ANALYSIS OF THE QUANTITY OF EXHAUST GASES EMITTED FROM VEHICLES IN A CROSS SECTION THROUGH COMPUTER SIMULATION PROGRAM

Ikromov Akmaljon Gofurjonovich
Ministry of Internal Affairs of the Republic of Uzbekistan Department of Public Safety Traffic Safety Service Chief Specialist of the Center for the Study of Traffic Safety Problems

Makhmudov Galib Nasimdjanovich
Usmonov Zafar Tursunovich
Abdurakhimov Lochinbek Xayitbekovich
Tashkent State Transport University Engineering of Vehicles Department

Abstract
This paper presents the results of the development of a model of the intersection using the PTV VISSIM simulation software. One of the problematic intersections in the city of Tashkent was selected and the traffic flow during peak hours was studied to analyze the intersection. The article discusses two solutions to reduce the amount of toxic gases and fuel consumption. The first solution is by optimizing the traffic light phases and changing their control cycle. The second solution represents a reduction by changing the geometric parameters of the intersection. After we applied both solutions, the service level of the intersection, LOS, increased from F to B.

Keywords: intersection model, simulation software, traffic flow, rush hour, toxic gases, fuel consumption, regulatory phase, regulatory cycle, intersection service level.

INTRODUCTION

A Brief Summary

In recent years, the number of cars has increased by 2-3 times, and about 700-800 thousand cars drive on city streets every day. Apart from creating traffic jams, they have a major impact on environmental degradation and safety of pedestrians and passengers. But the city's public transport and road infrastructure cannot adequately respond to these problems. The city lacks surface and underground pedestrian crossings and parking lots. Also, the city has more than 500 major intersections, 200 of which have low traffic capacity.

Air pollution by driven cars is very high, for example, when 10-12 liters of gasoline are consumed per car, 25 kg of various harmful chemical compounds are released into the atmosphere. One car consumes 4 tons of oxygen per year [2]. Engine exhaust gas contains more than 500 harmful organic compounds such as carbon monoxide (CO), carbon dioxide (CO2), nitrogen oxides (NO), hydrocarbons (HC), volatile organic compounds (VOC) and others. All this leads to the following situation. deterioration of human health and global warming worldwide [1]. Optimal organization of traffic lights at intersections will reduce these emissions. Road traffic is a source of harmful emissions. Studies show that drivers, passengers

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and people living near highways are the most affected. Sometimes their influence has disastrous consequences. Since 2019, the Yandex mobile application in Uzbekistan has started reporting traffic jams in the city. After 11 months of work, the company summarized the results of the year and found out how the traffic in Tashkent is changing. Average traffic has changed from 4.5 points in August to 5.8 points in April. If the most convenient time of the year for car owners is summer, then the most difficult time is morning traffic in April.
The intersection with the intersection of Bogishamol and Tashkent Ring Road was chosen. General street information is shown below. University Street has a total of 5 lanes, the width of the street is 21 m, there are dividing lines and pedestrian crossings on the street; Bogishamol Street has 6 lanes in total, the width of the street is 25 m, there are dividers and pedestrian crossings on the street; The total number of road lanes near the intersection of the Tashkent ring road is 5, the width of the streets is 22 m on one side, and 25 m on the other side, and there are dividing lanes and pedestrian crossings on the street. The traffic light works in 2 stages. The duration of the traffic light cycle is 98 seconds. Figure 1 shows the view of the studied intersection.

Figure 1. General view of the intersection

Table 1 shows the number of vehicles that passed through the intersection within 2 hours by type.

Types of vehicles	Car	Bus	Freight wagon
Amount	12639	294	687

Based on the above information, a simulation model of the current state of the intersection was developed using the PTV VISSIM program. The traffic quality of the intersection is evaluated as follows (Table 2).

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LOS	For an intersection controlled by a traffic light	For a controlled intersection without a traffic light
A	≤10 sec	≤10 sec
B	10-20 sec	10-15 sec
C	20-35 sec	15–25 sec
D	35–55 sec	25–35 sec
E	55–80 sec	35–50 sec
F	>80 sec	>50 sec

For regulated and unregulated intersections, LOS is determined by the average vehicle delay at the intersection. LOS can be defined for each intersection configuration, each movement or approach.

