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Research Paper

Capacity Analysis and Level of Service Estimation for a Section of the Highway Based on HCM2016 (Case Study: Shahid Sadr Highway Class-Bridge)

Hassan Khaksar[1,*], shahin hassani[2], Mohammad Hossein Tamaddon[3]

Abstract

Annually, traffic problems ranging from congestion, air and noise pollution, abundant accidents, unacceptable increases in travel time, and various types of damages are the advance of most countries, especially in developing countries. Environmental pollution, casualty, and financial costs, as well as accidents, increased fuel consumption, the extent of resources allocated to build the network, and the huge cost of construction of various transport systems, as well as other side costs, destroy large amounts of human and economic resources in the country. It becomes. Therefore, the prediction of traffic for a pre-construction route as well as analyzing and estimating the capacity and prediction of future demand, due to the expansion and improvement of the network and preventing the creation of problems developed from increasing demand and lack of facilities, and can have problems The existing network minimizes the country's roads. Functional criteria are determined by defining the concept of level-of-service (LOS). In this research, the analysis of highway capacity was obtained using the data from the Shahid Sadr class-bridge in Tehran, based on the 415, HCM2016 regulations and headway methods, and then the results were compared using Synchro and Aimsun software.

Keywords: Capacity Analysis, Level of Service, Traffic Performance Index, HCM2016 Regulation

* Corresponding author. E-mail: hasankhaksar@yahoo.com
[1] Assistant Professor of Civil Engineering,North Tehran Branch, Islamic Azad University, Tehran, Iran
[2] Ph.D. Candidate, Iran University of Science and Technology, Tehran, Iran
[3] MSc, Department of Civil Engineering, North Tehran Branch, Islamic Azad University, Tehran, Iran

1. Introduction

As we know, land transportation is the most in-demand among other modes of transportation. Road transport is of great importance in all countries in terms of both passenger and freight traffic. As the demand for road travel is increasing day by day, the need to pay attention to the expansion of the land transport network is of particular importance. Therefore, forecasting the demand for a route before construction, as well as predicting the future traffic volume and current capacity of an axis, play a key role in expanding a country's road network. since the invention of the automobile, man has always wanted to create facilities and regulations to regulate traffic. The increasing number of vehicles has occupied the minds of traffic engineers in order to facilitate transportation and prevent waste of costs and time. As traffic issues become more complex, the use of computers to control and manage traffic is becoming more common day by day, and among these, computer simulation as a powerful and efficient tool is becoming more considered and used by engineers.

Estimation level of service (LOS) and highway capacity are important and influential factors in traffic volume, delay, and volume of traffic. Thus, examining and identifying the relationship between these two important parameters can guide decision-makers in designing policies in different ways. A lot of users' time is wasted in traffic every day in cities, especially in a metropolis like Tehran; In addition to the time spent in traffic, we can point to other problems such as higher fuel consumption, air and noise pollution, and lower level of user satisfaction, which put a lot of costs on users as well as the government and decision-making institutions.

The LOS is a measure of quality on the roads that shows the practical traffic conditions and the level of drivers' satisfaction with these conditions. This criterion depends on factors such as speed, travel time, freedom, having enough space to maneuver, and road safety. LOS are classified into 6 categories from A to F. In a way, LOS A represents the best conditions and level F represents the worst traffic conditions. The maximum flow that can cross the road at any LOS (except level F) is called the traffic flow. Thus, each facility according to each LOS (from A to E) has 5 currents, which is the maximum hourly current that persons or vehicles can reasonably expect to cross a point or crossing line or rider in a period of time. On the other hand, two facilities with the same LOS may be different from two facilities with two different LOS. This has to do with how the LOS is defined. Note that the LOS should be introduced in terms of indicators that can be seen and touched by drivers. So, traffic volume, as a benchmark on the road that is not understood by drivers and passengers, will never be used as a benchmark for LOS.

Road capacity is defined as the amount of maximum passing of vehicles. In traffic engineering, the passage of vehicles or pedestrians from the facility is considered. Road capacity can be defined as the maximum volume of traffic crossing the road section, while with the addition of one unit of traffic volume, congestion, and obstruction can occur. On the other hand, due to variable weather conditions or traffic control conditions, there will be no unit value for road capacity and this value is introduced as a random variable that follows a specific statistical distribution. This indicates the possible nature of the capacity. Capacity doesn’t remain constant even under ideal conditions. The reason for this is the existence of immeasurable variables such as the behavior of drivers or vehicles. Thus, it is usually not possible to measure the ideal capacity and therefore to accurately estimate its statistical distribution.

