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ASSESSMENT OF TRAFFIC SAFETY IN THE PTV VISSIM SIMULATION PROGRAM

Abstract. In the paper, the simulation project to evaluate the capacity and the degree of congestion was presented. Due to the time-consuming traffic, the most advantageous modification is to optimize the duration of the light cycles in programs for signaling light. Based on the project, it was assessed that the communication and technical solutions used are optimal and don't require modification.

Keywords: computer simulation, motion engineering.

OCENA BEZPIECZEŃSTWA RUCHU DROGOWEGO W PROGRAMIE SYMULACYJNYM PTV VISSIM

Streszczenie. W pracy został przedstawiony projekt symulacji do oceny przepustowości i stopnia powstawania zatorów komunikacyjnych. Ze względu na czasowe obciążenie ruchem, najkorzystniejszą modyfikacją jest optymalizacja czasu trwania cykli świateł w programach do sterowania sygnalizacją świetlną. Na podstawie opracowanego projektu oceniono, iż zastosowane rozwiązania komunikacyjne oraz techniczne są optymalne i nie wymagają modyfikacji.

Słowa kluczowe: symulacja komputerowa, inżynieria ruchu.

Introduction

The aim of the project was to make a crossroads model in the PTV VISSIM computer program, which was used to simulate traffic of vehicles and other users at the example of the junction of Jana Pawła II Street and Armii Krajowej

Street in Czestochowa. The crossroads is one of the most heavily trafficked road junctions in the city, because it connects extremely important traffic directions, Jana Pawła Street leads towards the west towards Jasna Gora, and in the east to the expressway E75, towards Katowice and Warsaw. On the other hand, Armii Krajowej Street is a provincial road no. 48, which allows access to the center of the residents of the housing developments: "Tysiąclecie" and "Północ". In the research part was simulated actual flow of vehicles, people, cyclists on a working day in rush hour. Measurements were made at two hours on the same day: in the morning and in the evening. Based on the obtained data, a crossroads model and a computer simulation were used to evaluate traffic safety (Fig.1).

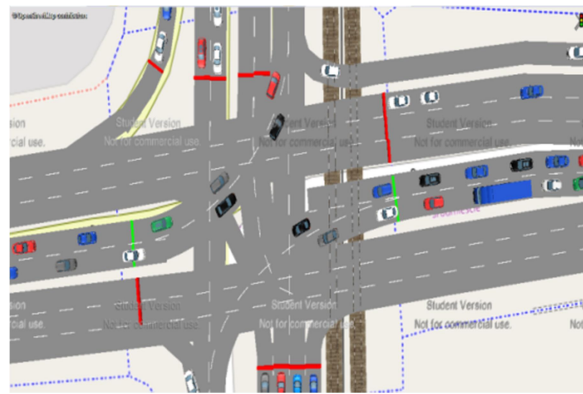


Fig.1. Virtual crossroads model, visible traffic and simulation of traffic lights [author: Szewczyk P., 2017]

For this purpose, a pedestrian crossing was created. Figure 2 shows the simulation with all participants in the traffic, divided into separate signaling groups. The next move, has been add pedestrians to create the road infrastructure.

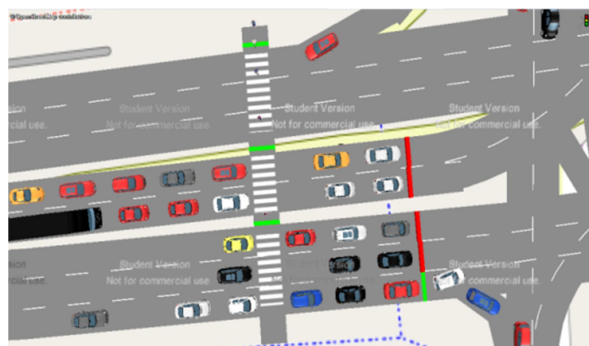


Fig.2. Simulation of pedestrian traffic [author: Szewczyk P., 2017]

In addition to the applied roads and pedestrian crossings, there were also plotted out traffic control infrastructure (traffic lights, traffic signs, detection equipment, etc.) (Fig.3). The actual signaling model was developed by the ZIR Group company commissioned by the Municipal Road Administration in Czestochowa (MZDiT).

