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# Quantitative and Qualitative Analysis of Traffic to Select an Effective Traffic Model for Analytical Operations

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## Abstract

Today, traffic analysis is a very necessary and complex component in urban transportation systems. Performing analyzes requires different analysis tools, each of which is designed for a specific need. These tools generally vary in limitations, capabilities, methodology, input and output needs. The purpose of the methodology for selecting traffic analysis tools is to assist traffic engineers, designers, and traffic operations specialists in selecting the correct type of traffic analysis tools to expedite operations. It also helps to establish the consistency and uniformity of analysis across public transport sectors and provincial / regional / local transport agencies. Choosing the right traffic analysis tools for a project requires judgment, insight and knowledge that can only be gained from years of experience and applications.

The purpose of this article is to present a codified method for selecting an effective analysis method according to the existing conditions from among all models that can be used for road and traffic engineers and other related organizations such as Ministry of Roads and Urban Development, municipalities, governorates and governorates, traffic organizations, Ministry of Interior and The country's engineering systems.

**Keywords:** Transportation, methodology, analysis, traffic, expert system

# 1. Introduction

The use of simulation in traffic engineering has many advantages and applications; One of these advantages is that in simulation, they can be examined in the virtual world before there is a problem in the real world due to the implementation of policies, methods, designs, etc. With the help of simulation science, designs related to different transportation systems can be tested in the virtual world without having to pay for the establishment of a model in the real world(Potkonjak et al., 2016).

Traffic simulation tools have been developed to study the environmental and functional efficiencies of transportation facilities. Performance Criteria Simulation models are used to evaluate system performance in terms such as capacity, travel time, and latency(Sokolowski & Banks, 2011). Environmental efficiency criteria are also used to investigate the effect of traffic on air pollution. Using environmental efficiency criteria, models for air and sound quality can be produced. The advantage of using simulation in a transportation system is enormous because of its ability to test and evaluate the system without disrupting existing traffic or putting crews at risk. In addition, there are several advantages to using simulation to analyze traffic systems(Hu et al., 2020). Many results are obtained for each study range in a relatively short period of time from the simulation. Simulation is used in the planning process and the early stages of facility design. Among the traffic software, some of them have the ability to connect to traffic control systems, and with this feature, it is possible to predict the traffic situation in the next hours and inform users and decision makers of the road network(Conti, Heibati, Kloog, Fiore, & Ferrante, 2017).

Traffic simulation models can be classified into three classes of macroscopic, microscopic, and mesoscopic models based on the level of detail; Macroscopic simulation models are inferred from fluid dynamics. In these models, traffic flow is simulated on a part of the road and individual interactions of road users are not considered. Therefore, these models provide parameters such as traffic volume, average speed and density(Bi, Mao, Wang, & Deng, 2016). These parameters are defined as continuous variables in time or space. Macroscopic simulation models are commonly used to analyze service, demand, and supply levels during regional planning or in large-scale transportation networks. An example of a macroscopic traffic model is the LWR model proposed by Lighthill and Widham (May, 1990). This model describes the traffic flow by means of a set of differential equations and describes the traffic flow as fluid. Light Hill and Widham hypothesized that the fundamental relationships between flow, velocity, and density exist in all traffic conditions, both free-flowing and dense-flowing conditions. Computer simulation in this model is used when analyzing road traffic flow interactions spatially and temporally. Discretization of the LWR model, commonly known as the Daganzo cell transfer model. DCTM is another form of macroscopic model (Daganzo, 1994). DCTM is based on the spatial discretization of the road into smaller parts (cells). Microscopic simulation models simulate the behavior of individual vehicles in a traffic system using sub-models of vehicle tracking, lane departure, chat acceptance, and route selection. Vehicle tracking sub-models determine the acceleration of vehicles and their interaction with other road users as well as with road objects. Sub-lane change models help the driver to move from one lane to the other lanes based on the prevailing traffic conditions and the driver's goals(Twaddle, 2017). Chat acceptance sub-models are used to describe the connection of vehicles to traffic flow for a route. Detection of the routes that drivers choose in practice is done using sub-models of route selection. Microscopic simulation models are also called micro simulation models. The parameters of these models include, spatial distance, time distance, vehicle speeds, acceleration and driver behavioral parameters, etc(Xu & Zhai, 2017). The average of these parameters is used to infer macroscopic parameters. In addition, in microscopic simulation models, the spatial and temporal variables of each vehicle are of great importance, and they are based on time-space diagrams (trajectory diagrams), which examine how vehicles move and how they interact with each other in traffic. be. Micro simulation models are more detailed than macro simulation models. Therefore, they can be used to assess the effects of the proposed improved level on road facilities with a higher degree of accuracy. However, due to the nature and breadth of information that microscopic models simulate, these models run slowly compared to macroscopic models; Hence they are computable. Depending on the purpose and by lightening and weighting, microscopic models are selected from macroscopic models. The main limitation of using microscopic models is to address many descriptive parameters in driving behavior in these models(L. Li & Chen, 2017).

