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# Route Choice Decision based on Real Time Information

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**Abstract:** The aim of this study is to find out the travel time between the zones by different routes of the study area and discover the shortest travel time which is calculated by using the online data. In this study the OD matrix of the flow is updated in each loop of the algorithm by using the double constraint gravity model and traffic assignment, also the delay time of the intersections are calculated. The calculated travel times are capable for informing the traveler on the internet or other Medias for letting the traveler to choose the best travel route. The data required for this study are collected from Closed Circuit Television (CCTV) and the program is written with Visual Basic.NET (Microsoft, 2008). Users of this program are capable for selecting their origin and destination and they find out the travel time, the length of the route and different possible path is illustrated by different color on the figure for the users.

**Key words:** Travel time, best travel route, traffic congestion, traffic flow, delay time

## INTRODUCTION

Nowadays, in the majority of the cities, chronic traffic jam happens and traffic congestions lose billions hours and money. For decreasing these losses, it is required to create an efficient method to resolve traffic congestion and reduce the delay time (Hashimoto, 1990). There are three basic strategies to relieve congestion. The first is to increase the transportation infrastructure. This strategy is very expensive and can only be accomplished in the long term. The second is to limit the traffic demand or make traveling more expensive, which will be strongly disapproved of by travelers. The third is to focus on efficient and intelligent utilization of the existing transportation infrastructure. This strategy is the best trade-off and gains more and more attention. Currently, the Intelligent Transportation System (ITS) is the most promising approach to implementation of the third strategy (Li *et al*., 2008). Jennifer and Shearer (1998) found that the availability of the pre-trip information to the driver enhances drivers' self-belief to use the best route and allow commuters to make better-informed transit choices Travelers information and guidance saves travel time and helps a traveler to avoid congestion on the other hand it can improve traffic network performance and it's more efficient than paper maps or written instruction. There is now a strong need to make our route travel as efficient as possible (Schrank and Lomax, 2005). Travel time reliability refers to variability of travel times from time to time because of unpredictable underlying conditions over the time. Travel time variations on expressways are the result of interactions between demand, capacity, weather conditions, accidents, work zones and traffic composition (Mehran and Nakamura, 2008)

Existence of trip planning system considering activities help people for optimum use of their time and money and also helps in understanding travel behavior (individual travel behavior includes route, mode and destination choices), travel frequency, activity scheduling and pre-travel decision making in an urban area and daily activities that affect estimation of individual response to policy measures and changes because of environmental constraints (Kolyaie *et al*., 2009).

Most people will have had the experience of giving or receiving directions for navigating through an unfamiliar geographic environment, in such situations, often the travelers are addressed by the shortest route to their destinations and this is the goal of most automated navigation systems and they don't consider the delay time and the fuel cost of the vehicles. Moreover, with explosive growth of traffic, the shortest path routing paradigm of the current situation of traffic also leads to unbalanced traffic distribution: links on frequently used shortest paths become increasingly congested, while links not on shortest paths are underutilized (Crawley *et al*., 1998).

Travel time depended very much on local factors such as the amount of traffic, frequency of interruption of

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traffic flow by pedestrians, the ratio of traffic density on the different branches etc. Travel time is a key variable that influences motorist's choice of route, mode, destination, frequency and trip timing (Sascha *et al*., 2005). Provision of travel time information to motorists has the potential to influence traffic patterns and thereby reduce congestion and improve network efficiency (Ben-Akiva *et al*., 1991) while also benefiting users in less tangible ways by decreasing uncertainty and reducing stress (Adler and Blue, 1998). Consequently, the provision of travel time information to motorists via roadside or in-vehicle systems has become a priority for many road authorities.

Travel time has effect on the behavior of the drivers. They often require drivers to decelerate from and reaccelerate to, highway speeds and can involve one or multiple stops. One concern about congested route is that vehicle emissions will increase because of the occurrence of excessive delays, queue formation and speed change cycles for approaching traffic. These occurrences could have a significant impact on congestion and air quality in the surrounding urban area (USFHA, 2000).

