Implementation of transport data in to the transport forecasting in Slovakia

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Abstract

The transport forecast is the unconditional part of every transport studies, LOS capacity calculations or town transport plans. It is processed for several time horizons or time intervals.

The basic purpose of transportation planning and management is to match transportation supply with travel demand, which represents ‘need’. A thorough understanding of existing travel pattern is necessary for identifying and analyzing existing traffic related problems. Detailed data on current travel pattern and traffic volumes are needed also for developing travel forecasting/prediction models. The prediction of future travel demand is an essential task of the long-range transportation planning process for determining strategies for accommodating future needs.

Further sustainable mobility in Slovak cities, their competitiveness, economy as well as living conditions of inhabitants are depend also on the way of transport planning, development of transport infrastructure and services.

Generally the calculation of the interzonal transport relations (number of trips) is a challenge. The practical application of the transport forecast theory is not easy. Some steps are hardly implemented to the practice for various reasons. The discrepancy between needed data and available data is one of the common problem. The traffic modelers must often study the method of data gathering which use an institutions possessing of demanded data. The discrepancies are showed on different levels (for examples the borders of urban zone and statistic area units are different in principle). One of the problematic issue is the definition of work trips or business trips. The origin and destination is defined at office address. The mobility survey contains data characterized one household, people not admit usual mentioned trips. The official company address are different as transport department. The ration of these trips in traffic flow is not negligible. The article is aimed to brief description of the transport forecast process calculation. The main part of the article describes outputs from mobility surveys of some regions of Slovakia and them implementation in...

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transport forecast calculation process. This methodically tool is intended for traffic analysis, planned solutions and arrangements verification of problem situations solutions. The University of Žilina processed several mobility surveys. The sample covers different regions with different gravity areas. The database was detailed evaluated and compared. Two Slovak regions were modeled in the Visum software (PTV Vision). Output data were used for town transport plans. Other mobility surveys were made for analysis of interstate transport relations (Slovak republic – Hungary).

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1. Introduction

The travel demand forecasting is based on the large database of data. The Transport model maker needs describe the current transport situation as the results of current transport-socio characteristics of inhabitants.

An important strategic question should be one of ‘what is required from the model?’ Indeed ‘fitness for purpose’ should be a guiding principle throughout the design process. Whatever the scheme or policy under investigation, the analyst should always ensure that the budget designated for data collection and mode choice modelling, and the timescale for such activities, is commensurate with the nature and complexity of the problem, and the likely scale and extent of impacts (including any potential second order impacts).

The main objective of the article is the description of current possibilities of using the database for travel demand forecasting in Slovak cities, districts and regions.

2. Input data gathering

There are several ways to define basic transport relations on solved area. Generally the values must represent relevant and real situation. The quality of data sources are the determining factor of transport forecast quality. It is possible use several sources to filling the database in Slovakia. The first useful source is Statistical Office of the Slovak Republic (SO SR).

The system of demographic statistics in the SR based on monthly processing of data on demographic events drawn from the exhaustive population survey, regularly performed censuses of population and housing and supplementary population surveys (microcensuses); provides the decisive bulk of information on population as a whole, on its spatial distribution, number, structures, and characteristics in the specific period of time.

Labour Market Statistics provide information on present situation and trends in employment, unemployment, job vacancies, wages, labour costs and strikes. Primary source of this information consists of regular statistical surveys carried out in enterprises and households. Labour Force Survey (LFS) quarterly monitors labour force supply focusing on economic activity of population, employment and unemployment.

Social statistics are aimed at obtaining relevant and comparable statistical information on social protection, income and living conditions of households, labour and wages, education and learning, health, culture and criminality. This information is needed for making and monitoring policy on each level of public administration management including international organizations and for meeting users’ requirements on national and international level.

The system of quarterly and annual enterprise surveys represents the key instrument of data collection in the labour and wages statistics. It provides information on the number of employees, hours worked, job vacancies, average nominal and real wage (classified by branches, size of enterprises, regions) for operative measures of central bodies as well as for experts and for general public. Information on a level of average monthly nominal wage of employees published by the SO SR is a basis for calculation of other significant social indicators (e.g. basis of pension assessment, earnings of institutional representatives, limit of deposit protection etc.). For the purpose of a regional overview, the employment and wages have been surveyed in annual periodicity referring to work place. Furthermore, a total employment balance has been compiled for the national economy along with regional and NACE breakdowns.
The first step in data gathering process is sharing the sophisticated data system DATAcube. Database DATAcube contains multidimensional tables for indicators of economic and socio-economic development. The classification system of individual tables is based on maintaining the structure of domains and fields similarly as in the web Portal. Data from various statistical fields are presented in the form of multidimensional tables in monthly, quarterly or yearly time series and allow to create your own selections. At the end of the title of each table there is an eight-digit code, which is the unique identifier. The outputs can be exported to file formats: PDF and XLS.