In addition to the stochastic nature of capacity, various definitions have been proposed according to the purpose of the studies for road capacity. Capacity for design is a unit value that is usually derived from random distribution functions and represents the maximum volume passing through a section of the road with a certain probability and with certain environmental conditions. This value is used for road planning and design and can be calculated from indirect experimental methods such as highway capacity instruction methods. Strategic capacity is a value that is usually derived from random distribution functions and represents the maximum volume of traffic that a road section can pass. This value is used to allocate traffic and simulations This capacity or distribution is calculated based on traffic flow information and calculated by static models. Execution capacity, on the other hand, is the amount of capacity that represents the maximum volume that actually crosses the road. This value can be used for short-term traffic estimates and can be calculated based on direct experimental methods with the help of dynamic capacity models.

It is necessary to explain about the two regulations (415 Code and HCM2016) that have been used for analysis in the research.

1.1. Highway Geometric Design Code (No.415)

The Highway Geometric Design Code No. 415 refers to a specific set of guidelines and standards for the design of highways. These codes typically include specifications for various elements such as alignment, cross-section, sight distance, intersections, and other geometric features.

The specific details and requirements outlined in Code No. 415 may vary depending on the country or jurisdiction that has established it. It is important to consult the relevant transportation authority or agency responsible for highway design in your area to obtain the most up-to-date version of the code.

Some common topics covered in highway geometric design codes include:

- **Horizontal Alignment:** Guidelines for determining the curvature and alignment of the road, including minimum radius of curves, superelevation (banking), transition curves, and horizontal clearances.
- **Vertical Alignment:** Specifications for vertical curves, grades (slopes), crest and sag vertical curves, sight distance requirements, and vertical clearances such as overhead bridges or tunnels.
- **Cross-Section Elements:** Standards for roadway width, number of lanes, shoulder widths, median design (if applicable), drainage provisions like ditches or culverts, and pavement markings.
- **Intersections:** Design criteria for various types of intersections such as signalized intersections, roundabouts, and interchanges (grade-separated junctions), including lane configurations, turning radii, sight distance at intersections, etc.
- **Access Management:** Guidelines for controlling access points along highways to ensure safe traffic flow and minimize conflicts with adjacent land uses.
- **Pedestrian and Bicycle Facilities:** Requirements for providing safe accommodations for pedestrians and cyclists along or across highways through sidewalks, crosswalks, bike lanes, or shared-use paths.
- **Safety Considerations:** Standards related to safety features like guardrails/barriers placement based on crash severity levels; signage requirements; visibility considerations; lighting provisions; etc.

It is important to note that these are just general topics that may be covered in a highway geometric design code, and the specific details and requirements can vary significantly depending on the jurisdiction.

1.2. Highway Capacity Manual (HCM) 2016

The Highway Capacity Manual (HCM) is a publication that provides guidelines and methodologies for evaluating the capacity and operational performance of various types of highways and transportation facilities. It is widely used by transportation engineers, planners, and researchers to analyze and design transportation systems.

The HCM covers a wide range of topics related to highway capacity, including traffic flow theory, level of service analysis, intersection design, freeway operations, pedestrian and bicycle facilities, transit operations, and more. It provides detailed procedures for estimating traffic volumes, analyzing congestion levels, determining the capacity of different roadway elements, and evaluating the effectiveness of various operational strategies.

The manual includes several chapters with specific methodologies for different types of facilities such as urban streets, signalized intersections, roundabouts, freeways, toll plazas, etc. It also provides guidance on how to incorporate emerging technologies and innovative practices into transportation planning and design.

Overall, the Highway Capacity Manual serves as a comprehensive resource for professionals involved in transportation planning and engineering to assess the performance of existing highways or plan new ones in an efficient and effective manner.

The main difference between the 2016 version of the Highway Capacity Manual (HCM) and previous versions is the inclusion of new methodologies and updated research findings. Some key differences include:

– **Incorporation of Freeway Facilities:** The 2016 HCM includes a comprehensive chapter on freeway facilities, which was not present in previous versions. This chapter provides guidelines for analyzing and evaluating freeway operations and capacity.

– **Multimodal Analysis:** The 2016 HCM introduces a multimodal approach to transportation analysis, considering various modes of transportation such as pedestrians, bicycles, and transit vehicles. Previous versions primarily focused on vehicular traffic.

– **Performance Measures:** The 2016 HCM emphasizes the use of performance measures to evaluate transportation systems' effectiveness and efficiency. It provides guidance on measuring various parameters like travel time reliability, delay, and level of service.

– **Software Tools:** The latest version incorporates new software tools that facilitate analysis and evaluation processes. These tools help practitioners apply the methodologies described in the manual more efficiently.

– **Updated Research Findings:** The 2016 HCM incorporates recent research findings related to traffic flow theory, capacity estimation, signalized intersections, roundabouts, pedestrian facilities, transit operations, and other relevant topics.

Overall, the 2016 version of the Highway Capacity Manual reflects advancements in transportation engineering practices and provides more comprehensive guidance for analyzing different types of roadways and modes of transportation.