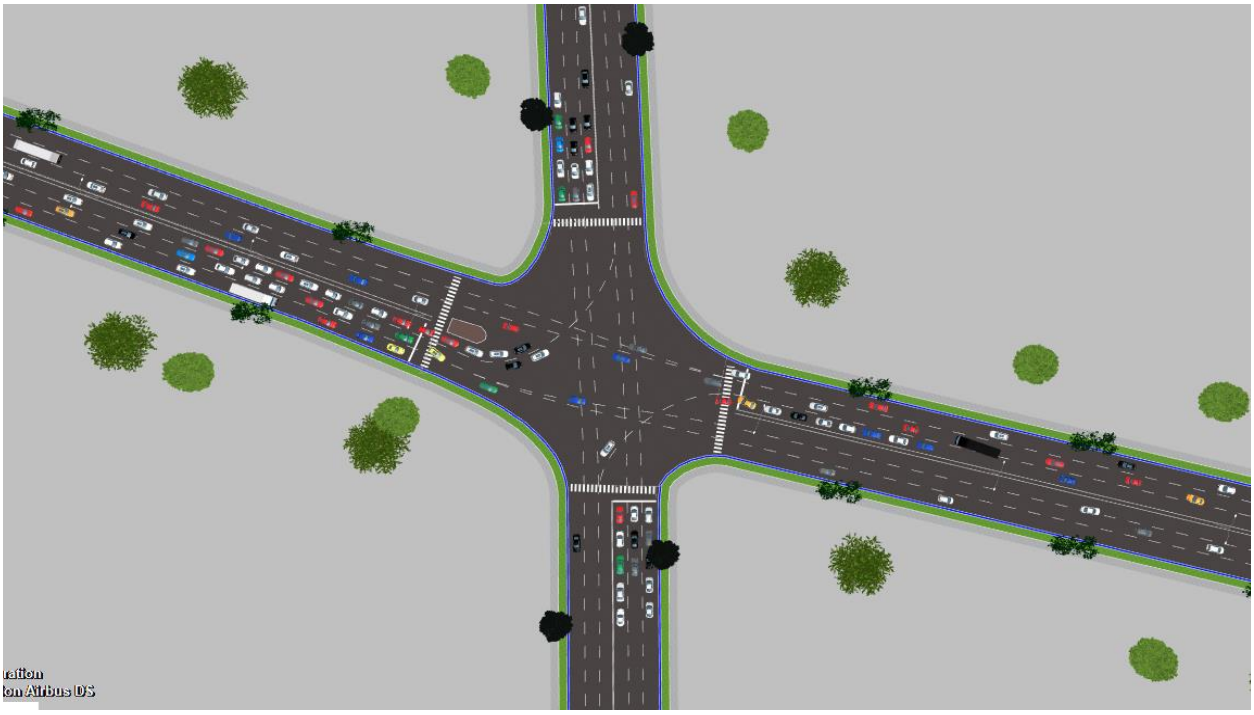

Figure 2. A simulation view of the current state of the intersection under investigation.

A computer model of the current state of the intersection was developed taking into account traffic flow, traffic light phases and rotation duration, and the following results were obtained (Table 3).

No	Indicators	Current condition
1	Intersection Level of Service (LOS)	F
2	Number of cars (units)	5317
3	Fuel consumption (l)	1067.959
4	Exhaust gas CO (grams)	19720.533
5	Nitrogen Oxide NOx (grams)	3836.899
6	Organic compounds VOC (grams)	4570.424

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At the moment, traffic lights are installed at the intersection, they work in two stages (phases) and the duration of the cycle is 98 seconds. The effective green time of a green traffic light is 92 seconds and the lost time is 6 seconds.