The base data could be easily imported to the prepared transport model which is used for the transport forecast. The picture above shows the ratio between numbers of inhabitants and number of employed persons in Slovakian administrative districts.

![Fig. 1. Imported data from DATAcube to the transport database.](image)

The next source of data is available on the Road databank (RDB) webpages. Through own facilities, in close cooperation of road owners and administrators, it executes:
- collection and processing of technical data on roads,
- pavement diagnostics,
- development and building of GIS (geographical information system),
- information service of databank.

RDB operates the application system for assessment and determination of routes for the transport of excessive and oversized cargo, where the proposal and the evaluation of the transport route forms a part of the application for the authorization for a special utilization of roads. The RDB also offers the summary data on the road network SR, selected data of objects in the road network SR, length of roads since 1995 and the basic and thematic maps of the road network (road sections with toll, with payment, international road E, TEM, TEN-T), maps of regions, districts, map sheets and maps of intersections.

The international databases are also used for definition of transport cross-border relations (Eurostat). The finished project ETISplus (European Transport policy Information System Development and implementation of data collection methodology for EU transport modelling) have requirement for good quality input data to support models, evaluation methodologies and indicator frameworks. As a partner of project we covered the data gathering of selected EU state. Without information integration, DG-MOVE lacks a consistent data source covering:
- passengers and freight,
The database of the Ministry interior of the Slovak Republic is also useful. It disposes of vehicles ownership data. The data are on request and it is necessary to define the structure of data (metada). The using of mentioned data is conditional on separation of vehicles ownerships. The address of the fleet cars are same as the address of company. Several companies don’t have their own parking places and the employees could use cars also for private purposes. The transport attraction is distorted for transport zones mainly for residential areas.

The described sources of data have to be supplemented by results from regions, districts mobility surveys. The Department of Highway Engineering (University of Žilina, Slovakia) is a coordinator of several mobility surveys. The Žilina district, as our home region, is monitored from 2007 and the results have continually evaluated. The Martin region was monitored in 2012. The sample of evaluated data are showed in the next part of article.

Our department was the main processor of the surveys in project “Improving mobility in the Hungarian-Slovakian region by development of public transport” within the framework of Hungary-Slovakia Cross-border Cooperation Program 2007-2013, released in 2013. The overall objectives of the project are the creation of an integrated public transport system in the Slovakian-Hungarian border region and the support of sustainable transport in the cross-border regions. The project started on 1 September 2012 and lasts for 18 months. We prepared, organized and evaluated data from large mobility survey, the questionnaire survey which was realized during two days (Wednesday and Sunday). Actually we process the Žilina region mobility survey cooperating with Žilina self-governing region.

The transport habits of inhabitants were also described in project Brawissimo (Region BRAtislava – Vlenna: Study about MObility behavior). The mains activities of the projects were:

- Translating the Austrian handbook on traffic and mobility inquiries KOMOD into Slovakian.
- Mobility survey – personal interviews in Austria (about 10.000), in Slovakia (about 17.000) and in the bordering region (about 5.000).
- Analysis and monitoring of traffic and mobility development and its effects, amongst others on environment and road safety.

The partners of the project were Minister of Transportation, construction and regional development of the Slovak Republic., BOKU Wien, Slovak University of Technology in Bratislava, TU Wien, and Statistical Office of the Slovak Republic. The source data are freely available.

3. The regions traffic problems

Administrative division of Slovakia is formed by 8 regions (Higher Territorial Units) with 79 districts. There are four main highways D1 to D4 and eight express ways R1 to R8. Most of them are still in the planning phase. The D1 motorway connects Bratislava to Trnava, Nitra, Trenčín, Žilina and beyond, while the D2 motorway connects it to Prague, Brno and Budapest in the north-south direction. The D4 motorway (an outer bypass), which would ease the pressure on Bratislava’s highway system, is mostly at the planning stage.

