Faculty of Operation and Economics of Transport and Communications
University of Žilina
Žilina, Slovakia

TRANSPORT AND COMMUNICATIONS

Scientific journal

tac.uniza.sk

I/2017 Volume V ISSN 1339-5130

TRANSPORT AND COMMUNICATIONS

Scientific journal intended to combine theory and practice in the field transport and communications and thus advancement of transport and communications sciences

DOI: 10.26552/tac.J.2017.1
ISSN 1339-5130

Table of contents

Transport and Communications, 2017; Vol. I.
ISSN: 1339-5130
DOI: 10.26552/tac.C.2017.1.1

A diverging diamond interchange (DDI) in conditions of road network in Slovakia

Matúš Korfant[1], Ján Palúch[2], Alica Kalašová[3]

[1]University of Žilina, Faculty of Operation and Economics of Transport and Communications, Department of Road and Urban Transport, Univerzitná 1, 010 26 Žilina, Slovakia
[2]University of Žilina, Faculty of Operation and Economics of Transport and Communications, Department of Road and Urban Transport, Univerzitná 1, 010 26 Žilina, Slovakia
[3]University of Žilina, Faculty of Operation and Economics of Transport and Communications, Department of Road and Urban Transport, Univerzitná 1, 010 26 Žilina, Slovakia

Abstract This article focuses on the comparison of the current uncontrolled intersection and the new type of intersection. To obtain the most accurate results the intersection is simulated in the Aimsun software. The intersection is situated in Bratislava. It is formed by exits and entrances to the highway D2. The new type of the intersection is denoted as a Diverging diamond interchange (DDI) which increases the safety and fluency of the road traffic. It is most used in the interchanges.

Keywords Intersection, Delay Time, Diverging Diamond Interchange

JEL classification of article according JEL

1. Introduction

The diverging diamond interchange (DDI) is also known as a double crossover diamond (DCD) and is an alternative to the conventional diamond interchange or other alternative interchange forms. The primary difference between a DDI and a conventional diamond interchange is the design of directional crossovers on either side of the interchange. This eliminates the need for left-turning vehicles to cross the paths of approaching through vehicles. By shifting cross street traffic to the left side of the street between the signalized crossover intersections, vehicles on the crossroad making a left turn on to or off of ramps do not conflict with vehicles approaching from other directions. [1]

2. DDI Overview

The DDI design has shown to improve the operations of turning movements to and from the freeway facility and significantly reduces the number of vehicle-to-vehicle conflict points compared to a conventional diamond interchange. The DDI also reduces the severity of conflicts, as conflicts between left-turning movements and the opposing through movement are eliminated. The remaining conflicts are reduced to merge conflicts for turning movements, and the reduced speed crossover conflict of the two through movements. Chapter 4 provides additional discussion of these conflict points and DDI safety benefits. [1]

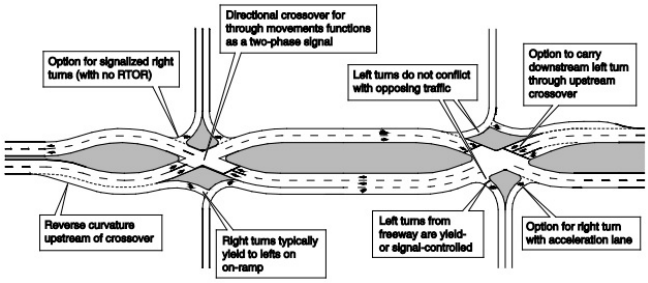

Figure 1. Key characteristics of a DDI

The street segment between the crossovers can be designed as an underpass or overpass depending on the site characteristics. The interchange design will be directly affected by whether or not the arterial passes over or under the limited access facility. In most cases, DDIs designed with a cross road as an overpass offer the most design flexibility in serving pedestrians. The majority of DDIs evaluated have reconstructed existing diamond interchanges, and the decision to go over or under the limited access facility had already been determined. [1]

Traffic Volume Relationships in the figure 2 conceptually depicts the relationship of conventional intersections, alternative intersections, and grade separations in their ability to serve increasing traffic volumes. [2]

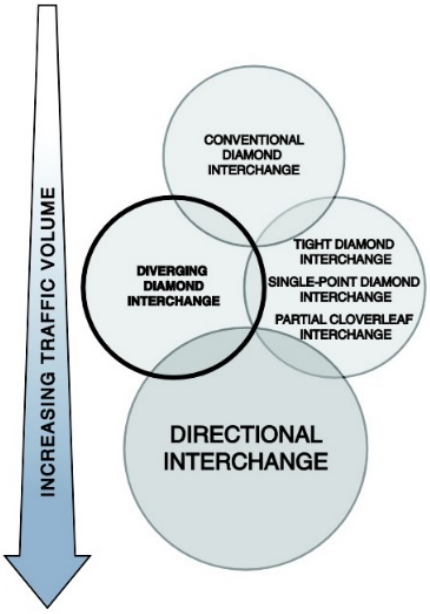

Figure 2. Relationship between volume and interchange type

The DDI is an alternative to the conventional diamond interchange, as well as other interchange forms like a single-point interchange or a partial cloverleaf. The primary difference between a DDI and a conventional diamond interchange is the design of directional crossovers on either side of the interchange. This eliminates the need for left-turning vehicles to cross the paths of approaching through vehicles. Cross street traffic is shifted to the left side of the street between the signalized ramp intersections. Drivers on the cross street who are making a left turn onto the ramps are allowed to continue to the ramps without conflicting with opposing through traffic and without stopping. The DDI design has shown to improve the operations of turning movements to and from the freeway facility, as well as significantly reduce the number of vehicle-to-vehicle conflict points compared to a conventional diamond interchange. [2]

3. DDI application in road network of Slovakia

In the Slovak republic as an example for the implementation of intersection DDI we may use the intersection in the urban part of Bratislava – Lamač. The intersection consists arms of D2 highway and of road II/505. This intersection is characterized by the fact that it does not have sufficient capacity in the morning, as well as in the afternoon traffic peak and. We expect a significant increase of traffic intensity in this area due to its development.

Intensity of traffic was obtained from the transport model which is using in the capital city of Slovakia. This is shown in the figure 1.

The simulation was processed for the morning traffic peak. Each input and their loads are shown in the figure 3 and in the table 1.

