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Modifying traffic routes and bus stations down town "Hamedan" using geographically informational systems(GIS)

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Abstract:
As we Know, all of the urban regions are developed by increasing population, social- economical activities and also demands for exploiting facilities and infrastructure in those areas. Transportation is one of the infrastructure facing the increase of demands in cities. Referring to this matter, it can be understood that most of the cities in developing countries as Iran, having developed considerably during the recent decades, include different problems in intra city transportation. So, they should change their public transport system.
"Hamedan" is a city, while developing, has had a special situation in extending travels or journeys, up to now, but it cannot provide enough welfare services for its own citizens. In other words, this city is lacking improved transportation systems to be able to meet these needs or demands. Because of this, it seems necessary the transport planning processes the so - called city to be corrected. According to the investigation here, since there are not any intra city railroads in "Hamedan" and citizens have no choice except travelling to other cities by bus, it will be essential to improve this system.
Developing the transportation system and the level of urban activities in the central part of "Hamedan " during the past 90 years have been caused by the radius Plan implemented within urbanization processes in this period of time. Moreover, the quality of bus service system in that city has decreased because of increasing population, traffic, urban trips and demands for travelling through the city center. The main aim of this study is to analyze the bus service transport system in " Hamedan" city center applying a geographical information structures and present some suggestions for bus lanes to be modified in this part, too.
Key words:
Public transportation, bus (service) lanes, geographical informational systems.

1- Introduction:

One of the best modern techniques helping resolve the problem of increasing traffic plus improve citizens' conditions is to use new technologies for controlling cities. For example , geographical information systems, as some kinds of these technologies, are so well- known and important that have been utilized to decrease traffic problems in many cities, of various countries and finally, they have resulted in positive consequences. The mentioned systems being considered computer- based information ones can receive, recycle, manage, model, change , analyze, process and also present reference data (De By et al . 2004)
Today, geographical information systems play basic roles in managing geographical areas. Allocating urban lands, identifying unsafe places, evaluating geographical regions to ensure whether there are any human risks there or not, measuring traffic jam and population movement in an urban scale.
And also predicting social – economical activities in cities are the other example of using these systems to control those areas efficiently as well.
Since traffic is now defined as an important and unavoidable problem in managing or Planning cities in some developing countries like Iran, geographically informational systems besides of intelligent public

transport help the quality and quantity of communication and transportation be increased tangibly/in those parts.

The general reason of this subject is that these systems can affect intelligent transportation and provide opportunities to plan or control intra city transport carefully and resolve traffic problems.

" Hamedan " is one of the Iranian megalopolises in which increasing population as well as social-economical activities have made traffic get complicated, on one hand and the lack of intercity trains has caused citizens often focus on the public bus service system, on the other hand. These critical problems are observed more clearly in managing this city and also public transportation being in this center, because the general plan of so - called city is one in which all of the main streets meet down town. By the way, it has changed that city to a place with a lot of people during days and the beginning of nights, the process has consequently had increasing effects on social- economical activities in " Hamedan" city center.

There are numerous factors here have made difficulties existed in the central part of "Hamedan" be investigated more seriously . Some of these factors are:

Increasing trips/journeys from the central part to the other parts for this city and its suburb , improving social- economical activities, locating central bus station down town and increasing traffic besides environmental Pollution.

The higher amount of traffic and environmental pollution in that city is resulted from distributing the intercity travelling routes of citizens. In this field, the bus service system has an outstanding role in these trips. There fore, it is needed to evaluate complexities relating to the public bus service structure and transport in " Hamedan" especially in its center and also suggest a few solutions to resolve those problems.

More over, using geographically informational systems in planning or controlling the urban bus service transportation system causes it to be surveyed completely and different enforceable methods to be presented to improve that system performance as well as reduce some problems such as traffic, pollution and increasing journeys.

Theoretical Principles:

Buses are considered major public transport in the third – world countries (Simon , 2003). These public transports including social economical advantages a lot can be used as vehicles in small cities with low income, more ("Aberha", 2007). Corresponding to this matter, we should always remember to plan a developed bus service system being reflexible and almost low- cost for citizens in various cities. It's notable that this planning process improves the bus service structure , reduces traffic in urban areas and meets citizen's demands in public transportation parts. Parallel bus lanes may be finally omitted by optimizing this system as well.

Up to now, a lot of researchers have utilized geographical information system to resolve the difficulties existing in traffic and public transportation field. For example, "Amini et al". (2007) recorded a research in which they used the GIS technology in managing transport systems in Iran. Before those scholars, Afandy zadeh and Pour Teimuri had prepared a project in 2007 on the basic of improving bus lanes through geographically informational systems in Kermanshah.

Also, another study attributed to Soft Ardejen et al. (2007) was done out of Iran to use the same systems as general techniques for presenting and analyzing accidental data. Qngly et al.(2008) examined GIS in order to compute the efficiency of public transportation systems to hold the Olympic Games in Beijing.

