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POTENTIAL OF PREDICTION QUANTIFICATION AND TRENDS IN TRANSPORT REQUIREMENTS AS TOOL OF TRANSPORT MANAGEMENT AND DEVELOPMENT

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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, prediction, region, transport performance, number of passengers**,** mass public transport (MPT)

1. Introduction

Transport is a phenomenon that consists of a large number of successive sub-events forming a complex whole. Human activities are always a 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 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, 7].

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 (Fig. 1):

= Bratislava region,
= Trnava region,

= Trencin region,
= Nitra region,
= Zilina region,
= Banska Bystrica region,
= Kosice region,
= Presov region.

Figure 1. Regions of the Slovak Republic [9]

The Slovak Republic is located in Central Europe with surface area of 49 035.56 km^2. The number of inhabitants is 5 410 836 (of which females 51.3 %). The capital city is Bratislava with 415 589 inhabitants. The Slovak Republic consists of 8 regions. In 2012, the most inhabitants lived in Presov region (817 382 – 15.1 % of the total population). On the contrary, the least inhabitants lived in Trnava region (556 577 – 10.3 % of the total population). Banska Bystrica region is the largest from all of them with surface area of 9 454.32 km^2 and with the lowest population density per km^2 (69.6). Conversely, the smallest region is Bratislava region (2 052.62 km^2), in its turn there is the highest population density per km^2 (298.5). The average population density per 1 km^2 in the Slovak Republic is 110.3.

Table 1. The Basic Data about Slovak Regions

Region	The number of inhabitants	Area in km^2 by region	Population density per km^2
Bratislava	612 682	2 052,62	298,5
Trnava	556 577	4 146,40	134,2
Trencin	593 159	4 501,98	131,8
Nitra	688 400	6 343,78	108,5
Zilina	690 121	6 808,58	101,4
Banska Bystrica	658 490	9 454,32	69,6
Kosice	794 025	6 754,51	117,6
Presov	817 382	8 973,37	91,1
Total	**5 410 836**	**49 035,56**	**110,3**

Data are on 31.12.2012 [8]

The number of passengers using public transport for their everyday trips has been decreased during the last years in the Slovak Republic. This development is very similar to the development in most of the countries in Europe in the last decades [7].

The trend regarding the number of passengers in several regions of the Slovak Republic for the period 2001-2012 is shown in Table 2. From a long-term perspective, the trend in the number of passengers shows a decrease almost every year for every region (or about the same value), with the exception of the Trencin region in the year 2005 and the Nitra region in the year 2008.

Table 2. Number of Passengers in the Enterprises, which are Specialised in Road Transport (Thousands of Passengers)

	Number of passengers (thousands of passengers)								
Region / ***Year***	**Bratislava**	**Trnava**	**Trencin**	**Nitra**	**Zilina**	**Banska Bystrica**	**Kosice**	**Presov**	***Total***
2001	22 743	47 832	95 495	85 399	89 076	104 041	52 895	68 964	***566 445***
2002	22 549	45 047	90 024	75 503	86 408	98 533	49 858	68 691	***536 613***
2003	20 220	40 354	81 651	65 293	79 103	95 775	45 501	65 809	***493 706***
2004	19 014	37 772	77 397	62 815	73 437	87 886	42 621	60 830	***461 772***
2005	18 229	37 549	85 019	61 436	69 187	79 999	41 219	56 818	***449 456***
2006	17 658	36 783	65 209	58 066	66 704	63 824	41 657	53 369	***403 270***
2007	17 094	35 145	62 301	58 101	62 926	59 487	40 488	49 095	***384 637***
2008	16 934	33 071	59 151	60 106	58 975	53 745	37 667	45 870	***365 519***
2009	15 722	29 027	53 177	54 651	52 904	46 020	32 037	39 604	***323 142***
2010	15 748	28 437	51 506	53 866	50 332	45 020	29 336	38 472	***312 717***
2011	15 564	27 450	48 242	50 175	49 745	42 692	29 341	36 370	***299 579***
2012	14 543	26 441	44 747	48 138	50 918	41 367	28 046	35 028	***289 228***
									4 886 084

Source: The Statistical Office of the SR

The greatest decrease in the number of passengers was in Banska Bystrica region. There was a decrease in the number of passengers over the period from 104.041 millions passengers to 41.367 thousand passengers. This is a substantial (60.2 %) decrease between the years 2001 and 2012. Conversely, the lowest decrease in the number of passengers was in Bratislava region, (36.1 %) from 22.743 thousand passengers in 2001 to 14.543 millions passengers in 2012. The average decrease in the number of passengers for all the regions during the period 2001-2012 is 48.9 %, from 566.445 millions passengers in 2001 to 289.228 millions passengers in 2012 (Fig. 2).

