

The simulation of the changes in traffic solutions in states of crisis

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Abstract. The aim of the logistics is to ensure that the right things and the right time are in the right place, all with minimum cost. Today, many software is used to solve the distribution. One of them is software PTV Vissim. This software explains individual microscopic simulations. The extensive analytical tools acquired in PTV Vissim make it a level tool for transport planning and traffic optimization. Using this system, you can simulate the existing transport system and then make changes. Due to the ever-increasing number of vehicles in operation and the increasing intensity of cars, urban traffic is deteriorating. The aim of the article is to design a new transport system in the city of Uherské Hradiště in connection with the arrival at the hospital in the event of the states of crisis. Twenty years ago, the town of Uherské Hradiště was hit by enormous floods that cut off the hospital from access. No correction has been made yet. The current proposals for solutions mainly for city development. The authors consider access to the hospital as a critical element of the service to the population. The development of the city is taken as a secondary task. The software is simulating the current state and then the proposed changes. The paper is divided into four parts. Introduction to the problem, determination of limiting factors, simulation using PTV Vissim software and conclusion.

1 Introduction

Logistics in addressing emergencies and crisis presents a vital role. At this time, it is essential that the components of the Integrated Rescue System (IRS) have reached the destination. It is necessary that in the event of an emergency - a fire of the injured persons in need of treatment, they enter the Emergency Medical Services (EMS) as soon as possible. It is essential for the IRS components to have a secure city transit. The number and distribution of output bases depending on demographic, topographic and risk parameters of the territory of individual towns and city districts of the capital city of Prague, so that instead of events in the area of different towns and communities it can be reached from the nearest outbound base in the landing time to 20 minutes determines EMS by the Act No. 374/2011 Coll., on EMS [1].

Due to the critical time of the EMS, a new base of EMS - Buchlovice was built in the Zlín Region. During the analysis before the construction of this base, routine exits on the E 50 road, section Buchlovice - Střílky were also taken into account. It is the territory of frequent traffic accidents, both for motor vehicles and for motor vehicle users. The travel time on the way to the hospital is significantly longer than the landing time from the

base of the EMS. It is, therefore, appropriate to create a way to reduce this distance to the hospital.

The idea is to create a new transport service of the hospital Uherské Hradiště. The advantage of this new transport service is the complete avoidance of the city center with high transport capacity.

Transportation systems in general belong to areas where optimization have been used successfully. However, the complexity and size of the problems often limit the use of exact methods. In this paper we used simulation software PTV Vissim. [2]

The aim of this paper is to simulate the new path to the hospital. A model is a representation of actual or planned events, objects or systems. To create the model, it is necessary to abstract description of the properties of the system. The model shows the system at a certain level of abstraction with the aim of representing it in a mathematically credible manner. [3] Simulation is a method in which are looking for, calculate the state and behaviour of the real system using the system. [4]

Transportation can be divided according to several points of view, the basic breakdown by object of transport is passenger transport, freight transport and transmission of information. [5] The basic means, which can be used include: rail, road, air transport, ship, pipelines. [5, 6] In road transport, these are the dynamic models of freight management [7], finding the optimal

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path of vehicles [8], planning of transport demand [9] and determining the optimal frequency of deliveries. [10]

2 Transport Operation of the Hospital Uherské Hradiště

From the sustainable development of the city, the primary element should be the availability of a hospital from the city center by mass means of transport. Nevertheless, car transport solutions present one of the critical roles. In this case, it is necessary to take into account the current capacity of private roads (intersections).

Regarding capacity, traffic flows are taken into account in the article. By the physical analogy, the traffic flow also has its status variables. For now, we are based on the intensity, or the number of units of current passing through the site as the time unit. [11]

This hospital is connected to the road via the streets of J. E. Purkyně and Jiří z Poděbrad. The mentioned communications form the only access road to the hospital. It is also the only access road to another western part of the city - Štěpnice, Zahrádky, Mojmir, Průmyslová. Due to the current development, the capacity of the streets is almost exhausted. Then it is also problematic to pass through the EMS. Therefore, it is necessary to create a new landline for the operation of the EMS to and from the hospital.