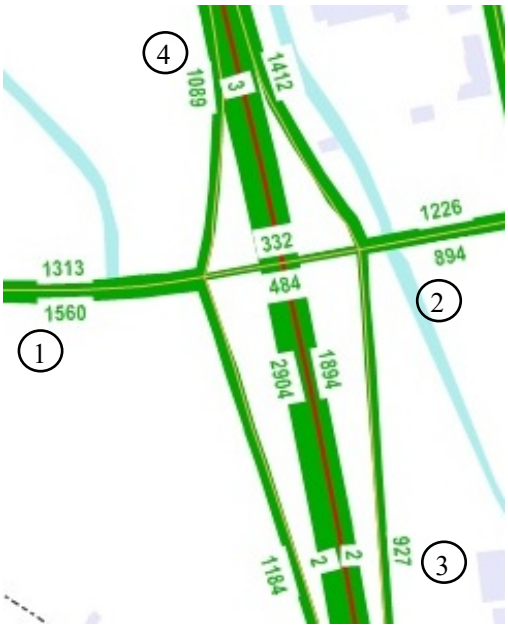

Figure 3. Intensity of road traffic during morning traffic peak [3]

Table 1 shows the matrix of traffic relations which shows the routing of the vehicles from the individual inputs.

Table 1. Traffic relations among the inputs

	Input n. 1	Input n. 2	Input n. 3	Input n. 4	Sum
Input n. 1	-	102	1138	320	1560
Input n. 2	87	-	45	1092	1224
Input n. 3	201	727	-	1894	2822
Input n. 4	1023	66	2904	-	3993
Sum	1311	895	4087	3306	**9599**

The composition of the flow of traffic has been divided in the ratio of 85% for cars, 12% for trucks and 3% for buses. The division represents approximate composition of the traffic flow. The capacity for each of the communication was for the highway set as 1 800 vehicles per lane and for the other roads it was 1 500 vehicles per lane. The speed limits for highway and entrances are at the level of 90 km/h because of going through the city and 50 km/h for the other roads.

To create a road network, we used Aimsun sotware for microscopic simulation of road traffic. The program allows to describe the road network at the requiring scale and run the microsimulation. The results of microsimulation are for both intersection types and they are used for interection comparison.

DOI: 10.26552/tac.C.2017.1.1

3.1 Non - signalized intersection (NSI)

Today´s shape of the intersection is non-compliant due to its load. Progress of the simulation can be seen in the following figure. In the morning traffic peak is critical especially the shoulder on the descent from the highway (entrance no. 4) and the arm in the direction of Devínska Nová Ves (entry no. 1). In the afternoon traffic peak, critical is arm no. 2 and arm no. 3.

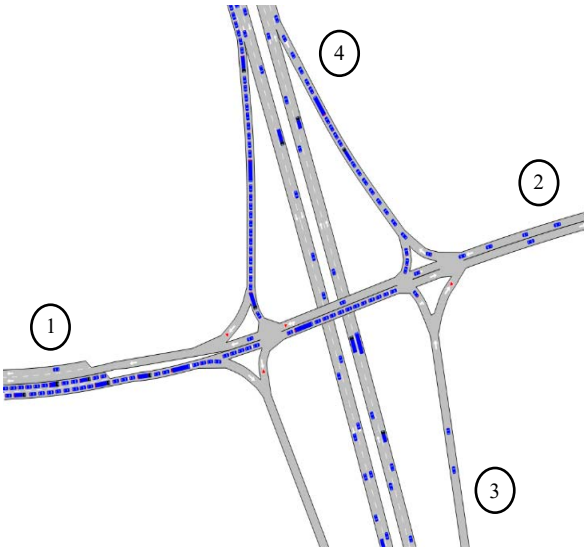

Figure 4. Situation in the morning traffic peak (NSI)

3.2 DDI

The new proposed shape of the intersection is adapted to spatial proportions and to the traffic intensity of intersection. The intersection is controlled in two stages by 60 second cycle. Phases are set to allow smooth crossing through the intersection. The total length of green sign in one phase is 27 second. This allows smooth operation in the present but also in the future higher intensity of road traffic. The new shape of intersection is shown in figure no. 5.

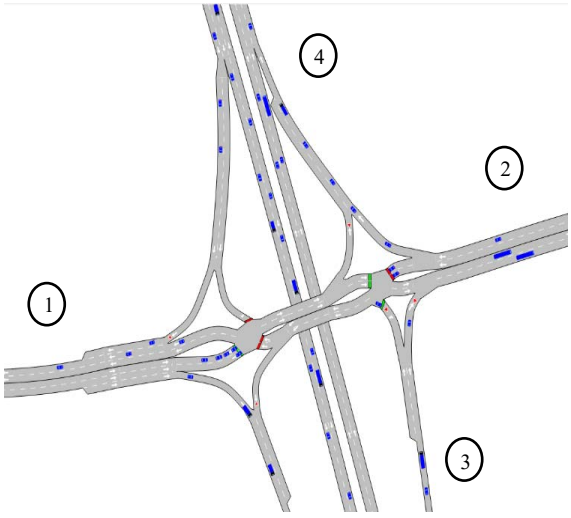

Figure 5. Situation in the morning traffic peak (DDI)

As we can see in figure no. 5, it is clear that there is no creation of congestions to the same extent as at the present. The proposal includes a separate lane for each turn on the descent and at the entrance to the highway. This solution allows a smoother crossing of vehicles.

3.3 Comparison of DDI and NSI

One of the most important indicators in the intersection comparison is growth of delay time. It shows the average delay of a vehicle for one kilometer in seconds. The average values were obtained from the 10 runs of simulations for each intersection separately. Comparison of the delay time for NSI and DDI and their average values is set in the following table and it is calculating for the whole described network.

Table 2. Delay time comparison

	Delay Time [sec/km]	
Time	**DDI**	**NSI**
7:00	8,15	39,78
7:10	8,24	40,32
7:20	8,65	95,15
7:30	8,78	136,72
7:40	8,25	97,41
7:50	8,27	123,57
8:00	8,54	124,33
Average	**8,41**	**93,90**

The average delay time for the DDI is 8,41 sec/km and for NSI is 93,90 sec/km. It shows a significant time saving and the faster crossing of vehicles through the intersection. The DDI reports 85,49 sec/km less delay than in the NSI. In the following figure, it is possible to see the course of the delay time at the intersection.

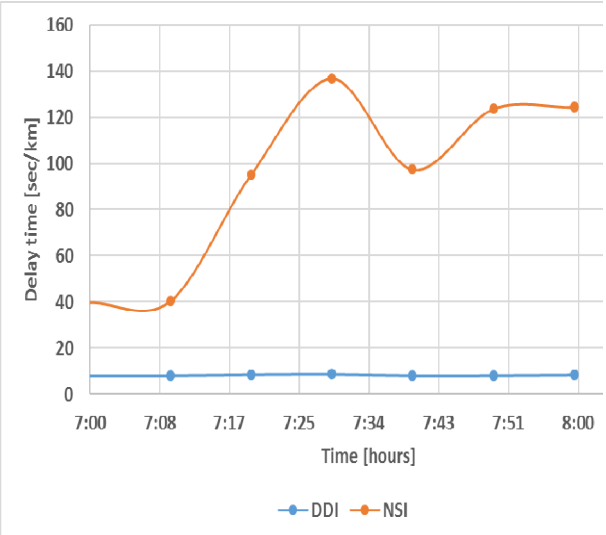

Figure 6. Course of the delay time

The course presents that DDI saves time in comparison

with the NSI. We can conclude that the delay time at DDI is almost constant. The other recorded values are presented in the table 3.