After being implemented for the first time in Canada in early 1960, GIS was accepted by different countries across the world and introduced as a global helpful system in 1980. Recently, most of the public organization and even small companies with just a few employees knowing the numerous functions of geographical information system can benefit from this technology to process data in many domains and access their goals easily.

It is possible for GIS to be enforced in regional planning, geological plus mineralogical studies, agriculture, natural resource as well as improving management . The so- called system is manipulated by the various categories of people like managers, planners, programmers, experts and also citizens themselves Current et al. Suggested a model called Maximum Covering Shortest Path (MCSP) to optimize transportation routes in 1985.

Then, they identified two start and end points as indicators in their model. The basic aim of related plan here was for the shortest path between these 2 points (the shortest path and the most or maximum demand) To be found. In other words, depending on decision- makers' idea, more value was given to one those Points.

Current and Schilling succeeded to prepare another model named Maximum Tour Covering Problem (MTCP) attending to the preceding one (MSCP) in 1994 too. Providing opportunities to travel all over, this plan can minimize demands and make stop points clear previously.
The mentioned models are different from each other in 2 ways:
1- The number of stop points being existed during the path between the start and the end are not displayed prominently in the first plan, but in the second, there are some limited stop points.
2- MCSP shows travelling routes instead, NTCP help complete trips be planed.
Maximum covering Route Extension Problem (MCREP) is also the model invented by Matisziw et al. (2003). It constitutes special paths with more bus stations passing from different points. More over, the amount of demands covering and the longitudinal size of routes are estimated as the highest and the lowest in this model, respectively. In fact MCREP is the compound from of 2 precious plans. However, the disadvantages of MCSP and MTCP models should be taken into account for the recent model advantages to be know better. Of covers, each one of these 3 suggested methods has several defects which can be removed here to implement a suitable plan to resolve urban transportation complexities. These defects are as follows:
1- The f actors being emphasized in MCSP and MTCP are only 2, but in MCREP , there is another parameter called bus service system ability except those existed factory.
2- As concluded by Current in 1985, if the number of connection edges decreases, problems observed in the MCREP model will be reduced and finally, it will be analyzed. In two first methods, all of those edges have been planned to final paths where as the third model in without this defect. It must be noted that the deficiencies are invisible in MCREP.
During this article, researchers have used a kind of model in which some new parameters in addition to the pointed ones, are hand for finding routes.
These parameters have been evaluated here through the Analysis Hierarchy Process (AHP) in accordance with how to affect on the bus service system. Determining the abilities of network analyst, scholars have decided to utilize GIS for studying this network more carefully.
Although it seems very difficult to plan the optimal bus service structure being helpful in accessing functional goals and there has been no appropriate method to do this work until now, the reported results show MCREP can be efficient to improve transportation paths acceptably.
Estimated in conformance with the bus service system in " Hamedan", that model should be allocated to transport activities in the central part of this city. Because of meeting all of the bus lanes in city center, there are traffic problems a lot there and it is necessary for these to be resolved.

Materials and Methods:

The method used in the recent article is a descriptive – analytical one. First, to fulfill the main aim of research, some spatial data is collected by library and scope studies. Next, the bus service transport system down town "Hamedan" is evaluated using this data as well as geographical information systems. In spite of these, a kind of comprehensive structure called Analysis Hierarchy Process (AHP) is manipulated here to make correct decision corresponding to diverse criteria. This technique causes issues to be formulated hierarchically (Ghodsipour, 1385). At the end, analyzing the spatial data, several plans or methods are suggested to review the bus service system in that city.
As shown in Figure 1 in this research, the transport systems are measured during different stages and nearly 8 factors are used to create bus lanes here, too. These parameters besides the process of shortening paths can play important roles in displacing bus lanes.

