Analysis of traffic accessibility of employers

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INTRODUCTION

The analysis and description of traffic accessibility have both a significant impact in private decision of migrating people as well as in decision taking for new investments where the placement of new facility depends on relative advantageousness of location. The traffic accessibility of basic services like job, education, health, culture, administration has to be assured on satisfactory level and local/central governments support public transport appropriate way what is connected with non-neglected requests to their budgets. Insufficient level of traffic accessibility of employers could be accompanied by higher level of unemployment, notable in certain professions with low income.

Analyses of traffic accessibility are usually based on data collected during census. Nevertheless its results for commuting are published with remarkable delaying. Monitoring campaign organised by specialised companies represents other possibility, but the cost of such statistical campaign is relatively high. The other possibility is the application of network analysis in the environment of geographic information systems for evaluation non-public individual transport. For evaluation of transport accessibility using public transport means, the analysis of time schedules can be applied. It is possible to evaluate existing public transport connections, analyse selected conditions, evaluate real costs of commuting, evaluate conditions of commuting like number and waiting time for changing and apply Monte Carlo simulation approach to evaluate not only average conditions but also the range of commuting conditions. Very important is comparison with labour market situation.

METHODS OF TRAFFIC ACCESSIBILITY EVALUATION

One of the many references to the practical providing of accessibility analysis (e.g. Burrough, 1998) similarly documents the analysis of car ambulance accessibility (limit is the time of the arrival: 9 minutes), but also the working place accessibility in the western part of Netherlands expressed by transport time by means of individual automobile and also the public transport. The comparison of public and bus transport accessibility associated with the censure of gravity model and exploitation of GIS environment (e.g. Hansen, 1996).

For traffic accessibility studies following main tools we use:

- analysis of census results
- network analysis
- analysis of time schedule of public transport

Other possibilities are survey, territorial monitoring, survey, territorial monitoring and socioeconomical models (e.g. gravity model, regression model). The presented methods were applied and tested for Bruntal district in the Czech republic. The traffic accessibility was studied from the point of view of commuting to work and the comparison with the situation on labour market was undertaken.

Ad 1. Analysis of census results

Analyses of traffic accessibility are usually based on data collected during census. The census represents an important source of information essential for various analyses and evaluations. The statistics is organised according sex, age, main economical sectors, frequency of commuting and time spent by commuting (in categories).

Unfortunately, censuses are organised with 10 years interval and its results for commuting are published with remarkable delaying - e.g. in the Czech republic usually more than 2 years. For part of application where the evaluation of current situation is crucial, it is insufficient. The data cannot reflect the changes of employment structure and commuting destinations in connection with the change of employers, whether it concerns their location change or orientation or even their existence.

Also the results are processed usually to a quite rough form, the documented time of commuting are classified by 15-30 minutes steps and, in particular, this time does not distinguish between the walk time and transport time, commuting to work and commuting to education etc. It is also necessary to notice that the persons, that commuted from present residences to the work or school another way than daily, have stated in questionnaire screening the time of daily commuting from the location of their alternative accommodation to work or school (e.g. Horák, 2004). This fact complicates evaluating of data processing. We cannot be sure that the stated time corresponds to the commuting from the present residence location (that is known) or from the alternative accommodation which location is not known.

For determination of the destination for commuting can be used several methods:

- guessing of destination on the basis of results of territorial monitoring (by specialized companies or some transport providers follow the frequency of travellers on links
- assignment of destination on the basis of census results

- expert assignment on the basis of database of firms (e.g. from labour office or from different firm catalogs)

In this study the destination for commuting was specified according location of important employers which were identified in collaboration with local labour office. There have been chosen the employers employing of 50 and more employees. Thanks to the boundary and mountain character of the region, the employers of the neighbouring regions were not included into the processing.

The example of census data processing is on the figure 1.

