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Research Article

DETERMINATION OF TRAFFIC CONGESTION AND DELAY OF TRAFFIC FLOW AT CONTROLLED INTERSECTIONS

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ABSTRACT

A sharp increase in the number of cars of the city leads to a rise in traffic jams and commuters' travel time. Car traffic firstly, when passengers or transported cargo are exposed to spending a lot of time on their way to the destination and an increase in the cost of transportation of transport, secondly, traffic on highways leads to an increase in accidents, and thirdly, the car can travel excessive distances or get stuck in traffic jams, and, accordingly, an increase in fuel consumption, In general, it causes socio-economic losses. One of the important issues is the correct management of the traffic flow on highways in the city and the effective organization of movement.

KEYWORDS

Transport, traffic, social, economic, street.

INTRODUCTION

The transport permeability and capacity of city streets will depend primarily on the geometric characteristics of the street, the cycle time of the controlled intersection, and also on the traffic composition of vehicles. The transfer capacity may vary depending on the composition of the traffic in the daily time interval, but the transfer capacity of the intersection is usually of a stable value, which can only be achieved by improving the geometric characteristics of the street or by the optimal distribution of the time of movement

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of cars at the intersection. Basically, it is possible to further increase the bandwidth by correctly distributing the time for the opposite movements in which the traffic light seeks to use the same area. The optimal distribution of time significantly affects its performance. When analyzing the permeability of the street, the number of road lanes on the specified Street will depend on its permeability.

For this research work, the main task was taken to effectively manage the managed intersection using the example of the plot presented in Figure 1. For this, the following A.Timur and A. Navoi-Shakhrisabz streets which are considered one of the complex intersections of the city of Tashkent at the intersection of Navoi-Shahrisabz streets will be analyzed. At this intersection, it was practically observed that cars were caught in large quantities during rush hours. A schematic view of the directions of movement on the specified plot is shown in Figure 2. The pedestrian movement was not taken into account in the current research work.

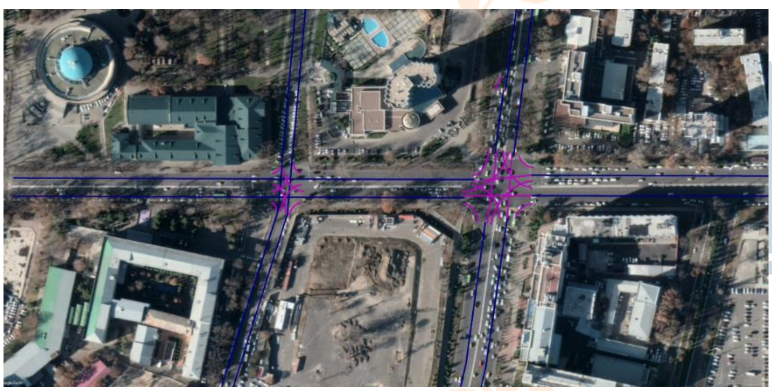

Figure 1. View of the studied intersection from Google map

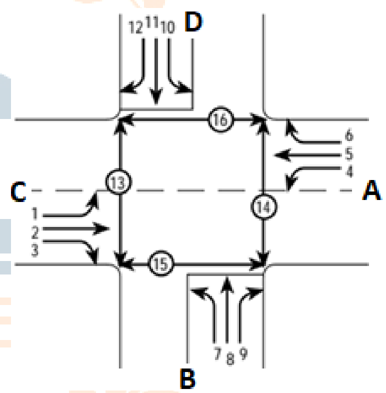

Figure 2. Schematic view of the intersection

There are various modeling and simulation programs for the implementation of Transport flow management activities. One of these is the PTV vissim program, a computer model created in this program is shown in Figure 3. We can evaluate and simulate different alternative situations that can be done by simulating different traffic flows in this model tab.