2. Literature Review

Issues related to road capacity and level of service have gained attention and have been extensively studied recently due to the increased traffic congestion in the urban road network. Afshin Shariat (2010) studied the alternative criterion of the performance index of suburban two-lane highways. To determine the service level of two-way two-lane routes, two performance indicators of tracking-time percentage and average travel speed are used. The results of this paper showed that the percentages of the sequence time obtained from the simulation in the software with the alternative index, the percentage of vehicles with a headway of 3 seconds or less are very close to each other. Mohammad Tamnaei et al. (2012) conducted a study to analyze the time distance distribution of vehicles in day and night conditions under heavy traffic flow. The purpose of this study was to evaluate the behavior of drivers to choose the distance during peak hours of day and night traffic. The results show that the log-normal distribution model is a suitable model for fitting the distribution of distances in the overtaking line, while the Gamma distribution model is suitable for fitting the midline distances. Also, the study of the results of the comparison in day and night conditions showed that drivers in the conditions of heavy traffic at night, take safer headway than during the day. Rahimef in 2014, examined the capacity and level of service in the urban transportation network. Traffic flow in this network is plotted based on the O-D matrix. Due to the constant current in the network, if a source request enters the network, it will face a problem. This problem has been investigated in this study. For this purpose, a new formulation and model has been proposed that examines this issue according to the O-D matrix. Velmurugan Senatipati in 2010, analyzed the road capacity assessment of multi-speed routes under heterogeneous traffic conditions using traditional and microscopic simulation models. In this paper, the speed-flow characteristics of different types of multi-lane highways, including four-lane, six-lane, and eight-lane used in plain areas, were investigated. From the collected data, free flow speed profiles and speed flow equations for different types of vehicles for different versions of multi-lane highways have been developed based on traditional and microscopic simulation models, and subsequently, road capacity has been estimated. In addition, the change in behavior of different types of vehicles has been extensively studied and its impact on road capacity on multi-lane highways has been estimated. Subhadip Biswas in 2016 conducted a study to evaluate the level of service on a class 1 arterial route in Calcutta, India. For this purpose, LOS criteria were performed based on field data obtained from an urban hexagonal arterial in the city. The free-flow speed (FFS) of several vehicle categories was calculated and it was found that the FFS varies considerably depending on the vehicle type. Smaller vehicles (excluding two-wheelers) have higher FFSs than larger vehicles. Compared to other types of vehicles, the results of this study showed that light commercial vehicles (LCV) and trucks behaved more consistently in low-density traffic conditions. To evaluate the LOS in urban arterials, the percentage of speed reduction (PSR) of FFS was selected as the functional indicator of traffic flow. An increase in PSR indicates a decline in the quality of transit services. In addition, the PSR value increases with increasing v/c ratio. His approach obtained the behavior of six groups of vehicles created using the K-mean clustering method that is compatible with PSR data. When the percentage of deceleration seems to be more than 50%, the performance of the traffic flow according to the LOS criteria based on PSR reaches the worst level of service level (F). The proposed method in this study for the analysis of LOS standards for urban arterials in different places and useful conditions provides acceptable results. B.R. Marwah and Bhuvanesh Singh (2018) sought to classify the degree of service for urban traffic conditions that are varied. Journey speeds of vehicles and motorized two-wheelers are taken into account while determining the LOS, as well as concentration and road occupancy. The four LOS are characterized based on the simulation results of the benchmark road and traffic composition (Level A). The LOS categorization developed in this study will be useful in identifying shortcomings in an urban road system and planning alternative improvement approaches to achieve the desired LOS. The capacity of the model to replicate urban diverse traffic flow conditions is clearly demonstrated by the examination of simulation data. Matti Pursula in 2019 conducted a study to estimate the level of traffic flow service on two-lane highways in Finland. The results are consistent with USA standard data on the flatness and linearity of flow-speed curves, as well as the capacity of two-lane highways. In HCM, deceleration appears to be faster than actual traffic on Finnish highways. The length of car groups and the forward distribution rates of car groups were considered in a simple study. A closer look at the progressive distributions of cars on the Luwal Al Highway, as well as statistical studies on the length distribution of car categories, showed that the assumptions were not valid. The simple theory, however, provided simple connections that were useful in examining the fundamental links between platoon percentage, mean platoon length, and flow speed. The percentage of vehicles moving shorter than 5 seconds was used as the approximate percentage of delay. The results of this study follow the HCM standard, although variations between Finland and HCM based on USA traffic conditions may have been used due to variance in actual values of delay-time and approximation.