## Introduction and comparison of traffic simulator software

So far, many software have been developed for traffic simulation, each with its own application. In this section, some of these softwares that are used more than others and have commercial applications are introduced.

***VISSIM and VISUM software***

Is a commercial software that has been distributed around 7,000 copies worldwide over the past 15 years. The software algorithm was first proposed in 1974 based on car tracking theory. The core of the model of this simulator software consists of car tracking model, lateral motion rules including, lane selection, lane change, lane continuation in a specific lane, models related to driver behavior and lane selection topics. VISSIM software is a shredding software for analyzing and modeling the network of roads, intersections, public transportation systems, park management, etc., which is able to provide specifications and performance indicators of roads with higher capabilities and planning accuracy than SYNCHRO and GETRAM 4.2 software. VISUM software is also a large-scale software for urban transportation planning(Karavakis, 2010).

***TRANSCAD software***

This transportation planning software is the first GIS designed for transportation specialists so that specialists can store, display, organize and analyze transportation information with the help of this software(Costin, Adibfar, Hu, & Chen, 2018).

***PARAMIC simulator software***

Is a microscopic simulator software that is used in many traffic projects, and one of the most important features of this software is its ability to microscopically model a large traffic network. The software is able to simulate 10 square kilometers of a traffic network with hundreds of separate sections and hundreds of kilometers of highways, freeways and arterial roads, as well as traffic flow and congestion of vehicles, and finally a video output with 3D display capability. To provide traffic management and network design of thoroughfares(Garcia-Nieto, Olivera, & Alba, 2013).

***TRANSIMS simulator software***

This software simulates the behavior of individuals depending on the position and direction of the vehicles they use. And provides such information to each individual. Using this simulator, one can answer the question of who will benefit or lose any change in traffic situation(Naumov, Baumann, & Gross, 2006).

***AIMSUN NG software***

There are a variety of methods and tools for traffic analysis. These tools are divided into the following groups; Approximate planning tools, travel demand models, analytical tools (HCM based), traffic light optimization tools, macro simulation models and shredder simulation models.

AIMAUN NG software is a type of partial simulation models. AIMSUN NG software is an advanced version of Jetram software, which is a product of TSS company and was created in 2005. AIMSUN 6 is a new generation of popular GETRAM and AIMSUN NG 5 software.

AIMSUN is the only software on the market that offers the following transportation models in three levels as a single software: static traffic allocation tool, new mesoscopic simulator. And this is the best microscopic simulation software in the world right now. In the soon-to-be-released version 7 of the software, AIMSUN has the ability to execute models in parts of the model mesoscopically and in other parts microscopically simultaneously. However, other simulation software such as CORSIM can only simulate one of these models, and this is a unique feature of this software.