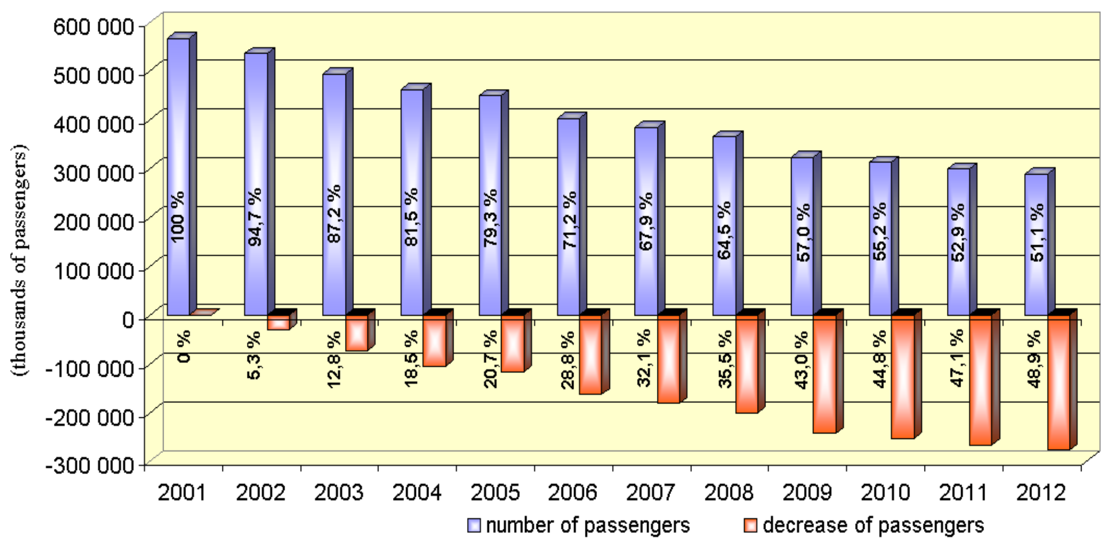

Figure 2. Trend in Number of Passengers in Enterprises, which are Specialised in Road Transport in Regions of the Slovak Republic

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 shown in the Table 3. The greatest decrease in transport performance was in the Presov region. The decrease in Transport performance decreased from 1 205 millions of passenger-kilometres in 2001 to 536 millions passenger-kilometres in 2012. This is a substantial decrease of 55.5 %. The lowest decrease in transport performance was in the Bratislava region: 24.6 %, from 566 millions passenger-kilometres to 427 millions of passenger-kilometres. The average decrease in transport performance for all the regions during the period 2001-2012 is 44.5 %, from 8 253 millions passenger-kilometres in 2001 to 4 584 millions passenger-kilometres in 2012.

Table 3. Number of Transport Performance in the Enterprises Specialised in Road Transport (Millions of Passenger-kilometres)

Region	***Transport Performance (millions of passenger-kilometres)***											
	2001	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***
Bratislava	566	820	483	511	469	479	478	449	360	364	411	427
Trnava	729	716	665	661	675	771	780	676	521	513	524	506
Trencin	992	974	934	1 006	1 019	971	1 084	706	586	666	645	666
Nitra	1 316	1 411	1 289	1 271	1 192	1 267	1 212	997	785	723	748	712
Zilina	1 055	989	1 096	863	872	818	937	747	620	567	602	615
Banska Bystrica	1 307	1 136	1 082	1 159	1 193	1 232	1 208	954	567	578	603	606
Kosice	1 083	988	1 073	914	942	950	952	836	501	457	528	516
Presov	1 205	1 202	1 135	1 497	1 163	1 177	945	1 081	598	568	550	536
Total	***8 253***	***8 236***	***7 757***	***7 882***	***7 525***	***7 665***	***7 596***	***6 446***	***4 538***	***4 436***	***4 611***	***4 584***

