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MODELING OF CROSS-BORDER INTERACTION IN CENTRAL DANUBE REGION

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Abstract. Opening of the European space and expanding of economic integration of the European Union are in conflict with the requirements for the transport infrastructure needs. This reality is manifested in the congestions on the road network not only in the countries themselves and their metropolitan areas, but also evidently in the cross-border regions, where is considerable potential for cooperation.
One of such area is the Central Danube region, defined by the territory of eastern Austria and western Slovakia with dominating centroids of capital cities Vienna and Bratislava. Considerable economic potential of high-tech, research and services in Vienna region combined with sufficient number of educated and skilled staff resources and relatively good infrastructure in Bratislava region create favorable conditions for further positive development in this cross-border area. This however requires compatible transport network, which is the first pre-requisite for the smooth movement of people and freight transport in this area. With the possibilities of interconnection of these attractive areas deals the project "VKM - transport model AT-SK", which is processed in framework of the Cross-Border Co-operation Program between Slovak Republic and the Republic of Austria in the period for 2009-2012. The project aims to create a compatible transport model for the transport network in cross-border territory of eastern Austria and western Slovakia. The first stage of the solution has to summarize the available basic documents and collects the necessary data for modeling of cross-border transport interactions. In the next period, the project will cover the entire territory of the CENTROPE region, including western Hungary and southern Moravia.
The paper presents the latest findings on progress, achieved results and possibilities for the utilization of the ongoing elaborated „VKM - transport model AT-SK " project.

Keywords:. integration, transport, infrastructure, mobility, region, surveys, modeling.

1. Introduction

Boundaries, which arose in Central Europe during the turbulent political events of the 20th century, afforced peripheral character of this territory, which had gradually faded and lost its attractiveness for further development. Perhaps the only positive contribution to inhibition of activities in this area was to maintain and in some cases the extension of the Central European rare species of fauna and flora. But the barrier effect of the "Iron Curtain" had more negative impact on social, cultural and economic ties, what was reflected in demographic trends, and consequently also in the suppression of the settlement structure and its transport infrastructure. What was the central area before, has become a marginal territory later on. The opening of borders after 1989 and start of the European integration process have created a unique historic opportunity to reestablish natural relations between countries in the Central Europe. It was also a great challenge for neighboring states to launch programs for rehabilitation and revitalization of this area. Given the priority to re-connection of Central European countries, reconstruction and new construction of transport infrastructure has become the intrinsic issue, that should ensure smooth mobility of passengers and freight.

2, Central European region CENTROPE

In the Middle Danube area, where the continental massifs of the Alps and Carpathians intersect together, the nature has created favorable conditions for life and cooperation. Ever since ancient times, important roads leading from east to west (Silk Road) and from north to south (Amber Route) led through this territory. This Euro-Asian and Baltic-Adriatic connection had created a "turntable" of Europe, in which different nations and religions had "mixed" together for centuries (Fig 1). Yet in Roman times, there the capital city of northern Pannonia named Carnuntum was founded here after which even today there is the city gate Heidentor towering in the wide-open field near by Petronell, a village in Lower Austria. Two nuclear cities of Central Europe have

gradually arose from this ancient city:
- Vienna at the foot of the Alps, south of the Danube, as a distribution point for south-west Europe and
- Bratislava at the foot of the Carpathians, north of the Danube, as a distribution point for the north-eastern Europe.

Fig 1. Location of the Central European Region CENTROPE

The most important development factor in this region was the Danube river, which has always been a connection element between different European cultures, religions and nations. Throughout the history, whole this area have had one important feature – to join the splitted. The north-southern and east-western transport routes enable direct links not only between neighboring countries, but also inwards each country, which constitutes an advantageous combination for exploitation of their existing economic, technological and human potential for further development of this area [1]. It is suggested that synergic effects of positive cooperation in Central Europe accelerate its development. These favorable preconditions for cooperation were also an incentive for joint cross-border project in the Central Europe, under the name CENTROPE, in which the most productive areas of adjacent states were involved.

