# POSSIBILITIES OF USING GEOGRAPHIC INFORMATION SYSTEMS IN TRANSPORT

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**Abstract**

Geographic Information System is a computer system that allows storing, managing and analysing spatial data. Nowadays we all use the possibilities of maps for smart devices. Whether it is for transportation, travel control or information. Geographic information systems can be used for transportation with which we can plan a route, look at traffic flow, traffic columns, and accidents and determine which route is best for us. This thesis describes the basic features of transport, geographic information system and the use of geographic information system in transport.

***Keywords:*** *GIS, transport, software, systems*

## 1 INTRODUCTION

Transport can be characterized as an activity related to the movement of persons and objects in various temporal spatial and volume contexts using various means of transport. Nowadays when modern technologies are increasingly being applied and mass digitization is taking place transport is also beginning to use and apply many technologies. Geographic information systems can be one of these technologies. Using geographic information systems it is possible to display individual stages of transport as well as their restrictions. Map portals are increasingly being used which are also used by individual cities to show the state of traffic to the public. There are closures, accidents, density but also other factors that can reduce traffic in any way.

## 2 METHODOLOGY

In this work were used methods of analysis and simulation. Analysis is a process of thought or real decomposition of the examined object into individual parts, which becomes the subject of further investigation. The analyses were used for the comparison of the geographical information systems. Simulation is an imitation of the real thing, condition or process (Lorenc, 2007-2013). In this work was simulation used for simulation of transport in the software PTV VISSIM. In this SW was simulated the density of traffic in the city of Kyjov as the one of the possibilities of using the geographical information systems in the transport.

For this work were created map compositions of the network of the railroads in the Czech Republic and railway roads. Map compositions were created by geographical information systems and dataset of ArcČR 500. These map compositions show how could be used geographical information systems for the transport.

## 3 TRANSPORT

Transport can be characterized as an activity related to the movement of persons and objects in various temporal, spatial and volume contexts using various means of transport. Nowadays, there are countless opportunities for transport and passengers (Zelený, 2007). Transport is a process, which we can, formulated as moving people or goods from point A to point B. There are many means of transport, whether it is a simple walk or a vehicle a bicycle, aircraft a ship

or a train as well as the associated transport facilities roads, airports, harbours and railroads. (ARCDATA PRAHA, n.d.; Eisler, Kunst & Orava, 2011)

Today transport is inherent in the day-to-day activities of people whether it is for their transport to work, shopping and school or anywhere for a trip. Transport is and will be our day's reservation anywhere. For example, there are 55,000 kilometres of roads, motorways and express roads in the Czech Republic are about 770 kilometres. Rail transport accounts for approximately 9400 kilometres of tracks. (ARCDATA PRAHA, n.d.; Kácal, 2014)

**Air transport** is one of the most used transports to transport people over long distances. Today, air travel is one of the busiest traffic at all. The advantage of this transport lies mainly in its safety. There are not so many accidents, collisions and it is very comfortable. One of its biggest advantages is its speed. Compared to road or rail transport, it saves tens of hours of travel. The benefits of air transport can therefore include its speed, comfort and safety. The disadvantages include weather and its impact on the environment. (Eisler, Kunst & Orava, 2011)

**Rail transport** is one of the most important transport sectors, although it is often referred to as an old transport sector because it has been used for more than a half-century. Today rail transport holds a high position very well and competes with other transport modes. Although it cannot offer such a more flexible response to the needs of passenger transport as compared to road transport, it replaces it by its capacity and its independence from the weather. Its advantages include the capacity of passenger and material transport and safety. Disadvantages include timetables, frequent delays and noise. (Eisler, Kunst & Orava, 2011)

**Road transport** is one of the youngest forms of transport in the world and is a very developing transport. Thanks to its speed and its operability, it competes very well with other modes of transport. Among the advantages of road, transport is its application both in domestic traffic as well as in international traffic. However, with the development of road transport there are also more frequent road accidents. Accidents in road transport reach the highest number of transport areas every year. These accidents often also cause environmental damage and loss of human lives. The advantages of road transport include speed, comfort, availability and purchase price. Disadvantages include accident rate, capacity and weather. (Pastor & Tuzar, 2007; Zelený, 2007)

