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 organizating 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 transportion 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 transportion planning needs to study problems at different levels. decision Policies in a level may be have complications and significant effects on the transportion 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)

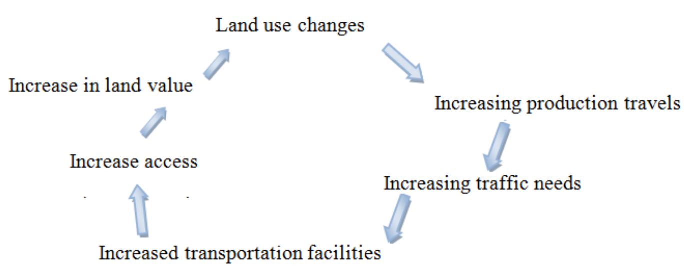

Fig 1 Cycle of transport and land

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

Transportion Model

Travel is done mainly for utilization of educational,recreational,social and business opportunities
In fact, close relationship between land use and transportion 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 is appears in land use,with changing the population size and distribution of residential population or changing industrial sites will changes the pattern of transportion 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 transportion 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 routs 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.) (Tabibian2008).Loading of transportation system should be this way to minimize trip attempt (ie a combination of time ,cost and lack of comfort etc.) between the regions for all of 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 routs 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 s 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 that are not marked from the other nodes and is an intermediate node, be 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.

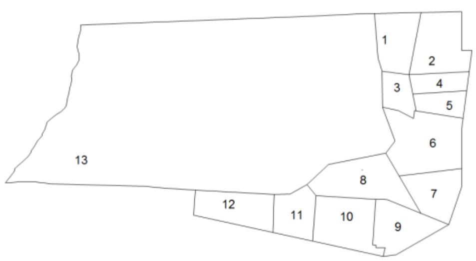

Fig 3: Neighborhoods Division

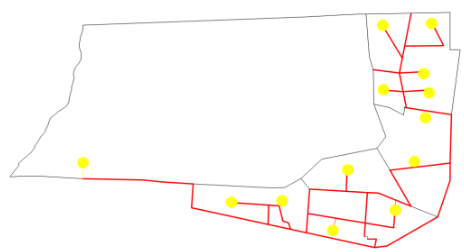

Fig 4: Population centers of gravity neighborhoods

□	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	1.18	0.84	1.35	1.57	1.62	0	0	0	0	0	0	0
2	1.2	0	1.49	0.85	1.05	1.65	0	0	0	0	0	0	0
3	0.8	1.49	0	0.83	0.96	0.82	0	0	0	0	0	0	0
4	1.4	0.85	0.83	0	0.65	1.02	0	0	0	0	0	0	0
5	1.6	1.05	0.96	0.65	0	0.68	0	0	0	0	0	0	0
6	1.6	1.65	0.82	1.02	0.68	0	1.69	3.75	3.45	4.5	5.47	6.26	8.74
7	0	0	0	0	0	1.69	0	2.04	1.65	2.8	3.77	4.53	7.01
8	0	0	0	0	0	3.75	2.04	0	0.69	0.8	1.46	3.01	5.49
9	0	0	0	0	0	3.45	1.65	0.69	0	1.2	2.66	3.49	5.97
10	0	0	0	0	0	4.51	2.78	0.84	1.15	0	1.67	2.5	5
11	0	0	0	0	0	5.47	3.77	1.46	2.66	1.7	0	1.58	4.06
12	0	0	0	0	0	6.26	4.53	3.01	3.49	2.5	1.58	0	2.48
13	0	0	0	0	0	8.74	7.01	5.49	5.97	5	4.06	2.48	0

Table 1.

Distance matrix

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

Matrix of distance beween centers of gravity is obtained by using two software: 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 decrease 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 of for this purpose. and optimum location of shopping center will be determined by using the linear programming .

13	12	11	10	9	8	7	6	5	4	3	2	1	
11.93	9.45	7.87	7.17	6.02	6.41	4.37	2.68	2	1.35	0.84	1.18	0	1
11.43	8.95	7.37	6.67	5.52	5.91	3.87	2.18	1.5	0.85	1.68	0	1.18	2
11.41	8.93	7.35	6.65	5.5	5.89	3.85	2.16	1.48	0.83	0	1.68	0.84	3
10.58	8.1	6.52	5.82	4.67	5.06	3.02	1.33	0.65	0	0.83	0.85	1.35	4
9.93	7.45	5.87	5.17	4.02	4.41	2.37	0.68	0	0.65	1.48	1.5	2	5
9.25	6.77	5.19	4.49	3.34	3.73	1.69	0	0.68	1.33	2.16	2.18	2.68	6
7.56	5.08	3.5	2.8	1.65	2.04	0	1.69	2.37	3.02	3.85	3.87	4.37	7
5.52	3.04	1.46	0.84	0.69	0	2.04	3.73	4.41	5.06	5.89	5.91	6.41	8
6.21	3.73	2.15	1.15	0	0.69	1.65	3.34	4.02	4.67	5.5	5.52	6.02	9
5.73	3.25	1.67	0	1.15	0.84	2.8	4.49	5.17	5.82	6.65	6.67	7.17	10
4.06	1.58	0	1.67	2.15	1.46	3.5	5.19	5.87	6.52	7.35	7.37	7.87	11
2.48	0	1.58	3.25	3.73	3.04	5.08	6.77	7.45	8.1	8.93	8.95	9.45	12
0	2.48	4.06	5.73	6.21	5.52	7.56	9.25	9.93	10.6	11.41	11.43	11.93	13