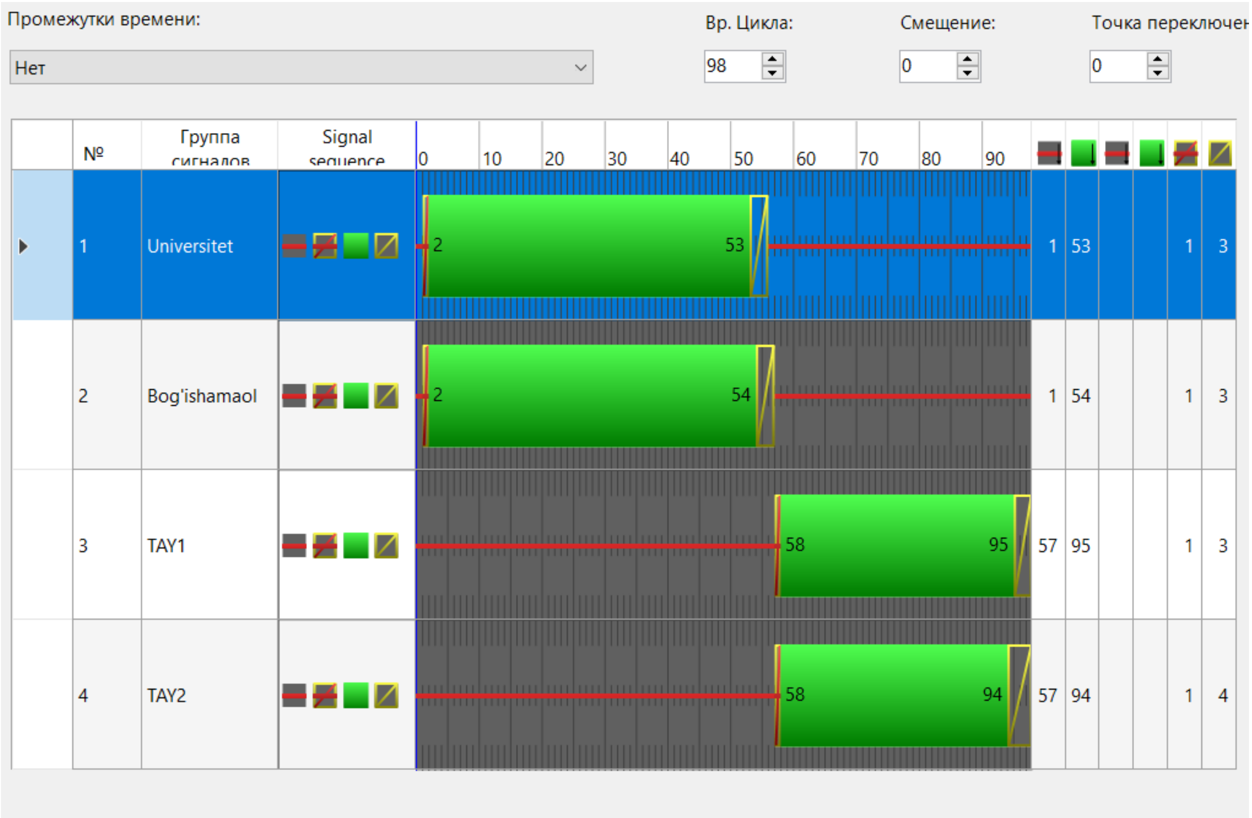

Figure 3. A computer model of the cycle and phase of a traffic light installed at an intersection

The optimal duration of the cycle at the intersection of University, Bogishamol and Tashkent Ring Road is determined as follows. Proposed traffic light phase and cycle

Table 4

	Stage A	Stage B
c	648/3 lines = 216	1246/2 lines = 623
c	1400	1400
v/c	0.15	0.44

A computer model of the intersection was built taking into account the recommended phase and traffic light cycle values. After computer simulation, the following results are obtained. The optimal value of the duration of the control cycle is determined by Webster's formula [4].

$$C = \frac{1.5 * L + 5}{1 - \sum Y}$$

where C is the optimal duration of the control cycle, s; L - time lost in the cycle, s; Yc - critical v/s - the sum of ratios (phase coefficients) was calculated using the data in Table 4 and the following results were obtained:

Yc = 0.15+0.44=0.59; L= 6 s,

C = (1.5 * 6 + 5) / (1-0.59) = 34 s.