**Shipping** is one of the first transports, which appeared in the world and allow the transfer of persons and property over a long distance. Compared to other forms of transport allows the transport of large quantities of material and provides a relatively fast moving. The transport itself can be divided into two categories namely inland swimmer and maritime transport. The advantages of shipping include in particular its capacity and favourable transport costs. The disadvantages include a limited network of transport routes, dependence on weather and high investment. (Zelený, 2007)

# 4 GEOGRAPHIC INFORMATION SYSTEM (GIS)

Geographic information systems are systems used for management, analysis and visualization of geographic data. These systems combine spatial and attribute information thus stores information about where something is and what it actually is. These linked data are called geographic information. Geographic Information System is thus an analytical tool that allows you to work with spatial relationships between objects so we can display data, maintain them, analyse and modelling them. It means that geographical information system is an integration of computer hardware and software. GIS is not just software but also other components like data, hardware, personnel and usage and GIS is not just a computer mapping system, although it is can also create. (Břehovský, & Jedlička, 2000; Miklín et al., 2018)

GIS consists of: (a) hardware - GIS is used on many devices, including a centralized computer server, desktop, tablet or smartphone; (b) software - GIS provides the tools and features needed to view, save, analyse and edit geographic data; (c) data - GIS cannot do without geometric and non-geometric data; (d) people - people include processors and GIS users; (e) procedures - GIS work is scheduled according to plan and certain creation rules.

Geographic data contains two but in some cases up to three basic types of information: (1) spatial information - describes its position, shape and their relationship to other objects; (2) descriptive information - they can also be labelled as attribute data and it is a property of a given object, type, name, and dimensions and so on; (3) time information - when this information is used, dynamic properties such as the date of the last repair are added to the system. (Břehovský, & Jedlička, 2000)

GIS data models are divided into two types, raster models and vector models. Raster model - is based on a cellular organization that divides space into a number of units. Each unit has a similar size as the other. Grids are the most common grid display. Each cell is assigned the X and Y coordinates as well as the value. This allows registration in the geographical reference system. Models created in this way have the disadvantage that their resizing causes a loss of quality so the closer we get it the worse the quality will be. Vector model - consists of three main elements, points, lines and polygons. Points are spatial objects without faces but can have attached attributes. Lines are spatial objects consisting of connected points that have no width. Polygons are closed areas that can be formed by the circumference of line segments.

The official definition of GIS from ESRI is: GIS is an organized collection of computer hardware, software and geographic data designed to efficiently acquire, store, modify, manage, analyse and display all forms of geographic information. For mapping serves a range of software applications. These can include for example ESRI ArcGIS, QGIS, OCAD.

### 4.1 ESRI ArcGIS

ArcGIS is a geographic information system designed to work with spatial data. It is used to create and manage data and can analyse, find new relationships and visualize all these elements. Data created in ArcGIS are clearly displayed in the created map, which can also be interactive and connected with a number of databases. It also offers the possibility of data interconnection using WMS servers so it is possible for example to connect data from the server of the Czech hydro-meteorological system and others. (ARCDATA PRAHA, n.d.) The Figure 1 below shows the road network of the Czech Republic created in the software ArcGIS. The ArcČR500 data was used here, with which the individual road networks were inserted.

