locating theory and linear programming

The next step after determining the minimum distance matrix, between the centers of gravity is locating among the neighborhood by using the Weber model. We must answer this question: The land use j in which neighborhood be located until the total distance from this land use to points of producing or absorbing of travel be minimal?
Using the Weber model is the answer to this question which is possible by using linear programming. Linear programming model is important for planning purposes. This model optimizes the series of related decisions which have been adopted for nodes in different space or time or different plans. General form of linear programming is: at first the objective function is defined that is the combination of different variables. The objective function can be demonstrated as follows:

\[ C_0 + C_1 X_1 + C_2 X_2 + \cdots + C_n X_n \]  \hspace{1cm} (2)

that We Look for minimizing or maximizing the objective function due to the limitation. For example, assuming (2) limitation we can show the limitation like the following figure:

\[ a_{11} X_1 + a_{12} X_2 + a_{13} X_3 + \cdots + a_{1n} X_n = A_1 \]  \hspace{1cm} (3)

Weber model look for a location that minimize the total of weighted Euclidean distance by itself, to another fixed point. Weber p median model is one of the most common models which is used in decisions about location of land use. This model helps to find the location of facilities for minimizing the final weighted distance between nodes of absorber or producer of travel and facilities that have been allocated. And can be formulated as follows. (Weber.1970)

Minimize: \[ \sum_{i \in I} \sum_{j \in J} h_i \times d_{ij} \times y_{ij} \]

Subject to: \[ \sum_{i \in I} x_j = p \quad \& \quad \sum_{i \in I} y_{ij} = p \; \forall i \in I \]

\[ \forall i \in I \; \forall j \in J \leq y_{ij} - x_j \quad \& \quad X_j \in (0,1) \; \forall j \in J \]

\[ I: \] Set of nodes produced or absorbing Travel

\[ J: \] Collection sites have the ability to facilitate placement.

\[ h_{ij}: \] Rate of Production or absorption of travel in the node \( i \)

\[ d_{ij}: \] Distance between nod of \( i \) and candidate site \( j \)

\[ y_{ij}: \begin{cases} 
1 & \text{If node } i \text{ to node } j \text{ assigned to facility} \\
0 & \text{Otherwise} 
\end{cases} \]

\[ x_j: \begin{cases} 
1 & \text{If in node } j \text{ Facilities to be placed} \\
0 & \text{Otherwise} 
\end{cases} \]

\[ p: \] Number of facilities that should be locate

Now the best optimal location for locating a shopping center in the region 9 of Tehran Municipality is determined using Weber's algorithm, and employing Linear programming

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<th>Population</th>
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Table 3. Travel demand of the 13 neighborhoods. If we establish the shopping center in neighborhood 6
Conclusion
What is Obvious, the geometry of transportation network in a region or in an urban location affects on functions from many sides. For example, linkage capacity, defines the total surface of interaction that is done through the entire network. So it limits the final amount of space interaction. Finally, the function characteristics of transportation systems and managing the peak hours of travel have a relationship with the allocation of travel directly. So optimum locating of land use that allocate the large volumes of travel to itself is very important for improving the traffic. In the article, the optimal location to establish the shopping center was determined in the neighborhood 6 of region 9 of Tehran Municipality which has the minimum length of travel from other localities, according to the traffic restrictions of the networks was obtained through the harvest of field.

Reference:
5- Suematsu, Ch. (2006), Interface from Transaction Cost Approach, Kyoto University Press

Appendices
neighborhood 6 As the optimal location for a shopping center is selected by qsb software
the shortest path between center of gravity of 13 neighborhoods