Proceedings of the 10th International Conference "Reliability and Statistics in Transportation and Communication" (RelStat'10), 20–23 October 2010, Riga, Latvia, p. 97-103. ISBN 978-9984-818-34-4
Transport and Telecommunication Institute, Lomonosova 1, LV-1019, Riga, Latvia

QUANTIFICATION AND TRENDS IN TRANSPORT REQUIREMENTS BY TRANSPORT INDICATORS

Jana Dicová[1], Ján Ondruš[2]

[1]University of Zilina in Zilina, Faculty of Management Science and Informatics
SLOVAKIA; 010 26 Žilina, Univerzitná 8215/1
Phone: +421 415 134 077, E-mail:Jana.Dicova@fri.uniza.sk

[2]University of Zilina in Zilina, Faculty of Operation and Economics of Transport and Communications,
SLOVAKIA; 010 26 Žilina, Univerzitná 8215/1
Phone: +421 415 133 526, E-mail: Jan.Ondrus@fpedas.uniza.sk

The basic aim of managers in transport is to preserve and expand their share of the transport market. This should be done through prioritising quality and customer service, preservation and expansion field of transport enterprise activity to transport market on the basic of priority orientation to quality and customer, maintaining transport networks and applying the latest knowledge from research. It should also involve making a contribution to favourable indicators of economic activity, and a consideration of environmental change. This paper deals with customer requirements, the possibility of quantifying customer requirements and the recognition of future trends on the basis of assessments of recent quantitative results and the application of managers' knowledge and techniques.

Keywords: *Transport, Customer, Mass Public Transport (MPT), Methods*

1. Introduction

Transport is a phenomenon that consists of a large number of successive sub-events forming a complex whole. Human activities are always key to this activity, because transport (except for planning, design, organization, management) involves controlling the movement of vehicles in space and time. [3]

The competitiveness of a service provided by a transport enterprise is likely to improve if the enterprise is interested in meeting basic customer needs regarding safety, quality, reliability and cost. For this reason it is important that the carrier should concentrate on the continuous monitoring of customers' requirements and indicators of transport performance at and between different locations.

2. Quantified Performance of Mass Public Transport (MPT)

Passenger transport is a necessary consequence of the spatial distribution of activities and a consequence of the adoption, use and settlement of the development environment. Passenger transport enables vital communication links generated by the interaction of the basic functions of the city (residence, workplace, cultural centre) to be maintained. [2]

The transport requirements of the population have significant effects on the way people live. The function of public transport is to provide transport connections to meet public demand as far as is practicable. At the same time, it is important that public transport organisations should be as efficient as possible to limit the demand for regional resources. [6]

The quantification of customers' requirements in regard to transport processes can be realised by transport indicators (number of passengers and transport performance). Trends can be identified by the progression of indicators that change with respect to time function and dependence on parameters. These represent trend tendencies.

The Slovak Republic can be divided into the following regions:

= Bratislava district,
= Trnava district,
= Trencin district,
= Nitra district,

= Zilina district
= Banska Bystrica district,
= Kosice district,
= Presov district.

The trend regarding the number of passengers in several districts of the Slovak Republic for the period 2001-2008 is shown in Table 1. From a long-term perspective, the trend in the number of passengers shows a decrease every year for every district, with the exception of the Trencin district in the year 2005 and the Nitra district in the year 2008.

Table 1. Number of Passengers in the Enterprises which are Specialized in Road Transport (Thousands of Passengers)

District	*Number of passengers (thousands of passengers)*							
	2001	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*
Bratislava	22 743	22 549	20 220	19 014	18 229	17 658	17 094	16 934
Trnava	47 832	45 047	40 354	37 772	37 549	36 783	35 145	33 071
Trencin	95 495	90 024	81 651	77 397	85 019	65 209	62 301	59 151
Nitra	85 399	75 503	65 293	62 815	61 436	58 066	58 101	60 106
Zilina	89 076	86 408	79 103	73 437	69 187	66 704	62 926	58 975
Banska Bystrica	104 041	98 533	95 775	87 886	79 999	63 824	59 487	53 745
Kosice	52 895	49 858	45 501	42 621	41 219	41 657	40 488	37 667
Presov	68 964	68 691	65 809	60 830	56 818	53 369	49 095	45 870
Total	***566 445***	***536 613***	***493 706***	***461 772***	***449 456***	***403 270***	***384 637***	***365 519***