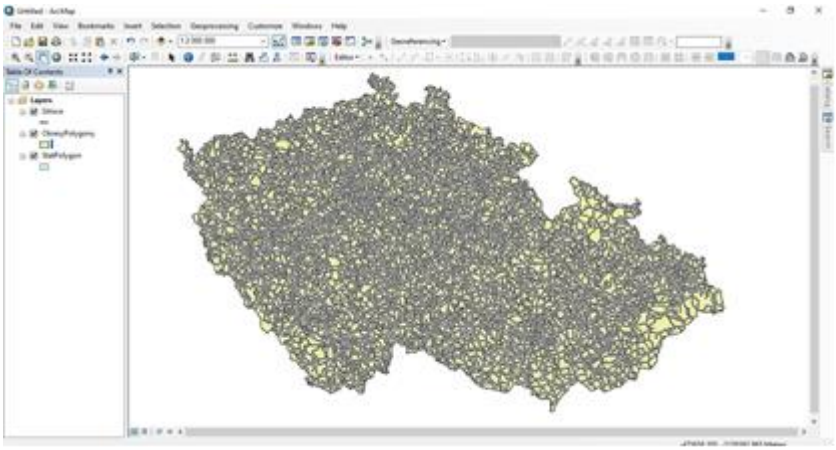

Fig. 1 – Demonstration of software ArcGIS. Source: own research

## 4.2 QGIS

QGIS is open source software, which was previously called Quantum GIS. Like ArcGIS software, it provides mapping with the ability to view, edit and analyse data and allows you to work with a wide range of raster and vector formats and databases. This project was founded in 2002. Currently QGIS software is being developed by a wide community of volunteers and professionals (Miklín et al., 2018). As a practical demonstration of the use of QGIS software for transport applications, a map containing the railway network of the Czech Republic was created below. The ArcČR500 data was used here to insert individual railway networks.

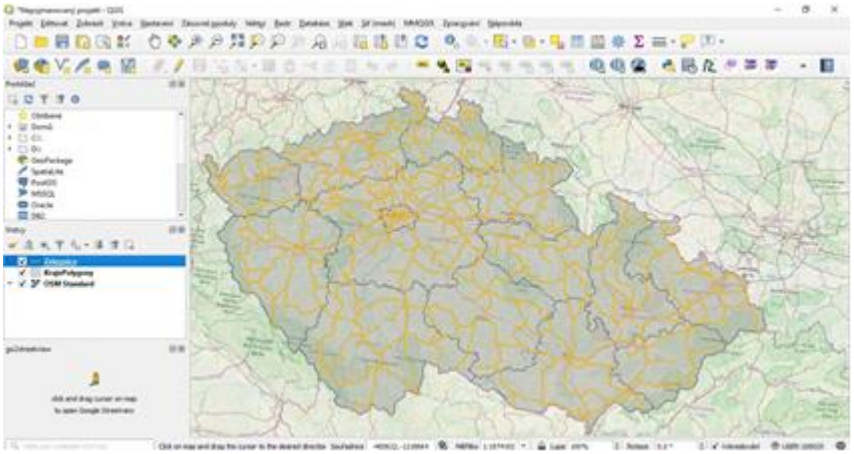

Fig. 2 – Demonstration of software QGIS. Source: own research

## 4.3 OCAD

OCAD is vector cartographic software for creating maps. This program is offered in two basic versions. These versions are OCAD for Cartography and OCAD for Orienteering. The difference between these two versions is that each focuses on a different target audience either classic cartography as provided by ArcGIS and QGIS or mapping for orienteering along with the design of the tracks for which the software was originally developed. (OACD, 2019)

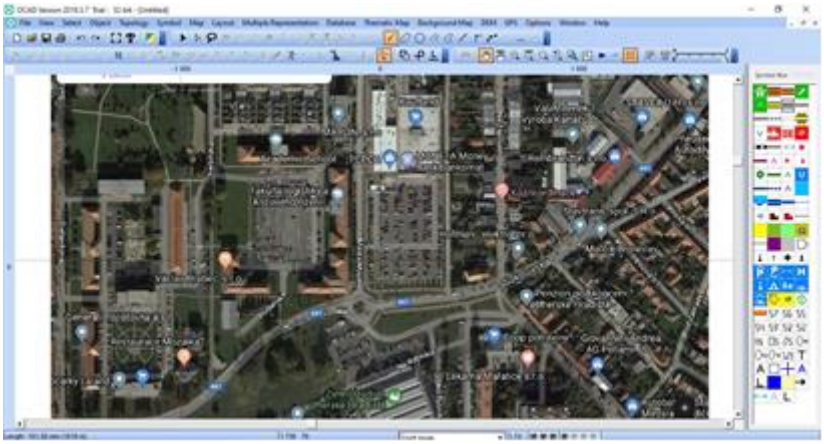

Fig. 3 – Demonstration of software OCAD. Source: own research

## 4.4 PTV VISSIM

PTV Vissim is a software that is used to microscopically simulate individual and public transport. The program can simulate traffic in cities including cyclists and pedestrians as well as individual sections of motorways and large intersections. PTV Vissim software thus simulates car traffic, pedestrian, cyclist and other road components. PTV Vissim combines