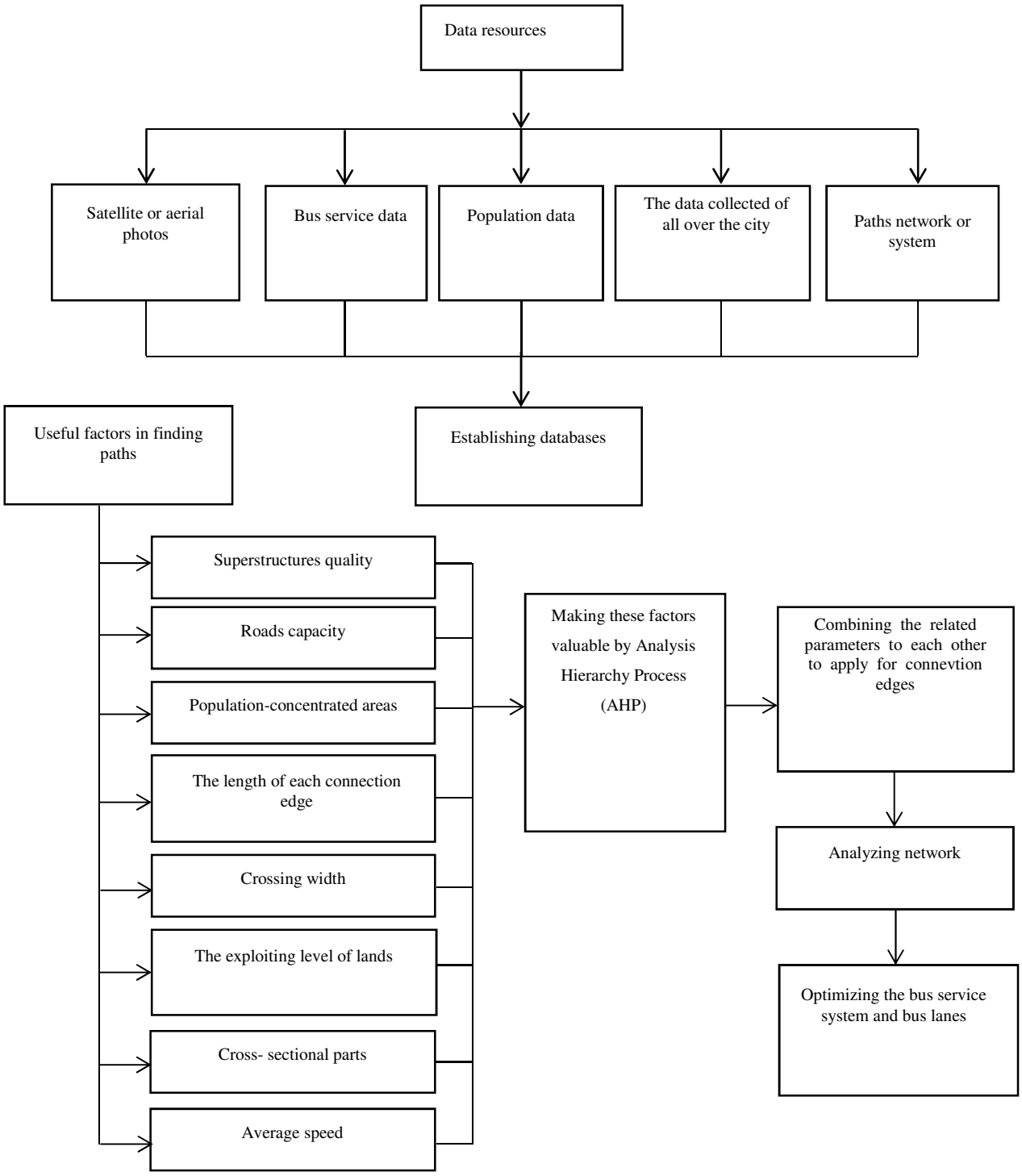


Figure1: the different stages of research

Functional Goals:

Generally, the chief goals of this article consist in:

1- To decrease bus lanes with no change in covering them in " Hamedan" .

2- Reducing parallel bus lanes in streets to lower their meeting in common stations there.

3- Increasing transportation speed in that city.

4- To decrease traffic jam resulted from stopping buses in city center stations.

5- Minimized buses stop time in the central area.

6- To minimize intercity journeys in which citizens don't have any choices except passing from this area.

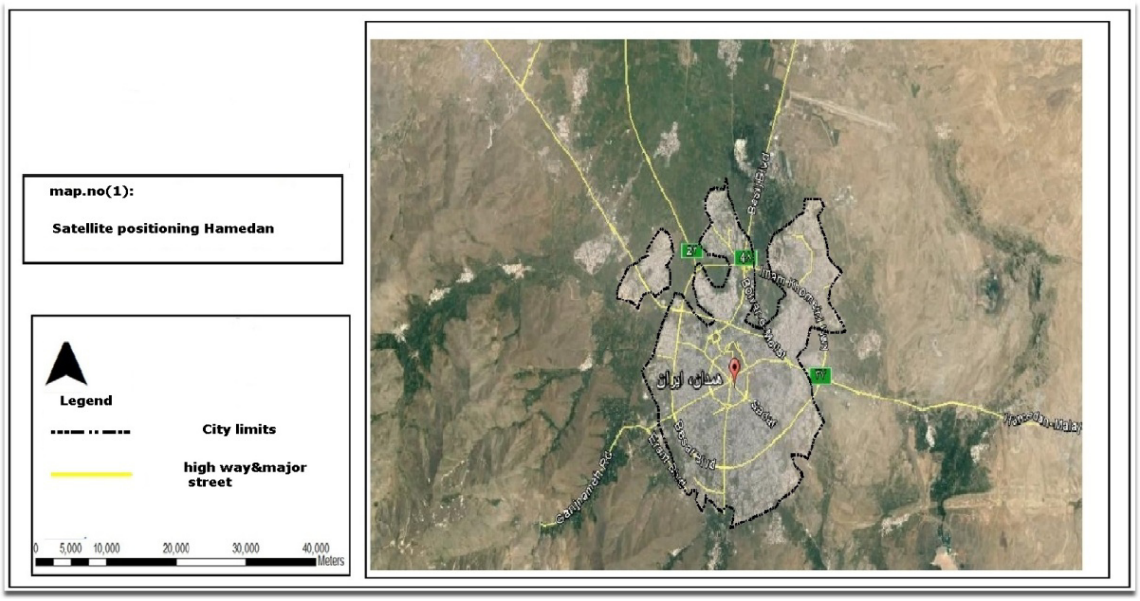
Question:

What Kinds of changes can be made in bus lanes to increase the qualitative level of bus service system considerably in " Hamedan" and decrease the traffic down town?

Result:

Developing urban regions and increasing their population have made demands for intra city transportation as well as facilities or service increased there. Over and above this, numerous trip have left a lot of negative effects such as air pollution, acoustic pollution, decreasing human health, heavy traffic and accidents on human life. Despite highway, tunnels and bridges constructed and also transport limitations enforced by municipality organizations to reduce these unfavorable effects, traffic complexities are still increasing and described as major concerns in managing cities (United Nations, 2003).

Traffic is one of the basic problems exited in "Hamedan". During the past decades , the populate rate in this city has increased from 473149 people in 1385 (sci.org.ir,2010) to 525794 people in 1390 (sko.ir,1392). On average, if every citizen goes on a trip inside the city twice per day, there will be about 105000 journeys daily over there. Because of being planned on the basis of the architecture style called "Baruk" (including concentric circles), "Hamedan" has differentiated structurally from other Iranian cities (map1).



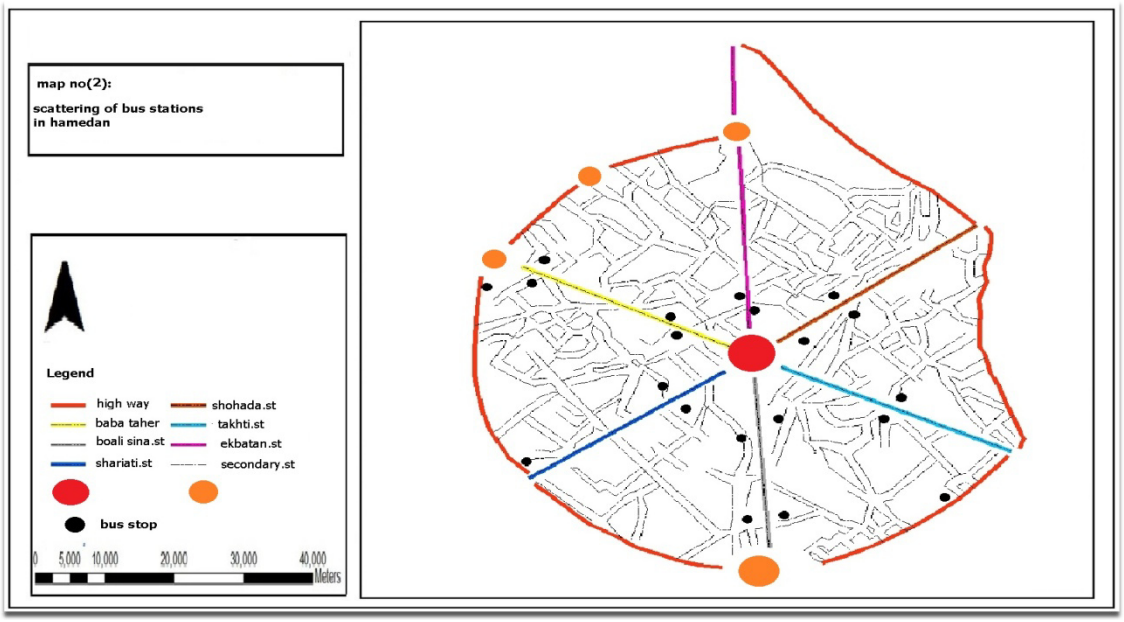
Map 1: Satellite positioning" Hamedan"

Using this style in planning the city has caused many streets to be angular in squares and intersections and vehicles speed to decrease, consequently.

The low width of main streets meeting down town is also another reason for increasing traffic in this area. Although it looks very essential to widen intra city routes, manager and planners prefer to improve public transportation system in " Hamedan" since, compared with widening roads which needs much expense as well as long time, it is more low- priced economically and executively.

Nevertheless, modifying the bus service system may principally reduce traffic jam in the city center and resolve the related problems. So, the process of improving the mentioned structure is attended as the best and most accessible method from researchers' point of view to confront traffic complexities and try to minimize them down town "Hamedan".