Table 3. Other measurable traffic values

	NSI	DDI	Difference	Units
Harmonic Speed	24,59	66,89	42,30	km/h
Mean Queue	89,34	3,40	85,94	veh
Mean Queue	536,04	20,40	515,64	m
Total Travel Time	177,52	94,22	83,30	h

Harmonic speed is verified for the whole network while it is about 42,30 km/h higher for DDI than NSI. The length of the column is about 85,94 vehicles lower for DDI. Due to the current technical conditions (TP 102) it is possible to recalculate the length in meters. Thus it´s possible to state that a new type of intersection brings significant time savings and increases transit and harmonic speed.

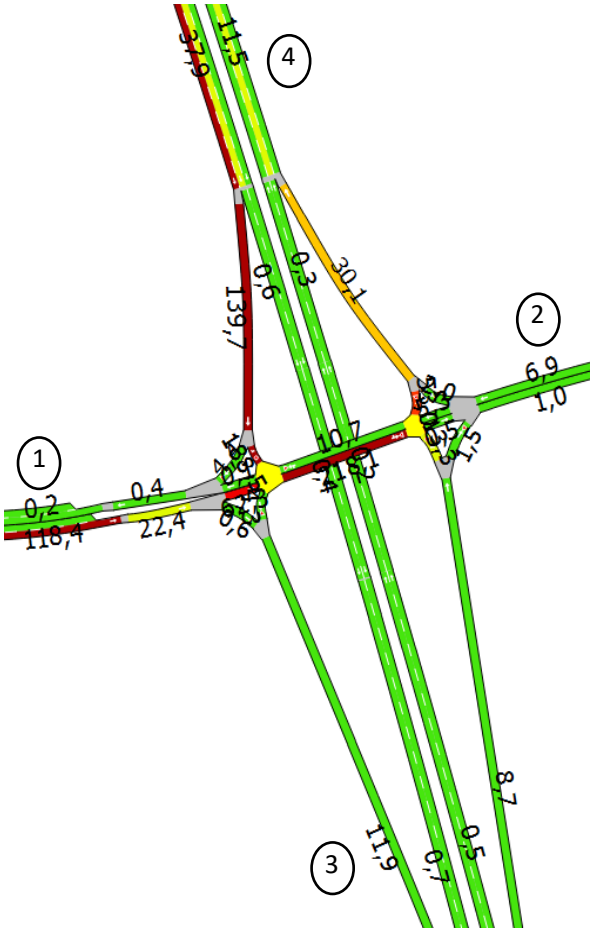

Figure 7. Delay time for NSI

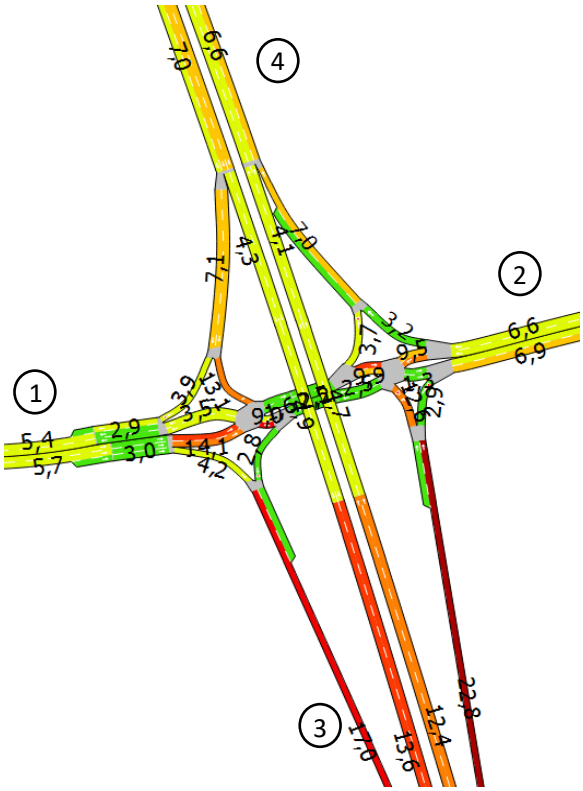

Figure 8. Delay time for DDI

In the figure 7 and figure 8, we can see the delay time for the individual sections of the road network.The green color indicates the minimum of delay and red represents a big delay. The delay depends on the length of the particular section.

4. Conclusions

Based on the results of the simulation, the result is that the current condition highly exceeds the capacity intersection.

The consequences are increased time delays which create congestions.

Although this type of the intersections in Slovakia is still not occurred, this solution is the only for increasing the capacity of the intersection. The DDI allows smoother and safer crossing through the intersection with the lower time delay. The type of intersection can also handle the increase in the intensity of road traffic in this area for the next years, therefore it appears as the only solution to the problem with growing share of individual car traffic in this area.

REFERENCES

[1] Online Available: https://safety.fhwa.dot.gov/intersection /alter_design/pdf/fhwasa14067_ddi_infoguide.pdf.

[2] Online Available: https://www.udot.utah.gov/main/ uconowner.gf?n=14769524027177477

[3] Traffic model of Bratislava city in PTV Visum

Transport and Communications, 2017; Vol. I.
ISSN: 1339-5130
DOI: 10.26552/tac.C.2017.1.2

The trend of a number of internet connections in Slovakia and selected European countries

Matej Pechota[1], Mária Matúšková[2]

[1] Department of Communications, The Faculty of Operation and Economics of Transport and Communications University of Žilina, Žilina, 010 26, Slovakia
[2] Department of Communications, The Faculty of Operation and Economics of Transport and Communications University of Žilina, Žilina, 010 26, Slovakia

Abstract Nowadays we live in a time, when the number of internet connections are growing as users start sending information mostly via the internet. This article consists of statistics and information about the internet connections in Slovakia and through statistical methods we will calculate if the trend grows or rises in every district of Slovakia. The trend shows us, how important it is to adapt from postal services to new trends and take care about users who want to use postal services in this new way and to demonstrate that the number of internet connections are growing in every country. In this article we will compare statistical data between Slovakia and selected European countries. For more specific results, we should calculate the trend per citizen. The reason is, that we should compare countries where much more citizens live, than in Slovakia. This article focuses on the situation in the Slovak market. It could help to demonstrate how electronic communication and postal services could cooperate.