Source: The Statistical Office of the SR

The greatest decrease in the of number of passengers was in Banska Bystrica district. There was a decrease in the number of passengers over the period from 104 041 thousand passengers to 53 745 thousand passengers. This is a substantial (48.3%) decrease between the years 2001 and 2008. Conversely, the lowest decrease in the number of passengers was in Bratislava district, (25.5 %) from 22 743 thousand passengers in 2001 to 16 934 thousand passengers in 2008. The average decrease in the number of passengers for all the districts during the period 2001-2008 is 35.5 %: from 566 445 thousand passengers in 2001 to 365 519 thousand passengers in 2008 (Fig. 1).

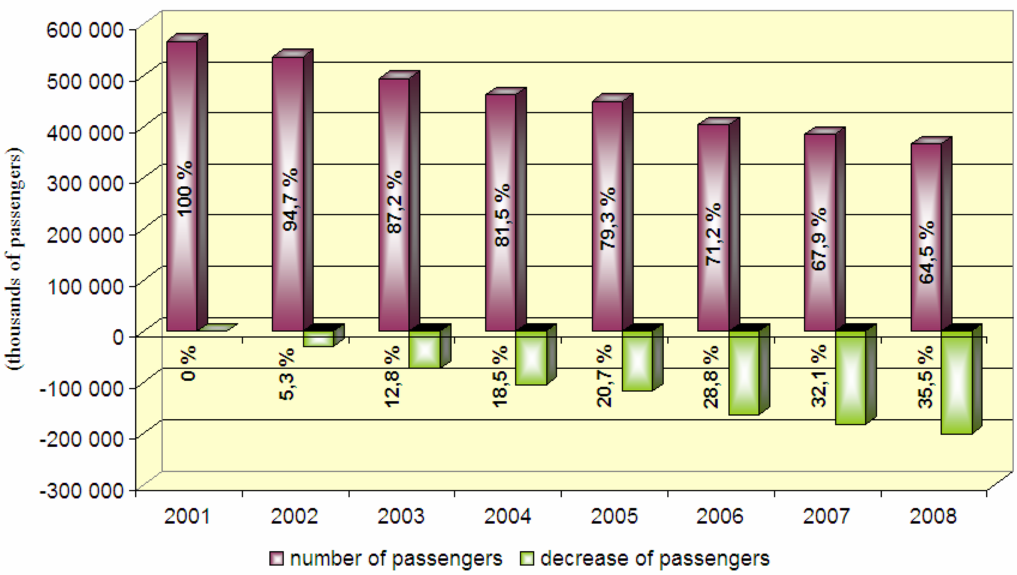

Figure 1. Trend in Number of Passengers in Enterprises which are Specialized in Road Transport in Regions of Slovak Republic

To ensure a serviceable transport system in the regions, regional transport systems operate with different capacities for different means of transport and deal with different passenger demand. It is necessary to monitor also the actual transport performance in millions of passenger kilometres rather than the number of passengers. There is a comparison of trends in transport performance over several years of monitoring time in table 2. The greatest decrease in transport performance was in the Zilina district. The decrease in Transport performance decreased from 1055 million of passenger kilometres in 2001 to 747 million passenger kilometres in 2008. This is a substantial decrease of 29.2%. The lowest decrease in transport performance was in the Trnava district: only 7.3 %, from 729 million passenger kilometres to 676 million of passenger kilometres.

Table 2. Number of Transport Performance in the Enterprises Specialized in Road Transport (Millions of Passenger kilometres)

District	*Transport performance (millions of passenger kilometres)*							
	2001	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*
Bratislava	566	820	483	511	469	479	478	449
Trnava	729	716	665	661	675	771	780	676
Trencin	992	974	934	1 006	1 019	971	1 084	706
Nitra	1 316	1 411	1 289	1 271	1 192	1 267	1 212	997
Zilina	1 055	989	1 096	863	872	818	937	747
Banska Bystrica	1 307	1 136	1 082	1 159	1 193	1 232	1 208	954
Kosice	1 083	988	1 073	914	942	950	952	836
Presov	1 205	1 202	1 135	1 497	1 163	1 177	945	1 081
Total	***8 253***	***8 236***	***7 757***	***7 882***	***7 525***	***7 665***	***7 596***	***6 446***