In this inquiry , the start point of 14 bus lanes being in the central part is reviewed. All of the public transportation data leads us to conclude that there are the highest range of traffic plus the most central bus stations (20 Stations) over there (map 2). These stations are analyzed inclusively through the model described in materials and methods section.



Map 2: Distribution bus station in the central ring

A- Planning Real Paths Networks:

Totally, geographically informational systems are computer- based patterns related to the some dimensions of real world. These systems can present the real world simply in a way that it will not be possible to do this work by computers in detail (Haywood, 1998). The data bases provided here are used to create enough conditions for modeling and save general networks information.

Paths networks or systems consist of connection edges, nodes and turning circles.

Connection edges refer to lines which are, in fact, routes specialized in transporting while networks nodes are defined as final points intersecting the connection edges. Another constituent parts of paths networks are turning circles playing prominent roles in registering transportation data among different connection edges. For example, when two paths or streets meet in a point, that point is a node and

these two paths are connection edges. Turning to the left from one edge to another is determined as a turning circle, too.

Operations of topological errors remove, separation to movement, increase of circulation element to the network, height column increase in order to different levels simulation was used.

B: Determination of effective components:

Is minimum length and maximum demand coverage of population from the main objectives in determination of transport services route and especially bus? These two purposes are summarized in improving the structure and availability improving of service level. In order that a rout has had the movement ability of public transportations, especially buses, it should have a set of characteristics and factors. The number of these affective factors increases or decreases depending on the situation. The effect level of each of these factors was considered according to the traffic experts' idea and to each weight factor was assigned according to its importance. To finding bus Route paying attention according to the following factors is important:

1- Road capacity: level of Road service: is the maximum number of public transportation which can pass in a definite time with an acceptable quality at the specified section of the road, from one of the lines or all the road width, in one direction or both direction of the road. The Road traffic condition is determined by the service level in term of quality. Traffic condition has six service levels A, B, C, D, E, and F in terms of quality. (Arbani, 1385: 89)

2. Average speed: speed reduction will cause travel time increase. Travel time Increase, the bus performance will decrease and system efficacy will drop (Guberinic, 2008: 17). Speed shows rate of movement. Distances that are passed in the time unit (its unit is a kilometer per hour). In analyzing the traffic flow, different definitions for speed are used (Arabani, 1385: 20). In this study average speed is used for the analysis.

3- Lands use: The starting point of the public transportation network should be based on the role of lands use that which one of the usages has a greater impact on the maximum traffic. Of course, maybe public transportation network influences lands use role. Although we can't deny the private automobiles role, but a bus has the greatest effect on the use of urban lands (white, 2009:98). Based on the use type in the side streets, attracting demand level of population is different and also population density varies at different times and days, For example existence of government agencies is population attractor and population absorption is different at different times and days of a week .lands use in cities can be divided to the major types of residential, commercial, governmental, cultural, green space, wastelands and entertainment places ones.

4- Pavement condition: The road pavement condition is effective in traffic volume and naturally streets where better pavement condition have, has a more smooth traffic And naturally travel speed comes down And it pull more cars pull into itself. The pavement Surface is generally divided into three types includes high, medium and low. Selection of pavement coverage type depends on the traffic volume and its properties, the availability of good materials and contractors, the initial cost and maintenance cost (Behbahani et al., 1374, 19). Comparison basis was put the pavement condition of excellent type surface. A set of criteria was used in order to identify the

surface condition that has been identified by relevant experts. These factors include cracking level in the square unit, surface damage of surface color, deformation and the number of.

5- Crossing line width: Crossing line width has a great impact on safety and driver comfort, crossing line width is equal to 3 to 3.5 m standard and there is a tendency to its increase according to the continuous increase in traffic volume process, speed of vehicles and the trucks. Conversely, the width Less than 3 m can have effect on the capacity and safety. So its use should be in ways other than facilities having traffic volume and high speed (Behbahani et al., 1374, 21).

6- **Type of road (Boulevard or non-Boulevard): Components of the way cross-sectional :** traffic in the Boulevard because of traffic routs separation have more safety and traffic has been faster And it has an ability to pass the traffic through itself faster and it has a direct impact on traffic.

7- **Population density areas**: Population density areas have a great impact on transportation demand. Areas with higher population density make higher traffic volume (White, 2009:100). One of the goals of line routes buses is covering the majority of the population, because social justice requires not only a certain class of people, but also all or most of the population benefit from advantage of such services (Azizi, 1383, 130).

8- The length of each edge (ARC): Minimum path length and maximum demand coverage is the most important goal in transportation services such as bus transportation (Matisziw, 2003:663). Typically, as the distance between the beginning and end of a route is shorter, it causes to increase the speed of service. Short routes cause passenger fatigue reduction and travel speed increase and it attracts greater volume of travelers to itself.