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AIMSUN's ability to combine static and dynamic approaches in a single environment is a unique feature of this software. Its excellent efficiency and capability have made it possible to develop dynamic models of most major cities in the world using it. Direct user interface, logical execution, ease of calibration and a significant set of software outputs and reports reduce project time. AIMSUN is a very complete set of interfaces and interfaces and can exchange information with other well-known software in the field of demand modeling, optimization of lights program and light control tools. Regarding software localization by considering different traffic characteristics, behaviors and cultures in different parts of the world and using it in online traffic management projects, AIMSUN has special tools with a high degree of flexibility using PYTHON and C ++ programming languages to communicate with the control system. SCATS and provides access to details of information and their analysis and processing and design of external control systems. Network modeling is one of the important capabilities of this chronological software that can solve problems related to urban networks, freeways, highways, arterial and belt routes or a combination of the above networks. Another benefit of this software is the assistance of traffic engineers in the design and analysis of traffic systems and is a very useful tool in testing traffic control systems and new methods of traffic management and intelligent transportation systems. Other features of this software include: Analysis of the impact of infrastructure projects such as construction of non-coplanar intersections, tunnels, squares, etc., environmental studies, cost and toll cost studies as well as traffic areas such as even and odd plan and restricted areas, road network design and support system To manage public transportation as well as to define complex traffic management strategies in the network such as accidents, roadblocks, diversion of vehicles based on traffic volume, etc. Determining the required parking capacity and how to access the passages, optimizing the traffic control program, urban and interurban traffic management, designing the road network and support system for public transport management, safety analysis, evaluation of transportation systems Intelligence and development of new transportation models and algorithms, modeling of advanced traffic management systems, car navigation systems, public transportation system scheduling, the ability to calculate environmental indicators such as air pollutants and fuel consumption. AIMSUN outputs include fuel consumption, traffic, air pollution, network speed, number of stops per unit time, density, network travel time, before and after delays. The input of this software is the specifications of the passages such as the volumes and geometry of the passages, the control status of intersections and public transportation lines. Two-dimensional and three-dimensional display of network traffic, network performance indicators such as travel time throughout the network, latency imposed on vehicles, average vehicle speed, lane density and identifier information are among the outputs of this software. Some of the parameters used in traffic flow analysis are: - current; The number of vehicles that pass through a particular point at a given time. - Density; The number of vehicles passing along the unit of a crossing line - average speed; Ratio of traffic or distance traveled per unit time(McLane, Semeniuk, McDermid, & Marceau, 2011).

Table 1 summarizes the research results in the comparative analysis of some traffic simulation software.

Table (1): Types of comparative studies of traffic simulation software

| **software studied** | **findings** |
|---|---|
| CORSIM<br>PARAMICS<br>VISSIM<br>SIM Traffic | According to a study by Barrios et al., These traffic simulation softwares have been evaluated based on the power of graphical display, especially public transport performance. Based on the results and imaging power, Vissim software is superior to other simulation software under study due to its 3D display capability(L. Yang et al., 2019). |
| CORSIM<br>VISSIM | According to the study, Bloomberg and Dale software were compared based on their simulation power in arterial congestion pathways, both of which have the same capability in this field(Chowdhury, 2019). |
| CORSIM<br>SIM Traffic | Based on the Trueblood study, which was based on the user-friendliness of the user and the model's ability to accurately simulate non-coplanar intersections, the two software showed slight differences in the simulation of low to medium traffic arterial pathways(Mechael et al., 2010). |
| CORSIM<br>PARAMICS<br>VISSIM | According to a study by Choa et al., Corsim has a better ability to calculate and control latency for standalone approaches than other software, and Paramics and Vissim better represent real-world conditions due to their 3D display capability(X. Li, 2015). |

| | |
|---|---|
| CORSIM<br>VISSIM<br>SIM Traffic | Based on the study of Tian et al., Roads with lighted intersections were evaluated. The results of the software have different outputs by changing parameters such as path length, speed and volume(Huang et al., 2015). |
| SIM Traffic<br>AIMSUN<br>CORSIM | Based on Jones' study, it was concluded that Aimsun performs better than other two software in simulating the urban road network(Keyvan-Ekbatani, Papageorgiou, & Knoop, 2015). |
| PARAMICS<br>VISSIM<br>AIMSUN | In the study of Panwai and Dia, the theory of car tracking was studied in the mentioned softwares, among which Aimsun has less error than the other two softwares(Soria, Elefteriadou, & Kondyli, 2014). |
| VISSIM<br>AIMSUN | According to the results of the study, Xiao et al. Both software have the ability to simulate the characteristics of traffic flow and have the same degree of accuracy(S. Yang et al., 2019). |
| HCS<br>SYNCHRO | Effendi Zadeh and Zabihi in 2011 compared the analytical results of Hcs and Synchro softwares in urban light intersections. In 2-stroke intersections, the number of movements in it is not complete (9 movements and less). But at the intersections of 3-stroke and 4-stroke, neither of these two softwares provide proper analysis(Ghods & Kilerci). |

## 2. Research Methods

Traffic analysis tools have emerged as one of the most effective ways to evaluate the improvement of transportation projects. Based on these criteria, the classification of analytical tools of measurable traffic operations is arranged but does not include real-time or predictive models. Traffic analysis tools may include software packages, methodologies, and methods, as well as tools commonly used for the following tasks:

- Evaluate, simulate or optimize the operations of transportation facilities and systems
- Modeling existing operations and predicting possible outcomes for the proposed proposal
- Evaluation of various analytical fields including planning, design and operation / construction of projects

Microscopic simulation models simulate the movement of personal vehicles based on theories of vehicle tracking and lane departure. Typically, vehicles enter the transportation network using the obtained statistical distribution (random process) and are tracked through the same network at short intervals (for example, 1 second or less than 1 second). Usually, upon arrival, each vehicle is assigned a destination, a vehicle type, and a driver type. In many microscopic simulation models, the traffic operation characteristics of each vehicle are influenced by vertical degree, horizontal curvature, and degree of height based on the relationships developed in previous research. The most important tool for calibration and validation of the microscopic simulation model is obtained by adjusting the driver sensitivity factors. For microscopic models, computer time and storage requirements (storage space) are important and can usually be covered by limiting the size of the network and the number of simulation runs.