The crossroads of the streets - Svatoplukova, tř. Maršála Malinovského, Svatoplukova, U Stadionu. The following figure shows this junction and their capacities are shown at selected time intervals.

Table 1. Capacity of the interesting junction [12].

Entrance Exit	from A		from D		
	to D	to C	to A	to B	to C
8:00 – 8:30 a. m.	48	118	64	7	40
8:30 – 9:00 a. m.	94	167	111	13	76
9:00 – 9:30 a. m.	101	166	89	9	67
9:30 – 10:00 a. m.	80	154	79	4	96
10:00 – 10:30 a. m.	71	148	75	5	92
10:30 – 11:00 a. m.	83	149	95	2	116
1:00 – 1:30 p. m.	60	107	81	7	109
1:30 – 2:00 p. m.	67	124	114	8	96
2:00 – 2:30 p. m.	80	130	120	8	93
2:30 – 3:00 p. m.	84	164	93	10	104
3:00 – 3:30 p. m.	99	134	125	13	102
3:30 – 4:00 p. m.	79	152	128	8	92
4:00 – 4:30 p. m.	68	127	123	9	97
4:30 – 5:00	66	112	90	10	91

p. m.					
Total	1080	1952	1387	113	1271

Table 1 shows the results of the capacity of the exciting junction, which is critical for the hospital. As can be seen in the table, the highest intensity of the way is in the time interval from 10:30 a.m. to 11:00 a.m. The second highest intensity of the road is in the time interval from 1:00 p.m. to 1:30 p.m.

The following figure 1 shows the intensity of this junction from software PTV Vissim.

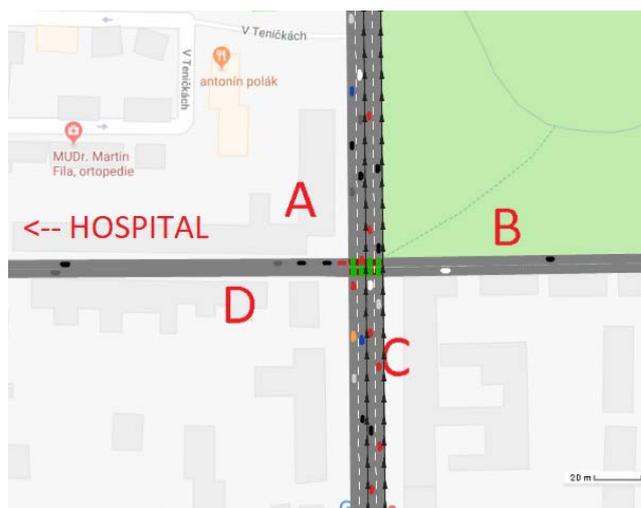


Fig. 1. Interesting junction [author].

3 Case study

The city of Uherské Hradiště hit the flood in 1997, and a part of the hospital Uherské Hradiště was ordered to evacuate. The situation was further complicated by the fact that the driveways to the hospital were flooded. It was, therefore, necessary to choose other access roads, which were not an ideal solution.

The aim of the hospital Uherské Hradiště should be to provide a new driveway that would allow free movement of ambulances to the hospital even in the emergency. This situation could be resolved by arriving from another side to the hospital. The town of Uherské Hradiště and Kunovice have available unconstructed areas which are intended for development. These areas could serve as a place for the future development of the hospital Uherské Hradiště. Therefore, new transport services would also be suitable.

