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PLANNING FACTORS AFFECTING METROPOLITAN TRAFFIC IMPROVEMENT (CASE STUDY: METROPOLIS OF TABRIZ)

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Abstract: In modern urban planning, traffic management and planning are considered essential elements in urban planning and design. In fact, there is an increasing need to consider and apply certain policies for traffic system improvement in the modern urban planning and management due to the important role of urban roads and their direct relationship with population growth in cities. The urbanization phenomenon in Iran and the increasing number of automobiles in its cities have led to an exponential growth in urban traffic, which is the main concern of urban managers in Tabriz Metropolis in this country. Considering the current conditions in Tabriz, this study attempts to evaluate the traffic management and planning strategies in this city. Desk and field research methods were used for data collection. The related data was then analyzed using SPSS through the one-sample t-test and regression analysis. The mean value of the studied indicators for traffic planning improvement is 4.56, which is higher than the average and indicates the important role of the factors affecting traffic control planning improvement in Tabriz. Finally, CORSIM was used to examine the high-traffic areas of Tabriz and evaluate the traffic volume reduction rate in this city.

Keywords: Urban Traffic, Urban Planning, T-test, Traffic System

Introduction

Traffic is an internationally known term referred, in law, to the passage of vehicles, persons and animals on roads. It consists of three elements: human, road, and vehicle, without each of which there would be no phenomenon called traffic. Studies have shown that the best way to control traffic and minimize its consequences is to use three

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groups of factors that can be prescribed to improve the current poor traffic condition in Iran. These factors are:

1. Traffic engineering

2- Law enforcement

3- Training

In traffic engineering, roads and intersections are constructed or renovated to ease traffic congestion. Traffic signals are installed and road markings are made. Teaching international traffic rules and regulations to all classes of society, including the general public, government officials, and managers plays a very effective role.

In fact, the communication network and the transportation and traffic system, as an integral part of urban areas with whether organic or predetermined designs, show the dynamicity of an urban complex [1]. This network is mixed with the daily lives of people in such a way that it is almost impossible to imagine a world without mobility [2]. Policies, opportunities and possible strategies that can be used as the basis for discussion about sustainable and desirable urban transportation and traffic include: rational location and distribution of urban land use, determining congestions, developing pedestrian crossing facilities, training and cultural development, generated traffic, urban traffic flow guidance (diverting traffic from densely populated areas), urban road network and urban decay, parking prediction, urban road network planning, freight forecasting and planning in the urban road network, predicting the needs of the disabled and the elderly, the role of transport in improving the environmental quality, focusing on the role of the transportation network in disaster management, integration of intra-city transport service management, creation of special lines for the public transportation system, and the use of modern technologies and decision support systems. These factors, i.e. regulatory-managerial factors, proper design of roads and intersections, land use, population density, training and cultural development, integrated management of public transportation, urban texture and environmental management are, in fact, considered by the sample population to have improved traffic planning and control.

In modern urban planning, traffic management and planning are considered essential elements in urban planning and design. In fact, there is an increasing need to consider and apply certain policies for traffic system improvement in the modern urban planning and management due to the important role of urban roads and their direct relationship with population growth in cities [3].

Nowadays, considering the economic conditions of big cities, any proper planning and investment for the development, improvement and strengthening of the transportation system will have a significant positive effect on their performance. The proper performance and greater efficiency of this system will not only increase user satisfaction but will also decrease the negative impacts of the network traffic congestion [4].

Several studies have been conducted on this subject, some of which are mentioned in this section. Diakaki *et al*. (2015) conducted a study on traffic flow as a function of land use [5]. In their study on the application of electronic license plates in traffic management, Benitez *et al*. (2017) studied the development of these plates and electronic identification systems as an example of such technologies [6]. Samad Kamal *et al*. (2014) attempted to identify ways to determine the optimal urban traffic pattern, concluding that social, economic, cultural, environmental and executive factors and the geographic location of the environment play a significant role in creating the traffic congestion problem [7].