C: Weighting factors

One of the important processes of factors integration and relevant maps is determination of the relative importance of effective factors and assigning appropriate weight to each of them. Combination of informational factors regardless the importance of each of them in routing can't interfere their actual value the final integration. And valuable different units are put in a value, while each of these parameters has a certain importance degree in routings. For this reason, the method of paired comparison is used. This weighting method is a part of AHP method which is proposed in 1980 by Saati 12 and was developed in 2001. (AHP is one of the effective techniques in multi-criteria decision-making). This weighting method is based on expert knowledge. The ratio of 14 to pairwise comparisons is paid to create a matrix in this method. Pairwise comparisons are considered as input in this method and relative weights are produced as output. (Parhizgar & Ghaffari Gilan Deh, 1385, 314). Each of the factors based on importance and preference that have towards each other settles in a range between 1 and 9 (Malczewski, 1999:182. Weighting to each of effective factors for routing was done in Expert Choice software. Determination of affective factors and account of factors Final weight is one of the most important and sensitive issues of this model. In this model In addition to weighting to informational factors in this model, the specific weight is given to the existing classes in each informational factor according to their importance in the

routing, too. In this model, each factor is divided into different classes. The class that has the highest value, has the highest importance and the most important class, has the highest value. After weighting to factors and classes, output weight is subtracted of the number 1 so that the highest weight is assigned to a factor which has the least weight. The reason of such weighing is that the used algorithm knows a minimum weight as the best and passes a route which has the least value (Esri, 2008)

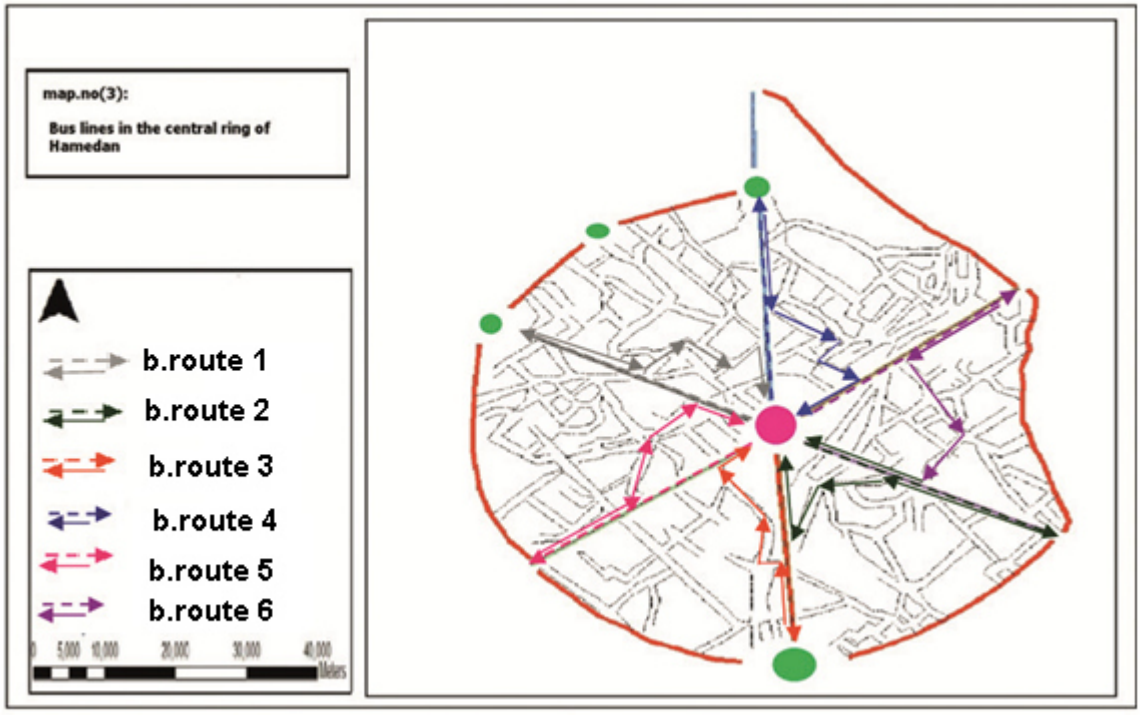
Network analysis and optimal routing of bus lines

After the above steps, network is ready to analyze in the ARC and GIS software environment. Network designed by the researcher becomes the same as network lines; Network designed by the researcher is the same as network lines in nature environment with the same characteristics and features at the software. This software with having a series of algorithms is able to make the best decisions in the least time. In this study, an algorithm is used to find the closest way to determine the best rout. Ring of "Hamedan" was designed and built according to a design in 1924 AD, inspired by the Baroque urbanity style that was popular in European countries. All streets in "Hamedan" are ended to a square named "Imam Khomeini" that locates at the ring center of "Hamedan". 6 streets are branched with angle of 60 ° and 30 meters from this square and are developed at its route throughout the city of "Hamedan". This style of urban planning causes "Hamedan" turn to single core city in terms of design and city function. And a large part of transportation and economic and social activities focus on the margin of the city's ring (fig. 1)

Figure 1: Aerial image of the central ring of "Hamedan"

Given the historical context locates in this area, in practice the possibility of any city design operation for widening streets and also change in the city context in this region is not possible and it is necessary to solve the problem of traffic ,other methods are benefited .