Table (2): Advantages and Challenges of Operational Analysis Tools

| Tools / Materials and Methods | Advantages of use | Challenges |
|---|---|---|
| Design planning tools | • Low cost • Fast analysis times • Requires limited information • Show "big picture" | - Limited in scope, analytical power and presentation capabilities |
| Travel demand forecasting model | • Valid models available For most metro areas • Regional impact assessment • Compatible with common planning methods | - Limited ability to analyze operational strategies - Usually does not include non-periodic delays |
| Definitive models | • Quickly predict effects for an isolated area • Widely accepted | - Limited ability to analyze operational strategies - Usually does not include non-periodic delays |
| Traffic Signal Optimization Tools | • An effective tool for testing previous programs for field implementation • Proven (tested) operational benefits | - Limited ability to analyze wide area effects - Limitations in measuring functions |
| simulation | • Accurate results, especially in micro simulation • Dynamic analysis of events and real-time deviation patterns • Visual presentation opportunity (possibility of visual display) | - The calibration process can be time consuming - Requires data for calculations, especially in micro simulation Required resources may be limited by network size and number of analysis modes |

## Analytical context

The first step in choosing the right type of traffic analysis tool is to identify the analytical context of the project. Table 2 typically shows the process of transport analysis, which consists of several analytical steps, including: Planning: This stage includes short- or long-term studies, or in other words, regional or local transportation plans (for example, master plans, congestion management plans, ITS strategic plans, etc.). Design: At this stage, projects are approved and funding is allocated through alternative (proposed) analysis or initial design to determine the best option for implementation. This step also includes the required analyzes of road characteristics to be applied at the desired service level. Complete project design (eg horizontal / vertical alignments, pavement design, etc.) is not included in this category. Operations / Construction: These projects have many similar features to design projects, but are designed to determine the best approach to optimizing or evaluating existing systems.

**Software or method of selecting analytical tools**

Given that our case study is in the planning framework, the relevant weight should be given according to the importance of the project and zero should be given to other factors, namely design and construction operations. As the software has shown, the categories of travel planning and planning tools and models have high weights, which indicates that in the planning framework, the goals related to travel planning and planning and model should be prioritized. . 1: The study area is 320 hectares. We can only give points to the sub-criteria of the section and the rest of the sub-criteria will be given zero. Which has been selected as the effective tool category by giving a score related to the sub-criteria of the HCM toolkit and analysis tools category.

Among the sub-criteria of various facilities, there are only 4 of them within the scope of Tabriz traffic plan, which are squares (Daneshsara Square, Prayer Square, Shohada Square and Saat Square), Arterial (which ends on the north side of the area to Chaiknar Street) , HOV line and bus line. The special bus line of Basij Square to the railway passes through this area. Strengthening the public transportation system will satisfy the people and is one of the main goals of the project. Special public transportation lines reduce travel time, reduce costs, reduce fuel consumption, increase travel reliability and make people more comfortable. With these explanations, all four items should be given a high weight, in order of priority, the highest score to the bus line, ie 5, to the HOV line, score 4, and to the arteries that have a large decrease in density, 4, and to the squares, which play a small role compared to the other 3 criteria. Have a weight of 3 given. As indicated in the software, in the discussion of the types of facilities, all categories of tools have positive advantages that it turns out that all of them should be given importance. However, according to their scores, first the cases related to the movement of vehicles should be examined from a microscopic and macroscopic point of view, and in the next stage, travel management strategy, such as intelligent transportation systems, destination selection, route selection, etc. To be checked and then to be examined in order of priority of other tools.