Source: The Statistical Office of the SR

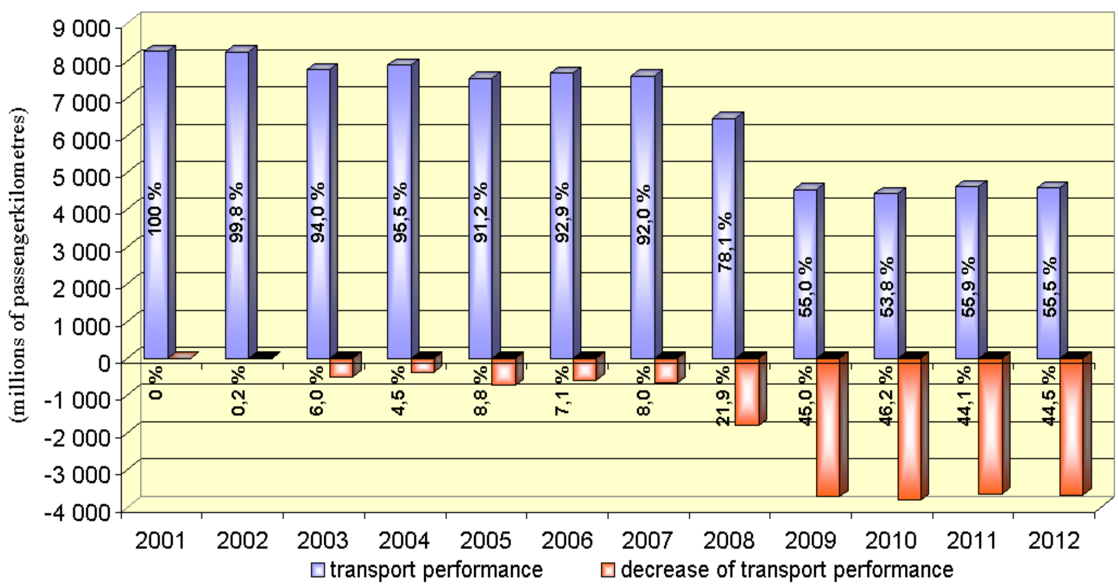

Figure 3. Trends of Transport Performance in Enterprises Specialised in Road Transport in Regions of the Slovak Republic

Figure 3 shows the recorded trend of transport performance in several regions of the Slovak Republic over the years 2001-2012. 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 2004, 2006 and 2011), a significant decrease was occurred in 2009. In 2012, the transport performance for the regions of the Slovak Republic was at of 55.5 % of the level recorded in 2001.

3. Determination of Trend Performance MPT

The modelling of transportation and transport processes in a major territory unit (region or district) 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 region (Zilina region) 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 2001-2012).