Traffic management goals

Generally, the traffic management goal is to make optimal use of existing communication networks and enhance road safety. This goal must be achieved possibly without damaging the environment. In other words, traffic management involves using the existing facilities, increasing their efficiency, and maintaining the public interest in road networks. Measures related to urban traffic management depend on the type of traffic. For example, those related to facilities for pedestrians, cyclists, or heavy vehicles are different. There are always inconsistencies in these actions, and rarely does a plan end in mere profits in all aspects. For example, increasing green spaces for pedestrians, as a morale-boosting action useful for the elderly and the disabled, may reduce the spaces required by normal pedestrians. Traffic management plans basically

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differ depending on the type of road and different needs of people. [8]. A traffic plan may also differ depending on time and place. To sum up, the most important traffic management measures are as follows:

1- Rapid and low-cost implementation of the project

2- Improving the efficiency of existing facilities taking into account the different needs of road users

3- Increasing the safety of roads or at least minimizing their dangers

4- Protecting against urban environment pollution to the extent possible

The concept of traffic and its dimensions and components refer to the volume of vehicles moving in a particular spatial area. Accordingly, the volume of traffic is defined as the number of vehicles moving in a specific direction or directions of one or more lines over a specified period of time. The vehicles may be automobiles, buses, trucks, or any other means of transportation passing through the road, in which case the unit of traffic volume will be the number of passing cars.

From another perspective, urban traffic and transportation is so important that it has led to the development of particular cities based on transportation services. Some cities are mainly involved in areas such as services, military tasks, business affairs, administrative activities, while some cities are developed alongside shipping lines just for transportation affairs [9]. The research model includes five main dimensions of traffic, presented in Figure 3

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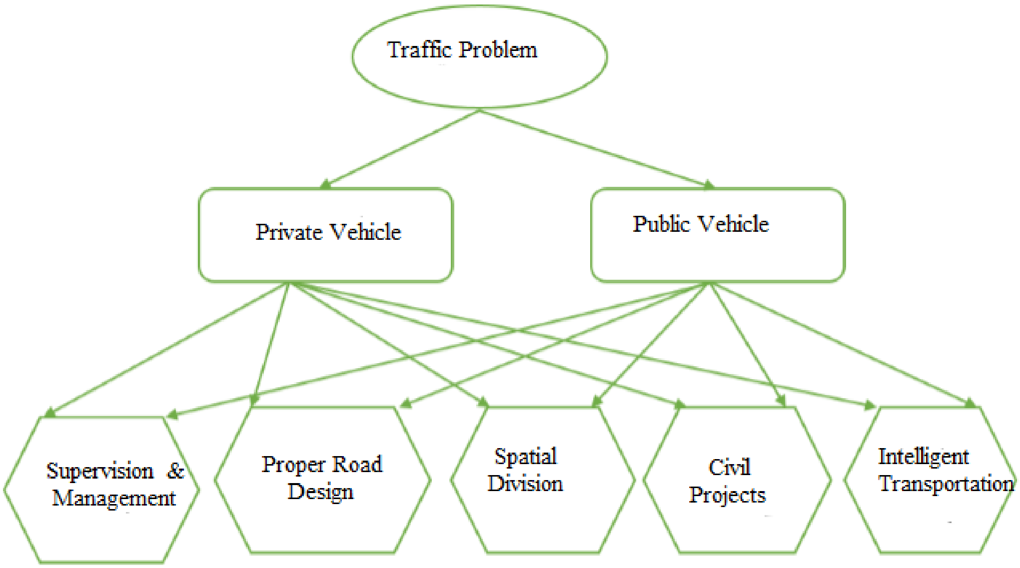

Figure (3). Traffic Dimensions

Study Area

Tabriz is a metropolis in the Azerbaijani region of Iran and the center of East Azerbaijan Province. It is the largest city in the northwest of Iran and the economic center and the administrative, communicative, commercial, political, industrial, cultural and military center of this region (Figure 1 shows the geographical location of the city). According to the most recent census figures, this city has a population of 1,494,000, which adds up to more than 1,800,000 if the population residing in the suburbs are included. This metropolis has witnessed population growth and an increased number of vehicles in recent years, although its infrastructure has not developed proportional to the population growth, which has led to a traffic congestion problem in this city. The traffic problems of Tabriz streets are mostly due to the low street widths and the increased number of vehicles, improper design of traffic elements, inter-sectoral inconsistencies, lack of parking lots, lack of urban amenities, lack of special measures expected from specialized managers, and drivers' disregard for traffic signals.