3. Data Description

In order to obtain the LOS of Sadr Highway based on the source of this research, various parameters of the highway must be collected. This information is listed below:

- The width of the crossing lines
- Obstacle distance from the right edge of the highway
- Density of ramps. (Density of ramps are number of ramps entering and exiting the highway in the range of 4.8 km before and 4.8 km after the middle of the base section of the highway)
- Equivalent traffic rate (veh/hr/ln)
- demand flow rate under equivalent base conditions
- Peak hour factor (PHF)
- Number of lines
- Adjustment factor for the presence of heavy vehicles
- Adjustment factor for the presence of occasional or non-familiar users of a facility
- Percentage of heavy vehicles and buses on the route
- Percentage of recreational vehicles on the route
- Passenger car equivalence on heavy vehicles
- Passenger car equivalence on recreational vehicles
- Density
- Average speed

Because the measured case sample should be a good indicator of the condition of the passage, it shouldn’t be at the beginning and end of the week, so Sunday was found to be suitable for the census. It was also considered to conduct surveys in sunny weather to prevent the effects of weather on drivers' behavior. Video recording will be used to obtain effective parameters at the level of the crossing service, and some parameters were also measured on site, such as the width of the crossing lines and the distance of the obstacles from the right margin of lines. the filming will start when the volume of the crossing is very small (less than 1000 (veh/hr/ln)) and the filming will continue until finds that the vehicle volume its full capacity and may later reach supersaturation. Because Sadr Highway in Tehran has a high volume of vehicles volume from the early morning hours, in May 2021, it was decided to start the census from 5 A.M. to obtain FFS and continue until 10:30 A.M. to include the peak hours of traffic. Also, when there is the highest volume of traffic on one side of Sadr Highway in Tehran, there is a small volume of traffic on the other side, and the speed of vehicles can be measured in this approach and compared to the speed of vehicles at 5 A.M. If these speeds are inconsistent, it is clear that the FFS of vehicles depends on the brightness of the sun in addition to the lighting of the route, and if the speeds are the same, the difference in lighting between 5 A.M. and 8 A.M. can be ignored.

Due to the fact that it is not possible to create a bottleneck in Sadr highway in Tehran to obtain the capacity from direct methods, the capacity analysis was selected based on the Greenshields curve and the time interval of vehicles methods, and since HCM is one of the most reliable sources for determining the level of road service. As mentioned, in this research, using HCM 2016, the service level of Sadr highway in Tehran city has been measured in the basic stages (away from the effects of entrance and exit ramps and the combination of entrance and exit ramps) and possible differences in the speed chart. Check the traffic

3.1. Volume of Traffic

To investigate the traffic effects on Sadr highway, 5 hours of counting vehicles were taken in the morning in the period from 5:30 to 10:30 A.M and the analysis of the obtained statistics indicates the peak time in the area is between 8:00 and 9:00 A.M. Figure (1) shows the equilibrium volume chart of the East-West approach of the mentioned range in the period of 5:30 to 10:30. According to the chart in below the volume of the peak hour is equal to 5838 vehicles.

Figure (2) shows the volume of passenger car equivalence of the East-West approach of the Sadr class-bridge highway between Kaveh Boulevard and the entrance of Niayesh tunnel at the peak hour.

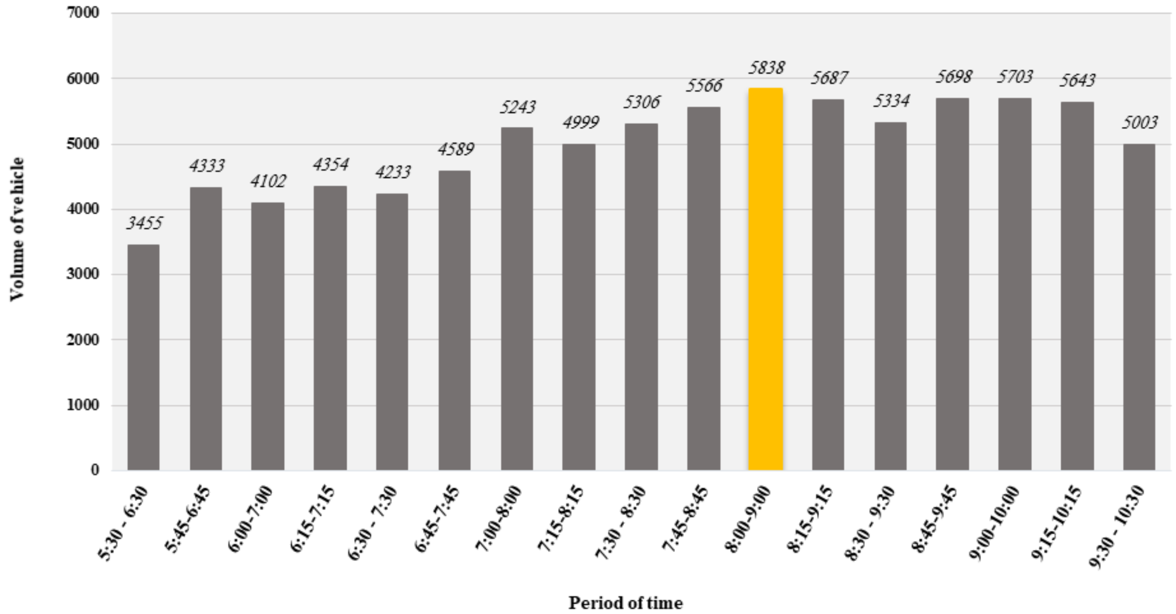

Figure 1. Passenger car equivalence of east-west approach of the Sadr highway between Kaveh Boulevard and the entrance of Niayesh tunnel