Today, there are about six and half million people that speak four different languages living in this area, which partly overlaps the territory of following four states (Fig 2):
- Austria (Lower Austria and Burgenland)
- Czech Republic (South Moravia region)
- Hungary (Komitat Györ and Sopron) and
- Slovakia (Bratislava and Trnava region)

These factors are forming a perfect "interface" for effective collaboration within uniting Europe. According to some sources, the gradual changes in the performance of global economy over next 50 years, will be an incentive for formation of a transformation point of freight and passenger transport that is to encourage more than quadruple increase of population in this area [2].

The key factor for further development of this region in the forthcoming period will be thus primarily a functionable and compatible transport network as well as a sophisticated transportation infrastructure. These assumptions are approved by sustained growth of passenger and freight transport volumes on existing networks in metropolitan areas of the CENTROPE region. Neglecting these requirements could lead to negative synergic effects, overloading of its vital functions, to overhaul and ultimately to collapse of the entire system.

A proper understanding of the urgency to solve these issues leads to a requirement to identify the driving forces of this process in the current period and to be able to anticipate their future development. An appropriate tool for analysis of the current state and for the determination of claims and assessment of real options in outlook, is the transportation modeling.

Fig 2. Disposition of the region CENTROPE

3. Requirements for transportation modeling in the CENTROPE region

Possibilities of modeling of transport relations in the CENTROPE region are dealt within the project "VKM transport model AT-SK" [3], which is being worked-out in-between 2009-2012 within the Cross-border Cooperation Program Slovak Republic – Austria. The project aims to create a transport model to simulate the traffic load on compatible intermodal transport networks in selected areas of the cross-border region of eastern Austria and western Slovakia. Available data necessary for modeling of displacement relations have been summarized in the first stage of the project implementation. The current transport network of the CENTROPE region is under considerable pressure of rising road transport volumes, which is further enhanced through emerging activities being built in this attractive area. The need of analysis of the current state of cross-border traffic and a

prognosis of its prospective claims are logically given, in particular by the proximity of Bratislava and Vienna, as well as by the Schengen area, allowing the free movement of passengers and goods among EU member states. Transportation modeling is very suitable tool for regulation and management of existing entitlements and services for effective planning of new transport infrastructure. It provides for a possibility for determination of current traffic load as well as estimations of cross-border traffic on existing and planned transport network in variant forms, along with alternative proposals of appropriate solutions for optimal use and determination of potential environmental impacts in terms of sustainable development.

The main objective of the "VKM transport model AT-SK " project is to create a unified transport model covering selected border areas between Slovakia and Austria, which will enable to model the variations of displacement relations within the continuous and compatible transport network.

The incentive for submission of this task was especially the diversity of the documents of available data and different approaches of individual partners in solving of traffic problems on both sides of the border area, so far on inhomogeneous transport networks. The Project "VKM transport model AT-SK " is a result of long-term cooperation between the Institute for Transport Sciences (Institut für Verkehrswissenschaften) of University of technology in Vienna, Austria and the Department of Transportation Engineering of the faculty of Civil Engineering of Slovak University of Technology in Bratislava. The long-term goal of the project is a wider scientific and research cooperation its intensifying and involvement of other institutions of neighboring countries in the formulation of a functional transport model for current and prospective traffic demands of the CENTROPE region.

4. Project Objectives

The current period is characterized by persistence of discontinuities in solutions of transport problems in the border area, which is – in a relation with the passenger and freight transport – causing:

• lack of adequate information about the current state of traffic
• difficulties in operational management and regulation of transport
• impaired coordination of acute and prospective requirements for function ability of the transport system
• problems in dealing with risky transport situations in the event of natural disasters or other unexpected events, respectively.

Providing solutions for these issues requires organizational, operational and infrastructure ties in the common system of passenger and freight transport. The growing demand for individual and public transport in the rapidly expanding cross-border CENTROPE region can only be satisfied with a high quality and flexible supply management system within a inter-connected and compatible transport network infrastructures.