In recent decades with the increase in "Hamedan" population and the growing number of vehicles, traffic subject has become an important problem for the center of "Hamedan". So that to solve traffic problem designing traffic limitation in the certain times of a day and designing transportation rout of current buses in the central core of the city is proceed (map 3). But because of vehicle traffic volume and also the great number of passengers who use this area to move around in the city, the traffic problems still exist.



Map3:bus lines in the Central ring of Hamedan

By studies that were done in this research process on the bus system in "Hamedan", It was found that buses allocated a significant percentage of traffic volume in the area (table 1). To analyze this issue by researchers during a process, bus movement routes and also level of their stop at the central station were studied that results show city bus system "Hamedan" city center is one of the major causes of severe traffic and transportation speed reduction in the region. Because each bus route in the central ring of it allocates itself two stops with a long time : a) Exit station that is used for passengers' mount who are going to go out of town, b) Entrance station is exploited for passenger's dismount who enter to the city center. In addition, the input and output stations do not conform to each other and each of them locates at another six streets of "Hamedan" central ring, and only cause

to complicate the bus system in this area. Table 2 display Total numbers of input, output stations, and mean time to passengers' discharge and mount.

Table1: Distribution of traffic in the central ring of" Hamedan"

row	Vehicle type	Traffic volume
1	bus	18%
2	taxi	39%
3	Private cars	43%

Table 2: The number of stations and waiting time of bus systems at "Hamedan" central ring

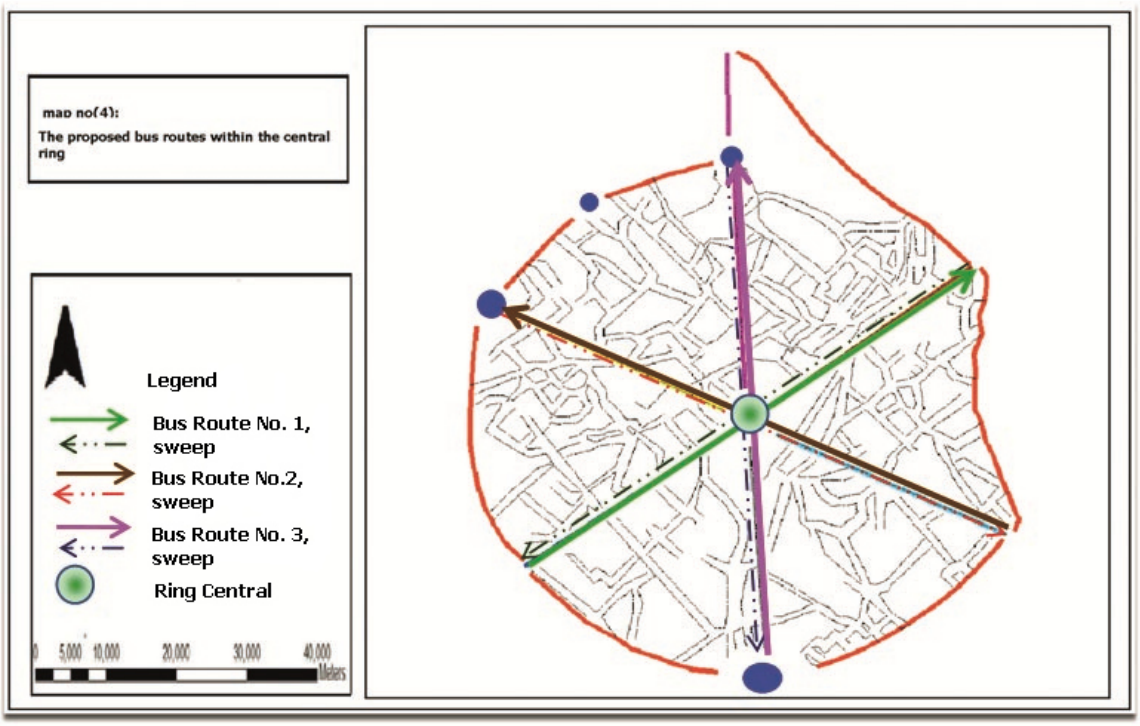
The number of rout	Exit station	Entrance station	waiting time in exit station	waiting time in entrance station
13	13	12	15 minutes	5- 6 minutes

In this study, as previously mentioned, the values of each of the affective parameters in routing as expertise were determined by AHP method. Now by comparison the two impressive main factors of the rout length and number of population of each line before and after the algorithm application, efficacy of this approach can be investigated. The results of the bus lines optimization in "Hamedan" central ring indicates station focuses in the ray of 100 meters of central square of "Hamedan" city passengers' growth demand to use bus system has increased change necessity in the bus system of this city. After performing the algorithm the closest rout running on a virtual network of roads in the central ring of "Hamedan", this result was found that it is necessary to make 13 change lines from 14 bus lines in the traffic rout and an allocated line that its station is out of "Hamedan" central ring doesn't change.