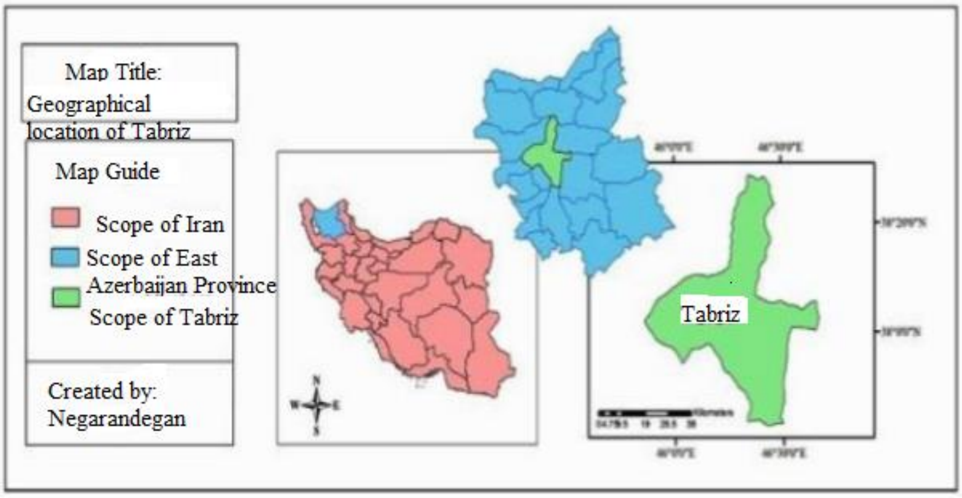

Figure (1). The geographical location of Tabriz in the political divisions of Iran

According to the Transportation and Traffic Deputy of Tabriz Municipality, more than 650 thousand vehicles and about 250 thousand motorcycles pass through the streets of Tabriz on a daily basis, most of which move in the city's central routes. In the public transport sector, about 1000 buses and 12000 taxis are active in the city on a daily basis, which need to be controlled and managed in order to avoid traffic congestion. Traffic reduction in the center of Tabriz and easier access to public transportation vehicles such as buses and ammunition require special attention of city managers and planners to manage intra-city trip demands. The Traffic Coordination High Council of Iran determined the TCP scope of Tabriz based on the traffic analysis results, the status of the road network, the distribution of city trips and other traffic considerations. The boundaries of this scope are shown in Fig. 2. According to the Traffic and Transportation Organization of Tabriz Municipality, this scope is about 320 hectares and makes up about 2.5 percent of the total area of Tabriz Metropolis.