The project aims to create a single cross-border transport model CENTROPE to be an effective tool to support:
• operational,
• regulatory and
• planning process in the management and development of transport infrastructure in this area. The first step is to create a transport model for the nuclear CENTROPE territory, which includes (Fig 3):
• Vienna Great Area
• Lower Austria,
• Burgenland
• Bratislava self-governed region, and
•Trnava self-governed region.

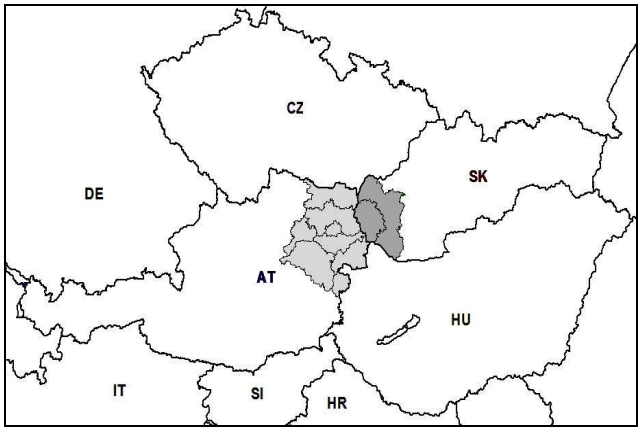


Fig 3. The model area of the "VKM-transport model AT-SK"

In order to solve this difficult task, it is also necessary to evaluate various existing "independent" national models of Austrian as well as Slovak territory. Based on the assessment of available models, it is further necessary to define conditions for modeling of variant traffic situations and optimization of available transport system supply in the given cross-border area.

The ambition of researchers of the project is its gradual extension to the whole territory of CENTROPE region. In this year (2011) there are already running negotiation with Hungarian partners from the SZE University in Györ to extend the project with the region of Györ-Sopron in western Hungary. In the next stage, it is expected to extend the project to the region of South Moravia. The transport model is to be multimodal, which means that it will fully support individual as well as all the public transport modes (buses, rail, suburban rail), running according to specific schedules. The project is co-funded by the EU and by Austrian and Slovak governments, and therefore, its output will be fully available to all potential users on both sides of the border.

5. Collection and updating of the necessary data and documents for cross-border model

The processing of such cross-border problematic requires a comprehensive analysis of the current traffic situation, the available documents, information and inputs to address current, but also perspective issues on both sides of the project.

Nevertheless, the situation in partner countries of the project is significantly different. As for the Austria, they have already now available and updateable data for multiple transport models. In Slovakia there is practically no relevant data source, or an institution that would deal with a comprehensive collection of necessary data, which could enable a complex modeling of a cross-border traffic as such.

Because of this, the most important task of the project in the first phase was the analysis of the current situation in order to gain sufficiently credible documentation and input data for modeling of transport process, at first separately for Austrian and Slovak border area of the CENTROPE model.

The solution of the project requires considerable flexibility and management work in each step. Because of these reasons, regular meetings of the Advisory Board are being organized twice a year. Members of the advisory board – formed out of specialists of relevant organizations in both countries and representatives of the team – meet alternately in the Austrian and Slovakian site and have the opportunity to comment on the submission of partial results, as well as to evaluate submitted partial solutions in terms of planned schedule and scope of the project. In a period between these meetings of the regular Advisory Board there are further regular meetings of the project team, where special operational issues of the project are being discussed.

For the Austrian territory of CENTROPE region there are following functional models available, covering the territory of Vienna Great Area, Lower Austria and Burgenland, or the whole Austrian territory, respectively:

- Demand model BMVIT (Austrian Ministry of Transport, Innovation and Technology)
- VOR model (Verkehrsbund Ost-Region - Eastern Region Transportation Association of Austria)
- Model ITS Vienna Region and
- Model for the city of Vienna (MA 18).