engineering experience with transport presentation in both 2D and 3D animation. PTV Vissim software is mainly used for network analysis, from simple intersections to large metropolises. In these areas road animations are created that include highways and utility roads. PTV Vissim uses geographic information systems. It uses an open street map as the base map. There are therefore to link geographic information systems and tools for creating PTV Vissim simulation of transport and transport systems. (AF CityPlan, 2017; Voženílek & Strakoš, 2009)

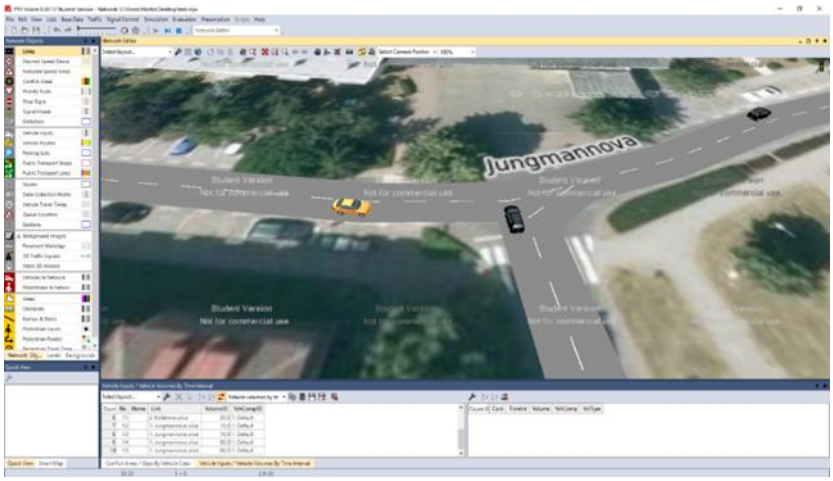


Fig. 4 – Demonstration of software PTV Vissim. Source: own research

To demonstrate the use of the PTV VISSIM program, a traffic simulation was created in selected sections of the city of Kyjov, which are the most fictional. With the help of traffic census statistics under the auspices of the Road and Motorway Directorate of the Czech Republic, traffic data was used and applied to the PTV VISSIM program.