Table 2 .Minimum Distance Matrix

Estimation 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 of 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

$h\,i = f\,i * pop_{(i)}$ (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 / 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 optimize 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 differentvariables. The objective function can be demonstrated as follows

$$C_0+C_1X_1+C_2X_2+C_3X_3+........C_nX_n \qquad (2)$$

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

$$a_{11}X_1+a_{12}X_2+a_{13}X_3+........a_{1n}X_n=A_1 \qquad (3)$$

$$a_{11}X_1+a_{12}X_2+a2_3X_3+........a_{2n}X_n=A_2$$

....

$$a_{m1}X_1+a_{m2}X_2+a_{m3}X_3+........a_{mn}X_n=A_n$$

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)

$$\text{Minimize:} = \sum_{i \epsilon I}^{n} \sum_{j \epsilon J}^{n} hi * dij * yij$$

$$\text{Subject to:} \sum_{i \epsilon I} xj = p \quad \& \quad \sum_{i \epsilon I} yij = p \;\; \forall i \in I$$

$$\forall i \in I \quad \forall j \in J \quad \leq \text{y ij} - \text{x j} \quad \& \quad X_j \in (0,1) \; \forall j \in J$$

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)

$$y_i : \begin{cases} 1 & \text{If node i to node j assigned to facility} \\ 0 & \text{Otherwise} \end{cases} \qquad x_j: \begin{cases} 1 & \text{If in node j Facilities to be placed} \\ 0 & \text{Otherwise} \end{cases}$$

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 programing

	1	2	3	4	5	6	7	8	9	10	11	12	13
Population													
Trip Production Rates	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Trip Production	628	1092	573	593.96	701.2	498.7	1057	664	735.07	1043	426.2	350	338.865
Travel demand, from Neighborhoods	1685	2380	1237	789.96	476.8	0	1786.2	2476	2455.1	4683.2	2212	2370	3134.5

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

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appendices

neighboarhood 6 As the optimal location for a shopping center is selected by qsb software

olution Summary for LP Sample Problem

3-29-2011 18:46:08	Decision Variable	Solution Value	Unit Cost or	Total Contribution	Reduced Cost	Basis Status
1	y11	0	0	0	0	basic
2	y12	0	1,288.2300	0	0	basic
3	y13	0	480.9554	0	0	basic
4	y14	0	801.8392	0	0	basic
5	y15	0	1,402.4480	0	0	basic
6	y16	1.0000	1,336.3950	1,336.3950	0	basic
7	y17	0	4,618.8760	0	2,697.6030	at bound
8	y18	0	4,254.9320	0	2,333.6590	at bound
9	y19	0	4,425.0970	0	2,503.8240	at bound
10	y110	0	7,478.5250	0	5,557.2520	at bound
11	y111	0	3,354.0440	0	1,432.7710	at bound
12	y112	0	3,307.5000	0	1,386.2260	at bound
13	y113	0	4,042.6590	0	2,121.3860	at bound
14	y21	0	741.7444	0	0	basic
15	y22	0	0	0	0	basic
16	y23	0	961.9109	0	0	basic
17	y24	0	504.8618	0	0	basic
18	y25	0	1,051.8360	0	0	basic
19	y26	1.0000	1,087.0680	1,087.0680	0	basic
20	y27	0	4,090.4000	0	957.9004	at bound

03-29-2011 18:46:08	Decision Variable	Solution Value	Unit Cost or	Total Contribution	Reduced Cost	Basis Status
34	y38	0	3,909.7590	0	0	basic
35	y39	0	4,042.8630	0	133.1045	at bound
36	y310	0	6,936.1490	0	3,026.3910	at bound
37	y311	0	3,132.4300	0	0	basic
38	y312	0	3,125.5000	0	0	basic
39	y313	0	3,866.4500	0	0	basic
40	y41	0	848.6060	0	0	basic
41	y42	0	927.9620	0	0	basic
42	y43	0	475.2298	0	0	basic
43	y44	0	0	0	0	basic
44	y45	0	455.7956	0	0	basic
45	y46	1.0000	663.2111	663.2111	0	basic
46	y47	0	3,191.9920	0	0	basic
47	y48	0	3,358.8080	0	0	basic
48	y49	0	3,432.7580	0	73.9504	at bound
49	y410	0	6,070.4350	0	2,711.6270	at bound
50	y411	0	2,778.7000	0	0	basic
51	y412	0	2,835.0000	0	0	basic
52	y413	0	3,585.1920	0	226.3838	at bound
53	y51	0	1,257.1940	0	0	basic