Various data for common transport model are consecutively being analyzed from these models.

On the Slovak territory, currently we are working on completion of input data for more detailed processing of the transport model of the Bratislava and Trnava region. The key issue is the breakdown of the interest area into basic units, transport analysis zones. The limit for total number of zones is the capacity of computational model, which does not exceed 3000 zones in the whole cross-border region of the "VKM transport model AT-SK".

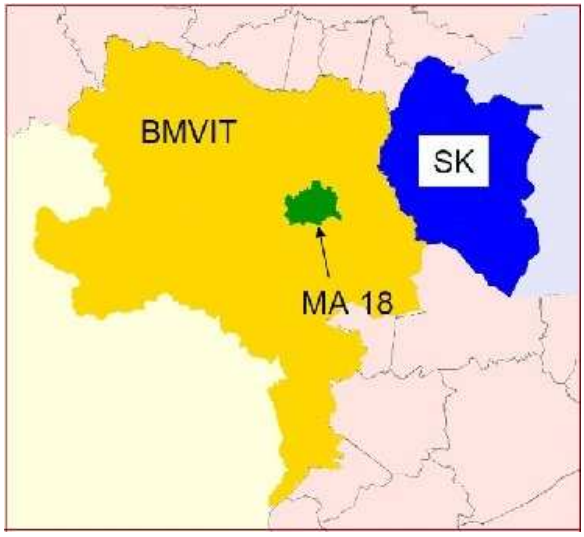


Fig 4. The extent and patterns of land distribution

Therefore, the size of zones is defined by population or the function of the area, respectively, in case it contains a single activity attracting significant volumes of traffic (shopping centers, transfer nodes, etc.). For the Slovak part of the Transport GCM model, covering most of the western Slovakia, each settlement (town or village) is considered as (at least) one zone in extent of its cadastral area. However, for the purposes of the cross-border model, it was necessary to disaggregate larger cities into smaller spatial units (more zones), and to obtain necessary information for their parameterization.

For purposes of the project, the inputs from a transport model developed for the Ministry of Transport are partially used. This model has the following network parameters: 23 200 lines, 8900 nodes, 592 zones, 1449 stops, 3525 PT lines and finally, 34450 connectors.

Table 1. Distribution of settlement types in the model area in Slovakia

Region	Settlement size category (number of settlements by number of inhabitants)							
	<2000	2000-5000	5001-10000	10001-20000	20001-50000	50001-100000	>100001	Total
BSK[x]	47	17	5	2	1	-	1	**73**
TSK[x]	194	41	6	5	4	1	-	**251**
Sum	241	58	11	7	5	1	1	**324**

Notes:
BSK...Bratislava Self-governing Region
TSK...Trnava Self-governing Region

Necessary parameters to be known for each zone are following characteristics:

• population (disaggregated by gender, age, economic activity, etc.)
• number of jobs (by different sectors)

• number of places in kindergartens and schools for children and pupils and students (capacity)
• transport characteristics (automobilisation ratio, parking characteristics, etc.)
• temporarily present persons (accommodation capacity of dormitories, etc...).

For the transport model were used available data from several possible sources, notably: the Slovak Statistical Office, the Slovak Road Administration, Police Directorate, National Health Information Center, a specialized company for mapping and other data. Another source for obtaining information necessary for the transport model was a questionnaire survey of all municipalities in both counties. Unfortunately, the rate of return of questionnaires and the relevance of the responses, proved to be insufficient (approximately 11% returned questionnaires).

In Austria, there are better resources available for necessary information, which are primarily obtained from existing functional models and also, some additional data that can be obtained from the Statistical Office and other institutions. For more detailed setting of zonal parameters the so-called cadastral (Katastralgemeinde) breakdown is used, for which it is possible to obtain statistical data on population, houses and flats and the number of employers in the site. Further details are provided by Eurostat (heavy vehicles) and the Ministry of Transport (Bundesministerium für Verkehr).