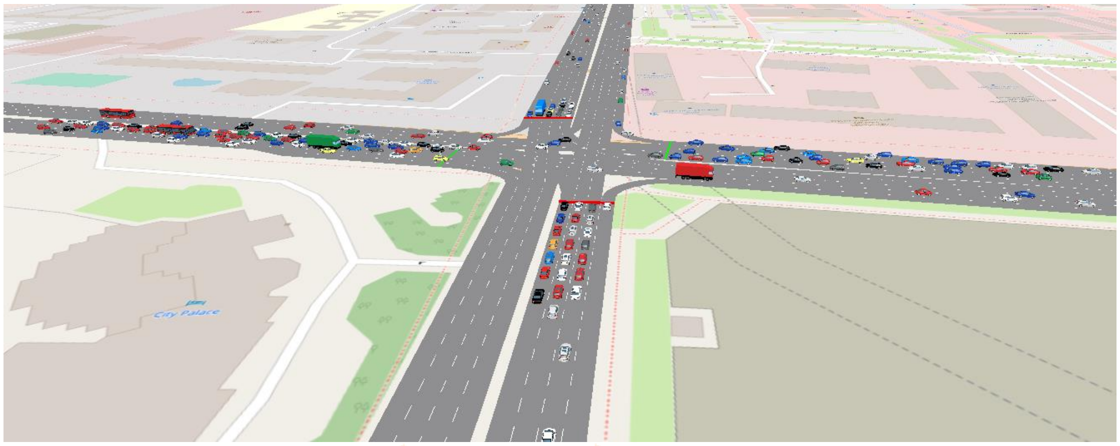

Figure 3. Computer model of the research intersection

In practice, speed or travel time in determining the amount of traffic flow and the carrying capacity of the street is an important indicative measure of the quality of the transport service. At intersections, not the speed of the vehicle, their delay indicators are the main measure. It determines the level of service for city streets and is an important measure of efficiency. Assessing the quality of a regulated intersection is difficult to describe some measure of efficiency. There are a number of measures in the analysis and simulation of opportunities, all of which will depend on many aspects of the experience of a pedestrian or driver who crosses a regulated intersection. The most common measurement measures are the average vehicle delay, the average length of traffic jams and the number of car stops. These three indicators are the most commonly used measure of efficiency at regulated intersections, since, it is taken directly by the driver. Many studied sources have shown that the bandwidth of traffic light intersections in cities is from 1,400 to 1,800 per hour [1]. When evaluating controlled intersections, the level of Service is also assessed (LOS) (Table 1). For intersections, LOS value determination is more commonly used.

Table 1. LOS value of the intersection

LOS	(sec/auto)
A	≤ 10
B	> 10 – 20
C	> 20 – 35
D	> 35 – 55

E	> 55 – 80
F	> 80

To meet the demand of the traffic flow, the cross section is evaluated by the capacity adequacy, saturation level (v/c ratio) of the conductivity. While the V / c ratio is usually below 0.85, there is no expectation of sufficient capacity, i.e. waiting (queues) and delays in vehicles. When the V/c ratio approaches 1.0, the traffic flow can become unstable, and situations of delay and congestion appear. demand exceeds capacity when the V/c ratio is higher than 1.0, traffic flow is unstable, and excessive delay and congestion are formed. In these conditions, vehicles may require cycle rotation of several traffic lights to pass through the intersection, as well as cycle failure occurs. When planning the V/c ratio for long purposes, the feasibility of applying it for conditions ranging from 0.85 to 0.95 compared to multi-year (usually 20 years) rush Times is given [1.2].

While each car requires h seconds to cross the intersection in a green light, the saturation of the flow of cars passing through each lane per hour (saturation rate) will be as follows:

s=3600/h

An increase in the length of the traffic light cycle will increase the number of cars in the queue and can lead to an increase in the number of cars on the left turn Line, which will reduce the permeability while blocking the moving parts. As the cycle length increases, each vehicle leads to an increase in latency.

The red-light interval (R_i) is found as follows:

$$R_i = C_i - g_i$$

The transfer capacity of a route or lane is determined as follows:

$$c_i = s_i \frac{g_i}{C_i}$$

here, the C-cycle length and effective green light interval.

