Marian GOGOLA

THE TRANSPORT MODELLING
IN THE CITY OF ZILINA

Abstract
The city of Zilina is a good example of evolution of the traffic in post-communist country. The years when the biggest share of modal split was represented by public transport are away and in current time the traffic in the city is facing to the same problems as in western EU countries. For European cities is common to have own transport model and evaluate future scenario. For the analyzing and evaluation of transport as a complex system, the Zilina Transport Model has been used. The main reason why such kind of transport model is used is related to the fact that after years of changes, the city becomes an interesting place for developers and investors who came to the city. But together with new development came also new problems as increasing of car using, congestion, decreasing of the level of service on roads, reduction of PT usage, problems with parking, etc. The modelling has pointed on a various problems which are caused by wrong approach in land-use resulting from not respecting the basic principles of urban and transport planning, absence of systematic approach of parking and using the alternative means of transport.

INTRODUCTION
In recent years the land use changes were evident. The main problem of cities as Zilina is the fact that the politics have worked mainly on the improving the economical level, standard of living, looking for investors, etc. Moreover the economists presented the forecasting of economical impact [12], but they forgot to prepared the transport infrastructure of our cities or change the concepts of transport management. Now we are surprised we are living in the same transport problems as in Western - European countries as congestion, problems of parking, etc. For policy makers the linkage between transport and investments [1] is often missing. The main issue for city of Zilina, with population of 85 thousand, consists in the fact that there are presented the serious problems with transport, traffic and land – use. The city represents the important junction which connects transport infrastructure in the North – South and East – Western direction. In the past there was no evidence for using or developing city transport model in Zilina. Therefore the task for modelling [2] was to find out the objective reasons and provide the adequate solution for municipality which is criticized from not satisfied citizens who perceive the quality of urban life. A various transport model [7] techniques have been reviewed. Therefore the task for transport model can be in providing the information about social support for transport policy measures as already presented in [4]. The usage of transport models has a long tradition [9,10]. The area or modelling detail varies from city level [11, 13, 14] to national level [8].
1. THE TRANSPORT MODELLING APPROACH

The city of Zilina has decided to change the problematic situation and it started to solve the traffic problems in systematic way. Therefore the city transport model (ZTM) has been developed. ZTM is an integrated multimodal model which allows a modelling of traffic, urban environment, land – use and the interaction among them. The city in model is divided into 120 zones and 378 subzones. The model allows also various level of modelling. The old data sets it is only possible compare in aggregate way, but current data sets is possible model with disaggregate approach. Most travel demand models account for mode and route shifts associated with induced travel, but many do not account for other induced travel effects such as changes in land use, number of trips, destination choice, and departure time choice. The representation of induced travel effects in travel demand modelling is critical to the accurate evaluation of road and public transport alternatives. For that reason ZTM allows the dynamic transport planning with gravity model. Dynamic gravity model which already has proved its function [5] is suitable for modelling various socio-economic groups and various modes within time. The OD matrices of socio – groups are possible to assign on the network according the various transport mode. The input data represents the statistical data in evidence of municipality, offices, transport companies and surveys. The model also works with survey data which represent the intensity, direction, socio economical classes, etc. The problems with historical data sets consist in „level of detail” and therefore it is not possible to compare all parameters from past to actual time. Especially the method of daily travel diary and first travel pattern is suitable for aggregate transport model.

Moreover the transport model is based on real data and it represents the real status of transport infrastructure, see Fig. 1.

Fig. 1. The ZTM transport infrastructure

2. LAND – USE DEVELOPMENT AND IMPACT ON THE TRAFFIC

ZTM pays attention to analysing of zone, therefore each zone has been analysed with the respect to the land – use and compared to the historical data and especially for new complexes. That means that model evaluates the generation and attraction, type of land – use. For this reason a multisource inputs have been used. The input data are coming from the various resources which make important and more realistic the whole transport modelling process.
The modelling approach consists of calculating the production and attraction for each zone. Then the skim matrices are created. The citizens are divided into subgroups and they are assigning on the network based on time demand and also based on transport means that is used. To take into account the difference among travel groups and transport means, the simultaneous gravity model is used. In comparison with common gravity model [6] the simultaneous model [15] distinguishes between user groups can be built more specifically by making this classification for either the Productions or Attractions. If a classification according to ownership is made at the Attractions, the model uses the formulas (1-3):

\[ T_{ijvg} = \rho \cdot Q_i \cdot X_{ijvg} \cdot F(z_{ijvg}) \]  
\[ \sum_g \sum_v \sum_i T_{ijvg} = A_j \]  
\[ \sum_v \sum_j T_{ijvg} = V_{ig} \]

where:
\( \rho \) = the scaling factor
\( T_{ijvg} \) = the number of trips from zone i to zone j by mode v for group g
\( A \) – the number of attractions at zone j
\( V \) – is the number of productions for zone i for group g
\( Q \) – row balancing factors
\( X \) – column balancing factors
\( F(z) \) = the distribution function, describing the extent to which people are willing to make a trip with a particular impedance z. The distribution function is specified for each mode/user combination.
\( Z_{ij} \) – the cost impedance between zone i and zone j for mode v.