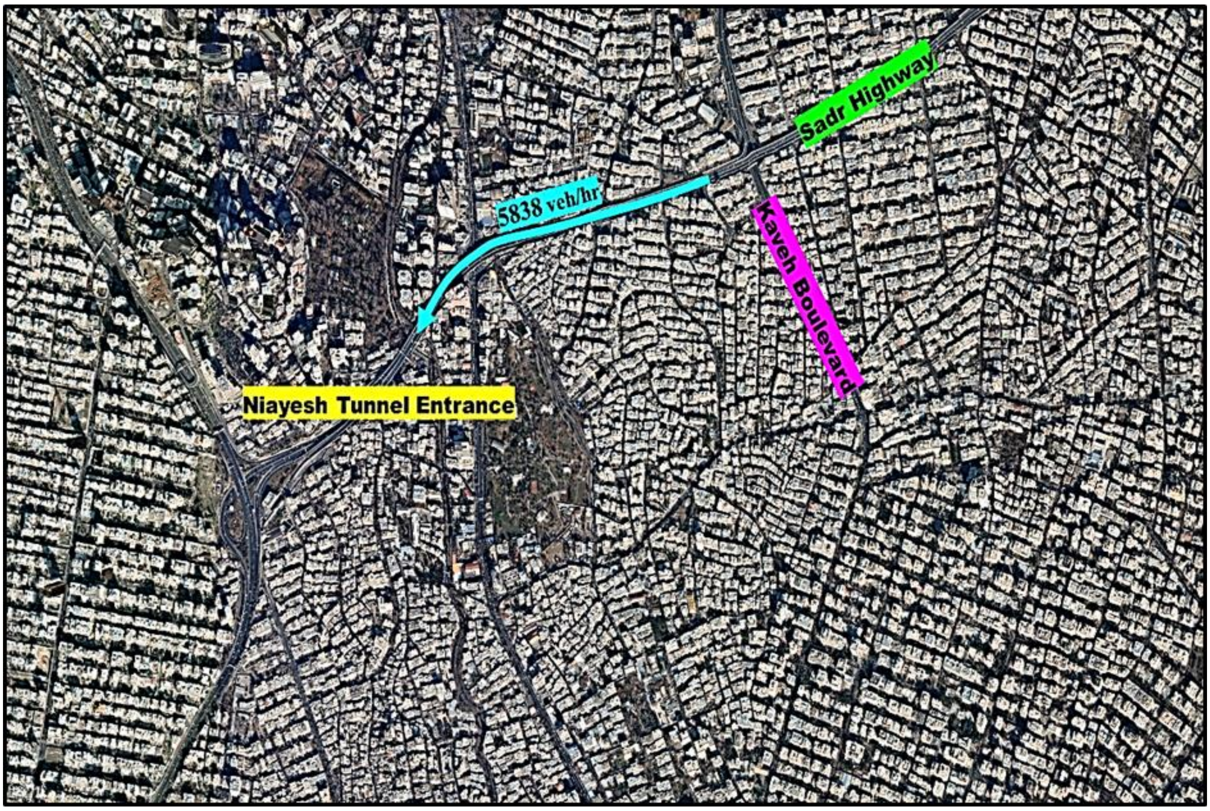

Figure 2. Passenger car equivalence of East-West approach of Sadr highway between Kaveh Boulevard to the entrance of Niayesh tunnel at peak hours

3.2. Network Modeling of the Study Area in Synchro Software

To calculate the traffic index considered in this step, the network of studied routes is modeled in Synchro software. After the simulation, it has prepared software outputs that will be presented below. Figure (3) shows the results extracted from the model in Synchro software.

Lane Group	EBL	EBT	WBT	WBR	SWL	SWR
Lane Configurations						
Traffic Volume (vph)	0	0	5838	0	0	0
Future Volume (vph)	0	0	5838	0	0	0
Ideal Flow (vphpl)	2400	2400	2400	2400	2400	2400
Lane Width (m)	3.7	3.7	3.5	3.5	3.7	3.7
Lane Util. Factor	1.00	1.00	0.91	1.00	1.00	0.88
Frt						
Flt Protected						
Satd. Flow (prot)	0	0	6352	0	0	4187
Flt Permitted						
Satd. Flow (perm)	0	0	6352	0	0	4187
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)						
Link Speed (k/h)		70	70		48	
Link Distance (m)		1287.0	730.5		225.0	
Travel Time (s)		66.2	37.6		16.9	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	6346	0	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	0	6346	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		0.0	0.0		0.0	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		1.6	1.6		1.6	
Two way Left Turn Lane						
Headway Factor	0.72	0.72	0.74	0.74	0.72	0.72
Turning Speed (k/h)	24			14	24	14
Turn Type			NA			Perm
Protected Phases			8			
Permitted Phases						6
Minimum Split (s)			22.5			5.5
Total Split (s)			294.0			6.0
Total Split (%)			98.0%			2.0%
Maximum Green (s)			289.5			1.5
Yellow Time (s)			3.5			3.5
All-Red Time (s)			1.0			1.0
Lost Time Adjust (s)			0.0			0.0
Total Lost Time (s)			4.5			4.5
Lead/Lag						
Lead-Lag Optimize?						
Walk Time (s)			7.0			7.0
Flash Dont Walk (s)			11.0			11.0
Pedestrian Calls (#/hr)			0			0
Act Effct Green (s)			289.5			
Actuated g/C Ratio			0.96			
v/c Ratio			1.04			
Control Delay			28.8			
Queue Delay			0.0			