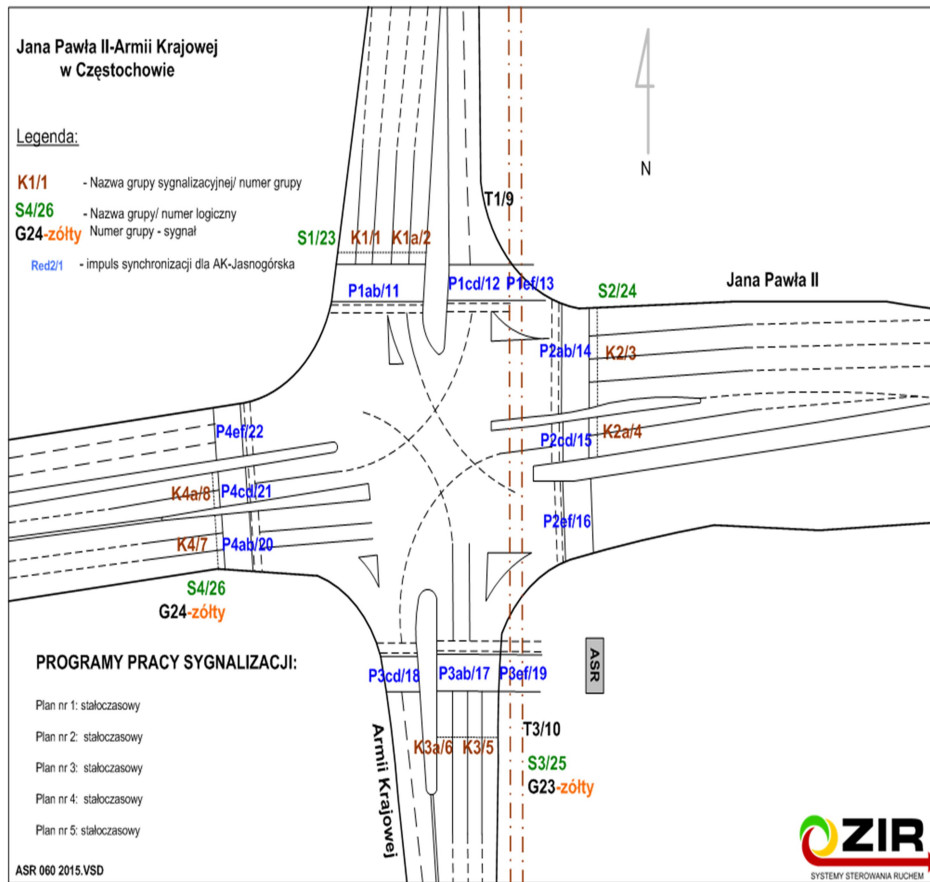


Fig. 3. Traffic light scheme at crossroads of Jana Pawła II Street - Armii Krajowej Street in Czestochowa [source: Municipal Road Administration and Transport in Czestochowa (MZDiT)]

The above diagram shows four signaling groups ring-fenced for all traffic participants. Each of them has a name and a group number, as well as a logical number specifying a specific signal. The pedestrians are marked in blue. Because it is a large crossroads and pedestrian crossings cross the dual carriageway - according to the rules - the pedestrian islets were marked. In this case, each junction of the roadway is considered as a separate passage and designates a se-

parate signal. The signaling groups referring to wheeled vehicles are marked with brown and green, and the green group is a conditional turn signal to the right. The last of the groups, defined in black, refers to public transport vehicles - trams. Owing to the high variability of traffic at this crossroads, five fixed timetable plans have been developed, which are run according to the time of day (Fig. 4). The most important and difficult task in organizing traffic at crossroads is to develop traffic signals in a safe and economical way. This means that the same signals can not be duplicated on the collision inlets. You should also take into account the geometry of the crossroads, where each vehicle has a different turn radius. Therefore, their mass, speed and different braking distance of the vehicles should be treated into account light signals. The time of stop is important for safety reasons. The red light should not take too long, as it can cause overload on a given section, and also lead to nervous situations among drivers. Frequent changes are also not advisable due to the multiple launching and stopping of vehicles. This is disadvantageous because of the fuel economy, the increase in emissions of toxic substances and the generation of excessive noise.

In Częstochowa there is an ITS system, ie Intelligent Transport System. The task of the system is functional and efficient communication planning in urban agglomerations and local areas requiring traffic management. Its activities include minimizing congestion, increasing the throughput of street sections and junctions, and improving safety, liquidity and traffic economy. The system consists of some integrated subsystems, such as traffic control, vehicle monitoring and traffic monitoring. Their purpose is to collect data from detectors and cameras located in different places. Obtained information about the number and speed of vehicles, traffic congestion and data throughput junctions are analyzed by the system and by means of algorithms determined appropriate variable values for traffic signals. The system effectively defines priorities for individual inlets and adjusts the characters for specific traffic flows.