Source: The Statistical Office of the SR

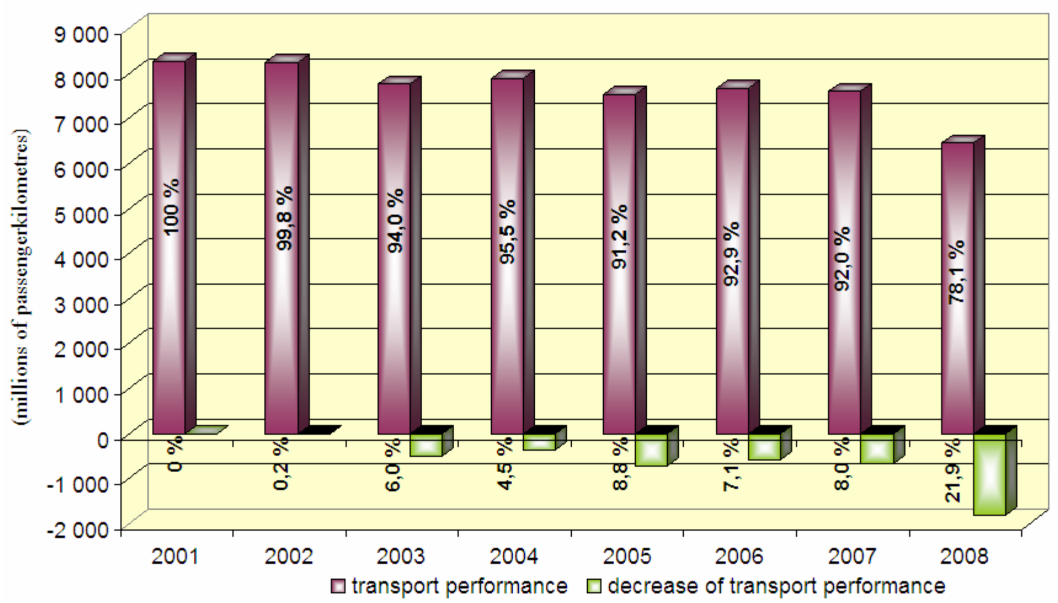

Figure 2. Trends of Transport Performance in Enterprises Specialising in Road Transport in Regions of the Slovak Republic

Figure 2 shows the recorded trend of transport performance in several regions of the Slovak Republic over the years 2001 – 2008. While the number of passengers carried by organisations specialising in road transport in regions of the Slovak Republic decreased overall, transport performance showed a slight upward trend in some years (for example years 2002, 2004, 2006). In 2008, the transport performance for the regions of the Slovak Republic was at of 78.1 % of the level recorded in 2001.

3. Determination of Trend Performance MPT

The modelling of transportation and transport processes in a major territory unit (district, region) uses the same methods as in towns. On the other hand there are some differences which must be considered. First of all there are the size of the modelled area and the volume of requirements for the input data regarding the distribution of activities in the area, and regarding the transport networks. Next there are the specific characteristics of behaviour of people living in towns or in the country, or in different parts of the area. There are regions where industry, agriculture or recreational use prevails, and they have different social and economic conditions. [4]

The succession of steps that allow a forecast in the trend of transport indicators to be determined is represented in the next figure. Input information for choosing the appropriate model for trends and predictions for the selected district (Bratislava district, which contains the capital city of the Slovak Republic) introduces quantified customer requirements to the transport process (indicators of MPT performance). These take into consideration the spatial distribution of the Slovakian territory and the time aspect (time period: years 2001-2008).