Travel-time information could be applied in various fields and purposes. From the travelers' viewpoints, the travel-time information helps to save travel-time and improve reliability through the selection of travel routes pre-trip and en-route. In the application of logistics, travel-time information could reduce the delivery costs, increase the reliability of delivery and improve the service quality. For traffic managers, travel-time information is an important index for traffic system operation (Lin *et al*., 2005).

Predicted travel-time information provides the capacity for road users to organize travel schedule pre-trip and en-trip. It helps to save transport operation cost and reduce environmental impacts. Besides, accurate travel time information also helps delivery industries to promote their service quality by delivering on time. However the development of travel time estimation and prediction are suffered from the shortage of traffic data sets and too much interference from transport environment (Paterson and Rose, 2007). Travel time calculation has an increasing demand for the accurate short-term travel time counting. Depending on the data source, short-term traffic counting models can be mainly classified into three groups: (1) those using only historical data (2) those using only current data and (3) those using both historical and current data (Lin *et al*., 2004).

This study tries to analysis and calculates the travel time of the routes and find out the effect of different levels of traffic on travel time for finding the best route in the dynamic traffic network. This study proposes an efficient traffic congestion reducing scheme where each vehicle can obtain adequate traffic information to the vehicle and each vehicle can select a route to its destination.

## MATERIALS AND METHODS

**Urban street class:** Many attempt happened in many parts of the world especially in advanced countries for using the Intelligent Transport System (ITS) and new technologies create for helping the passengers. Total travel time contain of some different items, this study shows the travel time which is enclose delay time and free flow travel time. This study conducted in Mashhad which is one of the biggest cities of Iran. Mashhad is a religious city in Iran that many pilgrims visit it annually and it makes the city very crowded in some part of the year. There are also many other places that they make production and attraction such as universities, schools, factories and its 1000 km away from Tehran. This study tries to solve the problem of traveler in one part of the Mashhad which is called Hashemie. The data are collected in fall of 2009. The study area is contained of 6 different zones that they are more important parts of the Hashemie on the other hand, this study consider that the travels occur among these parts, furthermore the distance between each zones are illustrated in Table 1 and Fig. 1.

**Travel time:** The total time that a vehicle spends on a segment of an urban street is running time ($T_r$) and total delay (D) at signalized intersections (Highway Capacity Manual, 2000):

Table 1: Distance between the zones

| Link | Length (km) |
|---|---|
| AB-BA | 2 |
| BC-CB | 5 |
| AE-EA | 2 |
| EF-FE | 4 |
| FD-DF | 4 |
| CD-DC | 3 |
| ED-DE | 7 |
| EB-BE | 2 |

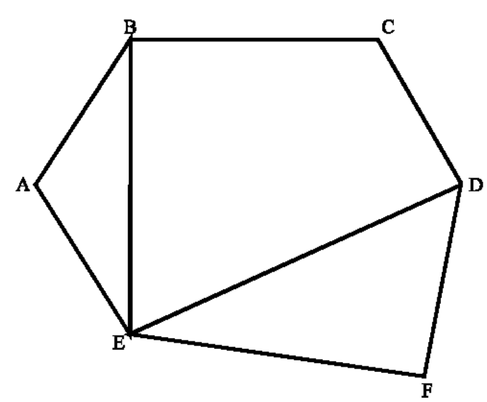


Fig. 1: Study area

$$\text{Total time} = T_r + D \quad (1)$$

Where:
$T_r$ = Running time per Mile × Average Segment Length

**Running time:** The first step of this part tries to find the production and attraction of each zone by using the land use calculation for morning and evening. That the result of calculation of the morning illustrate in Table 2. For calculating the production and attraction the area should consider all the land use of the zones such as office, government health center, shopping complex, school, college/university, shop house that they have different impact on the attraction and production of the area.

After doing the OD matrix the numbers are multiply to the average number of the production and attraction to make the total number of them the same. Table 3 is the number of production and attraction after editing.