Methods of Research

The collection of the necessary data for the PTV VISSIM simulation program was made at two hours of the day. The first measurement was from 7:25 am to 8:25 pm, while the second one was measured in the evening from 17:30 to 18:30. Due to the large number of vehicles and inlets, the measurement was made for a quarter of an hour, and the result was multiplied by four, giving a full hour of measurement. Due to the sequence duration of 110 seconds, seven vehicle measurements were obtained within fifteen minutes. The traffic control programs received from the Municipal Road Administration and Transport in Czestochowa (MZDiT) proved invaluable. Data was collected in specially prepared form (Fig. 5).

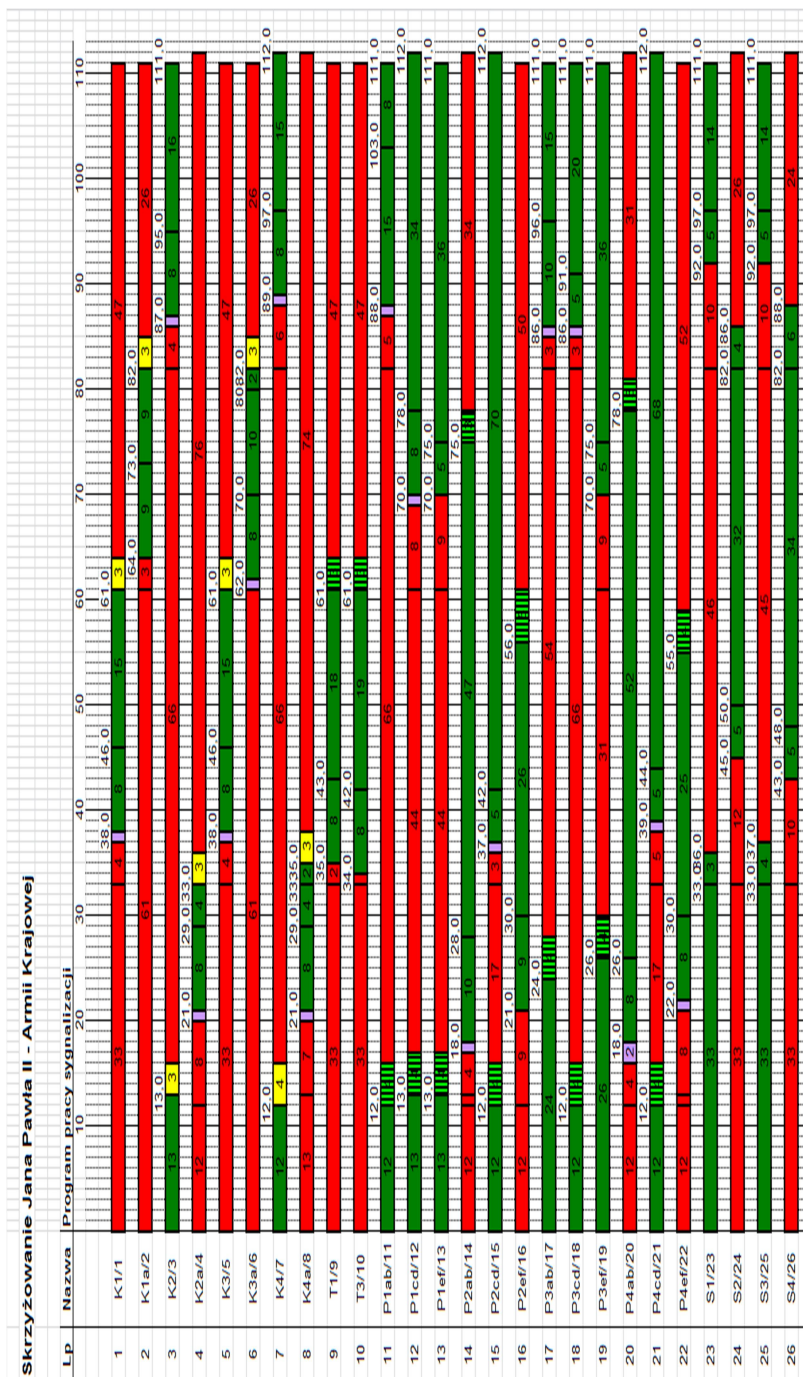


Fig. 4. Exemplary signaling program of crossroads. [source: Municipal Road Administration and Transport in Czestochowa (MZDiT)]