The area of the Žilina region is the place with the highest density of protected territories in Slovakia (55.8%). The region shares 9 borderline checkpoints with Czech Republic and Poland. Žilina also plays an important part in the railway transport industry with direct rail links through Cadca and Zwardon to Poland, and from Czech Republic through Cadca and Žilina to Bratislava or Kosice. Important parts of the international road network lead through Žilina’s region, the most important are: E 50 Czech Republic – Žilina – Košice – Ukraine, E 75 Poland – Čadca – Žilina – Hungary and Austria, E 78 Poland – Trstená Dolný Kubín –Šahy – Hungary, E 442 Czech Republic – Makov – Bytča – connected with E 50 and E 75.

The Žilina city is a city in north-western Slovakia, around 200 kilometers from the capital Bratislava. It is the fourth largest city of Slovakia with a population of approximately 82,000, an important industrial center, the largest city on the Váh river, and the seat of a Žilina Region and a Žilina District.

The Martin town is a city in northern Slovakia, situated on the Turiec river, between the Malá Fatra and Veľká Fatra mountains, near the city of Žilina. The population numbers approximately 61,000, which makes it the eighth largest city in Slovakia. It is the center of the Turiec region and the District of Martin.
The large directional surveys was made for both cities in 2012 (Žilina) and in 2013 (Martin). The full database was completed by surveys at crossings and profiles in the same years. The results confirmed the noticeable ratio of transit, origin and destination transports on the main urban roads. There are many critical points and sections causing the queues.

Mobility and traffic counts surveys are an essential component of transport planning and modelling efforts. Standards for mobility surveys are non-existent, while those for any type of social survey are uncommon, and deal with only a few aspects of surveys. Evaluated results of household mobility survey have to be use like the demand inputs data for the calculation of trips generation.

The transport departments has several long-term proposals. These proposals doesn’t solve current problems during the peak hours. Both towns have worked on the strategic traffic plans. The results have shoved the critical points and causes. It were proposed complex solutions on the base of results after the first surveys phase.

The capacity analysis of Žilina and Martin road networks evaluated the degrees of saturation (volume capacity ratio). The intersections cause the main capacity problem of network. The wideness parameters of urban streets are sufficient.

The suitable propose of intersections (controlled intersection, roundabout, separated turn lanes) must be adequate for forecast traffic (20-years perspective). The Slovak Road Administration evaluated data from traffic counts and published grow coefficients split by region and a type of vehicle. The coefficients could be used only in intravila road sections. The forecast transport cannot be calculated by grow coefficients published in Slovak Road Administration in urban areas. The urban development is more dynamic. Mentioned factors have an influence on choice of method for calculation of transport relations in the cities. We have experiences with transport models which include a lot of important factors (demography, forecast number of jobs, degree of motorization, mobility, new investments …). The real problem is the filling of source data (input data).

4. Area traffic plans

The main document represented area traffic plan is the General Transport Plans – part of urban land-use planning. The General Transport Plan (GTP) is transportation planning documentation which presents a complex addressing of the transport system of a built-up area, in connection with its catchment territory. In recent times ever more emphasis has been placed on transport planning and its meaning as related to land-planning documentation. Large-scale investments which come into being do not impact only on the nearest vicinities, but often affect traffic over a wider territory. The construction of residential sets on the outskirts of towns has changed transportation relations – it is not exceptional for a family to have a number of automobiles, use of public transportation decreases continuously, gridlock situations begin to occur. For these reasons it is necessary to update or even recreate much of the land-planning documentation designed in the past.

4.1. Transport models

The transportation planning models of cities, districts, regions or countries are used for estimate the mobility. The transport model is defined more often as a requirement in the specifications of area traffic plans. The progress of the transportation forecasting method is faster than the application of changes in the established structures. Each one transport model defines not only solved area but it defines also the gravity area. The actual region transport models are in development. We have tried to find a right way to prepare transport forecasting process in cooperate with the interested parties.

The Czech company AF Cityplan s.r.o. has worked on the Slovakian transport model. The model has to contain the demand and assignment models in commitment to surrounding areas, countries. It will be multi modal system. Another large transport model is currently made for Bratislava. Model is created as a base tool for Bratislava traffic plan. There is a real example of possibility using the gathered data from other Austria – Slovakia transport model as part of the described project BRAWISIMO.