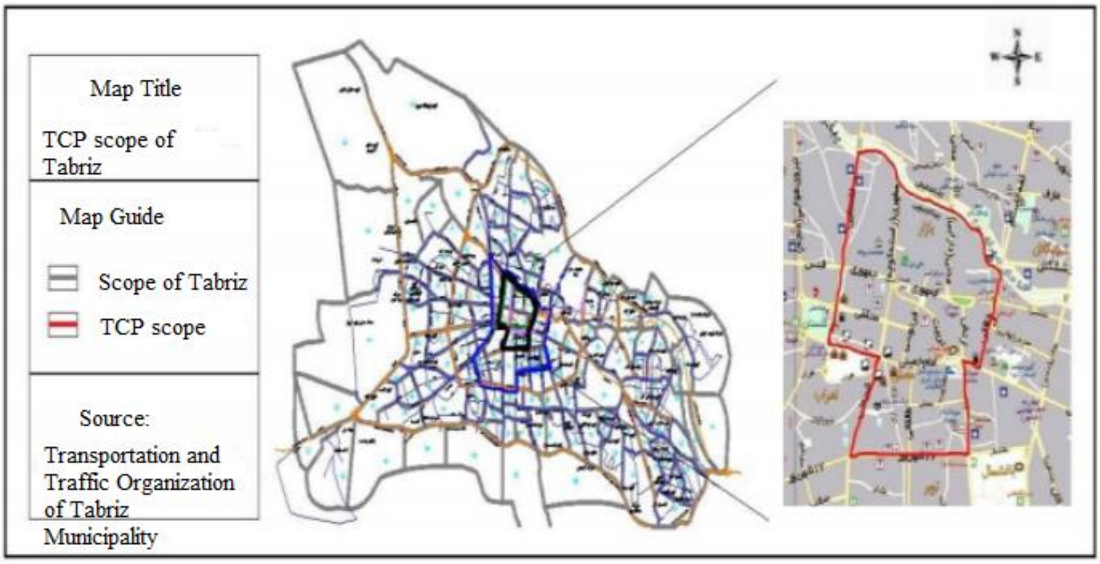

Figure (2). Study area boundaries

1- Evaluation of factors affecting TCP improvement using the one-sample t-test

This is an applied study conducted using deductive analysis. The statistical population consists of a panel of 90 traffic experts selected using the Delphi method. The main criteria and parameters of traffic planning and management were identified based on the expert panel's opinions using the comparative analytical method.

The one-sample t-test results show that the mean value of the sample population in all components is higher than the average and the level of significance is less than $\alpha = 0.05$. This means that the components of managerial strategies are considered by the sample population to have improved traffic planning and control in Tabriz. As shown in Table 1, the results of the one-sample t-test have been evaluated for all factors affecting traffic control.

Table (1). One-sample t-test for managerial and supervisory strategies

Managerial and	Test values					
						Confidence interval

Supervisory Strategies	Standard deviation	T-statistic	Level of significance	Mean deviation	Mean	Lower limit	Upper limit
Road control by surveillance cameras	0.83	39.21	0.0000	1.321	4.17	1.126	1.481
Effect of one-way roads	0.61	61.32	0.0000	1.733	4.79	1.469	1.811
Traffic Council	0.73	48.22	0.0000	1.523	4.39	1.329	1.503
Police presence in traffic control centers	0.54	57.29	0.0000	1.632	4.76	1.621	1.711

Table 2 includes traffic signals, intelligent traffic control systems, CCTV cameras and intelligent alarm system.

Table (2). One-sample t-test for the intelligent transportation system (ITS)

ITS	Test values						
	Standard deviation	T-statistic	Level of significance	Mean deviation	Mean	Confidence interval	
						Lower limit	Upper limit

Increasing information systems	0.518	61.21	0.0000	1.581	4.77	1.626	1.881
Using the GPS and GIS systems	0.679	56.32	0.0000	1.433	4.89	1.609	1.861
Driver Attention Warning System	0.681	14.22	0.0000	0.523	3.79	0.319	0.513
Public Transport Priority System	0.665	13.89	0.0000	0.632	3.51	0.311	0.411

Table 3 shows the training and cultural development strategies for traffic control in Tabriz. All components of the infrastructure and civil project strategy are higher than the average of the sample population and the level of significance is less than α=0.5, meaning that all components of this strategy are considered by the sample population to have improved traffic planning and control in Tabriz.