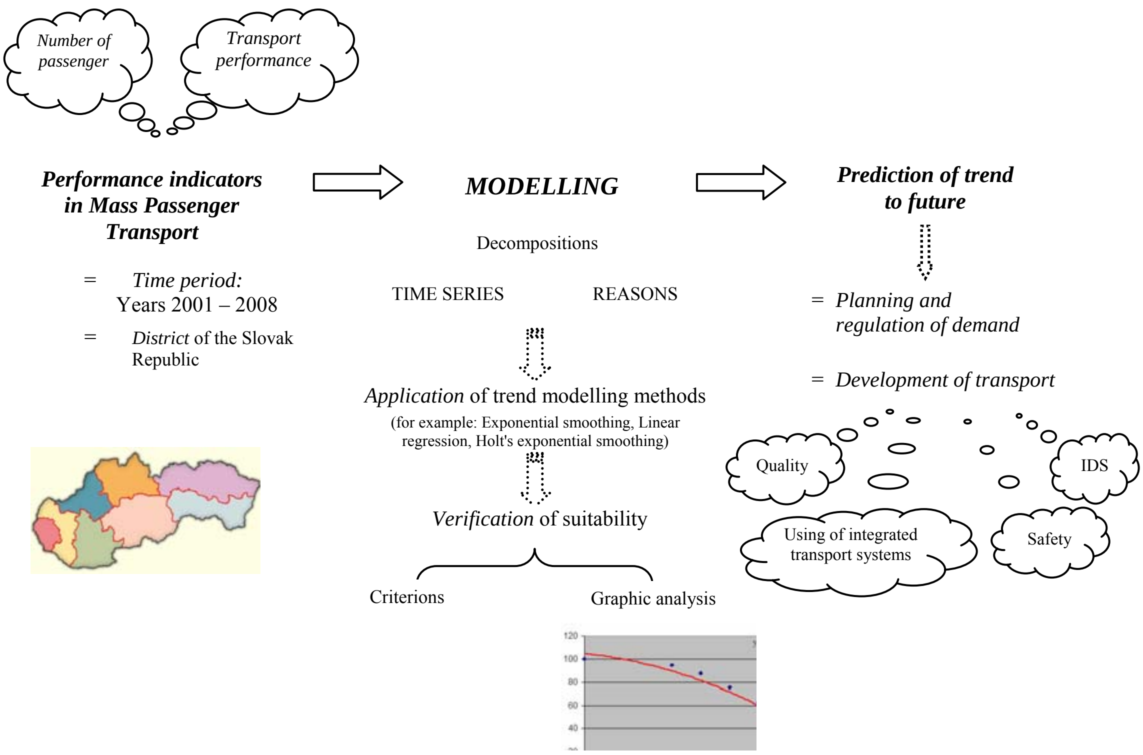

Figure 3 Succession of Steps for Determination of Trend Performance MPT

The correct identification of input information creates the basis for modelling, which is a tool of systemic analysis of complicated problem solving. This can include also the determination of development of investigating indicators prediction. Model choice is influenced by the time series analysis of input information on the basis of decomposition. The main reason for decomposition is the revelation of relations and trend tendencies. The forecast is likely to be more accurate if seasonal variation is removed. The main condition is to represent every single value of the time series that can be represented as a summation or product of its components by single models of the time variable.

Table 3. View of selected prognostic methods

Methods	*Characteristic*
Exponential smoothing (Brown's model)	= based on increases of observed value towards initial situation (condition), represents trend relations. Typically there is an increase in growth rate of model parameters,
Holt's e exponential smoothing	= using exponential smoothing, appropriate for application if time series has evidently linear trend and exponential smoothing takes distorted value
Quadratic trends	= not suitable method for application of prognosis with remote time, applicable in cases where trend has parabola shape.

The choice of the optimal method in terms of exactness of processing and accuracy is conditioned not only by theoretical knowledge of the selected method but also by a considerable amount of experience and subjectivity. Achieved outcomes should be the starting point for the process of making important decisions in a firm. [5]

The application of selected methods represents a choice of appropriate trend function for a given time series on the basis of realized decomposition and estimated attributes of development with respect to examined problems. Model parameters will be estimated from the value time trend. In case we should initiate presumption parameters, the complete condition of importance can be used to determine the forecast.

The verification of the appropriateness of the applied methods is realized on the basis of an adjudication of selected criteria because of the reason of measure precision, smoothing finding or average value residues characteristics introduces value RMSE.

$$RMSE = \frac{1}{N}\sum_{t=1}^{N}\left(y_t - \hat{y}_t\right)^2 \qquad (1)$$

where: y_t ~ variance of real trend value, $\hat{y}_t$ ~ smoothing - estimated trend value, *RMSE* ~ Root Mean Square Error.

Consecutively after evaluation of reached results quantities, value of future trend investigating indicators follows the period of the year 2009.