6. Problems with data gathering

The data were initially intended to be obtained during the first year of the project (X/2009-X/2010). However, based on real experiences with gathering the necessary data and after a detailed review of returned questionnaires, it was concluded that the quality of services, level of processing of available data, as well as indifference of respondents and inadequately filled questionnaires, requires much more efforts to obtain reliable input data. For this purpose, a direct survey was conducted in summer 2010 at local authorities in selected major towns (over 5000 inhabitants) and their departments for urban planning, construction, or transport respectively. Here, the possibilities for obtaining relevant input data and information for the model area of the VKM model were verified. However, in majority of towns, they were not able to provide necessary data, or these were obsolete, broken or have been in awkward configurations for needs of the transport model (breakdown into urban / regulatory / traffic zones). Documents and data for planning and forecasting services for larger regional units are clearly very difficult to obtain publicly. There is no uniform methodology for collection and disclosure of such data. Towns and villages choose the form of processing and types of observed characteristics by themselves, but which then leads to difficulties for comparison and comprehensive evaluation in a larger territorial unit. In many cities, these basic transport and planning characteristics are not even being tracked. Therefore it was necessary to devote increased efforts to find other new sources to obtain necessary data for analysis and solution of the current state of traffic conditions in the model area of the project.

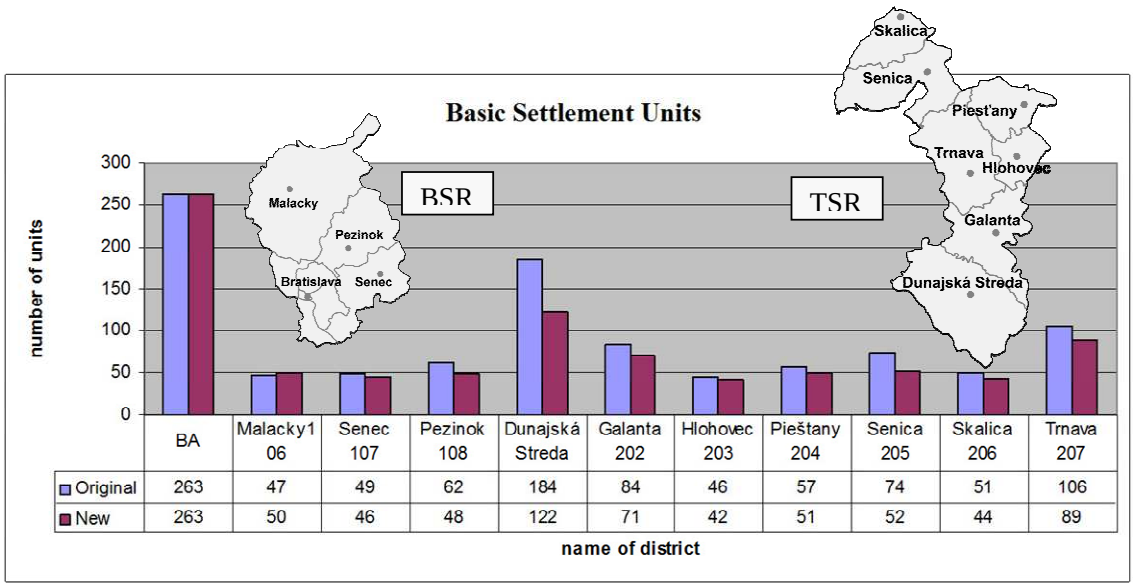
7. Availability of transport planning documents

Based on previous experience by data gathering for modeling of cross-border traffic interrelation it can be suggested that despite new possibilities offered by computer technology and electronic media, it is very difficult to obtain. The main factors affecting the collection and provision of quality transport planning data are:
- inadequate level of staffing at institutions,
- the reluctance of stuff to provide quality and adequate documentation,
- non-uniform methodology of data gathering and processing for cross-border traffic data modeling,
- uneven division of the territory of each municipality and
- not updated traffic-planning documentation of municipalities.