Table (3). One-sample t-test for infrastructure, civil projects

Infrastructure and civil projects	**Test values**						
	Standard deviation	**t-statistic**	**Level of significance**	**Mean deviation**	**Mean**	**Confidence interval**	
						Lower limit	**Upper limit**

Urban traffic planning improvement	0.498	51.21	0.0000	1.484	4.17	1.126	1.181
Construction of overpasses and underpasses and connection with highways	0.779	33.32	0.0000	1.333	4.59	1.209	1.361
Installation of traffic signals	0.511	44.22	0.0000	1.523	3.29	1.119	1.213
Construction of bypasses and destruction of the urban worn-out texture to reduce traffic congestion	0.665	43.89	0.0000	1.332	4.51	1.311	1.411

Table 4 presents the spatial division strategies for traffic control in Tabriz, in which 4 items are included. The one-sample t-test results show that the components of this strategy have been effective in traffic control in Tabriz. The result of the one-sample t-test for proper road and intersection design is also presented in Table 5.

Table (4). One-sample t-test for spatial divisions

Spatial divisions	Test values						
	Standard deviation	t-statistic	Level of significance	Mean deviation	Mean	Confidence interval	
						Lower limit	Upper limit
Standard streets and width of roads and public passages	1.223	3.598	0.0000	0.359	4.13	0.126	0.486
Volume of vehicles in proportion to street widths	0.911	13.320	0.0000	0.369	4.22	0.209	0.561
Expanded area of the city followed by increased traffic congestion	0.489	53.22	0.0000	1.691	4.99	1.419	1.543
Construction of bypasses and ring roads to reduce	0.597	41.89	0.0000	1.322	4.59	1.351	1.481

traffic congestion							

Table (5). One-sample t-test for proper design of roads and intersections

proper design and construction of roads and intersections	Test values						
	Standard deviation	t-statistic	Level of significance	Mean deviation	Mean	Confidence interval	
						Lower limit	Upper limit
Street widening and improvement	0.899	8.598	0.0000	0.559	3.93	0.396	0.556
Road construction or removal	1.091	7.320	0.0000	0.349	3.72	0.249	0.461
Standard bike and wheelchair lanes	0.779	-24.22	0.0000	-0.69	2.99	-1.191	-0.891
Increased safety and reduced delays	0.897	-13.89	0.0000	-0.712	3.59	1.351	0.781

Table 6 presents the results of the one-sample T-test about the factors affecting the TCP improvement in Tabriz.

Table (6). One-sample t-test for factors affecting TCP improvement

Indicator	Test values						
	Standard deviation	t-statistic	Level of significance	Mean deviation	Mean	Confidence interval	
						Lower limit	Upper limit
ITS	0.635	33.91	0.0000	4.24	4.56	0.96	1.126

Civil projects	0.613	43.16	0.0000	1.417	4.14	1.191	1.291
Spatial division	0.805	28.00	0.0000	0.93	4.48	0.776	1.01
Proper road design	0.916	-6.27	0.0000	0.123	3.55	0.201	0.226
Managerial and supervisory strategies	0.677	51.51	0.0000	1.55	4.52	1.386	1.626

Table 6 indicates the important role of the factors affecting TCP improvement in Tabriz. Multiple regression analysis was used to determine which of the variables had the greatest effect on TCP in the study area.

Multiple regression can be used to identify the effect of each indicator on the TCP and develop a causal model that illustrates the interactions between indicators and factors. One of the goals of this study is to develop a causal model for the effective indicators of TCP in Tabriz. The main question for this model is which indicators and factors of TCP have the greatest causal effect on TCP in Tabriz.

Table (7). One-sample t-test for the factors affecting TCP improvement

Indicator	**Test values**						
	Standard deviation	**t-statistic**	**Level of significance**	**Mean deviation**	**Mean**	**Confidence interval**	
						Lower limit	**Upper limit**
Effects of TCP improvement on urban traffic	0.199	0.129	0.0000	0.859	3.881	0.899	0.989

Regression analysis allows researchers to predict changes in the dependent variable through the independent variable (TCP indicators) and determine the effect of each of the independent variables on the dependent variable. However, we have to use beta values to find out about the importance and role of independent variables in predicting the regression equation. Since beta values are standardized, they can be used to judge the relative importance of variables. A large beta value indicates the relative importance of an independent variable in predicting the dependent variable.