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PK

DATA: Pn Wt Śr Cz Pi So N

STAN POGODY: Sucha Stan JEZDNI:

Możliwość: Mokra

Przebieg: Obłożona

Op. Deszczu: TEMPERATURA

Op. Śniegu:

Szkice:

POMIAR NATĘŻENIA RUCHU NA SKRZYŻOWANIU

Skrzyżowanie: Nr Stanowisko Nr

Wlot ul. od. str. Obserwator:

		1		2		3	
		od godz.	do	od godz.	do	od godz.	do
Typ	A		B		B		B
	O						
	D						
	C						
	Cp						
	M						
	R						
	K						
	A		B		B		B
	O						
	D						
	C						
	Cp						
	M						
	R						
K							
P							
Rs							

1. godzina: L W P
 RZ U RZ U RZ U
 2. godzina: L W P
 RZ U RZ U RZ U
 O - osobowe, D - dostawcze, B - mikrobusy, A - autobusy, C - ciężarowe,
 Cp - ciężarowe z przyczepą lub naczepą, R - rowery, K - zaprzęgi, maszyny
 i tzn., P - piesi na przęsiadach, Rs - rowerzyści na przęsiadach dla rowerów

Fig. 5. Form for measuring traffic intensity at junction [source: Department of Construction and Traffic Engineering, Cracow University of Technology]

The form allows you to analyze each inlet intersection by direction and type of traffic participants. The time frame was chosen because of the time of commute of people to work. In these hours there is the greatest rotation in the city, and thus at the junction, which is conducive to obtaining reliable data for analysis. The second measurement took place on the same day, however, in the evening from 18:00 to 19:00. At that time, traffic is slowing, people moving around the city are mostly passers-by, walkers and locals going shopping.

Results of Research

On the basis of the data from the traffic intensity form, a table was drawn up in Excel and graphical interpretation of data showing the direction of travel of vehicles (Fig.6). Both the participation of pedestrians and the participants in the public transport are not considered because of their negligible effect on congestion. Blue backgrounds are marked by vehicles entering the junction.

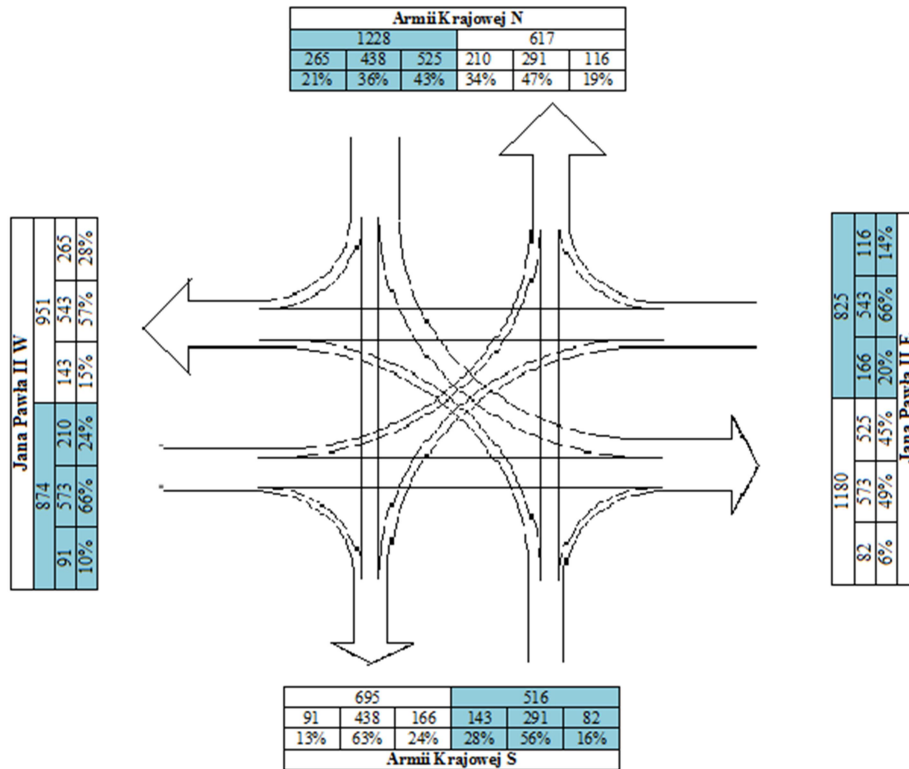


Fig. 6. An exemplary diagram showing the traffic intensity at the junction during measurement period 1 [author: Szewczyk P., 2017]