It turns out that the most appropriate data is provided by the Statistical Office of the Slovak Republic, which are available in uniformly divided territory of Slovakia called "The Basic Settlement Units" (BSU). BSU system was applied as a „permanent statistical districts" in all population and housing censuses since 1970th. BSU make stable system of spatial units for the geographic location of information about the land. The source in Slovakia is Register of The Basic Settlement Units under the auspices of Ministry of the Environment of the Slovak Republic.

In most of the cases, municipalities were broken down in terms BSU too much detailed and this resulted in merging of some units into larger territories. (see Table 2), which gives the original number of BSU in districts and after adjustment adequate for transport modeling). The initial number of 1023 zones were assembled to final number of 878 zones in the Slovak part of the model. The BSU, however, are not always identical with urban and/or traffic breakdown of the affected area. Moreover, data for BSU nationwide census which is conducted in ten-year intervals and therefore does not always provide up-to date information. Even in this case, the updated data will be only available by the end of the project (in 2012), since the next census in Slovakia will be processed in 2011. This requires a greater effort in the processing of input data for solving cross-border traffic interrelation and in searching for additional resources for acquisition and subsequent calibration to comparable form suitable for modeling of transport in the CETROPE cross-border area.

Coming out the above mentioned facts, following requirements in order to improve the availability of



	BA	Malacky1 06	Senec 107	Pezinok 108	Dunajská Streda	Galanta 202	Hlohovec 203	Pieštany 204	Senica 205	Skalica 206	Trnava 207
Original	263	47	49	62	184	84	46	57	74	51	106
New	263	50	46	48	122	71	42	51	52	44	89

Fig 5. Basic Settlement Units - the original and new segmentation

transport planning documentation and input data for modeling the cross-border traffic interrelation in CENTROPE region, in particular:

• to ensure the systematic collection of data transport planning,

• to establish a uniform methodology for gathering geographical and traffic characteristics

• to create the institutional conditions for accessing and providing such data,

• to ensure legislative support data collection and requirements in terms of cross-border issues.

8. Further steps in the project

Based on conclusions from the last meeting of the Advisory Board, a number of further tasks were defined, which is necessary to dealt with in the next steps of the project, given in particular:

• preparation of documents for demand modeling (data for trip-chains based on extensive surveys of households in Slovakia have not yet been implemented. In the first stage of the project it is supposed to transfer the data from the Austrian and German surveys),

• integration of the Slovak and Austrian traffic model and its coordinated calibration,

• keeping the input data and their complementarity in the field of demographic and urban-transport planning,

• expanding the project to the Hungarian cross-border region and negotiations to extend it to the Czech Republic territory.

9. Conclusions

Integration of the territory in terms of transport and traffic modeling appears to be very good step for cross-border relations between neighboring countries. The emergence of significant activities in border areas clearly affects the lives well beyond the borders and international services will continue to gain their importance. It is therefore important to address the modeling of transport beyond the borders of respective regions, provinces and countries and lessons learned in implementing transport policies and transnational decision.

Availability of transportation-planning documentation should clearly correspond to its importance in the planning of transport in respective settlements and/or larger territorial units, especially in those areas, where natural historical cross-border relations are being reestablished, and new economic cooperation ties are being developed. Without systematic legislative measures cannot be ensured by the quality of control process and traffic control and planning of new transport infrastructure in sensitive areas, such is the cross-border CENTROPE region in the middle Danube area. This paper has been partially developed within the project "VKM - transport model" No. N-00043, within the Cross-Border Cooperation Program Slovak Republic - Austria 2007-2013, which is processed in the framework of the Centre of Excellence SPECTRA. This contribution is partially the result of the project implementation: Centre for the Development of Settlement Infrastructure for Knowledge-Based Society, ITMS 26240120002, supported by the Research & Development Operational Program funded by the ERDF.

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