Software modeling application for verification of transportation planning engineering hypotheses

N Shchegolova¹, V Talalai², C Gorshenina¹, D Smirnova³

¹ Saratov State Technical University Gagarin U.A., 77, Polytechnic, Saratov, 410054, Russian Federation
² Moscow Automobile and Road Construction State Technical University, 64, Leningradsky prospekt, Moscow, 125319, Russian Federation
³ Astrakhan State University, 20A, Tatishcheva, Astrakhan, Russian Federation

Emails: shegoleva123@mail.ru, talalay@bk.ru, ekaterina_84_07@mail.ru, dsmirnovad@mail.ru

Abstract. The organization of traffic is a complex of engineering and organizational arrangements aimed at maximizing the use of traffic flows opportunities represented by the road geometric parameters and condition. The article deals with an example of using software modeling for creating a digital twin of a complex intersection in Saratov in order to verify the engineering hypotheses concerning the effective transportation planning. The current traffic situation in the PTV VISSIM program is simulated. The transportation planning engineering hypothesis proposed and simulated the solution options of changing the working traffic light duration at the intersection for verifying and widening the carriageway by adding a lane. The analysis of two models options allowed determining the most effective transportation planning measure in a given transport hub of the city with a high level of traffic delays, which is actually the duration change of the working traffic light at the intersection. The software modeling application is confirmed for creating a digital twin complex intersection in Saratov.

1. Introduction

Road transport put down deep roots in modern life. It provides a large volume of traffic in all spheres of human activity. The global car fleet is steadily increasing. Saratov took the 17th place among the major cities of Russia according to the number of officially registered cars. There are 253,000 registered cars in Saratov. According to Russian and international practice the growth of number of cars provide both the positive impact on the economy and social city development and the negative one associated with a large number of motor vehicle collision (MVC), fatalities, injuries, huge material damage. These problems are of great interest to the transportation planning experts whose task is to ensure traffic safety [1]. For solving these problems, many methods are used, including software modeling. Their use helps to significantly relieve the teacher and students, to free up additional time for analysis of complex or specific moments, allow making a creative element in the study of the subject.
2. Methods of creating a multimedia textbook

We consider the application of digital twin of a complex road intersection in Saratov, performed in the program PTV VISSIM. The software package allows the transportation planning engineering hypotheses verifying [2].

We use the following hypothesis: the identification of an acceptable transportation planning solution in a given transport hub of the city with high level of traffic delays [3]. On the basis of such multimedia technologies, it is possible to create electronic educational resources (EER) for educational materials containing images, texts accompanied by sound, video, animation and other visual effects.

3. Materials and methods

The acceptable solution for transportation planning is considered: change the duration of a traffic light at an intersection or widen the carriageway by adding a lane. To verify the hypothesis, we selected a complex intersection of «Sokolova» and «Murmansk travel» streets in Saratov (Fig. 1), as it is a high traffic and busy transport way of the city. The traffic is provided in two directions, four lanes on the «Sokolova» street in one direction and two lanes on the «Murmansk travel» street.

![Figure 1. Intersection of «Sokolova» street and «Murmansk travel» street in Saratov: (a) - the scheme of the intersection "Google Maps" (Internet resource); (b) - the general view of the intersection.](image)

We make a diagram of the intersection and determine the traffic intensity at the intersection.

![Figure 2. Scheme of the intersection of «Sokolova» and «Murmansk travel» streets in Saratov](image)
The inhabitants of the city are used to the road network constant congestion on the considered segment.

Consider the current single-phase of stage-by-stage movement of cars, which allows providing the separation of conflicting flows in time [4-6]. The «Sokolova» street traffic is organized in 2 phases, it is necessary to let the traffic flows pass in straight and turning directions 3 and 4 in first phase. The direct and turning directions 1 and 2 are just as the parallel flow 3 in the phase 2 in accordance with the scheme of Figure 2. The pedestrian traffic through the roadway is organized by pedestrian traffic signals with a button for pressing which has the duration of working traffic signals positive go signal for 30 seconds. The traffic signals cycle is 116 seconds.

![Figure 3. Single-phase of stage-by-stage movement of cars (a) - the first phase of regulation; (b) the second phase of regulation.](image)

We present the Intensity plot of the traffic flow by the hour from 6.00 am to 12.00, determined by the monitoring (Fig. 4).