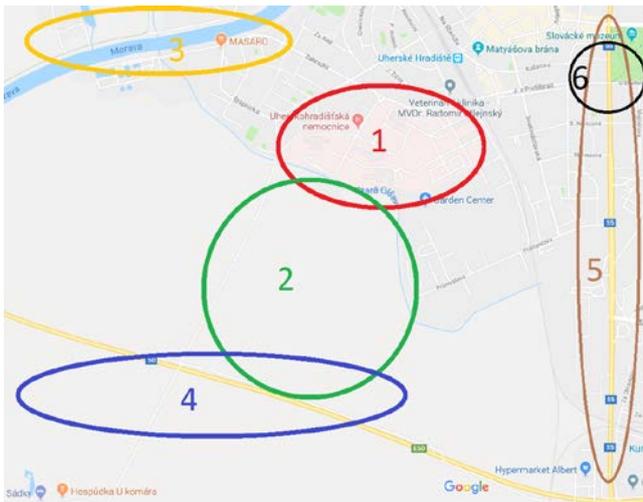


Fig. 2. Interesting areas [author].

Figure 2 shows the exciting areas in the map of the Uherské Hradiště, where:

- 1 – hospital Uherské Hradiště
- 2 – developmental area
- 3 – river Morava
- 4 – main way E50 (out of the city)
- 5 – city way 55 (in the city)
- 6 – exciting junction (Fig. 1.)

Based on the designation of the areas of interest, it is appropriate to address the access road with suitable capacity, given the future construction.

The original study addresses the development of free spaces. It is divided into five stages. The study does not address the future increase in traffic intensity after the construction of another city district. Its implementation is very long and does not solve the current problem of hospital inaccessibility during floods. The proposed study furthermore loads traffic on the E 55 and E 50 roads. Figure 3 from the study.



Fig. 3. Final version of the original study resonance [12]

Of course, everything can change the construction of the planned D55 motorway. This structure changes the distribution and intensity of traffic flows. [13]

4 Critical Points of the Proposal

Within each proposal, critical points have to be taken into account. In the case of designing a new transport service of the hospital Uherské Hradiště, it is necessary to take into account the hospital protection zones and the noise limits.

About protection zones, it is magnetic resonance and CT. For these devices, the frequent passage of vehicles can affect the accuracy of the examination and thus the diagnosis of the patient. [12]

The following table shows the minimum distances from the center of the magnetic field.

Table 2. Minimum distances from the center of the magnetic field [14].

Type	Axis X/Y (m)	Axis Z (m)
Steel objects to the weight 50 kg	5,5	6,5
Steel objects to the weight 900 kg	6,5	8
Steel objects to the weight 4500 kg	7	9,5
Mobile metal beds, chairs	5,5	6,5
Passengers cars	6,5	8
Trucks, lifts	7	9,5
AC transformers up to 100 kVA	12	8
AC transformers up to 650 kVA	13	12
AC cables up to 10 A	2	2
AC cables up to 50 A	2	2
AC cables up to 250 A	7	3
AC cables up to 1000 A	12	5
Refrigation unit for MR 3T	4	4

The table shows what the axle distances in the hospital's protective zone are. Due to the intention of this paper (building a new driveway), it is clear that the buildings with selected devices have an X / Y axis of 6,5 meters for passenger cars and an axis of 8 meters. As for trucks X / Y axis 7 meters and Z axis 9.5 meters.

The following figure shows the buildings in which the selected devices are used. Magnetic resonance is located in building J and CT in building B.



Fig. 4. Areal of the hospital with the building of the CT and magnetic resonance [14].

The second critical point of the project is the noise limits from the proposed communications.

Government Regulation No. 272 from 2011 sets noise limits for public local communication III. classes and other unspecified classes.

Table 3. Traffic noise emissions values [15] [8].

Communication type	Part of the day	$L_{Aeq,T}$ (dB)
Road I. and II. class	Daily	65
	Night	55
Road III. classes and purposeful communications	Daily	60
	Night	50

Road traffic noise levels for the use of another +5 dB correction.

From the project, it is evident that the hospitals form purposeful communication (these are premises of hospital communication).

5 Method

PTV Vissim software has been used to simulate transport services in the state of crisis. It is the software that solves microscopic simulations of individual and public mass transport. This program can affect both urban traffic, including cyclists, and motorway sections, including significant, cross-country intersections. The extensive analytical tools gathered in Vissim make it a tool for traffic planning and optimization of transport and transport systems, as well as some interfaces for different traffic management systems.