Keywords internet connection, trend, analysis, postal services, electronic communication

JEL L87, L86, C15

1. Introduction

We would like to present in this article, aspects that are useful for the next stage in postal services, but in internet services too. Throughout this article there will be theoretical bases about the general definition of internet services, types of connections and postal services. More important is the methodology which we applied to prove the correlation between amount of sent items by domestic service and amount of internet connections in Slovakia. We applied statistical methods to calculate the trend of the amount of internet connections in each region of Slovakia and the trend of amount of sent items by domestic service. Thanks to the trend we can predict next stage. Another calculation will prove if there is some positive effect or not. The most important calculation is about the correlation between sent items and internet connections. According to these results we can decide what to do in postal services, what to add or what to apply to make it better.

2. Theoretical bases

To get closer to the main topic of this article we will describe postal services as well as services provided via internet.

2.1. Postal services

Postal services are provided by postal operators in each country. We are going to focus on national postal operators which should provide special postal services. This postal service can be called "universal service" and it means that:

"It is an offer of postal services which serves the minimal needs of all postal service users in Slovakia and to ensure accessibility to access points of the public postal network and the contact points of the public postal network under the same conditions within a specified quality at a fair price. Every working day with at least one recess and daily delivery." [1]

Postal services topic is too big for this article, hence we should concentrate on two main services which is provided by the national postal operator. These are: [2]

Letter mail

Letter mail is the most popular service provided by postal operators in the selected area. Letter mail is a letter service communication or small article sent by this operator. You can send it within the domestic area or abroad. Letter mail has got some specifications which are different in every country. You can use it for sending letters, letters for the blind, direct mail (within Slovak Republic). Communications can be sent on any kind of physical media (paper, card, CD, DVD). There could be different quality standards of transit times, size and weight, but in Slovakia the specifica-

tions for letter mail are the following:

- **Letters within the Slovak Republic:**
  - 1st Class Letter - D+1 (delivery on the next working day after the day of posting),
  - 2nd Class Letter - D+2 (delivery on the second working day after the day of posting)
  - Letter for blind - D+4 (delivery on the fourth working day after the day of posting),
  - Direct mail - D+4 (delivery on the fourth working day after the day of posting),
- **Letters abroad**
  - assumed transit times of letters addressed abroad depend on the respective country of destination, for an expedite transit time, choose the "1st Class" Letter option [2]

Letter mail is a paid service, but every country has got different control devices which control if the price is regular for that market. There are many things which are important to set up for the right price for this service. Analysis of these topics is too large and it is not the main area to be characterised. There is one thing which is set up for letter mail and that is the method of payment. Here are some possible methods of payment for letter mail:

- cash,
- postage stamps,
- bank transfer,
- postage credit,
- franking machine.

There are also some special services which can be added to it. It is for example: Reply service, Withdrawal of an Item from the Post at posting, Withdrawal of an Item from the Post at delivery, return to Sender immediately, do not redirect, return to Sender after ... days, do not return these special services are provided for letter mail send in domestic service. For those letter mails, which are sent abroad there are these possibilities: Reply service (up to 50 g to all countries, above 50 g to shortlisted countries), Withdrawal of an Item from the Post at posting, do not redirect, Poste restante. [2]

Parcels

The next important item in the postal market, is parcel service. Parcel service is also a service which is provided by the postal operator in selected areas, but it is something different than letter mail. Parcel service is a service assigned to deliver things with value or without value. Receipts are included in the service for the management of the delivery of the parcel to the consignee. Every postal operator provides a parcel service with different rules and specifications. Slovak post has set up the follows specifications:

- In terms of delivery there are two types of parcels
  - Parcel to the address – parcels will be delivered by Slovak post to the address which is written on parcel
  - Parcel to the post – parcel will be delivered by Slovak post to the post office which dispatcher set up.
- Delivery term of parcels is D+2 (delivery on the second working day after the day of posting)
- Price of parcel includes
  - Track & Trace (T&T) – it is tool to check progress of your item,
  - Text message or e-mail notification – postal operator notify consignee through text message or e-mail about progress of item.
- Insurance of parcel is special service offered to this item. Insurance secures parcel and dispatcher.

Parcel should be packed according to the rules which are specified. Packing rules are:

- Parcel can be posted in enclosed packaging or without packaging (for ex. tyre, suitcase, etc.).
- You can also use repackaging service in case the original addressing data, all labels and bands have been removed.
- In case the weight is over 3 kg, we recommend to cord up or put the shanks

Payment of postage is also set up. There are a few possibilities how to pay for parcel. Possibilities are follows:

- Cash,
- Bank transfer,
- Postal stamps,
- Postal machine,
- Postage credit.

For postal items it is common to add special services. These services are:

- Sender
  - Parcels within Slovak Republic – Insurance, Fragile Cumbersome, Cash on delivery (COD), Cancellation on posting, Cancellation on delivery, do not store, Store…day,
  - Parcels abroad – Cash on delivery, Fragile, Cumbersome, Insurance, return to sender immediately, return to Sender after…days, do not return, Redirect to Addressee after…days, do not redirect, Cancellation on posting/ delivery.

Both items which I have mentioned have a number of variables. I had to define some specifications about it. Then I can describe methods which could help us to set up the trend of the amount of sent items by domestic services. [2]

As we said in the beginning we should concentrate on postal services as services provided via internet. The reason is simple. Nowadays postal services are also provided via internet. Customers can use modern technology to save their time and they can save the environment too. We should define how we can offer this service via the internet from the beginning. Electronic communications service is a service normally provided for remuneration which consists wholly or mainly in the conveyance of signals in networks, including telecommunications services and transmission services in networks used for radio and television broadcasting. [3]

Services provided via internet are nowadays popular and its

DOI: 10.26552/tac.C.2017.1.2

offer increases every day. This service begins with connections.

2.2. Services provided via internet

The Internet is a "worldwide system of interconnected networks and computers", which can communicate with each other. [4]

Nowadays use of Internet is part of nearly every day for private and occupational purposes by its users. In the virtual environment of Internet there exists a lot of Internet websites. Website content itself is very important for the user. [5]

There are many types of connections and how to become a user. Internet providers offer for example these types of connections:

- Internet services provided via cable
  - Metal cable (DIAL-UP, ISDN, ADSL, CATV, DPL)
  - Optical cable.
- Wireless services
  - Fixed (WI-FI, FWA, VSAT)
  - Mobile (HSCSD, GPRS, EDGE, FLASH-OFDM, UTMS) [6]

According to these different types of connections and per the information based on research in Slovakia, which has been provided by the Regulatory authority for electronic communications and postal services the most frequent types of connections are: IDSN, Dial-up, xDSL, optical cable FTTx. There are lots of providers now offering electronical communication services that join you to the internet. In this article, we will calculate the trend of these internet connections. For better understanding we should define the digital economy index (DESI). [7]

Use of Internet services by Citizens in the EU

The DESI is a composite index that summarizes relevant indicators on Europe´s digital performance and tracks the evolution of EU member states in digital competitiveness. Specifically, use of the Internet. The use of Internet dimension accounts for the variety of activities performed by citizens already online. People in the EU engage in a range of online activities. They consume content, communicate, shop, use online banking services and much more. Such activities are captured in DESI (The digital economy and society index) on internet use. Denmark, Sweden and Belgium have the most active internet users, followed by Estonia, the Netherlands and Finland.