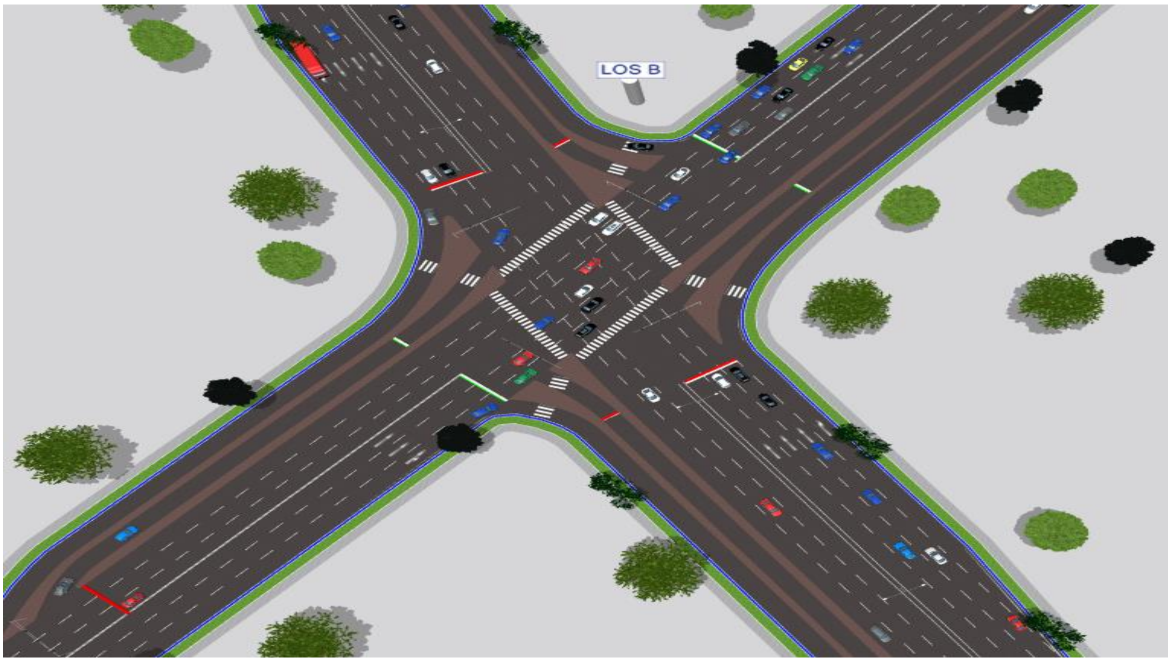

Figure 4. Proposed computer model of the intersection

According to table #=5, it can be seen that the traffic flow capacity of the intersection has been improved several times due to the optimization of the phase and cycle of the traffic light installed at the intersection.

Geometrical changes at this intersection allow to minimize the number of traffic light phases, reduce conflict points and minimize the time spent at the intersection.

The indicators obtained as a result of computer simulation, ie, the proposed state

Table 5

No.	Indicators	Proposed condition
1	Intersection Level of Service (LOS)	B
2	Number of cars (units)	7598
3	Fuel consumption (l)	608,773
4	Exhaust gas CO (grams)	11241.364
5	Nitrogen Oxide NOx (grams)	2187.161
6	Organic compounds VOC (gram	2605.295