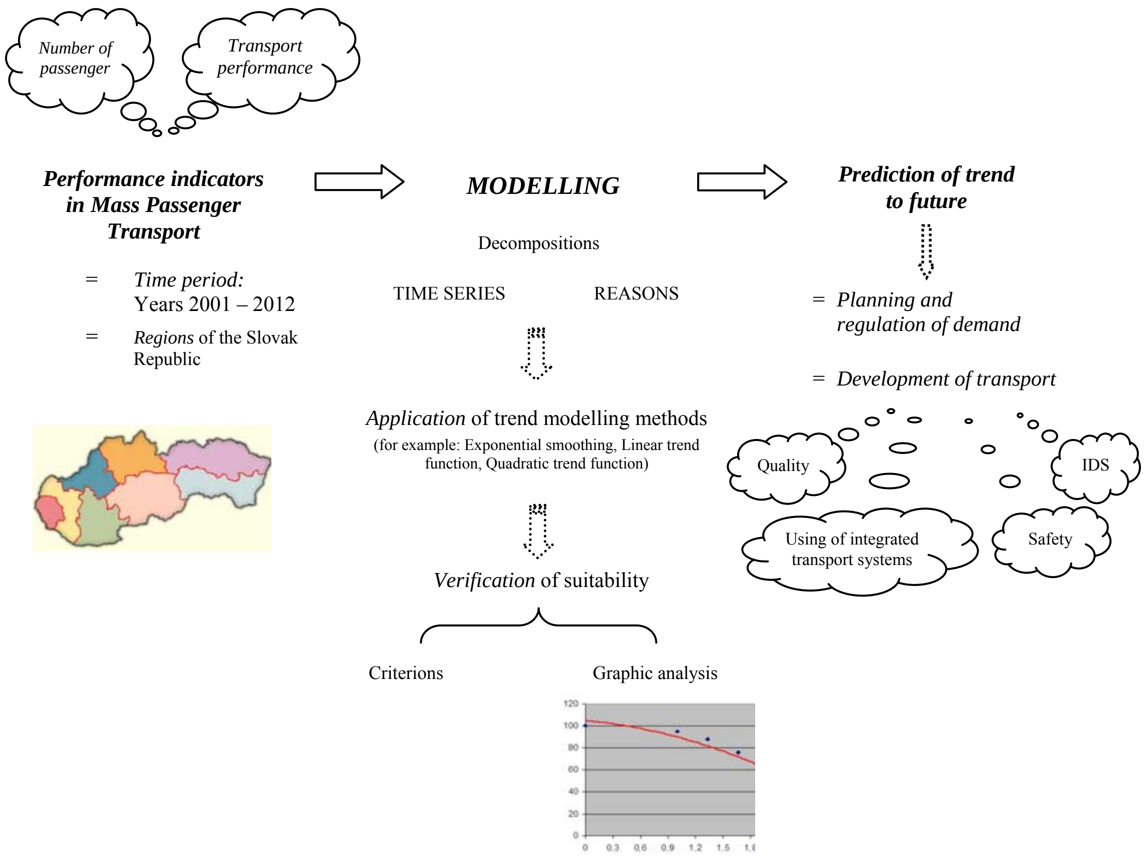

Figure 4. Succession of Steps for Determination of Trend Performance MPT

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 4. View of Selected Prognostic Methods

Methods	***Form***	***Characteristic***
Exponential smoothing	$S_t = \alpha \sum_{k=0}^{N-1} \beta^k y_{t-k}$ $\hat{y}_t = a_{0,(t-1)} + a_{1,(t-1)}.\tau$ where $\tau = 1$	= form for exponential average = exponential smoothing is suitable for modelling of time series with fluctuations. The greatest weight is attributed to the youngest observation. = weight decreases exponentially with time. The rate of smoothing is dependent on the size of the smoothing factor α. *Brown's double exponential smoothing* and *Holt exponential methods* are suitable for the local linear trend in time series,
Linear trend function	$T_t = A_0 + A_1.t$	= are regression models, where the independent variable is time, respectively its modification. = trend functions are appropriate for a uniform values over the time series, = where A_0, A_1 are parameters of the regression relationship
Quadratic trend function	$T_t = A_0 + A_1.t + A_2.t^2$	= are regression models, where the independent variable is time, respectively its modification. = trend functions are appropriate for a uniform values over the time series = where A_0, A_1, A_2 are parameters of the regression relationship

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.