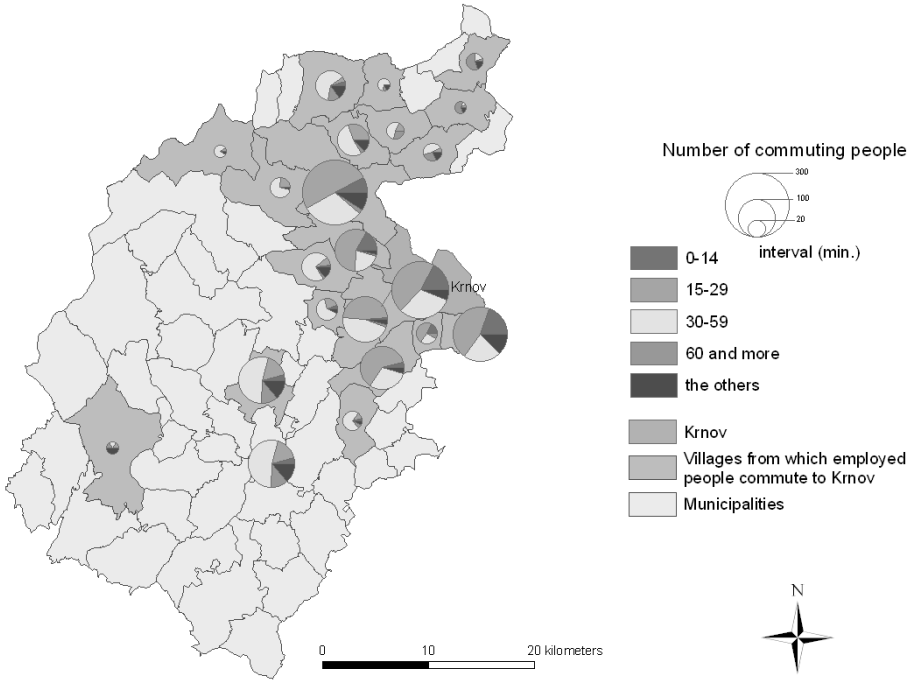


Figure 1 Commuting to work with destination of Krnov town (according to the Census 2001)

The selection of destinations was validated by comparison with results of Census 2001. It was proved that the order of destinations according census results highly correlates with the order of employers according the number of staff. Spearman coefficient of correlation reached 0.7. Regarding the existing limitations it is possible to consider the results to be satisfactory.

It is possible to evaluate positively the reality that besides the municipalities scheduled in the last and next to the last place there were identified all of the municipalities with the significant destination of the commuting to work from the evidences of the labour offices.

Ad 2. Network analysis

The transport situation has been transformed into topological correct network (graph). It represents a model where every segment can be evaluated appropriate way (time, velocity, conditions, etc.) and utilised in network algorithms based on the graph theory. Network analysis was applied to find the best route between two nodes. In GIS, due to automation of processes, it is able to calculate all combination for commuting between nodes which cover all settlement and all destination locations in the area (the resolution of node locations should be satisfactory in respect to acceptable walking distance), evaluate all routes and analyse the traffic accessibility of any location by individual transport means (e.g. Horák, 2005).

It is evident that the analysis results are not influenced by the algorithm type selection but above all by the adequacy of prepared network model. All of the significant transport flow lines have to be included in the model. It is not simple to designate which flow lines may have significant influence on the model above all in the case of towns and agglomerations. Then there is necessary to define the connection limits (e.g. one way streets) and above all to set up the impedance of individual network segments properly (generally the time needed to go through the segment). As well, there is commonly used the time allocation according to the speed, designated to the whole class of given type of communication. But it happens here to the greatest deviation from reality and it is possible do declare, that it is only hard to set up the model this way. It is possible to achieve better results by individual segments calibration according to the real travel time between 2 places. Above all the databases of transport providers can serve as a data source but also the timetable analyses or the census results. Of course there also remain certain model limits, given by the accepted assumptions such as the constant speed on the given road segment, there are not considered neither the meteorological conditions nor traffic density (e.g. Horák, 2005).

While processing the network analysis for the surveyed territory it has been evaluated the transport service of the significant employers by means of number of municipalities from which it is possible to commute to the employers. This indicator controls the catchment area of the individual employers and so the advantage in view of their accessibility to the potential employees (figure 2).