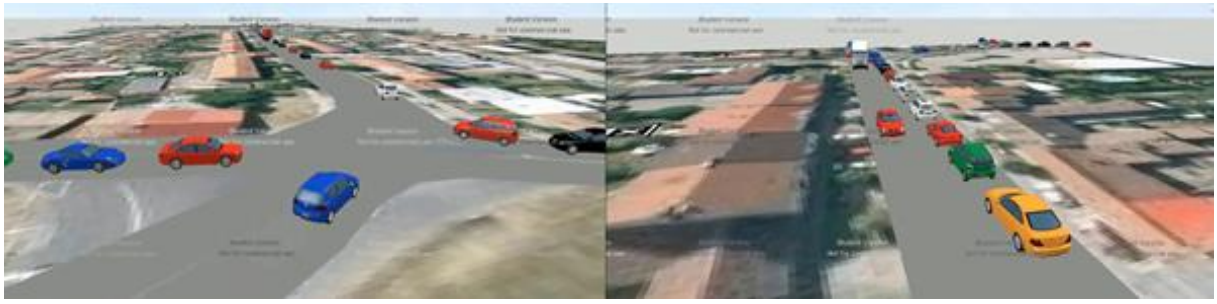

Fig. 5 – Simulation of traffic density in PTV Vissim. Source: own research

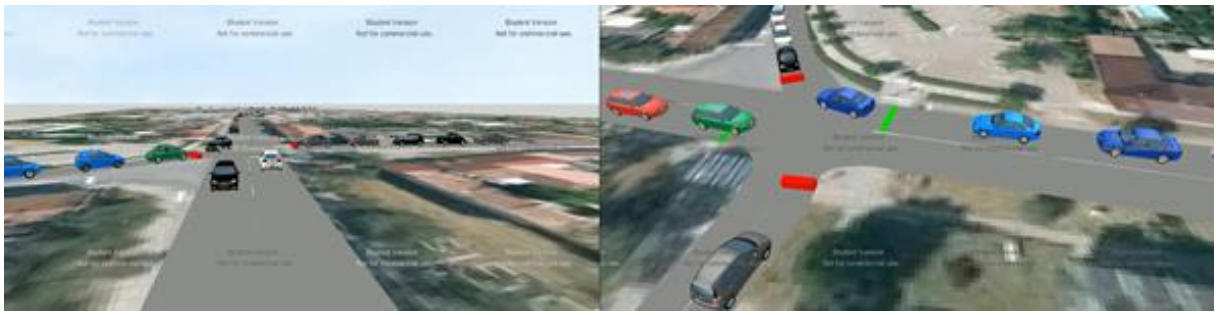

Fig. 6 – Simulation of traffic density in PTV Vissim. Source: own research

# 5 GIS IN TRANSPORT

Nowadays when digital map platforms are becoming more and more used and old prints are no longer used geographic information systems are on the rise. With GIS we can do anything. Geographic information systems have been used in transport especially in recent years. They are used for mapping of road and street networks, logistics, up-to-date accident reporting, road conditions, closures and traffic density, navigation systems, planning, maintenance, and registration of transport infrastructure, or emergency services that use navigation, location and surroundings and more.

Road networks are different from the topographic maps we are used to. Road networks consist of complex network charts described by vectors. This data can be obtained from road network operators such as the Road and Motorway Directorate of the Czech Republic. The data obtained in this way will save us a lot of time but it may not correspond to the current condition.

As the internet and wireless communications evolve faster, the number of internet and wireless applications using GIS for transport needs is increasing. These applications are most commonly used for driving directions, finding the shortest route possible, checking for congestion, columns, closures and traffic information. Navigation systems are slowly emerging as essential equipment in cars and smart devices. Along with wireless communications, these devices can also offer real-time traffic information and useful location services. GIS is also developing in the logistics industry. Because many companies are located in multiple countries and cities, GIS can show their customers all their branches, their routes and the way they deliver. (Shaw & Rodrigue, n.d.)

An example of the use of GIS in transport is the Waze mobile application. Waze gives you an overview of what is going on. It provides real-time information on traffic, road construction, police control and accidents. The application can also evaluate in real time the best route to the target according to the current traffic density.


Fig. 7 – Demonstration of application Waze. Source: own research

Another example of the use of GIS in transport is the information map portal of the City of Pilsen. This portal is freely available to the public and offers three types of Internet GIS map browsers with different demands and functions. Each map also provides a legend view with explanations and simple layer descriptions.

The first GIS Internet browser is the Traffic Map in Pilsen from traffic detector data. This application was created as part of the European project PoliVisu. The application serves as a tool to display the traffic intensity on the most important sections of roads in the city where traffic detectors are located to monitor the number of vehicles passing. In total traffic, density can be monitored on 307 sections of city streets fitted with detectors in the form of induction loops. The application stores data from March 1, 2017 until yesterday. When the application starts automatically read data from traffic detectors for the last 30 days and use them to calculate and display the map in average daily traffic for the current hour. (Mapový portal města Plzně, 2019a)


Fig. 8 – Demonstration of Traffic Map in Pilsen from traffic detector data. Source: own research

The second example of the use of GIS in transport is visualization of traffic intensity in Pilsen. This project was created in 2017. This application predicts traffic volumes on a specific day and hour based on measured data on the number of cars and based on scheduled closures for a specified date and time. Therefore, you can select the date and time in the application and the application will then display the current closures and traffic levels on the map. Data in the application are highlighted in colour according to their intensity and are described in detail in the legend. (Mapový portal města Plzně, 2019b)