Scenario 1 12:44 am 07/08/2021 Baseline — Synchro 11 Report

Figure 3. Synchro software output data

According to the information obtained from Synchro software, the v/c ratio for Sadr Highway at the peak hour is 1.04, and considering that the peak hour volume of 6346 vehicles is equivalent to riding, the capacity of this highway is equal to 6102 vehicles. Due to the fact that this highway has three lanes on each side, the capacity of each of its lanes is equal to 2034 vehicles.

3.3. Network Modeling of the Study Area in Aimsun Software

Aimsun software is a powerful tool in the field of road network modeling and simulation that is used for road network traffic studies.

The purpose of Aimsun is to study and evaluate the road network with respect to traffic studies and counting volumes, and to analyze the capacity of roads, the timing of intersections, and so on. In order to calculate the traffic indicators considered in this step, the network of roads in the study area has been modeled in Aimsun software. The outputs obtained after the simulation in the software are shown below.

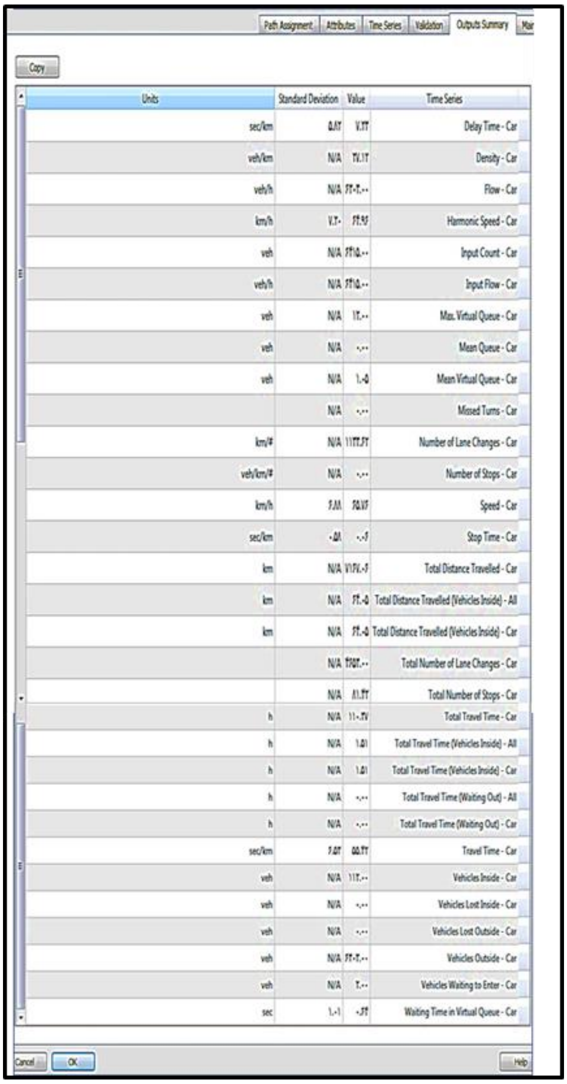

Figure 4. Aimsun software output data

Figure (5) shows the graph of the volume-to-capacity ratio (v/c) for the modeled network in the study area. It is observed that the ratio of volume to capacity on the Sadr Highway is more than one, but its value can not be calculated from the graph. As a result, to calculate the exact value of the volume-to-capacity ratio, the output of the volume-to-capacity ratio diagram is used, as shown in Figure (6). According to the output of Aimsun software, the v/c ratio for Sadr Highway at the peak hour is 1.08, and considering that the peak hour volume of 6492 vehicles is equivalent to riding, the capacity of this highway is equal to 6011 vehicles, which according to The three lanes of this passage on each side have the capacity of each of its lanes equal to 2003 vehicles.