The transport model of Žilina district is the oldest transport model in Slovakia. The acquired experiences were applied in the transport forecast model of Žilina neighbor town – Martin. The Žilina and Martin transport models are created on the vector maps (S-JTSK: Geographic Coordinate Systems). The principles of the forecast transport demand
calculation have been similar. The assignment model was made in parallel with the demand model. The definition of transport zones is the first basic step which needs time and detailed knowledges about solved area. The official urban town zoning system were used. It includes the statistical area units. The special areas (shopping centers, university…) were defined as the independent zones. The Žilina model area includes 60 town zones and 58 extra-urban zones. The Martin model area includes 59 town zones and 24 extra-urban zones.

Table 1 presents the comparison of data from demand models. The Austria – Slovakia transport model used 5 person groups and 35 activity chains. Žilina and Martin demand model consisted from 7 person groups and 56 activity chains. The activity chains were evaluated from mobility surveys and recalculated to the demand model templates.

<table>
<thead>
<tr>
<th>Demand model</th>
<th>Demand stratum</th>
<th>Activity chains</th>
<th>Person groups</th>
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</thead>
<tbody>
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<td>Austria – Slovakia transport model</td>
<td>175</td>
<td>35</td>
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<tr>
<td>Žilina and Martin demand model</td>
<td>392</td>
<td>56</td>
<td>7</td>
</tr>
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The Figure 2 shows the examples of transport models of districts Martin, Žilina, basic transport model of Žilina self-governing region and the Austria – Slovakia transport model.

The calculation of demand transport relations is based on classic four step model (trips generation, trips distribution, modal split and assignment model). The source data are obtained mainly from the results of the mobility survey. The mobility survey describes transports habits of inhabitants and households. The quality of the sample will depends on the ability of the sampling frame to truly represent the population, and the extent to which the sample selection procedures result in a random selection from the sampling frame.

5. Data implementation

The calculation of demand transport relations is based on classic four step model (trips generation, trips distribution, modal split and assignment model). The source data are obtained mainly from the results of the mobility survey. The mobility survey describes transports habits of inhabitants and households. The quality of the sample will depends on the ability of the sampling frame to truly represent the population, and the extent to which the sample selection procedures result in a random selection from the sampling frame.
The quantity of data collected will be a function of the number of respondents in the final dataset and the amount of information obtained from each respondent. This, in itself, presents a trade-off situation because any attempt to collect more information from each respondent (beyond a threshold level of information) may result in less respondents responding. The number of trips between traffic zones is determined by combination of structural parameters and results from traffic surveys (mobility survey).

Generally the inhabitants are divided by the social and traffic impacts on the traffic process. The data from Statistical Office of the Slovak Republic use only basic dividing by social status (employed, unemployed, student,…). The calculation of the trip generation needs added traffic characteristics. We could compare only the percent ratio of employees (the sum of employees with and without car available) with the data from the Statistical Office. The household survey determined 52.33% of economic active inhabitants of Žilina city, the Statistical Office of the Slovak Republic published 48% ratio for the region of Žilina. The difference is acceptable but the detailed validation is impossible or inaccurate because of car ownership database. The traffic police database is the single way to separate economic activated inhabitants by car ownership. It is used for calibration of final results.

All of relevant data from the Statistical Office of the Slovak Republic are linked with the area unit. Transport forecasting requires the smallest unit – basic statistical unit. Generally the borders of statistical unit copied the borders of urban town zoning system. Some urban zone have different boundaries as the statistical zones. Figure 3 presents the example of the real discrepancy of the zones boundaries. The red zone (right) is the statistical zone. It tie the all statistical data. The white zone (left) is the urban zone with the diverging area. We founded five imported discrepancies (zones). The data were split by combination of number of inhabitants, number of shops, etc….

The sum of origin trips determines the transport production and the sum of destination trips determines the transport attractiveness. The amounts of the origin and destination trips are needed to distribute into the matrices by using transport modes or purpose of trips. The data from mobility survey or another sources cannot be used for direct calculations of the trips distribution. The data could be implemented to the demand model through the parameters setting. For example the impedance functions from mobility surveys determines the quality of trips relations in the Origin–Destination matrix (O-D matrix). The functions should include variables which measure differences in travel resistance. The assignment model calculates the basic distance matrix which is used for the trip distribution calculation.