It is necessary to determine the traffic flow composition for creating the digital twin and the engineering hypothesis verification (Fig. 5).
We simulate the current traffic situation in the PTV VISSIM program, the result is presented in Figure 6.

We formed traffic congestion on the «Sokolova» street seen in Figure 6; therefore, we can speak about the low capacity at the intersection under review.

It is necessary to simulate the proposed solutions for verifying the transportation planning engineering hypothesis.

4. Discussion
PTV Vissim is a software package that allows simulating the traffic flow movement, as well as pedestrian traffic [8-11].

In general, the PTV Vissim provides the ability to simulate traffic, test the transportation planning engineering hypotheses, etc.

**Figure 4.** Intensity plot of traffic flow according to the hour of monitoring

**Figure 5.** Composition chart of the traffic flow during rush hour (10.00 am to 11.00 am).
Figure 6. Current situation model

We formed traffic congestion on the «Sokolova» street seen in Figure 6; therefore, we can speak about the low capacity at the intersection under review.

It is necessary to simulate the proposed solutions for the verification of transportation planning engineering hypothesis.

5. Conclusion

1. The software package PTV VISSIM is acceptable for the creation of a digital twin complex intersection in Saratov, as the model reiterated the actual traffic situation.
2. The models analysis allows confirming the hypothesis about the possibility of solving traffic congestion by the transportation planning in a given transport hub of the city with a high level of traffic delays.
3. The analysis of two models options allowed determining the most effective transportation planning measure in a given transport hub of the city with a high level of traffic delays, which is actually the duration change of the working traffic signals at the intersection. The most effective traffic signals cycle will be equal to 90 seconds. At the same time, the optimal working positive go signal duration of the foot traffic signals can be considered 10 seconds, because traffic of pedestrian is not intensive.

Reference

[1] Shchegoleva N V 2010 The road traffic safety problems In Proc. of international scientific-practical symposium “The socio-economic problems of residential construction and the solutions during the way out of crisis period” pp. 308-311 (Saratov: Saratov State Technical University)
[2] Gorshenina C Yu 2017 In Proceedings of the II International scientific-practical conference Science publication edited by Zhankazieva S V, pp. 334-341 (St. Petersburg: Publishing of Saint-Petersburg State University of Architecture and Civil Engineering)
[3] Shchegoleva N V, Gusev V A, Vorozhejkin M A 2016 The congestion formation in traffic flow Technical regulation in transport construction 5(19) 3 Retrieved from: http://trts.esrae.ru/38-204
[4] Konoplyanko V I 2007 Organization and road safety (Moscow: High school) p. 383
[5] Pugachev I N, Gorev A E, Oleshchenko E M 2009 Organization and road safety: studies and manuals (Moscow: IC "Academy") p. 272.
[6] Rabchinsky A I, Gudkov V A, Kravchenko E A 2013 Organization of transportation services and the safety of the transport process (Moscow: IC "Academy").

[7] Kochetkov A V, Andronov S Yu, Shchegoleva N V, Valiev Sh N, Talalay V V 2018 Industry risk management system in the technical regulation of transport construction *Building materials* 5 61-67.

[8] Zhankaziev S V, Vorobyev A I, Morozov D Y, Novikov A N, Kulev A V 2017 Efficiency of operation and functioning of the system of an indirect transport flow regulation and control *International Journal of Applied Engineering Research* 12 3645-3652.

[9] Zhankaziev S V, Vorobyev A I, Morozov D Y, Novikov A N, Kulev A V 2017 Definition of accuracy of qualitative correspondence matrixes for indirect traffic flow control and regulation *International Journal of Applied Engineering Research* 12 3653-3658.

[10] Ostroukh A, Nuruev Y, Ephimenko D, Zhankaziev S, Moroz D 2016 Automated dispatching control system of the mobile concrete batching plants *ARPN Journal of Engineering and Applied Sciences* 11 6733-6736.

[11] Maksimychev O I, Ostroukh A V, Pastukhov D A, Nuruev Y E-O, Karelina M Y, Zhankaziev S V 2016 Automated control system of road construction works *International Journal of Applied Engineering Research* 11 6441-6446.