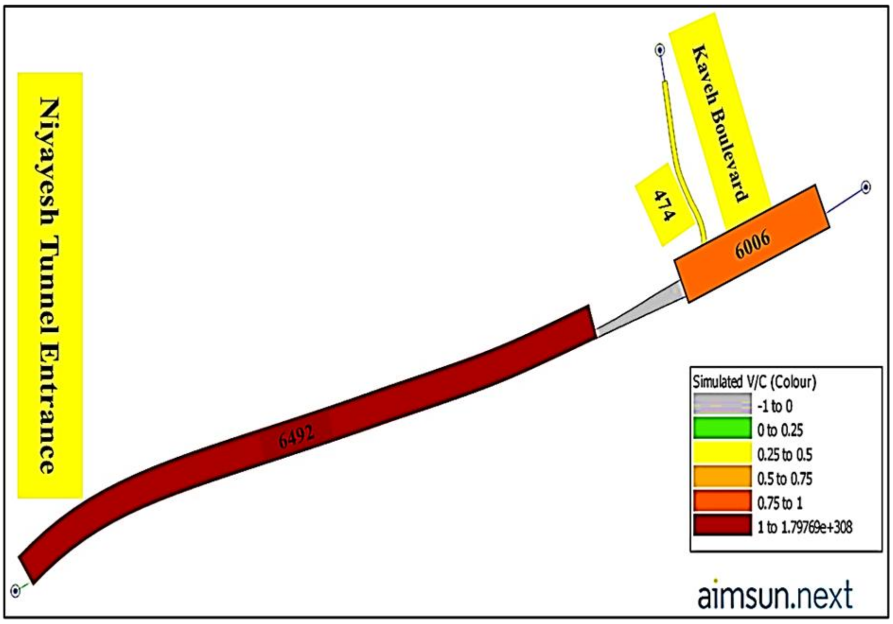

Figure 5. Volume to capacity ratio (V/C) graph for the modeled network in the study area

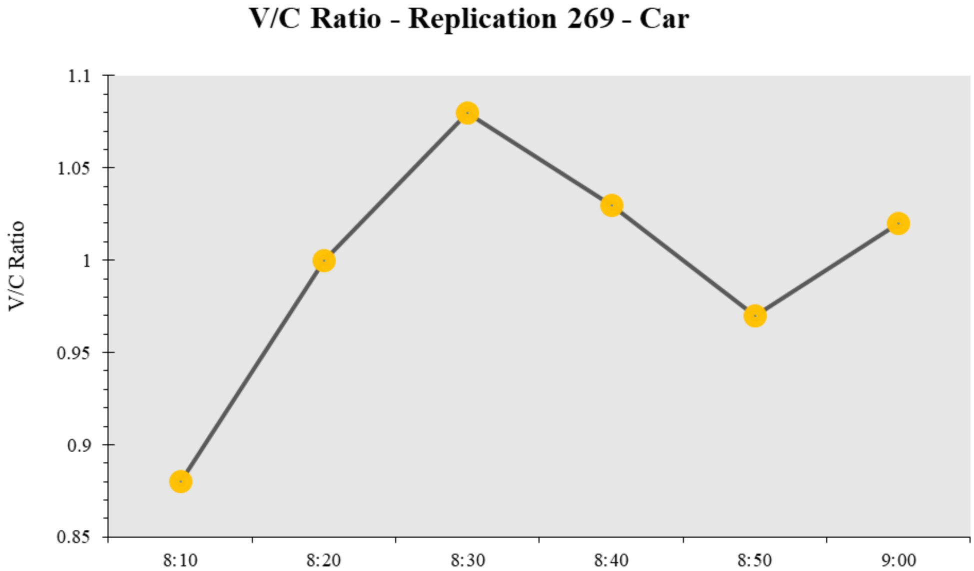

Figure 6. Volume to capacity ratio (V/C) diagram for the modeled network in the study area

3.4. Calculate the Capacity of Sadr Highway Based on Time Headway

The capacity of Sadr Highway was calculated using the relation $C=3600/h_0$. The average headway of vehicles in less than 3.5 seconds on each lane was calculated for 100 vehicles and the results are presented as follows:

- ✓ The average headway of vehicles on the first lane of the highway was 1.9 seconds.
- ✓ The average headway of vehicles on the second lane of the highway was 1.7 seconds.
- ✓ The average headway of vehicles on the third lane of the highway was 1.5 seconds.

According to these results, the capacity of highway lines is 1855, 2041, and 2291 vehicles per hour, respectively.

To obtain the speed-flow diagram, the speed of vehicles is measured. The average speed of non-stop vehicles was calculated every 5 minutes (because the passing rate of vehicles does not change much during this period) and during this period, the number of passenger vehicles, buses, and trucks was counted and the volume was converted to the equivalent transit volume. Table (1) shows the average speed of vehicles and the observed volume of traffic.

Table 1. Volume and speed of vehicles on Sadr Highway

The volume of vehicles on each crossing line	Average speed of observed vehicles
0	70
700	70
1250	63
1500	54
1750	50
2000	39

The free flow speed (FFS) is equal to the average speed of vehicles when the passing volume has no effect on the choice of speed, or in other words, the flow rate is less than 700 vehicles per hour. The free flow speed of vehicles in the measured section was 70 km/h (the average speed of vehicles traveling at a flow rate of less than 700 vehicles per hour was 70 km/h).