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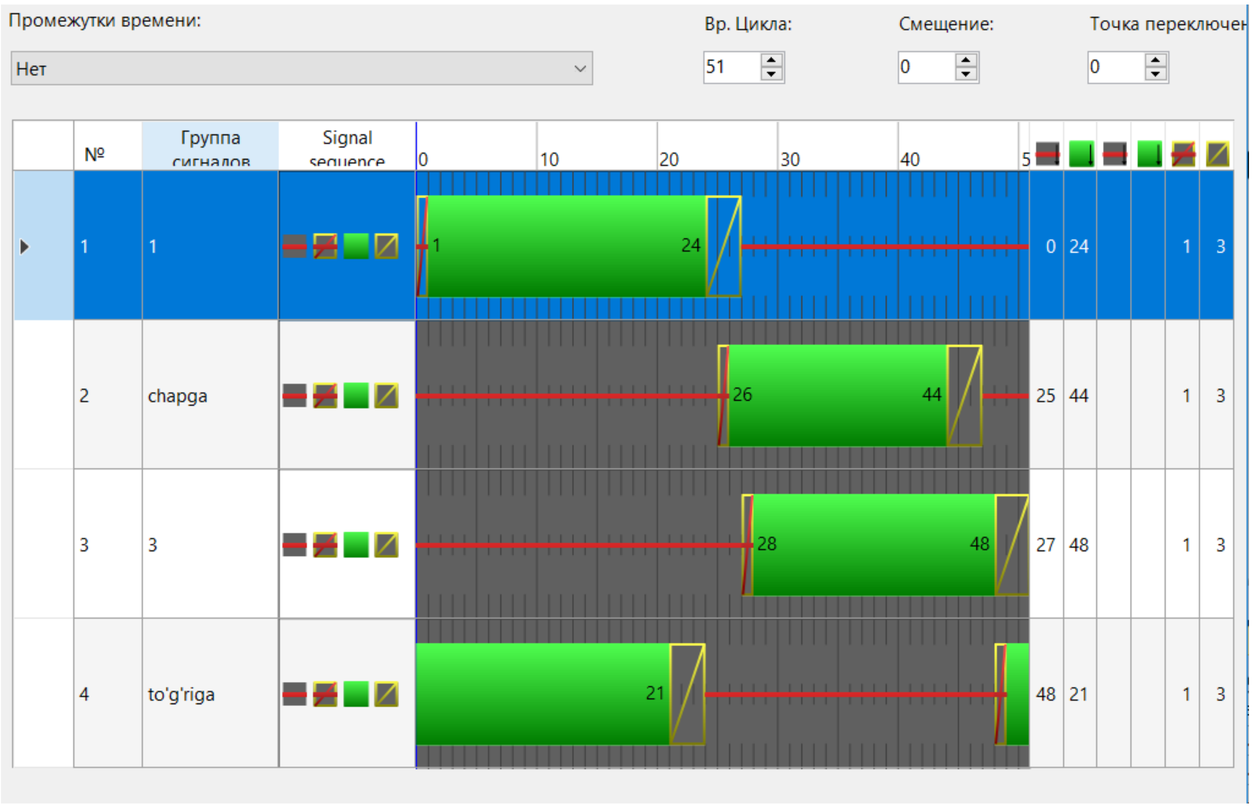

Rice. 5. The proposed cycle and phase of the traffic light at the intersection

The adequacy of the intersection's carrying capacity to meet the demand of the traffic flow is evaluated by the degree of saturation (v/c ratio). When the v/c ratio is generally below 0.85, sufficient capacity is not expected, i.e. vehicle waiting (queues) and delays are not expected. When the v/c ratio approaches 1.0, the traffic flow may become unstable, causing delays and congestion. When the v/c ratio is higher than 1.0, the demand exceeds the capacity, the traffic flow is unstable and excessive delay and congestion are created. Under these conditions, vehicles may require multiple traffic lights to cycle through the intersection, resulting in cycle shortages. It is recommended to use v/c ratio in long-term planning for conditions of 0.85 to 0.95 for multi-year (usually 20 years) peak periods [4]. PTV VISSIM software can be used to define a solution for effective street traffic management. Usually 15 minutes of analysis per vehicle is enough to determine the report data for a whole day. After analyzing the condition of the intersection with the modified parameters, the following results were obtained: •the capacity of the intersection for one hour during peak hours; •the maximum length of traffic generated at the intersection;

•average vehicle delay;

•car fuel consumption;

•Intersection Loss of Service (LOS);

•the amount of emissions from vehicles.

Table 6

No	Indicators	Current status	Proposed condition
1	Intersection Level of Service (LOS)	F	B
2	Number of cars (units)	5317	7598
3	Fuel consumption (l)	1067.843	608,773
4	Exhaust gas CO (grams)	19720.533	11241.364
5	Nitrogen Oxide NOx (grams)	3836.899	2187.161
6	Organic compounds VOC (grams)	4570.424	2605.295

The results of the computer model for optimizing the operation of the intersection are presented in Table 5. As can be seen from the table, the level of service of the intersection has improved from F to B. Vehicle emissions and fuel consumption are reduced by almost 50%. We can see significant improvement in other parameters as well. The results were achieved thanks to the computer model of the intersection developed using the PTV VISSIM simulation program.

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