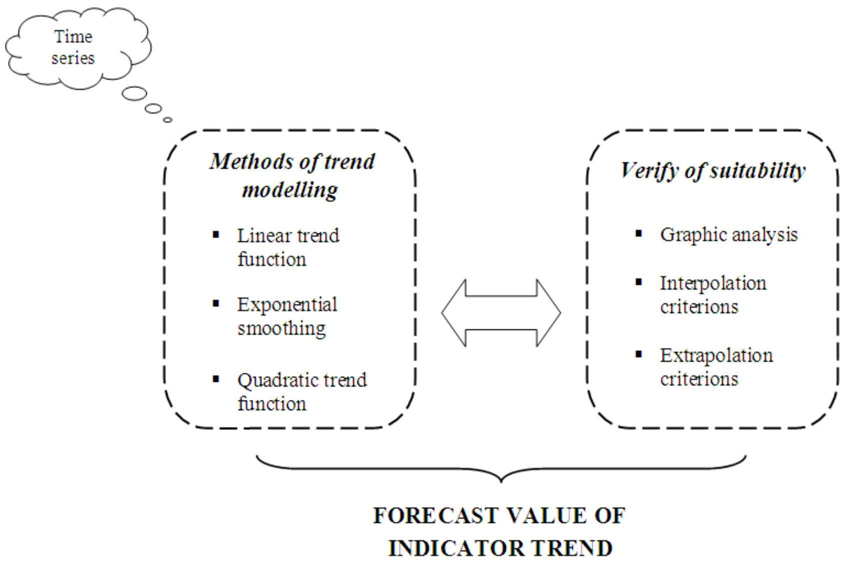

Figure 5. Succession of Steps for Forecast of Indicator Trend

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 2013.

Table 5. Indicators of MPT of Zilina region at the Period of Years 2001-2013

Year	***Value of MPT indicator***		***Predictions of MPT indicator***	
	Number of passengers *(thousands of passengers)*	***Transport Performance*** *(millions of passenger-kilometres)*	***Number of passengers - by methods exponential smoothing*** *(thousands of passengers)*	***Transport Performance - by methods linear trend function*** *(millions of passenger-kilometres)*
2001	89 076	1 055	89 799.8	1 085.45
2002	86 408	989	84 405.1	1 035.02
2003	79 103	1 096	79 334.6	984.582
2004	73 437	863	74 568.6	934.145
2005	69 187	872	70 089.0	883.709
2006	66 704	818	65 878.5	833.273
2007	62 926	937	61 920.9	782.836
2008	58 975	747	58 201.1	732.4
2009	52 904	620	54 704.7	681.964
2010	50 332	567	51 418.4	631.527
2011	49 745	602	50 332.3	600.154
2012	50 918	615	49 745.1	**552.577**
2013	-	-	**50 917.9**	**505.01**

Values of ***transport performance*** time series reached relatively periodic trend in monitored period of years 2001-2012.

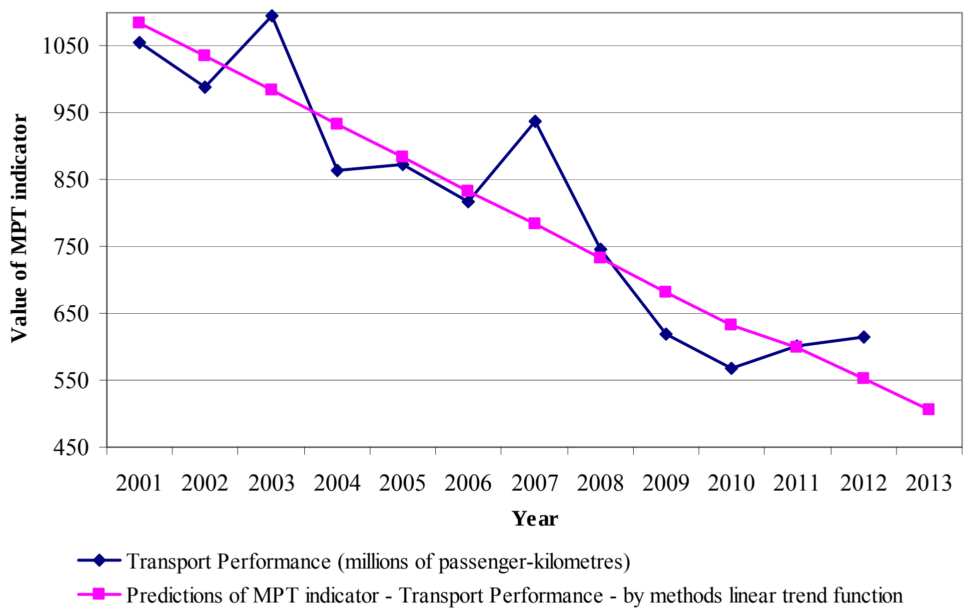

Figure 6. Predictions of MPT Indicator – Transport Performance of Zilina region

To initiate the regulated time period, the service methods were used on the basis of graphic analysis adjudication *Quadratic trend function, Holt's exponential smoothing* and *methods of Linear trend function* 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, *methods of Linear trend function* has been evaluated because, according to determined criteria, it recorded the lowest value of RMSE (75.6364) 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 Holt's e exponential smoothing* and *exponential smoothing*).