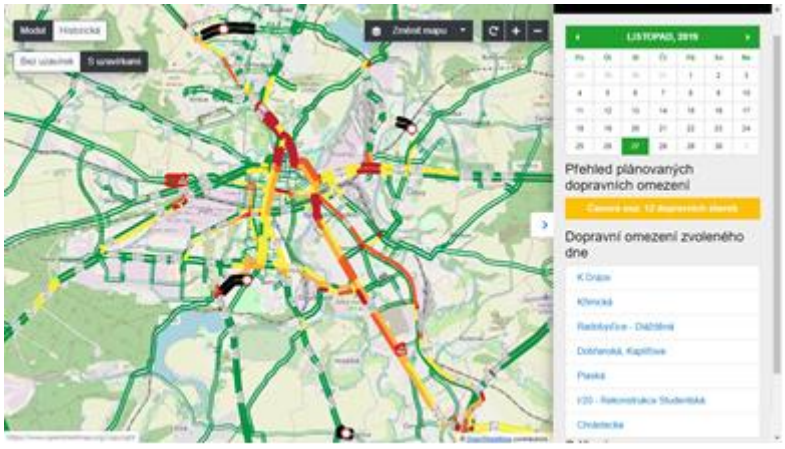


Fig. 9 – Demonstration of Traffic intensity in Pilsen. Source: own research

The third and last example of the use of GIS in transport in the city of Pilsen is the Map Project Transport. This project is intended primarily for employees of the Municipality and other organizations of the City of Pilsen but will also find its application in the public. You can find here information about closures, petrol stations, parking zones and more. All this information is sorted in the map into individual layers between which the user can choose. You can find here the category of public transport, which shows all Pilsen public transport lines including stops. In the application you can also find a category of communication network where is also cycling with layers of cycle paths, recommended cycle paths, and lockable cycle stands that can be used mainly by tourists. (Mapový portal města Plzně, 2012)

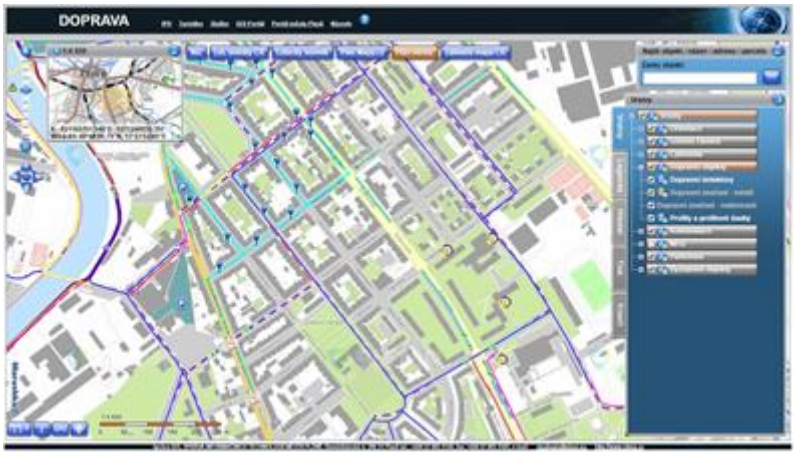


Fig. 10 – Demonstration of Map Project Transport. Source: own research

# 6 RESULTS AND CONCLUSION

In this paper there are given essential information about traffic and geographic systems and their interconnection. Geographical information systems are increasingly connected with the transport sector. Individual companies, municipalities, cities but also countries use geographic information systems to display their traffic data. With ever-increasing and sophisticated technologies, map bases and their layers are modernized and digitized to show current road conditions. They can identify the best possible routes for our transportation show negative factors that may make our journey unpleasant or affect us in any way such as road closures, road repairs, traffic jams, accidents or others.

The paper presents particular types of software designed for the creation of geographic information systems. Methods of analysis and simulation were used. As a practical example, a simulation was created in the PTV VISSIM program that shows the possible use of GIS in transport and map compositions were created, which are shown in the work under individual types of SW. Geographic information systems are systems that are applied in many sectors. They are very useful in transport and can help people very much.

The paper points to the various types of software and their employability. There is also listed a geographic information system, which are used for transport in the city of Pilsen. These systems point to the application of GIS in transport and their individual tools. There is also one case of using GIS in smart devices - WAZE application which serves as GPS navigation for cars and also provides up-to-date reports on traffic conditions, closures, controls and others.

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