Mobile use of the internet in Europe really started to take off around 2010. Today 43% of the population (aged 16-74 years) use their mobile phone to access the internet when they are away from home or work. [8]

Use of Internet in Slovakia

Slovakia ranks 18th amongst EU countries. The use of internet by Slovaks is still growing and it is close to the EU average. Slovak Internet users engage in a broad range of online activities. They read news online (65%), listen to music, watch films and play games online (35%), use the Internet to communicate through social networks (69%), Voice or video calls via internet are particularly popular (55%). The uptake of online banking services amongst internet users is stagnating (48%) whilst online shopping is growing (61%).
[8]

3. Methodology

For the correct calculation of the trend, geometric means and correlation between the amount of internet connections and the amount of sent items by domestic service, we applied statistical methods.

3.1. Trend analysis

A trend analysis is an aspect of technical analysis that tries to predict the future movement of a stock based model on past data. Trend analysis is based on the idea that what has happened in the past gives traders an idea of what will happen in the future. There are three main types of trends: short-, intermediate- and long-term. Although trend analysis is often used to predict future events, it could be used to estimate uncertain events in the past, such as how many ancient kings probably ruled between two dates, based on data such as the average years which other known kings reigned. In this case trend analysis help to predict the situation on postal markets and predict amount of sent items by domestic services next year. [2]

3.2. Geometric mean

It is very important when we want to say if a trend is increasing or decreasing. In mathematics, the geometric mean is a type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). The geometric mean is defined as the nth root of the product of n numbers, i.e., for a set of numbers x_1, x_2, ..., x_n, the geometric mean is defined as

$$\bar{x}_g = \sqrt[n]{x_1 * x_2 * \dots x_n}; (x_i > 0; i = 0,1,2 \dots n) \qquad (1)$$

When we calculate geometric mean in case when there is a table of frequencies then geometric mean is defined as

$$\bar{x}_g = \sqrt[n]{x_1^{f_1} * x_2^{f_2} * \dots x_k^{f_k}}; \sum_{i=1}^{k} f_i = n \qquad (2)$$

Geometric mean is one of the statistical characteristics which expresses the average rate of change. This is the main reason why I applied this mean to show the average change of amount sent items. [9]

3.3. Regression analysis

Regression analysis is used when you want to predict a continuous dependent variable from several independent variables. If the dependent variable is dichotomous, then logistic regression should be used. (If the split between the two levels

of the dependent variable is close to 50-50, then both logistic and linear regression will end up giving you similar results.) The independent variables used in regression can be either continuous or dichotomous. Independent variables with more than two levels can also be used in regression analysis, but they first must be converted into variables that have only two levels. This is called dummy coding and will be discussed later. Usually, regression analysis is used with naturally-occurring variables, as opposed to experimentally manipulated variables, although you can use regression with experimentally manipulated variables. One point to keep in mind with regression analysis is that causal relationships among the variables cannot be determined. While the terminology is such that we say that X "predicts" Y, we cannot say that X "causes" Y. Regression has got more to the process. In this case I will discuss only one process of regression. Regression analysis also has an assumption of linearity. Linearity means that there is a straight-line relationship between the X and the Y. This assumption is important because regression analysis only tests for a linear relationship between the X and the Y. Any nonlinear relationship between the X and Y is ignored. You can test for linearity between an X and the Y by looking at a bivariate scatterplot (i.e., a graph with the X on one axis and the Y on the other). If the two variables are linearly related, the scatterplot will be oval. Regression analysis consist of smaller part which is important to calculate the result. Regression can be written as: [10]

$$\hat{y}_i = b_0 + b_1 * x_i \quad (1)$$

$\hat{y}_i$- (predictable) value of depends of variable Y,

x_i – value of undepends of variable X,

b_0- point estimate,

b_1 – point estimate.

We can see that there are two unknown values b_0 and b_1. Basically, b_0 means the amount in the beginning. This article is about the number of events and yearly audience. In this case, the independent value is the number of events. Result of b_0 shows the audience in case when there will not be any event. On the other hand, there is another unknown value b_1 which means how the audience would change when we add one event. B_1 is well known as regression coefficient. These two unknown values can be calculated as:

$$b_0 = \bar{y} - b_1 . \bar{x} \quad (2)$$

$$b_1 = \frac{cov\,xy}{s_x^2} \quad (3)$$

$\bar{x}$- average value of undepends value X

$\bar{y}$- average value of depends value Y

s_x^2- variance of value X

$cov\,xy$- covariance of throw values X and Y

As we can see there are still two values which should be calculated. Firstly is the variance and secondly the covariance. Variance can be calculated as:

$$s_x^2 = \frac{\sum(xi-\bar{x})^2}{n} \quad (4)$$

Covariance means the value of mixed variability which consists of two statistical values X and Y. It can be calculated as:

$$cov\,xy = \frac{\sum(xi-\bar{x})*(yi-\bar{y})}{n} \quad (5)$$

Thanks to the mentioned patterns we can calculate the regression which is shown in the results and discussion part of this paper. [10]

3.4. Correlation

Regression is good to know for the prediction of a trend but as we can see there are two values X and Y. Dependent and independent values. To discover their connectivity, we need a correlation. This correlation has got coefficients. Firstly there is the correlation coefficient and secondly there is the coefficient of determination.

Correlation coefficient is used to calculate how strong the correlation is between the dependent and independent values. The following rules apply.

1. *If the number of correlation coefficient is from 1 to 0,9 there is strong correlation,*
2. *If the number of correlation coefficient is from 0,9 to 0,8 there is correlation,*
3. *If the number of correlation coefficient is from 0,8 to 0,7 there is weak correlation,*
4. *If the number of correlation coefficient is lower than 0,7 there is no correlation.*

It can be calculated as:

$$r_{xy} = \frac{cov\,xy}{s_x * s_y} \quad (6)$$

Coefficient of determination is calculated to determine the correlation in percentage value. Calculation of this coefficient is similar as in correlation coefficient, but there is just a little difference. Coefficient of determination can be calculated as.

$$rxy^2 = \left(\frac{covxy}{s_x s_y}\right)^2 \quad (7)$$

DOI: 10.26552/tac.C.2017.1.2

Thanks to the mentioned patterns the results will show the correlation between the number of events and audience during 5 years. [10]

4. Results

The main goal of this research is to calculate and interpret the trend of the amount of internet connections in Slovakia in each region, but also in Slovakia overall. For better comparison, we also add the trend analysis of the second value which is presented by the amount of sent items by domestic service. Next hypothesis is based on the fact that nowadays the internet is used more often as a transfer medium for people. According to this fact we expect that there should be a correlation between internet connections and sent items. Thanks to regression analysis and correlation indexes, we can now see the real result.