In the next step the number of traveller from each zone to their destination calculate with calculate with using the double constraint gravity model, In the gravity model is the difficulty of route that in the first loop of the algorithm it consider as a distance and in the second and the rest of the loops it consume as a travel time. On the other hand, different type of the vehicle has different impact on the traffic so the passenger car unit factor is used to make the same all the vehicle impact. One problem which is obvious after doing the OD matrix (Table 4) it shows that the number of production and attraction is not equal with the number of that which is shown in the Table 3 one so in the next movement the number of production and attraction fix to be equal with Table 3:

$$T'_{ij} = \left(\frac{A_j}{\sum T_{ij}}\right) \quad (2)$$

$$T'_{ij} = \left(\frac{P_i}{\sum T_{ij}}\right) \quad (3)$$

$$T_{ij} = K_i K_j \frac{P_i A_j}{C_{ij}^{\alpha}} \quad (4)$$

Where:
P = Production
A = Attraction
$C^{\alpha}_{ij}$ = Difficulty of travel

Formula 3 shows the double constraint gravity model that is used for calculating the number of the travelers between the zones (Behnam, 2006).

The OD matrix of the flow should illustrate the overall number of production and attraction and it have to be 9080 (regarding to Table 3) but its 7629 in Table 4, so with using formula 1 and 2 (Behnam, 2006) the values of the Table 4 is key in the formulas and after 19 time recalculating, the total number of the production and attraction become 9080. Table 5 shows the flow of the vehicle among the zones without considering of merging the cars together.

One of the problems of this study is to find out the number of the vehicles in each link, because the vehicles that have different origin and destination they merge together in each link and the number of the vehicles among the links are should calculate to find out the exact number of the flow along the links. In the next step the travel time among the zones are calculated with the following procedure;

The first step of calculating the travel time is to spread the volume of the vehicles in the links by using the incremental loading method to find out the number of the

Table 2: Production and attraction of each zone before editing

| Zone | Production | Attraction |
|---|---|---|
| a | 1500 | 1900 |
| b | 1760 | 1300 |
| c | 1300 | 2100 |
| d | 1500 | 1200 |
| e | 1100 | 1900 |
| f | 1700 | 900 |
| Total | 8860 | 9300 |

Table 3: Number of production and attraction

| Zone | Production | Attraction |
|---|---|---|
| a | 1537 | 1855 |
| b | 1804 | 1269 |
| c | 1332 | 2050 |
| d | 1537 | 1172 |
| e | 1127 | 1855 |
| f | 1742 | 879 |
| Total | 9080 | 9080 |

Table 4: First OD matrix before editing the number of travels between the zones

| Zones | a | b | c | d | E | F | Production |
|---|---|---|---|---|---|---|---|
| a | 0 | 632 | 84 | 18 | 1433 | 1 | 2168 |
| b | 847 | 0 | 136 | 48 | 768 | 5 | 1803 |
| c | 6 | 95 | 0 | 507 | 190 | 209 | 1006 |
| d | 113 | 53 | 433 | 0 | 185 | 5 | 790 |
| e | 543 | 365 | 10 | 22 | 0 | 12 | 951 |
| f | 15 | 159 | 70 | 340 | 326 | 0 | 910 |
| Attraction | 1523 | 1303 | 734 | 935 | 2903 | 231 | 7629 |

Table 5: Final OD matrix after 19 times of using formula 1 and 2

| Zones | a | B | c | d | E | F | Production |
|---|---|---|---|---|---|---|---|
| a | 0 | 375 | 168 | 10 | 728 | 256 | 1537 |
| b | 981 | 0 | 269 | 27 | 389 | 137 | 1804 |
| c | 13 | 146 | 0 | 605 | 202 | 366 | 1332 |
| d | 177 | 55 | 1209 | 0 | 90 | 6 | 1537 |
| e | 640 | 338 | 25 | 10 | 0 | 114 | 1127 |
| f | 44 | 356 | 376 | 520 | 446 | 0 | 1742 |
| Attraction | 1854 | 1270 | 2048 | 1173 | 1856 | 879 | 9080 |

flow in all the possible paths from each origin to their destination. Incremental loading is used for calculating the traffic flow and travel time of each link that the calculation method of traffic flow and travel time of one path is shown in Table 6. In this study the first two paths in travel time are considered the only possible path between two zones. Also each path divides to their links to help the designer to calculate the travel time in each link with using formula 4 (Behnam, 2006). After each step of adding the flow in incremental loading the new OD matrix should be produce and the travel time for each step will be finding from the OD matrix with following formula:

$$T = T_{\circ}\left[1 + 0.15\left(\frac{V}{C}\right)^4\right] \quad (5)$$

Where:

T = Travel time
$T_{\circ}$ = Free flow
V = Traffic flow
C = Capacity of the road

Travel time is the total time that the vehicle spend for travelling from one origin to the destination which is contain of running time and delay time. There are different types of delay time that they have different way of calculating that they are described in the following part.

After finishing the steps of adding the flow (incremental loading) the OD matrix of the travel time should construct and it's ready for informing the traveller by internet or mobile network.

**Delay time:** Travel time is calculated in the previous part with using Table 5 and Eq. 5. Travel time is calculated in the previous part and one example of that is illustrate in Table 5 and in the following section the delay time of the intersections are calculated to find out the total time. Intersection delay is the total additional travel time experienced by drivers, passengers, or pedestrians as a result of control measures and interaction with other users of the facility, divided by the volume departing from the corresponding cross section of the facility (Highway Capacity Manual, 2000). On the other hand this study tries to calculate also the total travel speed and total urban street LOS. The urban street class is separated into four categories: high-speed, suburban, intermediate and urban. Eq. 6 gives an estimate of control delay assuming perfectly uniform arrivals and a stable flow. It is based on the first term of the Webster's delay formulation and is accepted as an accurate depiction of delay for the ideal case of uniform arrivals. Values of X greater than 1.0 are not used in the computation of 1 (Highway capacity manual, 2000):

$$d = 0.5C\left[1 - \frac{g}{C}\right]^2 / \left\{1 - \left(\frac{g}{C}\right)\left[\text{Min}\,(1, X)\right]\right\} \quad (6)$$

Where:

X = V/C ratio for lane group
C = Cycle length (sec)
g = Effective green time for lane group (sec)

## RESULTS

After finding out the delay time at intersections the total time which is described in the formula 11 is calculated and the Table 7 shown the OD matrix of total travel time of the study area and this travel time is the time that is ready to inform travelers for helping them in their decisions.

One of the difficulties of this study is the shortage of the CCTV cameras that it makes the data collection hard, in this step the Moore algorithm is used for solving this problem, 4 cameras install on 4 different links (BC, ED, EA and DC) for observing the number of the cars. On the other hand, there is a straight relation between the flows of these four links with the rest of the links. So the traffic flow of the links should be collected as a historical data for all the times of day and the result of the data collection should list and arrange in one table for using in the Moore algorithm.

After broadcasting the travel time to travelers, the flow of the 4 links are counted by the CCTV cameras and with using the Moore algorithm the flow of the other routes are find out and the travel time of the paths are compute. In the next step, the calculated travel time key in the formula of the constraint gravity model and doing the rest steps of the first loop of the algorithm to find out the travel time of the travelers.

Table 6: Travel time of zone e to d from different paths without considering the delay time

| Route (e-d) | Percent of the flow | Travel time (e-d) min | Flow | Percent of the flow | Travel time (e-f) (f-d) min | Flow |
|---|---|---|---|---|---|---|
| | 25 | 5.6 | 2 | 25 | 5.6 | 2 |
| | 50 | 5.6 | 5 | 50 | 5.6002 | 44 |
| | 75 | 5.6000 | 11 | 75 | 5.6182 | 1379 |
| | 100 | 7.4126 | 342 | 100 | 7.3692 | 4322 |