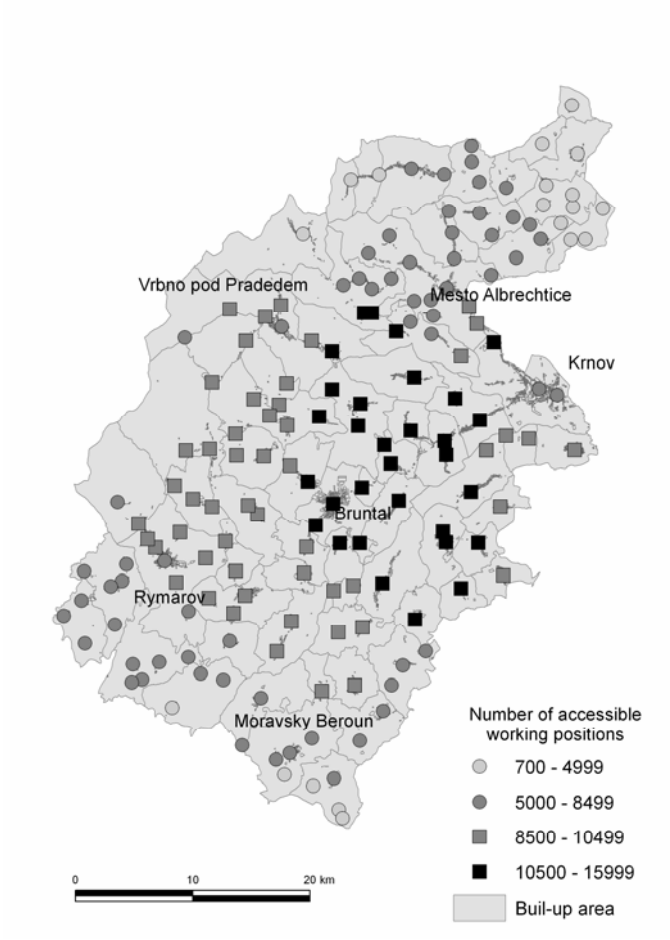


Figure 2 The number of working positions by the significant employers accessible by individual transport

Ad 3. Analysis of time schedule of public transport

For evaluation of transport accessibility using public transport means the analysis of time schedules can be applied. For these purposes it is necessary to prepare the program application, able to process thousands of requests for commuting. We utilised DOK programme which is tailored for searching in time schedule IDOS (application for travel connection searching). The programme opens the database, where the user inputs the input parameters of the searched connections. DOK reads the database and as soon as it reaches the demand that has not been searched yet it reads its input parameters that than inserts into users' interface of the IDOS application and starts the connection searching. As soon as the IDOS finds the connection, DOK lets the found connection save into the text file then identifies the parameters of found connection. It saves the results of this processing into the database. Created database can be easily next processed and evaluated.

The main advantages of such approach can be seen in:

- evaluation of existing (or planning) public transport connections
- extended processing of thousands of commuting requests with automation of result evaluation
- analysis for selected conditions (e.g. commuting in the specific time)
- evaluation of real costs of commuting
- evaluation of conditions of commuting like number and waiting time for changing
- possibility to apply Monte Carlo simulation approach to evaluate not only average conditions but also the range of commuting conditions (which can be next utilised with probabilistic approach or bulk service approach)
- low cost of analysis
- reiteration in any time

The weakness of this method can be found in the need of appropriate parameters setting (parameters for commuting like requested time of departure or arrival - it can be overcome by simulation approach), appropriate evaluation of results (evaluation of different parameters of found connections), selection of probable commuting destinations.

The analyses of time schedules were provided for various parameters setting and results were compared. Commuting for 3 work shifts were tested (1st work shift with 3 possible starting time), in all cases 15 minutes before the beginning of working time was the latest time of arrival and similar appropriate time interval after finishing working time was set. Any transport to work was linked with probable transport from work – only these coupled connections were evaluated. This condition assures the transport of employee from his/her residence to a workplace and after work time back home.

The public transport in this region uses both the train and bus traffic. Both of the types of transport including the eventuality of transport means change, have been considered while searching the connections.