4.1. Results of trend analysis

The basic information which we used for our calculation consists of data made by the Regulatory authority for electronic communications and postal services. In the next table, we can see the number of internet connections from the last 9 years in each region of Slovakia.

Table 1 Amount of internet connections in Slovakia

Region / year	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Bratislava region	126 256, 00	154 086, 00	172 263, 00	203 265, 00	190 573, 00	202 961, 00	211 158, 00	234 080, 00	254 840, 00
Trnava region	60 102, 00	69 156, 00	83 292, 00	89 307, 00	100 168, 00	112 173, 00	119 110, 00	124 663, 00	125 974, 00
Trenčin region	56 058, 00	66 387, 00	82 690, 00	97 473, 00	100 531, 00	112 563, 00	119 388, 00	126 083, 00	139 631, 00
Nitra region	61 328, 00	74 810, 00	97 985, 00	100 192, 00	128 922, 00	132 104, 00	140 037, 00	146 865, 00	164 986, 00
Žilina region	66 797, 00	82 813, 00	103 353, 00	111 036, 00	122 344, 00	134 239, 00	144 201, 00	153 296, 00	162 714, 00
Banska Bystrica region	49 923, 00	59 380, 00	82 688, 00	94 791, 00	102 632, 00	112 145, 00	118 496, 00	131 104, 00	137 552, 00
Prešov region	48 002, 00	65 166, 00	90 316, 00	100 074, 00	109 763, 00	121 271, 00	123 905, 00	126 752, 00	140 032, 00
Košice region	72 695, 00	92 590, 00	113 981, 00	126 528, 00	136 460, 00	147 692, 00	160 397, 00	175 316, 00	174 130, 00

Based on this data we could calculate the trend which can be seen in next graph.

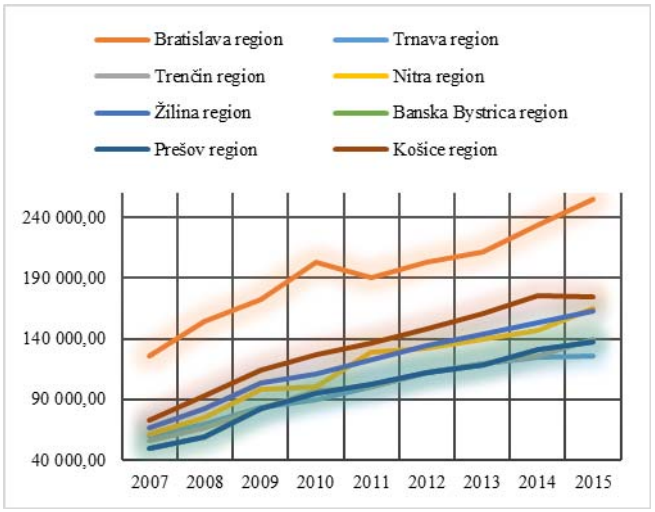

Figure 1 Result of trend analysis

In figure 1 is shown the calculated trend in each region of Slovakia. We can see all of the regions in Slovakia have got an increased trend in internet connections. The biggest region in this case is Bratislava. The result of this trend analysis is that in the next stage we can predict bigger interests in internet connections in every single region of Slovakia. We need to calculate the trend of internet connections in Slovakia overall which can be seen in next figure.

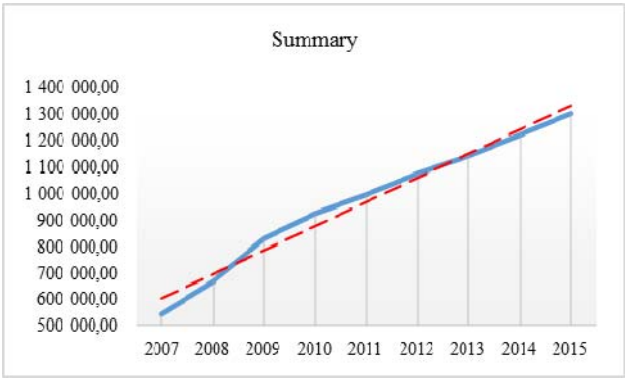

Figure 2 Result of internet connections in Slovakia

This result just proves our main thinking that there will be an increased style of trend, so there will be more interests in internet connections. Now we are getting closer to our main research goal. Firstly, we calculate the trend of the amount of sent items during the last nine years.

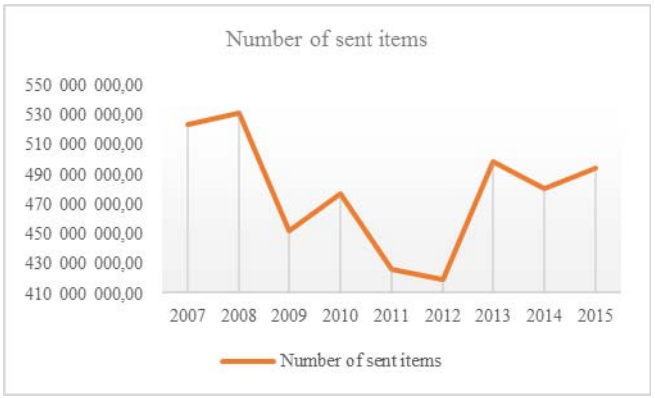

Figure 3 Result of the trend analysis - Number of sent items

This result is more complicated thanks to year 2012 where we can see a strong decreased trend, but in next 3 years we can see there is an increased trend and it is a positive sign for postal services.

4.2 Results of geometric mean

To prove that this is a positive effect for both services we decided to calculate geometric mean. Geometric mean presents number of changes. In the next two tables, there are results of geometric mean of internet connections and number of sent items.

Table 2 Geometric mean - Internet connections

Year	*Amount of internet connection in Slovakia*	X_n-X_{n-1}	X_1*X_2*.X_n
2007	541 161,00		
2008	664 388,00	1,23	
2009	826 568,00	1,24	1,5273976
2010	922 666,00	1,12	1,3887457
2011	991 393,00	1,07	1,1994089
2012	1 075 148,00	1,08	1,1652624
2013	1 136 692,00	1,06	1,1465604
2014	1 218 159,00	1,07	1,1330152
2015	1 299 859,00	1,07	1,1435455
		Geometric mean	**1,016908**

Geometric mean of internet connections is presented by 1,0169 value which means there is a positive change and our result for the trend analysis has just been proved to be better. In the same way we can say that the geometric mean is presented by 0,9988 value which means a positive effect too.