Solution Summary for LP Sample Problem

03-29-2011 18:46:08	Decision Variable	Solution Value	Unit Cost or	Total Contribution	Reduced Cost	Basis Status
67	y62	0	2,379.9500	0	0	basic
68	y63	0	1,236.7430	0	0	basic
69	y64	0	789.9601	0	0	basic
70	y65	0	476.8323	0	0	basic
71	y66	1.0000	0	0	0	basic
72	y67	0	1,786.2470	0	0	basic
73	y68	0	2,475.9590	0	0	basic
74	y69	0	2,455.1200	0	0	basic
75	y610-	0	4,683.2050	0	2,207.2460	at bound
76	y611	0	2,211.8790	0	0	basic
77	y612	0	2,369.5000	0	0	basic
78	y613	0	3,134.5010	0	658.5422	at bound
79	y71	0	2,746.9690	0	1,392.8250	at bound
80	y72	0	4,224.9570	0	2,870.8130	at bound
81	y73	0	2,204.3790	0	850.2354	at bound
82	y74	0	1,793.7440	0	439.6003	at bound
83	y75	0	1,661.9010	0	307.7571	at bound
84	y76	1.0000	842.7269	842.7269	0	basic
85	y77	0	0	0	0	basic
86	y78	0	1,354.1440	0	0	basic
87	y79	0	1,212.8590	0	0	basic
88	y710	0	2,920.4840	0	1,566.3400	at bound
89	y711	0	1,491.6340	0	137.4897	at bound
90	y712	0	1,778.0000	0	423.8562	at bound
91	y713	0	2,561.8190	0	1,207.6760	at bound
92	y81	0	4,029.3070	0	656.8932	at bound
93	y82	0	6,452.0650	0	3,079.6520	at bound
94	y83	0	3,372.4140	0	0	basic
95	y84	0	3,005.4120	0	0	basic
96	y85	0	3,092.3980	0	0	basic
97	y86	1.0000	1,859.9830	1,859.9830	0	basic
98	y87	0	2,156.1800	0	0	basic
99	y88	0	0	0	0	basic

03-29-2011 18:46:08	Decision Variable	Solution Value	Unit Cost or	Total Contribution	Reduced Cost	Basis Status
100	y89	0	507.1955	0	0	basic
101	y810	0	876.1452	0	0	basic
102	y811	0	622.2242	0	0	basic
103	y812	0	1,064.0000	0	0	basic
104	y813	0	1,870.5350	0	0	basic
105	y91	0	3,784.1540	0	2,118.6470	at bound
106	y92	0	6,026.2940	0	4,360.7870	at bound
107	y93	0	3,149.1130	0	1,483.6050	at bound
108	y94	0	2,773.7700	0	1,108.2620	at bound
109	y95	0	2,818.9200	0	1,153.4130	at bound
110	y96	1.0000	1,665.5080	1,665.5080	0	basic
111	y97	0	1,743.9690	0	78.4614	at bound
112	y98	0	458.0192	0	0	basic
113	y99	0	0	0	0	basic
114	y910	0	1,199.4850	0	0	basic
115	y911	0	916.2891	0	0	basic
116	y912	0	1,305.5000	0	0	basic
117	y913	0	2,104.3520	0	438.8439	at bound
118	y101	0	4,507.0410	0	699.4766	at bound
119	y102	0	7,281.7730	0	3,474.2090	at bound
120	y103	0	3,807.5640	0	0	basic
121	y104	0	3,456.8180	0	0	basic
122	y105	0	3,625.3280	0	0	basic
123	y106	1.0000	2,238.9610	2,238.9610	0	basic
124	y107	0	2,959.4630	0	0	basic
125	y108	0	557.5886	0	0	basic
126	y109	0	845.3259	0	0	basic
127	y1010	0	0	0	0	basic
128	y1011	0	711.7223	0	0	basic
129	y1012	0	1,137.5000	0	0	basic
130	y1013	0	1,941.6960	0	0	basic
131	y111	0	4,947.0590	0	2,359.0390	at bound
132	y112	0	8,045.9770	0	5,457.9570	at bound

the shortest path between center of garavity of 13 neighborhoods