Project Name: ______ Analyst: ______ Date: ______

Press This Button to START | Recalculate

| 1 | 2 | 3 | | | | | | | 4 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tool Category Relevance | | | | | | | Column 2 x Column 3 | | | | | | |
| Analysis Context | Context Relevance | Sketch Plan | TDM | Analytical (HCM) | Traffic Opt | Macro Sim | Meso Sim | Micro Sim | Sketch Plan | TDM | Analytical (HCM) | Traffic Opt | Macro Sim | Meso Sim | Micro Sim |
| *Please select only ONE analysis context. Enter a '5' on the selected category.* | | | | | | | | | | | | | | | |
| Planning | 5 | 10 | 10 | 5 | 0 | 5 | 5 | 0 | 50 | 50 | 25 | 0 | 25 | 25 | 0 |
| Design | 0 | -99 | 5 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operations/Construction | 0 | 5 | 0 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | Subtotal | 50 | 50 | 25 | 0 | 25 | 25 | 0 |
| | | | | | | | | Relevance Weights Above 0 | 1 | | | | | | |
| | | | | | | | | WEIGHTED SUBTOTAL | 50 | 50 | 25 | 0 | 25 | 25 | 0 |

| 1 | 2 | 3 | | | | | | | 4 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tool Category Relevance | | | | | | | Column 2 x Column 3 | | | | | | |
| Criteria | Sub-Criteria Relevance | Sketch Plan | TDM | Analytical (HCM) | Traffic Opt | Macro Sim | Meso Sim | Micro Sim | Sketch Plan | TDM | Analytical (HCM) | Traffic Opt | Macro Sim | Meso Sim | Micro Sim |
| 1 Geographic Scope (0 = not relevant, 5 = most relevant) | | | | | | | | | | | | | | | |
| Isolated Location | 0 | 0 | 0 | 10 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Segment | 5 | 10 | 0 | 10 | 0 | 5 | 5 | 5 | 50 | 0 | 50 | 0 | 25 | 25 | 25 |
| Corridor/Small Network | 0 | 5 | 10 | 0 | 0 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Region | 0 | 5 | 10 | -99 | -99 | -99 | -99 | -99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | Subtotal | 50 | 0 | 50 | 0 | 25 | 25 | 25 |
| | | | | | | | | Relevance Weights Above 0 | 1 | | | | | | |
| | | | | | | | | WEIGHTED SUBTOTAL | 50 | 0 | 50 | 0 | 25 | 25 | 25 |
| 2 Facility Type (0 = not relevant, 5 = most relevant) | | | | | | | | | | | | | | | |
| Isolated Intersection | 0 | 0 | 5 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Roundabout | 3 | 0 | 0 | 10 | 0 | 5 | 0 | 5 | 0 | 0 | 30 | 0 | 15 | 0 | 15 |
| Arterial | 4 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Highway | 0 | 10 | 10 | 10 | 5 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Freeway | 0 | 5 | 10 | 10 | 5 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HOV Lane | 4 | 5 | 10 | 5 | 0 | 10 | 10 | 10 | 20 | 40 | 20 | 0 | 40 | 40 | 40 |
| HOV Bypass Lane | 0 | 0 | 10 | 0 | 5 | 5 | 5 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ramp | 0 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Auxiliary Lane | 0 | 0 | 0 | 5 | 5 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reversible Lane | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Truck Lane | 0 | 0 | 10 | 5 | 5 | 5 | 5 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bus Lane | 5 | 0 | 10 | 0 | 0 | 5 | 5 | 10 | 0 | 50 | 0 | 0 | 25 | 25 | 50 |
| Toll Plaza | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Light Rail Line | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | Subtotal | 60 | 130 | 90 | 40 | 120 | 105 | 145 |
| | | | | | | | | Relevance Weights Above 0 | 4 | | | | | | |
| | | | | | | | | WEIGHTED SUBTOTAL | 15 | 33 | 23 | 10 | 30 | 26 | 36 |

There are HOV, bus, motorcycle, bicycle and pedestrian sub-criteria within the area, each of which has a role in reducing traffic, but according to the goals of the urban area traffic plan, HOV, bus and pedestrian sub-criteria have a greater role. More details in this chapter Is brought. According to the software analysis in the travel fashion section, it is determined that the cases and problems related to the category of simulation tools and travel demand model must be solved first. 4: In the criteria of management strategy and applications, according to the definitions that have sub-criteria and are explained in the section one by one, 8 of the sub-criteria are prioritized in order of goals and goals and plans of Tabriz traffic plan area, which have been weighted and the results of software analysis have shown the appropriate tools for management strategy and applications that should be considered in prioritization