Conclusion:

In Six streets located around the Imam Khomeini Square in central ring in "Hamedan", stations for passenger transport have been predicted in both entrance and exit direction. This matter causes a significant proportion of the around streets because of the stop incessant of buses encounter traffic problems, cars speed reduction and also crowds. According to an analysis done by AHP method and help of geographical information system in this case was, two solutions were identified that must be applied simultaneously to increase bus efficiency system and also reduce traffic in the central ring bus of "Hamedan". 1- 1- given all six streets were built and designed in pairs opposite each other, it can be proceed to integrate bus lines in streets where are opposite each other for

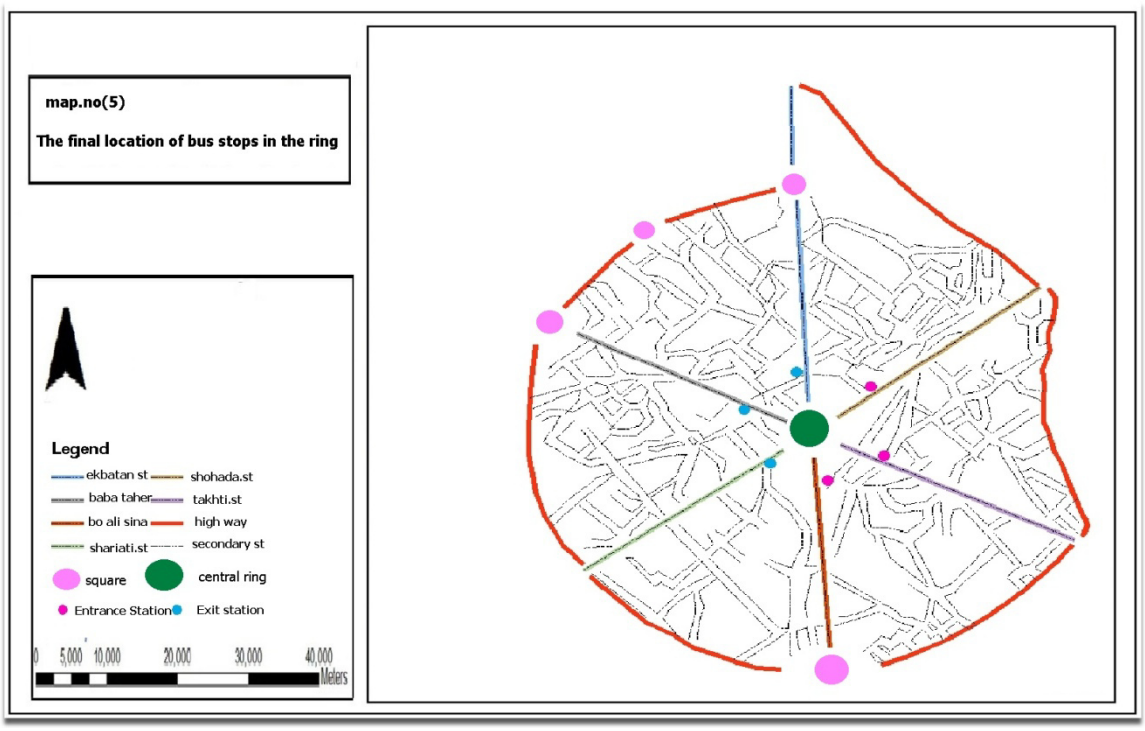
making bus lines that diagonally pass from central ring. This will make possible achieving the following results (map 4):



Map 4: The proposed bus routes within the Central ring

a) It prevents buses additional transit of each certain line in side streets that involves high time and costs
b) Those passengers who wish to travel diagonally in different geographical directions in "Hamedan", they don't need to get off the bus in the central ring and proceed to change the line.
c) By This method you can facilitate condition for the bus continues transit, the speed increase of passenger movement and also prevention of long- time bus stop in the central ring center of" Hamedan". This In turn, will reduce the high volume of traffic in the city center of" Hamedan".

2- Input and output stations in one of the rout of each street are integrated with each other. This causes to decrease the number of 13 exit stations and 12 entrance ones and time of buses stop to 6 focused stations to half in the central ring of "Hamedan" (Map 5).



Map5: The final location of bus stops in the Central ring

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