Table 4. Indicators of MPT of Bratislava Region at the Period of Years 2001 – 2009

Year	***Value of MPT indicator***		***Predictions of MPT indicator***	
	Number of passengers *(thousands of passengers)*	***Transport performance*** *(millions of passengerkilometres)*	***Number of passengers - by methods exponential smoothing***	***Transport performance - by methods Holt's exponential smoothing***
2001	22 743	566	22 571,1	-
2002	22 549	820	21 547,7	-
2003	20 220	483	20 570,6	508,87
2004	19 014	511	19 637,8	491,09
2005	18 229	469	18 747,4	494,41
2006	17 658	479	17 897,3	475,61
2007	17 094	478	17 085,8	468,11
2008	16 934	449	16 311,0	465,13
2009	-	-	**15 571,4**	**449,12**

** Note. Prediction was evaluated from time series from years 2003 - 2008*

In the monitored time period (2001 – 2008) there was one extreme value shown by indicators of transport performance. In 2002 there was an increase of 44.86 %, but in next years this increased level was not maintained. This value was a negatively influenced and misrepresented quantification of the indicators used to forecast of MPT – transport performance, with respect to the application of the smoothing method. Therefore it was necessary to regulate the subsequent time series, and these time series were applied to the forecasts for the years 2003 – 2008.

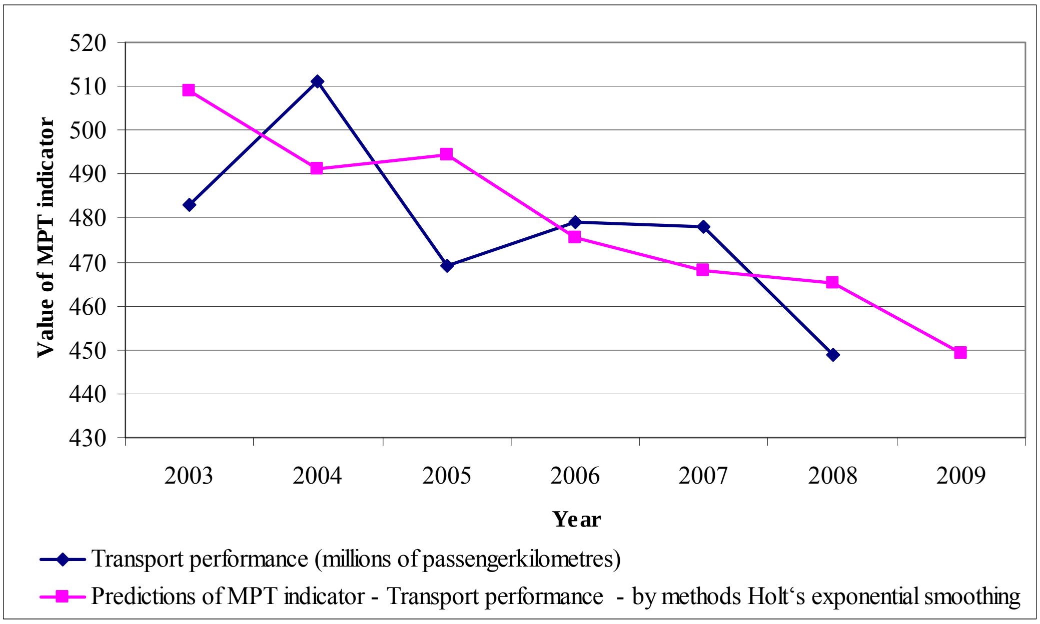

Figure 4. Predictions of MPT Indicator – Transport Performance

To initiate the regulated time period, the service methods were used on basis of graphic analysis adjudication *Holt‘s exponential smoothing* and *methods of linear trend* and methods of *exponential smoothing*. After the application of the time series, the verification of the appropriateness of single methods by selected criteria followed.

As the most appropriate method to describe the trend of the time series methods in the best way, *Holt‘s e exponential smoothing* has been evaluated because, according to determined criteria, it recorded the lowest value of RMSE (22,8061) and all model parameters were important. Other applied methods had no important model parameters and so it is not possible to recommend the application of these methods (*methods of linear trend* and *exponential smoothing*).