Within the traffic plan of Tabriz city, the criterion of changing the direction of travel is more important than the other criteria of passenger satisfaction. And inside the city, the change of route before the trip is done better than during the trip, therefore, the change of route before the trip is given 5 points and the change of route during the trip is given 4 points. And the change of travel mode within the city of Tabriz is done in two ways, namely by city taxi and bus, which has been given a score of 3 due to its importance. According to the results of the software regarding the most appropriate category of tools in the criterion of passenger response, the total score of one of the tools is negative and one is zero, which should not be used, and among the other 5 tools, the travel demand model. It has the highest score, which indicates that in the criteria of responding to the passenger, first the problems related to choosing the destination of trips, choosing the modes of travel within the city, travel time, travel route, etc. should be solved, then solving problems Related to the category of simulation tools.

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Performance Measures (0 = not relevant, 5 = most relevant) | | | | | | | | | | | | | | | |
| | LOS | 5 | 0 | 5 | 10 | 10 | 5 | 5 | 5 | 0 | 25 | 50 | 50 | 25 | 25 | 25 |
| | Speed | 4 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | Travel Time | 5 | 5 | 5 | 10 | 10 | 10 | 10 | 10 | 25 | 25 | 50 | 50 | 50 | 50 | 50 |
| | Volume | 4 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | Travel Distance | 2 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 20 | 20 |
| | Ridership | 2 | 0 | 5 | 0 | 0 | 0 | 5 | 5 | 0 | 10 | 0 | 0 | 0 | 10 | 10 |
| | Average Vehicle Occupancy (AVO) | 3 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 |
| | V/C Ratio | 4 | 0 | 10 | 10 | 5 | 5 | 5 | 5 | 0 | 40 | 40 | 20 | 20 | 20 | 20 |
| | Density | 4 | 0 | 0 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 40 | 40 | 40 | 40 | 40 |
| | VMT/PMT | 4 | 5 | 10 | 5 | 5 | 10 | 10 | 10 | 20 | 40 | 20 | 20 | 40 | 40 | 40 |
| | VHT/PHT | 4 | 5 | 10 | 5 | 5 | 10 | 10 | 10 | 20 | 40 | 20 | 20 | 40 | 40 | 40 |
| | Delay | 5 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 25 | 50 | 50 | 50 | 50 | 50 | 50 |
| | Queue Length | 4 | 0 | 0 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 40 | 40 | 40 | 40 | 40 |
| | Number of Stops | 2 | 5 | 0 | 0 | 0 | 0 | 5 | 10 | 10 | 0 | 0 | 0 | 0 | 10 | 20 |
| | Crashes/ Accidents | 1 | 5 | 0 | 0 | 0 | 0 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 5 | 5 |
| | Incident Duration | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 5 | 5 |
| | Travel Time Reliability | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Emissions | 5 | 5 | 0 | 0 | 0 | 0 | 5 | 5 | 25 | 0 | 0 | 0 | 0 | 25 | 25 |
| | Fuel Consumption | 4 | 5 | 0 | 0 | 0 | 5 | 5 | 5 | 20 | 0 | 0 | 0 | 20 | 20 | 20 |
| | Noise | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Mode Split | 4 | 0 | 10 | 0 | 5 | 5 | 5 | 5 | 0 | 40 | 0 | 20 | 20 | 20 | 20 |
| | Benefit/Cost | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | Subtotal | 285 | 365 | 390 | 390 | 425 | 500 | 510 |
| | | | | | | | | | Relevance Weights Above 0 | 22 | | | | | | |
| | | | | | | | | | WEIGHTED SUBTOTAL | 13 | 17 | 18 | 18 | 19 | 23 | 23 |
| 7 | Tool/Cost Effectiveness (0 = not relevant, 5 = most relevant) | | | | | | | | | | | | | | | |
| | Tool capital cost | 4 | 10 | 0 | 10 | 10 | 5 | 0 | 0 | 40 | 0 | 40 | 40 | 20 | 0 | 0 |
| | Level of effort/training | 4 | 10 | 0 | 10 | 5 | 5 | 0 | 0 | 40 | 0 | 40 | 20 | 20 | 0 | 0 |
| | Easy to use | 4 | 10 | 0 | 10 | 5 | 5 | 0 | 0 | 40 | 0 | 40 | 20 | 20 | 0 | 0 |
| | Popular/well-trusted | 5 | 5 | 5 | 10 | 10 | 5 | 0 | 5 | 25 | 25 | 50 | 50 | 25 | 0 | 25 |
| | Hardware requirements | 4 | 10 | 5 | 10 | 10 | 10 | 0 | 0 | 40 | 20 | 40 | 40 | 40 | 0 | 0 |
| | Data requirements | 3 | 10 | 0 | 10 | 10 | 0 | 0 | 0 | 30 | 0 | 30 | 30 | 0 | 0 | 0 |
| | Computer run time | 5 | 10 | 5 | 10 | 10 | 10 | 0 | 0 | 50 | 25 | 50 | 50 | 50 | 0 | 0 |
| | Post-processing requirements | 3 | 5 | 0 | 5 | 5 | 5 | 10 | 10 | 15 | 0 | 15 | 15 | 15 | 30 | 30 |
| | Availability of Documentation | 4 | 5 | 5 | 10 | 5 | 5 | 5 | 5 | 20 | 20 | 40 | 20 | 20 | 20 | 20 |
| | User support | 4 | 5 | 10 | 0 | 0 | 5 | 5 | 5 | 20 | 40 | 0 | 0 | 20 | 20 | 20 |
| | Key parameters can be user-defined | 2 | 5 | 10 | 5 | 5 | 10 | 10 | 10 | 10 | 20 | 10 | 10 | 20 | 20 | 20 |
| | Default values are provided | 2 | 10 | 0 | 10 | 10 | 10 | 10 | 10 | 20 | 0 | 20 | 20 | 20 | 20 | 20 |
| | Integration with other software | 3 | 0 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 15 | 15 | 15 | 15 | 15 | 15 |
| | Animation/presentation features | 3 | 0 | 5 | 0 | 0 | 5 | 10 | 10 | 0 | 15 | 0 | 0 | 15 | 30 | 30 |
| | | | | | | | | | Subtotal | 350 | 180 | 390 | 330 | 300 | 155 | 180 |
| | | | | | | | | | Relevance Weights Above 0 | 14 | | | | | | |
| | | | | | | | | | WEIGHTED SUBTOTAL | 25 | 13 | 28 | 24 | 21 | 11 | 13 |