It has been controlled the commuting from 153 municipalities parts to 35 parts of the municipalities, where the significant employers reside. As a suitable territorial entity it has been chosen the part of municipality which corresponds to pedestrian mobility within this territory in local conditions. This is question of small territorial entities, whose distance is approximately 2 kilometers from each other. This decision appears as a suitable compromise among the municipality level and individual traffic pick-up points (which bring problems not only because of the processing demandingness, but also because of problems in evaluating the results, because some of the transport connections do not stop at all of the pick-up points and so the 2 neighbouring pick-up points may be evaluated very different from the view of their accessibility). By each part of the municipality there has been chosen the representative public transport pick-up point from which is the public transport brought into effect (e.g. Horak, 2004).

The commuting has been controlled on two levels – as the suitable commuting and theoretical commuting. In the case of the theoretical commuting, there is possible the longer travel time and sooner departure than in the case of suitable commuting. The local situation was mapped and evaluated (figure 3).

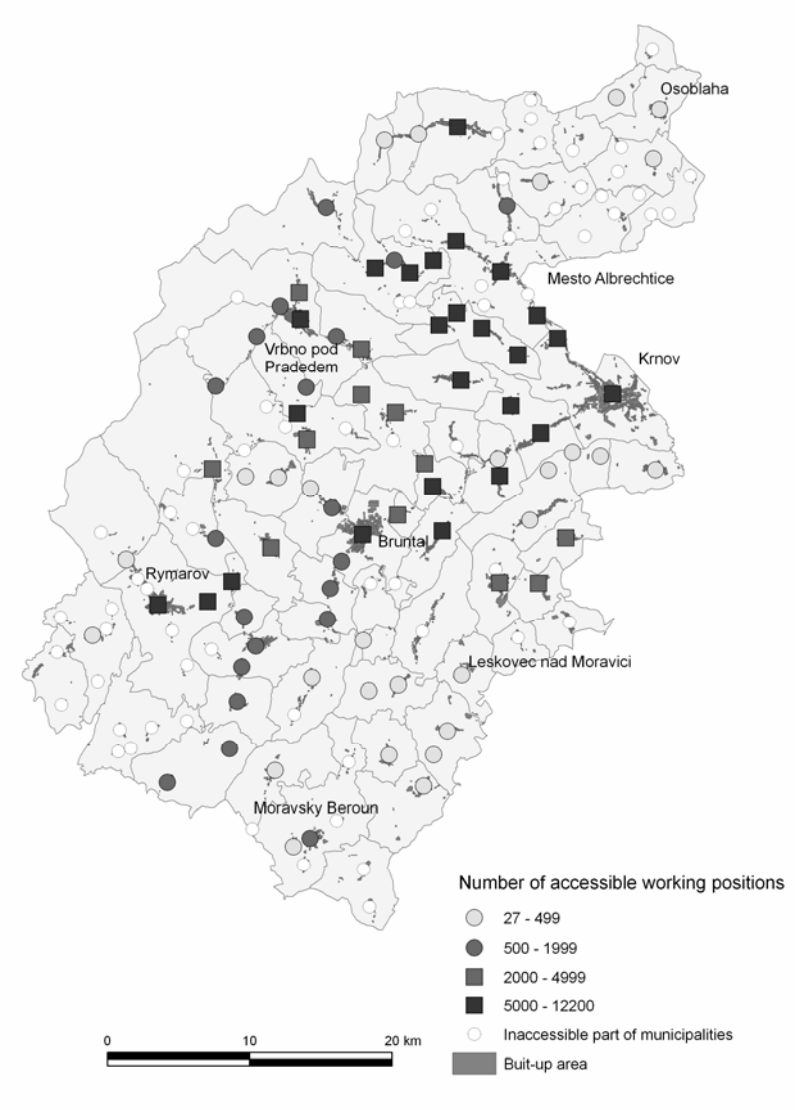


Figure 3 The number of work locations accessible suitable way by the public transport to the working hours beginning at 8: 00 a.m.

By the timetable analysis, there appears problem with correct parameter setting of searched connections, e.g. time of departure, arrival, selected connection limitations when the price or distance is abnormal. It is possible to use also the simulation access to the connection selection by the municipality transport accessibility analysis (e.g. Sedenkova, 2005).