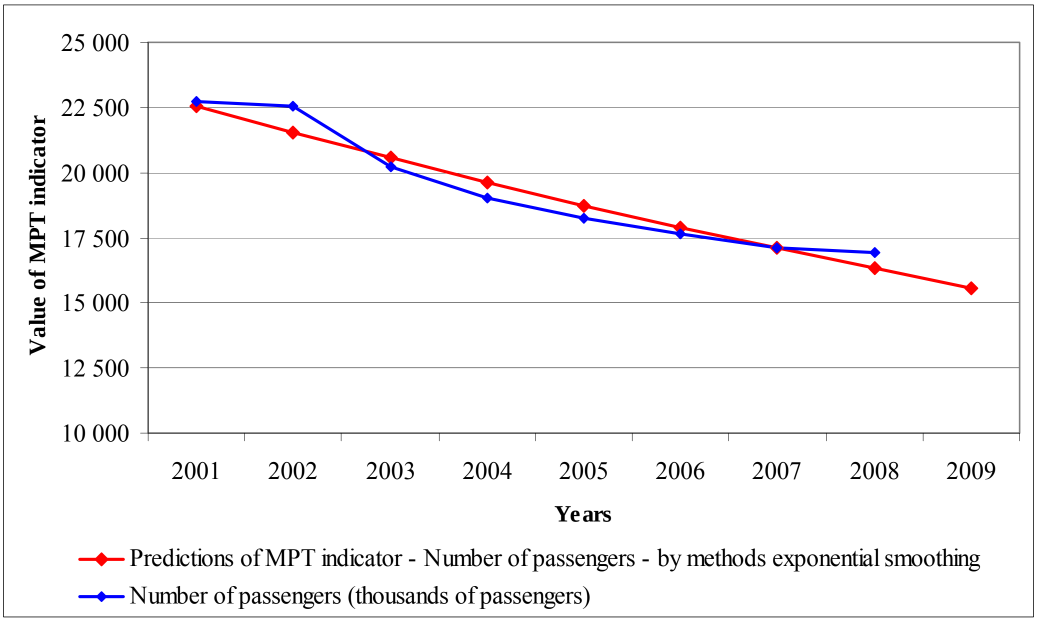

Figure 5. Predictions of MPT Indicator – Number of Passengers

Number of passengers by using the method of *exponential smoothing* the best results were achieved and the forecast values for the year 2009 were quantities of 15 571.4 thousand passengers.

4. Conclusion

Transport is one of the basic sectors that significantly affect socio-economic development and increases in living standards. This makes it one of the key factors in the development of each society. It is not a goal in itself, but a means of economic development and a prerequisite to achieving social and regional cohesion. [1]

Transport management concentrates on assessments of measures of the requirement for convenient transport, the requirements for a particular type of transport and transport service and maintaining or extending the existing market for transport.

In transport management it is necessary to create a modern structure and procedure for managerial work. The implementation of those appropriate prognostic methods and planning models allows the determination of the planned value of supply and demand by evaluating the time series trend, thereby introducing a possible way to realise stable and long time results for the regional transport enterprise activities. In addition it could enable the application of intelligent transport systems, the integration of transport systems and improved safety and quality of service with higher added value.

References

1. Dicová, J., Ondruš, J. Development of Public Passenger Transport in the Slovak Republic between Individual Road Transport. (in Slovak) In: Science journal Railway *Transport and Logistics*, Number 1, Year 2010, Volume VI., Žilina: FPEDAS, University of Zilina in Zilina, 2010. pp. 33 – 38. ISSN 1336 – 7943.
2. Kalašová, A., Paľo, J. *Traffic Engineering – Organization and Transport. (in Slovak)* Zilina: University of Zilina, 2003. 165 pp. ISBN 80-8070-076-1
3. Kalašová, A., Surovec, P. *Sedated Transport. (in Slovak)* Zilina: University of Zilina, EDIS, 2007. 202 pp. ISBN 978-80-8070-792-7
4. Ondruš, J., Paľo J. The modelling of transportation and transport processes of the region of Žilina. In: *Advances in transport systems telematics 2: Section V: Systems in road transport*. Katowice: Silesian University of Technology. pp. 29 – 37. ISBN 978-83-917156-6-6.
5. Pančíková, L. Application of Prognostic Methods in Transport. In: Science journal *Journal of Information, Control and Management systems,* VOLUME 5, No. 2/2. Zilina: Faculty of Management Science and Informatics, University of Zilina in Zilina, 2007. pp. 309 – 318. ISSN 1336-1716
6. Poliak, M. Konečný, V. *Market of Mass Public Transport and its Financing.* (in Slovak). Zilina: University of Zilina, 2009. 176 pp. ISBN 978-80-8070-999-0
7. The Statictical Office of the Slovak republic – www.statistics.sk