All the metrics of the performance measurement criterion are explained and additional explanations of the performance measurement criterion in relation to the scope of Tabriz traffic plan in Vali regarding software analysis, it should be said that if we want to measure the performance measurement criterion within the scope of Tabriz traffic plan Separately, as

the scores show, all categories of tools have positive scores, which should be studied one by one by the analytical tools in order of priority (from the final score), ie first the infrastructure that is studied by the class of simulation tools. They should be examined and their problems should be solved, then the priority of other tools should be studied.
In this criterion, one-by-one definitions of sub-criteria are given. And the most appropriate category of tools of this criterion has been determined with a score of 28 and 25, which should be the first priority in the study.

Criteria Weights

| 5 | | 6 | 7 | | | | | | | 8 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Context/Criteria (0 = not relevant, 5 = most relevant) | | Criteria Relevance | Weighted Subtotals | | | | | | | Column 6 x Column 7 | | | | | | |
| | | | Sketch Plan | TDM | Analytical (HCM) | Traffic Opt | Macro Sim | Meso Sim | Micro Sim | Sketch Plan | TDM | Analytical (HCM) | Traffic Opt | Macro Sim | Meso Sim | Micro Sim |
| 0 | Analysis Context | 4 | 50 | 50 | 25 | 0 | 25 | 25 | 0 | 200 | 200 | 100 | 0 | 100 | 100 | 0 |
| 1 | Geographic Scope | 2 | 50 | 0 | 50 | 0 | 25 | 25 | 25 | 100 | 0 | 100 | 0 | 50 | 50 | 50 |
| 2 | Facility Type | 4 | 15 | 33 | 23 | 10 | 30 | 26 | 36 | 60 | 130 | 90 | 40 | 120 | 105 | 145 |
| 3 | Travel Mode | 5 | 16 | 24 | 16 | 14 | 14 | 24 | 26 | 80 | 120 | 80 | 70 | 70 | 120 | 130 |
| 4 | Management Strategy/Applications | 4 | 16 | 8 | 14 | 9 | 19 | 19 | 23 | 65 | 33 | 58 | 35 | 75 | 75 | 93 |
| 5 | Traveler Response | 3 | 16 | 30 | -322 | 0 | 28 | 28 | 28 | 49 | 90 | -965 | 0 | 83 | 83 | 83 |
| 6 | Performance Measures | 5 | 13 | 17 | 18 | 18 | 19 | 23 | 23 | 65 | 83 | 89 | 89 | 97 | 114 | 116 |
| 7 | Tool/Cost Effectiveness | 5 | 25 | 13 | 28 | 24 | 21 | 11 | 13 | 125 | 64 | 139 | 118 | 107 | 55 | 64 |
| | | | | | | | | | WEIGHTED TOTALS | 744 | 720 | -310 | 351 | 701 | 701 | 680 |
| | | | | | | | | | Most Appropriate Tool Categories: | 1. Sketch Plan | | | | | | |
| | | | | | | | | | | 2. TDM | | | | | | |