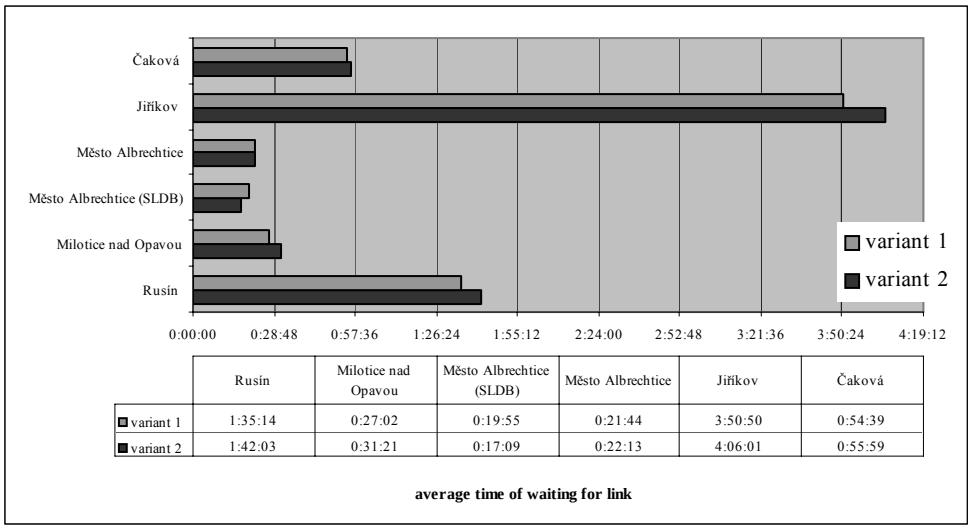
Main goal of this evaluation was to accomplish the simulation of departure times from 5 selected municipal parts to nearest parts of municipalities where the significant employers reside and to evaluate the transport service of given municipal parts by means of public transport.

The transport demands distribution has been simulated according to the expert assessment of transport demands frequency that clearly shows the main morning rush hour and secondary rush hour in the afternoon. At last there has been realised random selection of the departure time according to this distribution.

The drive destination has not been chosen randomly, but according to nearest significant employers. There has also been alternatively tested the arrival according to results of census. For the given municipality are the departure demands divided in proportion to the number of workers of significant employers in the destination or according to dimension of the arrival flow in case of census. Each municipality has been processed by two alternatives.

There have been chosen the nearby train or bus departures to the individual links from selected municipality to the final destination to the simulated times. In the case, when two traffic channels depart at the same time, the one with that arrives sooner to the employer part of the municipalities will be preferred. In the following there were preferred links with minimum price.

For visualization were used graphs, cartodiagrams, line cartodiagrams or 3D vizualization.



	Rusín	Milotice nad Opavou	Město Albrechtice (SLDB)	Město Albrechtice	Jiříkov	Čaková
variant 1	1:35:14	0:27:02	0:19:55	0:21:44	3:50:50	0:54:39
variant 2	1:42:03	0:31:21	0:17:09	0:22:13	4:06:01	0:55:59

average time of waiting for link

Figure 4

Comparison of average waiting time for link

COMPARISON BETWEEN METHODS

The results from each applied methods (census analysis, network analysis for individual transport and analysis of time schedules for public transport) were compared and evaluated.

By the timetable analysis were found the suitable accessible municipalities but to those is not any commuting performed according to the Census 2001. By some of the municipalities prevails strong influence of other municipalities by others the small number of economic-active inhabitants or in the municipality reside significant employers and that is why is not necessary to commute to work. The contrary case shows that the transport is being realised individually without any usage of public transport.

By the comparison of the network analysis and the timetable analysis it appeared that the territory accessible by individual transport is higher - as it has been expected. If we would not count in the vehicle amortisation, would the individual transport be more suitable from the view of shorter distances travelling cost (app. 10 km). Of course the travelling time is in most of cases shorter (the exemption is e.g. train transport on more suitable corridor).