Calculating the delay due to factors such as accidental arrival of vehicles, losses in vehicle downtime, etc., is complex. As a result of the functions of the dependence of vehicles on the number of arrivals and departures at the intersection, we can determine through Webster's delay model. To determine the average delay per vehicle, the total delay is divided by the number of vehicles i.e., the average delay model is expressed mathematically as follows [3]:

$$Q_d = \frac{1}{2C} \cdot \frac{(C-g)^2}{(1-\frac{v}{s})}$$

Here, the average delay (SEC), the flow of arriving cars (avt/hour), the transfer capacity (avt/hour), the flow of departed cars (avt/hour), the length of the S-cycle, the effective green light interval (SEC).

If the demand increases when approaching the controlled intersection at the beginning of the productive green period, a queue appears. And the queue is formed when cars arriving in the service zone are waiting. Cars arriving and departing in their real conditions are constantly changing the amount of current and the level of Service. These differences complicate the model, but the main relationship does not change. As far as tyranny can be expressed mathematically:

$$Q_L = \frac{T \cdot (v-c)}{N \cdot d_s}$$

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Here, the length of the traffic jam (km), the observed time (hours), the observed demand (avt/hour), the transfer capacity (avt/hour), the number of lanes and the density of the road (avt/km/polosa).

The values of one-hour (1800-1900) at the time of the daily and evening rush on the date 12.12.2019 by analytical counting the amount of cars passing through the intersection are presented in Table 2. In the range of times of the day, the values are presented in 4-7 pictures.

Amount of car flow	(A) A.Temur street (Alay bazaar)			(B) Shkhrisabz street			(C) A.Temur street (Museum)			(D) A.Navoii street		
Direction	↰	↑	↱	↰	↑	↱	↰	↑	↱	↰	↑	↱
Between daily and daily times, (7^{30}-20^{00})	9189	10765	6905	1323	16167	7687	1747	8029	1184	7000	14048	1441
	26859			25177			10960			22489		
18^{00}-19^{00} Value in the range Aut/hour	634	871	653	77	1614	720	116	935	125	669	1339	125
	2158			2411			1176			2133		
Share (%)	30	40	30	3	67	30	10	80	10	31	62	7

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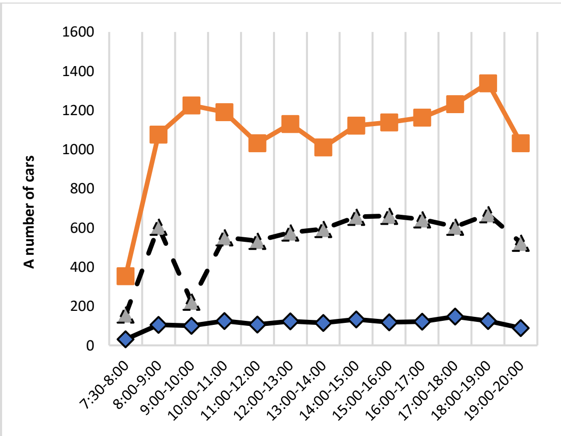