2- Assessing the factors affecting traffic improvement using CORSIM

CORSIM consists of a set of two microscopic simulation models that represent the entire traffic environment. NETSIM represents traffic on urban streets, while FRESIM represents traffic on freeways. CORSIM applies time step simulation to describe traffic operations.

The length of various parts of the network, along with other useful information, was measured using the GIS file taken from the Transportation and Traffic Organization of Tabriz. Table 8 was completed based on the encoded streets in Figure 4, and the network was modeled using other essential information. An accurate analysis of the target street involved measuring the impact of the proposed strategies on the adjacent streets. Therefore, all traffic and physical information of the entire area shown in Figure 4 was collected.

Modeling was carried out using the information gathered from the Transportation and Traffic Organization of Tabriz, as well as the information of the network collected using the field research method, and the software was given all its required information.

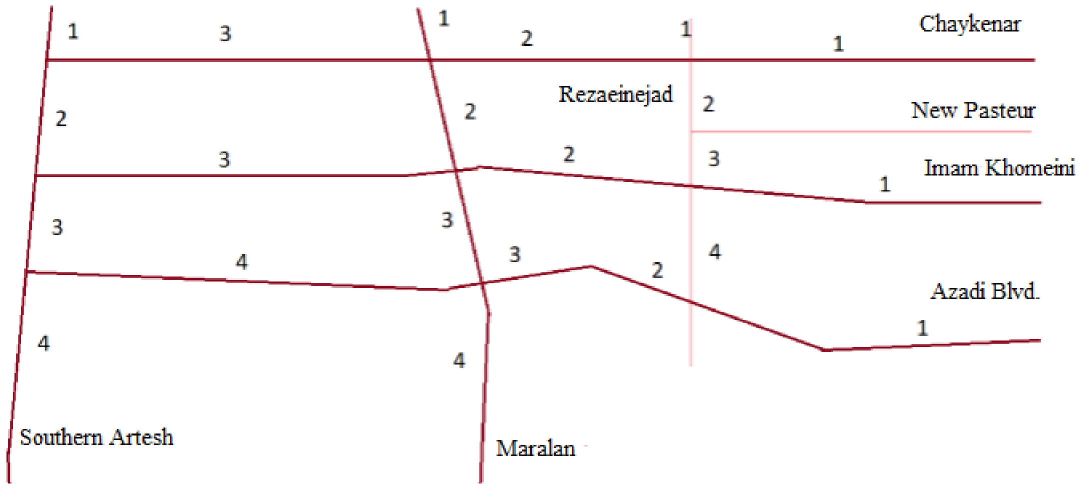

Figure (4). Case study network for simulation

Table (8). Designed network for simulation with encoded streets

Modeling area	Street code	Length	Slope percentage
Chaykenar Street (East to West)	1	870	-0.5
Chaykenar Street (East to West)	2	680	-0.6
Imam Street (East to West)	1	920	-0.3
Imam Street (East to West)	2	550	-0.4
Azadi Blvd (East to West)	1	1120	-0.7
Azadi Blvd (East to West)	2	890	-0.5

Considering the peak hour traffic at Azadi Blvd, engineering judgment of the location, and proposed ideas for traffic congestion and delay reduction, computer simulation modeling was carried out using traffic statistics and physical location.