RECOMMENDATION

After evaluation of many variants (various indicators, time schedules for 2 years, conditions for individual lower income professions etc.) we recommend:

- to evaluate the theoretical commuting (that with the free conditions of arrival), but the suitable commuting, limited by certain settings (recommended parameters, see the tab. No. 1).
- it is not needed to repeat the analysis for any possible starting time it is enough to use only 1 or 2 times (for the recommended travelling parameters see the table below)

- as the most suitable indicator of controlling the accessibility of municipality from the view of commuting to work "the number of accessible work positions at significant employers by commuting to 6:00 a.m.". When the details on employees' number are not available, we advise to use "the number of significant employers by commuting to 6:00 a.m."
- the inter-annual changes in public transport do not influence created model in principal that is why it is not evidently important to do the analysis of accessibility of significant employers by means of public transport repeatedly in case of slight changes of timetables.

	to 6:00 a.m. and back	**to 8:00 a.m. and back**	**to 2:00 p.m. and back**	**to 10:00 p.m. and back**
Arrival	5:15 – 5:45a.m.	7:15 – 7:45a.m.	1:15 – 1:45p.m.	9:15 – 9:45p.m.
Departure	2:45 – 3:15p.m	4:45 – 5:15p.m.	10:15- 10:45p.m.	6:15 –6:45a.m.
Travelling time	max. 60 minutes			

Table 1 Recommended parameters of suitable commuting

COMPARISON WITH LABOUR MARKET SITUATION

Relationship between number of available working positions at important employers and all indicators that give characterization of labour market was undertaken. It was found out that the relevant criteria – Spearman coefficient of correlation – do not show any dependence of listed indicators to the number of available working positions. There have been used 5 indicators of unemployment on the basis of made factor and multiple criteria analysis to the labour market situation characteristics (e.g. Horák, 2004):

- Rate of unemployment (RU)
- Share of unemployed required primarily the lowest qualification job on a total number of unemployed (PCKZAM9_U)
- Share of unemployed with primary education level on a total number of unemployed (PCVABC_U)
- Share of long-term unemployed (more than 1 year) on a total number of unemployed (PCE12_U)
- Share of unemployed older than 50 years on a total number of unemployed (PC5099_U)

All results of transport accessibility comparison of both the individual transport and public transport with the unemployment level show that there are no significant relationships to the situation on labour market in existing transport situation of this area (see table 2).

Indicator	**Spearman coefficient of correlation**		
	Individual transport	**Public transport**	
		6:00 a.m.	**8:00 a.m.**
UR	0,17	0,11	-0,05
PCKZAM9_U	-0,05	-0,05	-0,15
PCVABC_U	-0,05	0,02	-0,17
PCE12_U	-0,05	0,13	-0,04
PC5099_U	-0,05	0,07	0,01

Table 2 Spearman coefficient of correlation

CONCLUSION

The results present that it is possible to use the mentioned variants of employers' transport accessibility evaluation. Over the course of processing it has been proposed the whole range of recommendations to perform such analyses. We advise to calibrate the models of individual connections (personal transport) by exploitation of relationships of available data from the census (if it is not too obsolete and the situation has not changed obviously) and data of public transport and connections. The simulation approach to the link selection (on the basis of transport demands distribution) can be used to remove the problems with setting the parameters of searched connections.

The results may be used at labour offices by the assessment of commuting conditions and decision making of financial support of commuting to the employer, than by evaluating the level of transport service provision in individual municipalities with the consequences on decision making of support and transport service provision.

Not including into the processing the employers of the neighbouring regions have a influence on the worse traffic accessibility of municipalities near the boundary so it is necessary to include them to process. So is very important to determine the destinations of commute and which organization will be include into the processing.

ACKNOWLEDGMENTS

The project was supported by the Grant Agency of the Czech Republic ("Labour Market Modelling Using Geoinformation Technologies", GA 402/02/0855, available on http://gis.vsb.cz/gacr_mtp/) and by the internal grants of VSB-Technical University Ostrava ("Simulative Approach for Evaluation of Traffic Accessibility on Example of Commuting" and "Identification and evaluation of commuting destinations for study of traffic accessibility of working positions").

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