From this, it is easy to deduce the formulas needed to make a classification into groups based on Productions. The general condition for gravity model states that the number of trips from origin equals to number of trips between origin and destination. Based on this condition, the iteration in multiple steps is run. Very important and useful information can be provided by the dynamic features of ZTM. This feature use the time sequences (periods) which represent the single traffic intensity of traffic. The Figures 2 shows the comparison of period 126.

Fig. 2. Dynamic modelling in period 126
The dynamic modelling is suitable for analysis of traffic impact (i.e. new complexes) in land use planning. At the current time, the data for trip generation are divided according to land-use urban types: Housing, Education, Offices, Shopping, Relax, Cultural, Sport and Entertainment. Moreover, the relationship between land-use factors has been evaluated and further analysed. For illustration, in the last 20 years, there have been more than 50 big new sites that will influence trip generation and attraction. The comparison of old existing commercial areas (green) and new ones (red) shows Fig. 3.

Fig. 3. The comparison of development commercial areas 1980-2010 (green – old, red – new)

The large areas of shopping centres are also situated between the centre and housing sites. In afternoon peak, it is significant that the people who are coming back to their home are facing the people who are coming to these shopping areas. In these parts of infrastructure, the roads have full capacity. The LOS on these roads is critical and reaches the level D, E, F. These problems don’t cause only traffic but also environmental issues with increasing emission. But this is not only problem of traffic volume but also problem of signal timing on junction, where there is an absence of signal coordination. The city of Zilina has advantage and disadvantage that is situated on the very important transport junction. The main disadvantage from the transit point of view is that the highways end in the western part of the city and then continues in the city transport network.

There are also different modal splits for socio-economic groups as employees, children, students, pensioners. In general, the households which own the car and use it, will not change the means of transport, especially when they members moved from using PT. For example, you can see the Fig. 4 where is shown the comparison of modal split among particular socio-economic groups. The negative trend shows that the number of children who travel with parents by car. Problem with children is that they don’t use bicycles at all and potentially they are becoming dependent from cars. The PT use mainly for travelling the students and pensioners.
3. THE PUBLIC TRANSPORT ISSUE

The PT network in general is very good. But the evaluation based only on network analysis will be not successful, because it is misleading. For that reason we need to analyse a PT service within time and frequency. The time approach has several advantages. The time analysis provides the information about real provided PT service. That means we can evaluate how passengers or citizens can have an access to PT. This time analysis is based on comparison of the passengers travel purposes and the time availability of PT service. The main groups of PT passengers are represented by students, pensioners and employers. In recent years is significant the decreasing trend of PT usage, see Fig. 5. In comparison between year 1999 and 2009, you can see more than 77 % decreasing. For the year 2012 is estimated to decreasing around 2050 passenger per year in comparison to year 2009. The forecast has been made based on the Quality PT Passenger Survey with the aim to find out how are citizens satisfied with PT and what kind of factors can influent the usage of PT in the future. The results have showed that due to fact, there is not present the PT preference, the usage of PT will continue in decreasing trend.

In addition, in forecasting were implemented the historical parameters which were implemented with the help of multi-regression analysis. The analysis showed also how can bad rerouting caused the reduction of passenger. The explanation is simple. The PT operator changed the PT line routing with optimisation mainly based on operation cost. The rerouting was made on the reduction of long PT lines that connected the various sites of city but without consideration of OD matrices. The new organisation of PT service consisted in shorter lines with higher frequency of connection.

But the problem was that the passengers were forced to change the PT line in order to reach their destination. And for the small city as Zilina is, this represented the basic mistake in the planning and routing of PT. The comparison of the travel time has showed that such kind optimisation leads to the decreasing of passenger, because their travel time has increased.
Such kind of dependency is already state in [3]. City of Zilina is small city and to force passenger to change PT lines is not good way how to solve problem.

Another problem is caused by the fact that PT vehicles share the same infrastructure as the other traffic. That means during the peak they are stopping in the traffic jams.

For the improvement of PT have been developed the various scenarios. One is related to the building and marking separated bus lanes within centre. But this scenario needs the change in direction of transport infrastructure and creation of one-way routing. When this measure will be applied, the city has to change also the systematic policy of accessibility of individual car to the centre. But the benefit of this measure will improve the inner city traffic situation (traffic capacity, environmental impacts, etc.).

The modelling issue has been also focused on the way how to manage or decrease the negative mobility trends that are presented by the increasing volume of car usage. As an answer the ecological concepts has been analysed. These ecological concepts are represented by cycling and walking. The potential of cycling usage is quiet high, but there exist some obstacle for example in the form of inadequate transport infrastructure for cycling.

**CONCLUSION**

This paper discusses the topics of application of the Zilina Transport Model in order to analyse the urban environment where the relationship to land-use changes were described. The using of transport model in order to evaluate the future transport or traffic impact in demand is not quite common in the current time in Slovak republic. The hard task will be in conviction of decision or policy makers to use the transport model in all prepared land-use changes or transport strategies in order to see how can be impact in traffic condition, accessibility of city, etc. At the current time the traffic situation in city of Zilina is bad what is caused on the one side by the non respecting the limitation of solved area and on the other hand by the wrong evaluation of future impacts. With the help of ZTM is possible to evaluate the traffic impacts in land-use and also analyse the future changes or measures.

**REFERENCES**

10. Chicago area transport study. CATS 2000, USA.

**Autor:** Ing. PhD. Marian Gogola – Žilinská univerzita v Žiline