Vissim simulates some familiar but also unique geometric and operating conditions that occur in the transport network. The Vissim can define an unlimited number of vehicle types allows the user full range of multimodal operations. Types of vehicles include passenger cars, trucks, buses, cyclists, wheelchairs, pedestrians, airplanes. [15]

Vissim offers the unique ability to allocate vehicles to the network using one or a combination of three methods. The primary method assumes that traffic is stochastically distributed on fixed routes from a user-defined starting point to a destination point. The definition of junction maneuvers allows traffic to be distributed at a junction or several junctions. [16] Dynamic routes provide dynamic allocation of traffic to user-specified paths.

The Dynamic Load Method allows Vissim to assign traffic to the source/target matrix network (depending on vehicle time and category) and stochastic (load and load) loading techniques.

6 Results

As has been mentioned several times, this paper intends to propose a new hospital transport service. It would be the connection of the first class road E 50 and the hospital area.

The following figure shows how to make a connection to this route. The simulation was done in the PTV Vissim program.

Because of the required capacity, a crossroads, a three-armed T-junction, were used. [17]

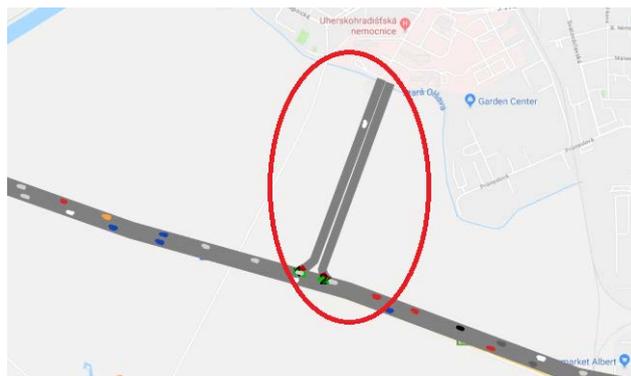


Fig. 5. New road to the hospital [author].

As part of the simulation, we tested the arrival of EMS vehicles, where significant positive time differences were observed.

Besides, the authors will continue to explore this area. Authors are already working on simulating traffic jams in the city when all road users will start using the new communications.

This proposal was also assessed using the SWOT analysis.

Table 4. SWOT analysis [author].

Strengths	Weaknesses
Developing a city in a location that does not create increased demands for motor traffic. Faster transport service of EMS. Traffic service outside the critical location - passing under the bridge at the hospital.	When rebuilding the territory, additional investment in the city's transport infrastructure would be appropriate.
Opportunities	Threats
The building new parking space in the development area. Building new pavilions of the hospital in the development area. Building new residential premises (for employees) of the hospital.	Junction capacities. Financial demands of the whole project.

7 Discussion

The aim of the paper was to analyze the current transport service of the hospital Uherské Hradiště and its subsequent solution proposal. Firstly, an analysis of the route over time and distance was performed. It is only a basis that is not essential for the design of a new transport solution. Secondly, the method of analyzing the critical points of the project was used. The map has highlighted areas of interest that are referenced in work. Within these critical points, the distances of the magnetic field from the roads and the noise capacity in the roads with the impact on the hospital were solved. Thirdly, the PTV Vissim software was used, in which the new transport service of the hospital Uherské Hradiště was designed. Finally, a SWOT analysis of the proposed project was carried out. As has already been mentioned,

article authors using PTV Vissim software continue to model traffic flows in the city.

8 Conclusion

The article dealt with the simulation of traffic changes in the city of Uherské Hradiště by the state of crisis. This goal was fulfilled, and there was a positive change in the traffic situation for the EMS. The proposed solution is easier and faster to provide access to the hospital in crisis situations. The authors of the article continue to work on simulation of the flood area in the nearest of the hospital Uherské Hradiště. Further simulations of junctions are made in Uherské Hradiště (in software PTV Vissim). It is believed that diverting traffic over a new route will significantly affect the hospital's transport services to citizens.

The authors are aware of the future prototypes of the D 55 motorway, but due to the speed of construction in the Czech Republic, this modelling will occur not earlier than five years. [18]

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