Figure 4. Distribution by Navoi Street in the direction of movement

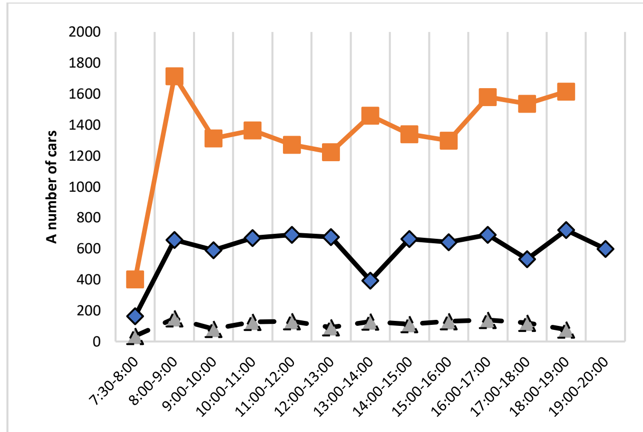

Figure 5. Distribution by Shahrisabz Street in the direction of movement

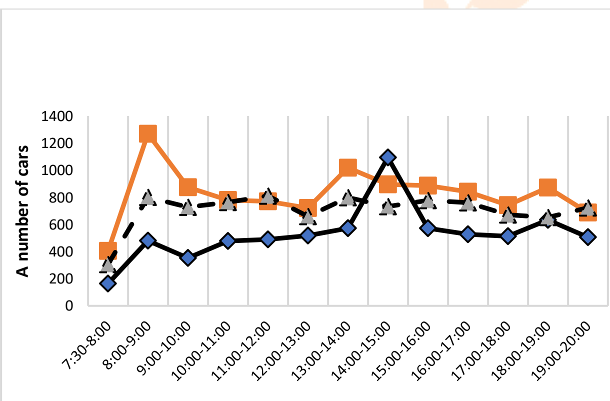

Figure 6. Distribution of Aloy by the market in the direction of movement

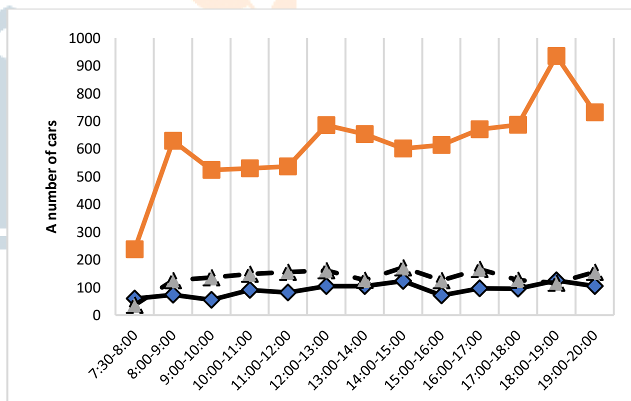

Figure 7. A distribution by the Timur Museum in the direction of movement

It is recommended to take the minimum number of permissible phases for a particular intersection. However, from the point of view of Motion safety, the number of phases should be maximum, since the more phases, the fewer collision points. At the same time, an increase in the number of phases leads to an increase in the length of the cycle. At the studied intersection, the daily traffic light mode of operation works differently depending on the time of day. Let's look at the calculation steps according to the work plan of this one-hour evening rush hour (cycle length 100 seconds). In the current position, the intersection is shown in Figure 8.a) operates on a two-phase system, while traffic lights are installed, the sides of which (A) and (B) are allowed to move in the direction of movement to the additional right. The duration of the green light is included in the program as follows.

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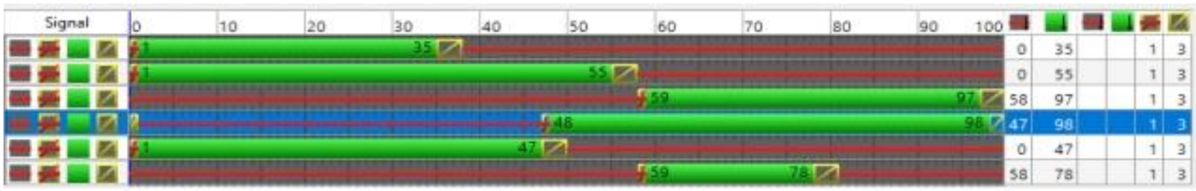

Figure 8. Duration of the green light for the current state

The purpose of phase planning is to divide movements in mutually opposite directions or bands into different stage phases, to ensure that the movements in the direction or polo do not have conflict. If all actions are separated without any conflict, then the adoption of the largest phase is required. The main goal is to ensure low conflict and effective management.

The best effective street traffic management solution was determined using the PTV vissim (student) software complex. Typically, for a ten-minute analysis period, each vehicle was evaluated from the point of view of the average observed measurement indicators. Through the academic version of this program, it is possible to carry out accounting work based on the need for the issue on the example of any period or day. To do this, the simulation time can be changed using the window shown in Figure 9 through the setting window. The numerical results will be in the form of Figure 10.