Table 3 Geometric mean – Number of sent items

Year	*Number of sent items*	X_n-X_{n-1}	X_1*X_2*.X_n
2007	523 031 470,00		
2008	531 112 510,00	1,01545039	
2009	451 440 804,00	0,849990907	0,8631236
2010	476 280 444,00	1,055023028	0,89676
2011	425 743 495,00	0,893892454	0,9430771
2012	418 642 574,00	0,983321129	0,8789833
2013	497 941 511,00	1,189419189	1,169581
2014	480 011 539,00	0,963991811	1,1465904
2015	493 492 002,00	1,028083623	0,9910642
		Geometric mean	**0,998879**

4.3. Results of correlation index and regression analysis

We have proved positive effects and increased trend in both the postal services and internet services. But now the main hypothesis is: "Is there any correlation between these two different services?" We calculated it based on statistical method of the regression and correlation index. In the next table, there can be found calculations which help us to achieve our results.

Table 4 Regression analysis

Year	*Number of sent items*	*Amount of internet connections*					
	yi	**xi**	**(xi - xav)**	**(xi-xav)^2**	**(yi - yav)**	**(yi - yav)^2**	**(xi-xav) *(yi-yav)**
2007	523 031 470,00	541 161,00	-42 842,78	178 796 014 718,83	45 509 653,44	2 071 128 556 633 430,00	-19 243 428 278 152,90
2008	531 112 510,00	664 388,00	-29 615,78	89 769 614 293,38	53 590 693,44	2 871 962 423 856 420,00	-16 056 617 298 007,70
2009	451 440 804,00	826 568,00	-13 435,78	18 888 593 013,38	-26 081 012,56	680 219 215 923 048,00	3 584 464 245 804,77
2010	476 280 444,00	922 666,00	-41 337,78	1 708 811 871,60	-1 241 372,56	1 541 005 821 686,60	51 315 582 840,99

DOI: 10.26552/tac.C.2017.1.2

20	425	991 393,00	27	750	-51	2 680 994	-1 418
11	743		389,	169	778	583 110	167 955
	495,00		22	493,94	321,	510,00	378,79
					56		
20	418	1 075	111	12 353	-58	3 466 765	-6 544
12	642	148,00	144,	038	879	203 915	087 618
	574,00		22	133,38	242,	950,00	870,79
					56		
20	497	1 136	172	29 821	20	416 963	3 526
13	941	692,00	688,	222	419	921 204	240 731
	511,00		22	094,27	694,	474,00	932,09
					44		
20	480	1 218	254	64 594	2 489	6 198 717	632 775
14	011	159,00	155,	876	722,	850	961
	539,00		22	982,83	44	370,29	139,43
20	493	1 299	335	112	15	255 046	5 363
15	492	859,00	855,	798	970	823 129	670 181
	002,00		22	730	185,	944,00	373,98
				293,94	44		
Su	**4 297**	**8 676**	**0,00**	**509**	**0,00**	**12 450**	**-30 103**
m	**696**	**034,00**		**481**		**820 451**	**834 447**
ma	**349,00**			**070**		**445**	**318,90**
ry				**895,56**		**800,00**	

Table 4 consists of xi values and yi values which has been defined in 3rd chapter of this article. Our result is represented by linear regression model and by correlation index. In this case regression model is:

$$\mathbf{Yi} = 534\,482\,146{,}96 * xi - 59{,}09$$

Based on this result we can simulate different situations on what will happen if there will be any internet connections or on the other hand if there will be xxxx number of internet connections. Thanks to the correlation index we can see there is no connection between the amount of internet connections and numbers of sent items.

$$\mathbf{R_{xy}^2} = 14{,}29\%$$

This result is not enough to prove correlation between mentioned values. Our result is services provided via internet and postal services can be modern together and we should focus on a way where we can connect them and help each other to offer better services to customers.

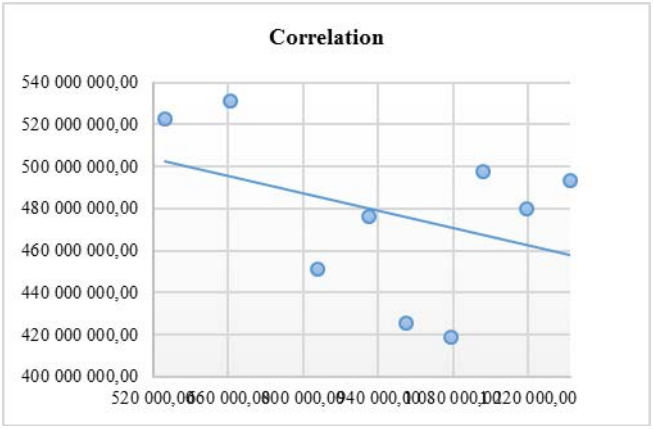

Figure 4 Correlation

For next research, we will create an interactive map where we can choose the relevant year and in the map, we can see the current internet connection in each region of Slovakia. This model can help us understand the predicted situation in upcoming years.

5. Conclusions

At the end of this article let us summarise our results: We have proved an increased trend in postal services and services provided via the internet too. We calculated geometric mean which proved our trend analysis and thanks to these results we can state that postal and electronic services should be developed together and postal operators should find ways how to offer these services to customers. It should help the companies, but the citizens too. Especially if you take into account the fact that our result proved 14,29% of correlation between these two values. It means that there is no negative effect on postal services if customers are interested in internet connections. They would send the same number of items even in the case that there would be a bigger amount of internet connections.

REFERENCES

[1] Online Available: http://www.postovesluzby.sk/postovy-trh/pojmy-postoveho-trhu/

[2] Matej Pechota, “Trends in amount of sent items on Slovak market compare with German, Denmark and Czech market” in Proceedings of 2016 8th International, pp. 250-258, 2016

[3] Zákon č. 351/2011 zo 14. septembra 2011 o elektronických komunikáciách a o zmene a doplnení niektorých zákonov.

[4] Online Available: ttp://www.nethistory.info/History%20of%20the%20Internet/index.html

[5] Analysis of Website Traffic Dependence on Use of Selected Internet Marketing Tools/ Radovan Madleňák, Lucia Madleňáková, Lebor Švadlenka, Daniel Salava, In: 2nd

GLOBAL CONFERENCE on BUSINESS, ECONOMICS, MANAGEMENT and TOURISM. - DOI:10.1016/S2212-5671(15)00355-X

[6] Online Available: https://ec.europa.eu/digital-single-market/en/scoreboard/slovakia#3-use-of-internet

[7] MATÚŠKOVÁ, M., MADLEŇÁKOVÁ, L.: *Významné aspekty regulácie v prostredí elektronických komunikácií a poštových služieb.* In Diagnostika podniku, controlling a logistika. ISBN 978-80-554-1191-0, 2016, roč. 8.