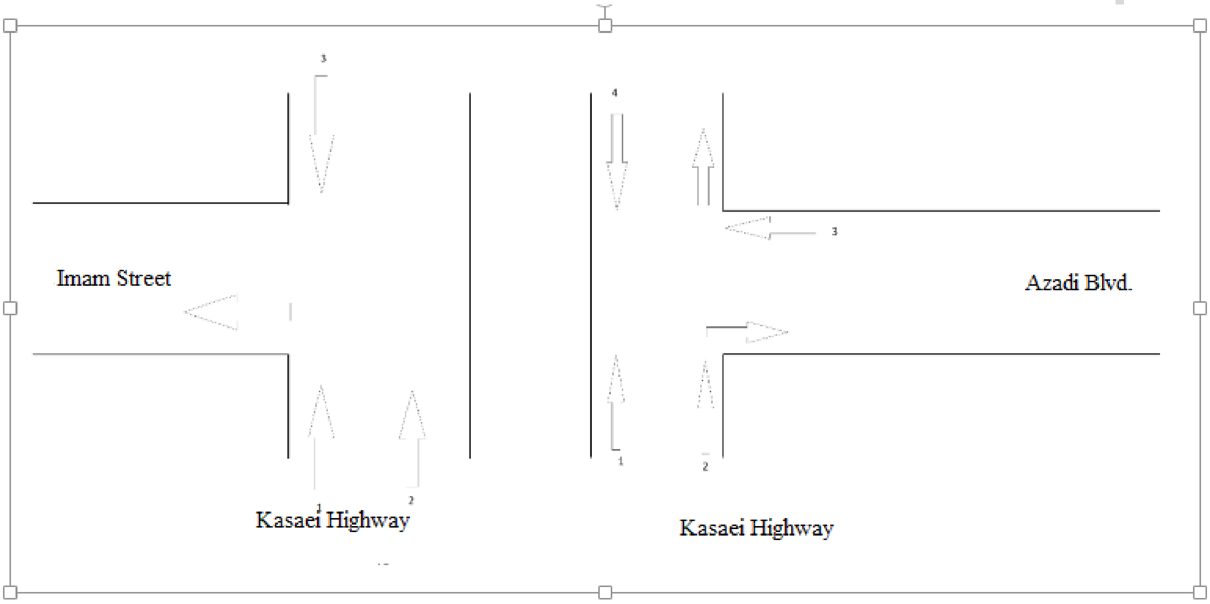

Figure (5). Traffic roads ending in an intersection

Table (9). Volume of vehicles at the Azadi Boulevard- Imam Khomeini Street Intersection

Traffic Volume			
Movement Code	**Heavy**	**Light**	Total PCU
1	3600	24	**2890**
2	29	14	**44**
3	81	11	**52**
4	3710	49	**2986**

Since Azadi Boulevard is a two-way street and the existing capacity seems not to respond the traffic volume, it is suggested to close this street from West to the East, and the vehicles intended to pass through New Pasteur Street move in adjacent streets, passing through the Rezaeinejad Street towards the north to reach Chaykenar Street. The change was analyzed and evaluated by modeling in the simulation software. Since some vehicles have to pass through an extra route, it must be examined whether this path change has a positive or negative effect on the whole network.

Table (10). Volume of vehicles at peak hours at Chaykenar Street- Imam Khomeini Street Intersection

Traffic Volume			
Movement Code	**Heavy**	**Light**	Total PCU
1	99	5	**1890**
2	1360	14	**44**
3	24	6	**1052**
4	1710	49	**2086**
5	250	3	**34**

Attempts were made in the analysis of this network to show that we can manage network traffic using this simulation software through changes in the vehicle movement direction. In fact, a change in the vehicle movement direction in many networks may have a positive effect in easing the traffic. However, taking such an approach practically might cause a disturbance in the network, since no positive effects are ensured beforehand.

Conclusion

This study discussed the factors affecting TCP improvement in Tabriz. The t-test showed that the mean value of TCP indicators was 3.881, which is higher than the average. ITS strategy and managerial and supervisory strategy had the greatest effect on TCP in Tabriz with the mean values of 4.56 and 4.52, respectively.

Software analysis was then performed for a more accurate analysis. Since one of the most commonly used analytical tools of traffic engineering in the modern world is computer simulation, the distance between Chaykenar Street-Abrasan Roundabout was simulated and solutions were provided. Considering the software outputs, turning Azadi Blvd. to Maralan Crossroad (west to east) into a one-way boulevard will reduce the morning peak-hour delays by 8.4% and the evening peak-hour delays by 3.5%.

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