During measurement first period, the highest traffic is at Armii Krajowej Street towards the city center, where the share of vehicles is 1228, of which almost half (46%), turns left towards the city bypass. Another 36% are vehicles moving straight to the center, while the remaining 21% are heading west Jana Pawła II Street. The next most burdened inlet is Jana Pawła II Street from the direction of Jasna Góra. In this case, the majority of vehicles (61%) are heading towards the city while driving straight ahead. The remaining 24% are left turning vehicles in Armii Krajowej Street towards the Technical University in Częstochowa, and 10% to the right in Armii Krajowej Street to the center. Another inlet with 825 vehicles is Jana Pawła II Street from east to west. More than half of the vehicles (66%) are moving towards Wieluń and Opole, another 20% turn right to the center and the remaining 14% to the right - the direction of Łask and Działoszyn. The least burdened inlet is Armii Krajowej Street from the center (516 vehicles), of which 56% go straight north, 28% west, and 16% right, towards the bypass. Most of the vehicles leaving the junction are heading towards Jana Pawła II Street - from the north is 525 vehicles, from the west 573 vehicles, and from the south only 82 vehicles. Analysis of the second measurement period showed that traffic was less than traffic in the morning. Based on data from measurement 1 and 2, it can be said that the most commonly chosen driving direction is Jana Pawła II Street in the direction of Warsaw and Katowice. This involves access to the E75 expressway and the newly built bypass of the city, which allows you to get out of the city quickly and avoid many traffic congestions in the center. Traffic data obtained in the field as well as received from the Municipal Road Administration and Transport in Czestochowa (MZDiT) allowed to compile the simulation in PTV VISSIM program. Measurements of simulation programs (Fig. 4) proved to be invaluable, as manual counting of signaling signals would not be reliable. Thanks to MZDiT the project actually reflects the real conditions at the junction. Creating a simulation program is based on the verification of the intersection geometry as well as the traffic density. We ought to remember that the individual signals have specific lengths. This is to optimize the loss of travel time and hence the throughput. Contrary to previous assumptions, the simulation project showed that the current simulation program is effective (Fig. 7).

The photos below show respect for traffic signals. Figure 8 presents Armii Krajowej Street on the north side, where in both measurements, this inlet was the heaviest. One of the belts has a large number of vehicles, but at the moment of change to a green signal, vehicles are systematically lowering the inlet. The signal lights are set up so that no participants are allowed to meet vehicle.



Fig. 7. Scheme of signaling program used during simulation [author: Szweczyk P., 2017]

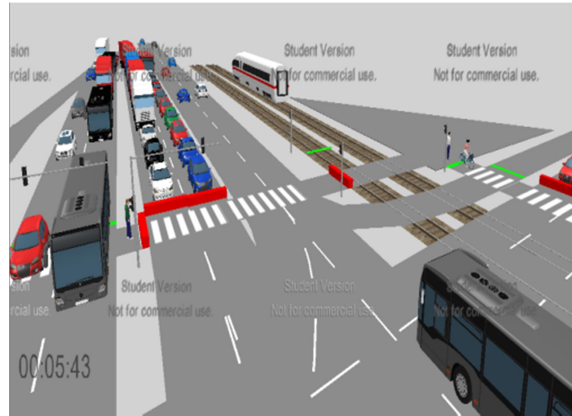


Fig. 8. Simulation of the traffic signal [author: Szewczyk P., 2017]

The studies conducted in rush hour, indicate that the collisions don't occur at the junction. A similar situation is in the case of traffic testing in the evening. Obtained measurements and results lead to the conclusion that the traffic signal is well organized and does not require improvement.

One of the ways to find congestion are mobile and desktop applications. They require access to the Internet to obtain location information. Data is obtained from GPS signals in vehicles, as well as from control of traffic cameras. Determining of the traffic jams is done on the basis of historical traffic information at a particular location, day of the week, and time of day and year. The information is updated on a regular basis and processed every few days. Examples of such applications are Targeo maps or NaviExpert. They allow estimation of travel time and anticipate unusual events, but do not have navigation functions (Fig. 9, 10).