**Tool Categories:**

- Sketch Plan = Sketch-planning methodologies and tools
- TDM = Travel demand models
- Analytical (HCM) = Analytical/deterministic tools (HCM-based)
- Traffic Opt = Traffic optimization tools
- Macro Sim = Macroscopic simulation models
- Meso Sim = Mesoscopic simulation models
- Micro Sim = Microscopic simulation models

*Please see the 'Tool Definitions' worksheet for more details*

Recalculate

## 3. Conclusion

Based on the analysis, the final score of the category of simulation tools (microscopic, macroscopic, mesoscopic), traffic signal optimization, travel demand model and plan planning are positive, and there is only one final score less than zero that should not be analyzed. used. Therefore, the most appropriate options should be selected within the 6 categories of tools whose scores are positive and usable. According to the results of analyzing the final scores of 5 tools (microscopic, macroscopic, mesoscopic, travel demand model and project planning) are above 600 and very close to each other, it is recommended that if the scores are close to the existing tools to choose a better option to be used. However, the most appropriate category of tools to study the scope of Tabriz traffic plan is to use the plan and program tools and travel demand model. This indicates that metropolitan issues such as the city master plan, the city detailed plan and the traffic traffic master plan should be examined first. Various studies on urban development plans, especially comprehensive plans, show that although parts of the plans, especially the proposed road network, have been implemented in all cities, but due to the lack of specific executive policies and the lack of a coordinating body. And organized, careful planning, and premeditated planning have not been successful. One of the main shortcomings of urban development plans is the separation between the process of project preparation and their implementation process, so that usually the responsibility of project preparation and implementation is assigned to two different and separate institutions. According to current regulations, the preparation and approval of comprehensive plans is the responsibility of the Ministry of Roads and Urban Development and the Supreme Council of Urban Planning and Architecture. However, their executive responsibility is assigned to the city administration (municipalities and Islamic city councils) and effective organizations in the development of the city. This situation is one of the effective factors in the failure and non-realization of urban development plans. The following can also be considered as the problems of Tabriz urban planning, which are the relative uniqueness of the city, the high concentration of commercial and service uses in the area, the width of the roads leading to the area and the existence of numerous educational centers, etc. In the context of the comprehensive plan of transportation and traffic in Tabriz, it is better to pay more attention to the issue of human-centered transportation and pay special attention to improving the road network, changing the type of view of public transportation and parking and parking. The development of public transportation systems on these roads should be on the agenda of any road where people are more inclined to travel and need to be identified as public transportation. Shopping malls should also be considered as a walking destination in the master plan. Based on successful experiences in the world's metropolises, this can be achieved by planning and building facilities and centralizing public transportation along with travel demand management. Increasing car ownership and increasing relative well-being, increasing travel rates, are the source of many other problems in the city, so that gasoline consumption by cars has increased, which in turn pollutes the environment and thus reduces the safety and health of citizens. At the same time, increasing the volume of vehicle traffic itself increases accidents and the resulting material and human losses. The city's bus and taxi systems carry a large number of passengers daily, and these numbers are also increasing, and this indicates the extent of metropolitan issues and problems in the transportation sector, which need to improve the following goals: - Reducing the demand for passenger travel - Development of public transportation such as improving the fare system, providing parking facilities, development of public and intelligent transportation, special services and linear services, creating a travel information system and creating coordination between different modes of transportation General. - Development of non-motorized transportation such as improving sidewalks and bicycle paths due to their compatibility with the environment, proper integration of sidewalks and passages, development of pedestrian land use, increasing bicycle parking lots, etc. - Development of taxi improvements such as fare reduction, establishment of taxi stations and provision of telephone services and integration of public transport and cycling - Special lines for crowded vehicles - Pricing of passages - Receiving tolls based on distance traveled - Increasing fuel taxes, modern urban planning with a focus on public transportation and calming traffic and managing freight transportation In the last step, the issues related to the urban area should be examined from a macroscopic and mesoscopic perspective.

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