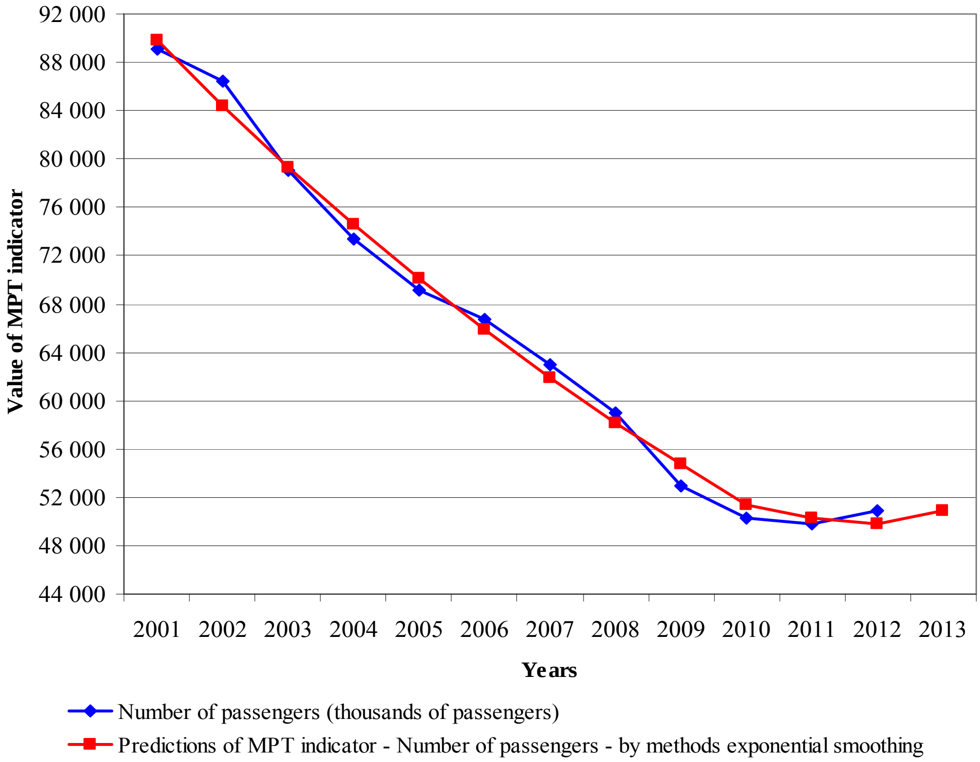

Figure 7. Predictions of MPT Indicator – Number of Passengers of Zilina region

Number of passengers by using the method of *exponential smoothing* the best results were achieved and the forecast values for the year 2013 were quantities of 50 917.9 thousands of passengers.

4. Conclusions

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 value-added.

Accomplishment of fundamental functions and operations of populate regions and city depends on mass passenger transport that must ensure all necessary transport requirements. To forefront extends distinctively strongly urgency of good coordination of all operations in complete transport systems in conditions increasing transport requirements and demands to regions and cities development [3].

Essential is in the process coordination otherwise self-contained participants (municipalities, cities, interest groups, natural person, juristic person, etc.) and place/put/lay emphasis on creativity, communication ability, ideas richness, engagement, effort to solve problems, flexibility, persuasion and natural authority [1].

In regional management is necessary to create modern and elementary procedure and structure of managerial work. Just implementation of appropriate prognostic methods and planning models those allow determining planned value of supply and demand by evaluation of time series trend introduces to possible solution to reach stable and long-time results of region and transport enterprise activities and also to application of intelligent transport systems, integrate transport systems, safety and quality of services.

Regional management of area can allow to Slovak regions and municipality fast adaptation to conditions EU market as innovation and integrated management tool. Regional management can help to break through and assume to market with competitive supply that to Slovak gives new human and financial capital and ensures so long-term perspective and permanent sustainable development.

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