The Fig. 4 presents different impedance functions by daily using of transport mode. The data was gathered in Žilina and Martin town. The results show the similar proportion. The traffic peak is shifted to 16 hours in Žilina (total trips) compared to Martin. These different is caused by different geographic structure of the road network. The accessibility of the Žilina center or the attractive traffic zones is better after decrease of origin and destination traffic.
The complexly set of impedance functions were defined in the dissertation report by Ripka. He summed up the data and implemented them to the real numbers. The example of the impedance functions for rural settlement (less than 5000 inhabitants) are showed in the next picture.

Fig. 4. The comparison of the daily functions of trips multiplicity of two Slovak districts (Žilina a Martin).

Fig. 5. An example of impedance functions.
5.1. Forecasted input data

The geographic position, speed of development affect the transport forecast. The model maker has to include the evaluation of the mortality, immigration and birthrate (all of the available forecast data) to the demand model. The municipalities must provide the real transport studies of selected subareas.

The real experiences show on the seriously discrepancies between real demographer data and the town expected vision. The town vision expresses more the potential of town (132 000 inhabitants in Žilina) as the real state (112000 inhabitants).

Next part of article describes the solution of the forecast private and public transport ratio in Žilina and Martin districts. Current decreasing trend of public transport using cannot be accepted. We calculated with two scenarios

- Scenario A – the public transport will provide the minimal service of the town.
- Scenario B – the private and public ratio will be balanced.

The next steps leads to exclusion one of the scenarios. The forecast of high sharing of private transport was unacceptable. The scenario B calculated with the ratio between the individual automobile transport and other transport 37/63 and the ratio between the individual automobile transport and public transport 56/64. Planned ratio is not optimal for urban trends or for town with 100 000 inhabitants in scenario B. In spite of all, the scenario B represents the real town condition and specifies the real objective.

The data for Martin demand model was split into two groups: potential and real development. The municipality calculated with their own growth – 70 000 inhabitants. Martin has around 60 000 inhabitants currently. The conclusions of the demographic study predicted the decreases of number of inhabitants – 53 000. There are only 5 small villages where the number of inhabitants will rise – but not markedly. The calculation scenario for demand model contained the combination between potential and real development (63 000 inhabitants).

6. Conclusion

The process of data gathering is a challenge for every transport departments. Socio-transport characteristics have to represent inhabitants living in solved area. The article described the possibilities of data gathering and their implementation to the transport forecast process or to the transport demand model. The incorporation of transport model to the transport area plans is the basic and main condition. The modern methods of transport forecast calculations are overpriced. The demands for data gathering, software tools are expensive especially for small towns. The creation of macroscopic models (regions, countries) is a need. Mentioned models can describe the transit, origin and destination transport relations. The districts models could reduce a final cost of transport forecast using existing databases with the predefined structures. The practical experiences have shoved on the duplications or lack of several needed surveys.

The main disadvantage of modern transport forecast methods is a professionalism of the processor. The hidden mistakes could depreciate the transport forecast. In that case we could name the incorrect way of transport forecast calculation – targeted transport forecast.

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References

Blanárová, T. Ing., General Transport Plans – part of urban land-use planning, Urbanita, 10. 2010.
D8 ETISplus Final Report, April 2014, Call Identify FP7-SST-2008-TREN-1.
Drliešák, M., Transport forecasting in Slovak regions, XXIV R-S-P seminar, Theoretical Foundation of Civil Engineering (24RSP) (TFoCE 2015).


Riegler S., How to use the BRAWISIMO database for analysis purpose, conference MOBILITA 15, June 25, STU Bratislava.

Ripka, I., The definition of impedance functions for transport relations forecast (Stanovenie odporových funkcí pri prognózovaní medzioblastných vzťahov), dissertation report, Žilina, 2011.

Ripka, I., Ivanko, J., Improvements of the transport model for the Twin-City region (VKM SK-AT) using BRAWISIMO data, conference MOBILITA 15, June 25, STU Bratislava.

Supplementary Guidance, Bespoke mode choice models, Department for transport, Transport analysis Guidance (TAG), January 2014.


The Slovak Road Administration portal, Road Databank.

The Statistic Office of the Slovak Republic portal, Databases- DATAcube.

The Statistic Office of the Slovak Republic portal, Demography and social statistics.