By fitting the data in Excel software, Equation (4) is obtained for the recorded data.

$$Q = -1.3321V^2 + 104.64V \qquad (1)$$

According to the concepts of speed, density, and flow relations, to obtain the cross-sectional capacity, the extreme point of the flow-velocity relationship gives the maximum density, or in other words the traffic flow capacity, relative to the speed parameter (V). It is Q_{max}=2055 veh/km/ ln.

Therefore, the maximum capacity will be equal to 2190 vehicles on the line using the quadratic curve model.

The diagram in Figure (7) shows the diagram for the Q_{max} determination relation.

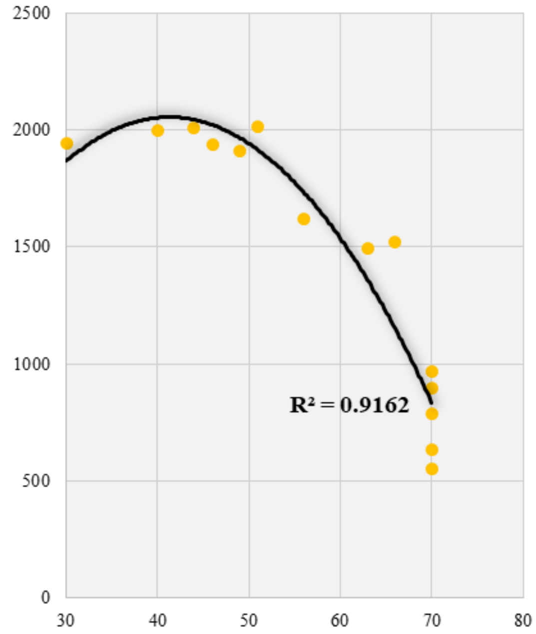

Figure 7. Qmax determination relationship diagram

Figure (8) shows the highway capacity of the study area, which is calculated based on different approaches.

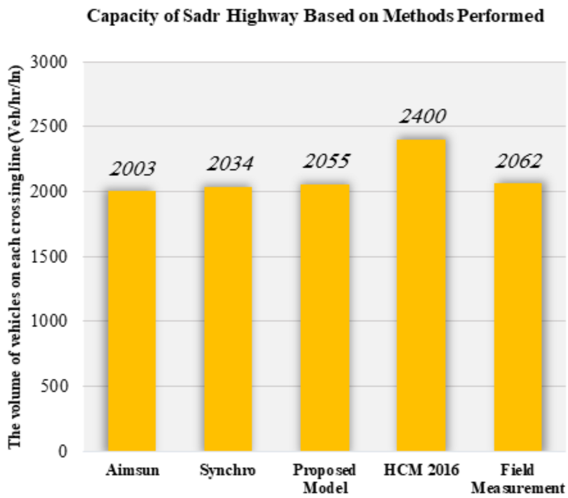

Figure 8. Estimation of capacity based on different methods

The capacity of highway lines in field measurement using the time distance method is 2062 (veh/hr/ln), but the capacity of the highway using the speed-flow diagram HCM2016 is equal to 2400 vehicles per hour per line. The predicted capacity of the crossing in the built model is equal to 2055 vehicles per hour on the line, which is not much different from the time distance method. But since one of the limitations and weaknesses of the HCM method in capacity calculation uses simplified models to estimate capacity, which may not accurately represent real-world conditions. These models assume uniform traffic flow, homogeneous vehicle types, and ideal geometric design features. As a result, the calculated capacities may not reflect the actual capacity of a roadway under different operating conditions. As a result, the output obtained from HCM's method in this study is not very reliable and usable. In the difference between relying on the results of Aimsun and Synchro software and the practicality of their output, If the main focus is on highway capacity analysis, Aimsun would be more suitable due to its comprehensive simulation capabilities. However, if the intersection capacity analysis is at well-marked intersections or smaller-scale projects, Synchro may be more applicable.

4. Conclusion

In this study, in order to analyze the capacity of the basic sections of Iran's highways (a case study of Sadr Highway in Tehran) and analyze the existing relationships between speed and vehicle traffic, traffic flow was recorded by filming a basic section on Sadr Highway and highway capacity This was achieved by using six methods that do not require a traffic density. After the studies, it was observed that the capacity of Sadr Highway lines in field measurement using the time distance method is 2062 vehicles per line, but the capacity of the highway using the speed-flow diagram, HCM2016, is equal to 2400 (veh/hr/ln) is on each passing line. The predicted capacity of the crossing in the created model is equal to 2190 vehicles per hour on the line, which is not much different from the time distance method. Also, the capacity obtained from Synchro and Aimsun software is 2034 and 2003, respectively, which is slightly different from the field measurement and the proposed model.

In this research, different methods were used to estimate the capacity of a road in normal traffic conditions. In order to suggest for future research, it can be suggested that special geographical conditions such as weather changes such as rainfall, and low light (night) can be investigated as the results of changes in road capacity.

On the other hand, in this research, different methods were used to estimate road capacity, which can be used in future research from other methods that were not used in this research.

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