Table 7: The OD matrix of travel time of the study area in minute

| Zones | a | b | c | d | e | f |
|---|---|---|---|---|---|---|
| a | 0 | 1.60 | 6.49 | 12.76 | 1.61 | 52.18 |
| b | 1.62 | 0 | 4.60 | 6.51 | 1.66 | 12.29 |
| c | 54.81 | 11.92 | 0 | 4.02 | 10.13 | 5.94 |
| d | 7.57 | 9.30 | 3.47 | 0 | 5.62 | 2.43 |
| e | 1.60 | 1.61 | 14.71 | 7.36 | 0 | 7.02 |
| f | 24.45 | 12.10 | 8.34 | 2.97 | 4.19 | 0 |

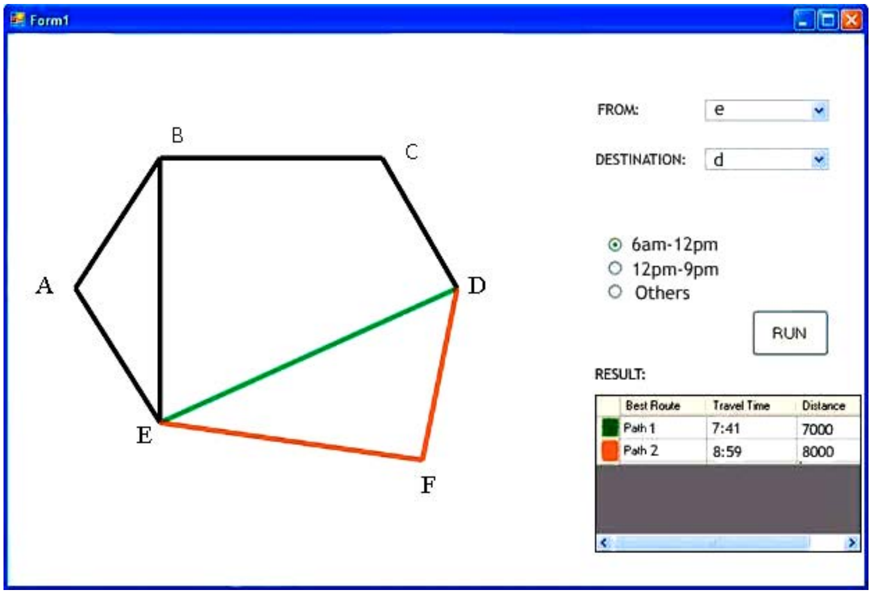


Fig. 2: Sample of program

For demonstrating this study, it is divided into three different period of time: phase one which is from 6 am to 12 pm and the second phase is from 12 to 9 pm and phase three that the third phase which is the rest time of the day that the travelers can travel with the free flow travel time. Figure 2 shows the program that is developed using Visual Basic.Net. This program will guide user the best route to go after user pick the origin and destination to go. It shows the total travel time included the delay time and distance for each route. The best route will display on the top part of the result bar and specify with the green color and the second choice is showed by the red color that both the routs are illustrated on the map. User will be able to choose the time they want to use the road and are able to plan their journey ahead.

## DISCUSSION

Traffic congestion is one of the most important issues in transportation network and it needs the immediate attention. One of the possible ways for remedy of the congestion is to establish more infrastructure, but it's usually financially and environmentally (Chabini and Gao, 2005) so this study tries to show that the drivers can benefit from good-quality advanced traveler information in many ways. It can help them to optimize their travelling or at least make more informed travel decisions. This study attempted to calculate the travel time, in order to promote greater use of Route Choice Decision and facing the less congestion on the streets for helping the travelers to reduce the cost and their time (Act, 2004); the new method is used for calculating the travel time by collect the real time data for analyzing the dynamic traffic network.

One of the important factors of this study is the dynamic information about alternative routes (Abdel-Aty *et al*., 1995). The findings of Karthik and Mahmassani (1999) indicated that many drivers refer to travel time information displayed on Variable Message Signs (VMS) and change their routes according to it.

The future research is to calculate the level of service, delay time of roundabout, make it possible for users to specify their origin and their destination by selecting them on the map and produce a device that is capable for installing on the car that it makes the decision of the users easy to change their destination or being inform about the latest update of the software.

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