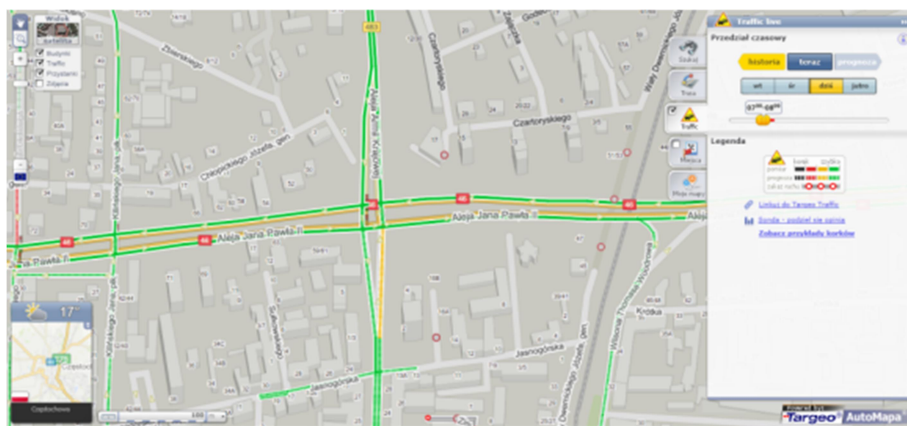


Fig. 9. Compaction level at intersection Jana Pawła II Street - Armii Krajowej Street during first measurement [map.thargeo]

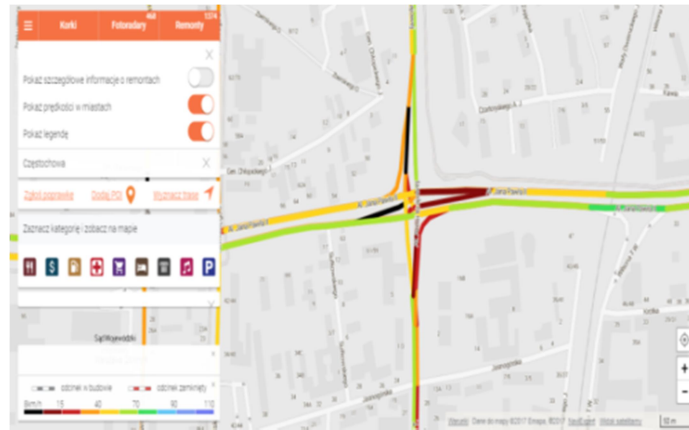


Fig. 10. Compaction level at intersection Jana Pawła II Street - Armii Krajowej Street during first measurement [NaviExpert map]

The NaviExpert map is more detailed and accurate than the Targeo map, because the traffic patterns of the given turn were also taken into account.

Conclusions

In our times technological development is especially dynamic and inevitable. Existing computer programs and simulators will over time be replaced by newer and better devices. In the age of computers all research and analysis are non-invasive, so this field of study will be certainly continue to develop. The collected empirical evidence shows that the traffic both in peak and evening time doesn't cause a large traffic jams at the junction. The project may be subject an errors resulting from the chosen method of counting vehicles. Due to the high traffic volume, the survey could not be conducted by one person. As a result, three additional people were used to help each other, who individually watched their assigned inlet. The number of participants was calculated according to the duration of the cycle. This means that approximately seven or eight results were obtained during a fifteen-minute measurement. All the same, the project included the total number of vehicles per hour, without dividing the duration of each traffic light cycle.

Comparing measurements taken by observers and received by mobile applications, differences in interpretation of inlet compaction can be noted. Maps are based on the large number of data received, which after verification, is processed into information about the degree of traffic congestion. The difference between the data results from a different way of counting some parameters

(eg. number of traffic participants, time of change of lights) affecting the final result. The results of the survey are also interfered by the student licence of application which limited the option of programme. Despite the use of averaged data, the simulation project can be considered as a relatively reliable reflection of the real traffic. The number of traffic participants identified in PTV VISSIM and obtained in the research is similar. The free version of application blocks some features, but this isn't an obstacle to creating a basic road infrastructure simulation. In order to determine the duration of the signaling cycles, it is necessary to first determine the traffic volume and the types of vehicles moving at the intersection. Next, you need to adjust the type of signaling program for the junction. This is a complex process, because it must take into account adequate bandwidth, security and time wasting. Unfortunately, it isn't possible to combine all these conditions due to their mutual exclusion. Ensuring high security is associated with an increased number of phases, which in turn leads to lower throughput and thus greater time losses. The presented theme is also a practical example of the use of deterministic simulation programs in technical and vocational education in accordance with the commonly proclaimed constructivism and cognitive science.

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