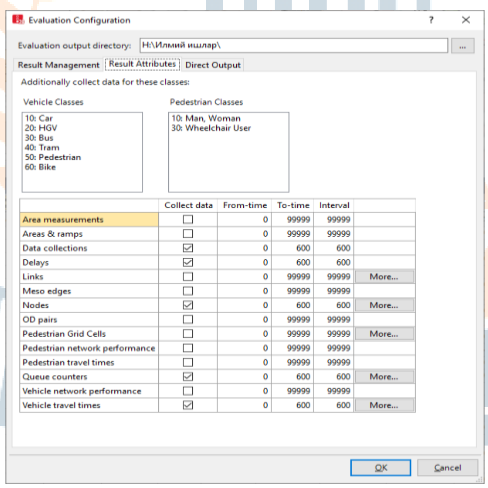

Figure 9. Simulation time setting window in PTV vissim app

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TimeInt	Movement	QLen	QLenMax	Vehs(All)	LOS(All)	LOSVal(All)	VehDelay(All)	PersDelay(All)	StopDelay(All)	Stops(All)	EmissionsCO	EmissionsNOx	EmissionsVOC	FuelConsumption
0-600	1	68,57	209,76	1005	LOS_D	4	48,29	48,29	33,72	1,41	2086,275	405,913	483,514	29,847
0-600	1 - 1@254.3 - 3@145.7	41,62	105,96	146	LOS_D	4	36,92	36,92	24,60	1,15	257,389	50,079	59,652	3,682
0-600	1 - 1@254.3 - 8@170.6	41,62	105,96	71	LOS_D	4	52,62	52,62	33,99	1,94	170,900	33,251	39,608	2,445
0-600	1 - 1@254.3 - 9@190.1	41,62	105,96	79	LOS_B	2	17,50	17,50	11,98	0,53	95,973	18,673	22,243	1,373
0-600	1 - 4@254.5 - 2@115.5	38,84	90,49	143	LOS_D	4	54,29	54,29	43,27	1,22	292,362	56,883	67,758	4,183
0-600	1 - 4@254.5 - 8@170.6	38,84	90,49	18	LOS_C	3	25,70	25,70	18,67	0,56	24,504	4,768	5,679	0,351
0-600	1 - 4@254.5 - 9@190.1	38,84	90,49	10	LOS_F	6	129,39	129,39	105,02	3,10	41,427	8,060	9,601	0,593
0-600	1 - 7@63.0 - 2@115.5	66,39	159,51	105	LOS_C	3	24,81	24,81	14,67	0,77	142,292	27,685	32,977	2,036
0-600	1 - 7@63.0 - 3@145.7	66,39	159,51	10	LOS_F	6	84,73	84,73	69,48	2,70	31,390	6,107	7,275	0,449
0-600	1 - 7@63.0 - 9@190.1	66,39	159,51	188	LOS_D	4	46,84	46,84	31,25	1,16	382,505	74,422	88,649	5,472
0-600	1 - 10@20.8 - 2@115.5	127,43	209,76	27	LOS_F	6	216,95	216,95	169,52	6,63	184,608	35,918	42,785	2,641
0-600	1 - 10@20.8 - 3@145.7	127,43	209,76	19	LOS_D	4	35,84	35,84	21,52	0,95	30,355	5,906	7,035	0,434
0-600	1 - 10@20.8 - 8@170.6	127,43	209,76	189	LOS_D	4	51,36	51,36	33,17	1,73	433,365	84,317	100,437	6,200
0-600	1	68,57	209,76	1005	LOS_D	4	48,29	48,29	33,72	1,41	2086,275	405,913	483,514	29,847

Figure 10. View of numerical results in the PTV vissim program

After simulating the results of the simulation, the state of the traffic flow using the PTV vissim program, the available intersection indicators, the holding capacity of the intersection with an interval of ten minutes during the evening rush hour was 1005 cars. The maximum length of the resulting queue was 209.7 m, and the average vehicle delay was found to be 48.29 SEC/hour. It turned out that with the level of Service (LOS) is the D level.

In place of the conclusion, it can be noted that the existing conditions on the streets of the city can differ sharply from each other and have a serious impact on parking lots, Transit buses, road width, connecting intersections around it and other factors, as well as the volumes observed. Based on the results of the computer model created for certain conditions, it is possible to effectively control traffic lights of different phases, check the correct Organization of movement, and there is an opportunity to choose an alternative suitable for the conditions.

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