[8] Online Available: https://ec.europa.eu/digital-single-market/en/download-scoreboard-reports

[9] RIMARČÍK, M. (2007) *Statistics for practice*. Bratislava: Marián Rimarčík. ISBN978-80- 969813-1- 1

[10] Bakytová. H and col., Bases of statistics. Bratislava: Academy of economy Bratislava SAV, 1975. ISSN 63-556-75.

Transport and Communications, 2017; Vol. I.
ISSN: 1339-5130
DOI: 10.26552/tac.C.2017.1.3

Temperature of the brakes and the Braking Force

Vladimír Rievaj[1], Lenka Mokričková[2], František Synák[3]

[1] Faculty of Operation and Economics of Transport and Communications – Zilina, University of Zilina, Slovakia
[2] Faculty of Operation and Economics of Transport and Communications – Zilina, University of Zilina, Slovakia
[3] Faculty of Operation and Economics of Transport and Communications – Zilina, University of Zilina, Slovakia

Abstract The kinetic energy of the braking vehicle is changed into heat and the resulting heat increases the temperature of each part of brakes. The changed temperature affects the coefficient of friction between the brake lining and brake drum of brake disc. Unless the brakes are actuated hydraulically there is the warning brake pads and brake fluid. Object of examination in this article is the impact of repetitive braking to change of these parameters and the impact of time to change the boiling point of the brake fluid.

Keywords: Brakes, the increase of temperature, the change of braking performance, brake fluid, the boiling point of the brake fluid

JEL R41

1. Introduction

The accident rate is one of the unintended effects of road transport. If we compare the different causes of accidents, the speed of driving is one of the most dangerous mistakes of drivers. Based on the statistics of the police [1] of Slovak Republic can be stated, that the Slovak republic had an accident, whose cause was the speed, the rate of the total number of 13.67 %, but he ration of the number killed was up 28.96 %. When it forms the column of vehicles on the road, the driver at the high speed must repeatedly brake from high speed to the speed of column and accelerated again. During this activity it occurs in the vehicle's brakes to transform the vehicle kinetic energy into heat, which causes the increase in temperature of the brake parts. In hydraulic brakes there is the raising the temperature of the brake fluid. We wanted find out in describing experiment just these thermal changes of individual parts. The aim was to determine the boiling point of the brake fluid at the time and the impact of absorbed moisture on it, because the brake fluid is strongly hygroscopic. We performed the measurement on passenger vehicle KIA cee'd 1.6 CRDi. When the vehicle was occupied by two persons the front axle was laden the mass m1 = 852 kg and rear axle m2 = 614 kg. Therefore the distance the center of gravity from the front axle was 1.11m. The measurement of temperature was performed on the brake disc of the front axle, brake caliper and piping with brake fluid at the place of connection to the calipers.

2. Change of the temperature of the brake components

As a test case we took the situation in overtaking the line of the traffic. The driver has to reduce the driving speed from 120 km/h to 60 km/h and accelerate again to its original speed. The purpose was to repeat this cycle several times. In order to perform the measurement of temperature at selected points we practised the measurement on laboratories on roller tester. It was necessary under braking converted the same amount of energy into heat as by driving on the road. It is more loaded during the braking the wheels of the front axle, so we focused on the change of temperature of the front axle. [2, 3]

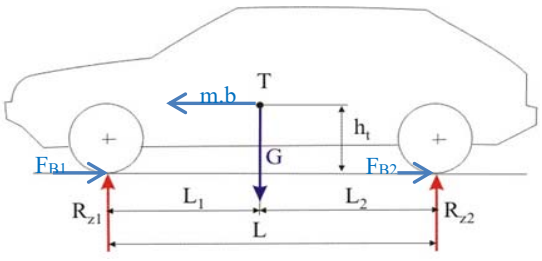

Figure 1. Reaction R_{Z1} Finding

To detect the change of temperature of the selected components of the front brake, it is necessary to determine what rate of kinetic energy the vehicle was converted into heat by the brakes of the front axle.

We suppose the driver draw the braking force that causes deceleration of 3 m/s^2. When the wheelbase of vehicle is L= 2.95 m and the known position the centre of gravity we can determine by calculation the load of the single wheel of the front axle during the braking to value m_1= 485kg, as is

shown in Figure 1.

To achieve the deceleration of 3 m/s^2 then must act on the wheel the braking force F'$_{B1}$ = 1 455N. This value of braking force must be set even if the measurement is performed on the roller brake tester.

Now it is necessary to determine the time of braking during the test on the roller brake tester. We will be average out the amount of kinetic energy which must be in the brakes of the one front wheel to turn on heat. This amount of energy is marked as ΔE_k. This energy is equal to the difference between the kinetic energy of the weight on this wheel at the speed of 120 km/h and 60 km/h. It is possible to write the following equality:

$$\Delta E_K = E_{K120} - E_{K60} \tag{1}$$

or,

$$\Delta E_K = \frac{m_1^{'} \cdot V_1^2}{2} - \frac{m_1^{'} \cdot V_2^2}{2} \tag{2}$$

Where,

m_1 = 485 kg - it is the weight on the one front wheel during the deceleration of the vehicle 3 m/s,

V_1- 120 km/h - it is the initial speed of braking test,

V_2 - it is the final speed of braking test,

ΔE_k - it is the difference of kinetic energies at the beginning and end of the braking test,

$E_{k\ 120}$ - it is the kinetic energy at the beginning of the brake test,

$E_{k\ 60}$ - it is the kinetic energy at the end of the braking test.

Using the information from the previous text, the change of kinetic energy of the vehicle is:

$$\Delta E_K = \left(\frac{485}{2}\right) \cdot \left(\left(\frac{120}{3{,}6}\right)^2 - \left(\frac{60}{3{,}6}\right)^2\right) \tag{3}$$

ΔE_k = 200 833 J

It must be transformed in the brake of one front wheel in to energy 200 833 J into heat. Thus, it was determined the amount of brake force and amount of energy that should be transformed into the heat. As it is a compensation of the real driving situation it is necessary define the time of living the braking force to operate. We determine it based on the track over which must apply the load to do the work 200 833J.

$$s = \frac{\Delta E_K}{F_{B1}^{'}} = \frac{200833}{1455} = 138.03\ m \tag{4}$$

The braking force should apply on the track 138.03 meters. When the roller speed of roller brake tester is V = 4.8 km/h, the time of measurement must be:

$F_{'B1}$ = 1 455 N

$F_{'B1}$ - It is the amount of braking force.

t - It is the time of activity the braking force [s],

V - It is the peripheral speed the roller of the roller brake tester [km/h],

s – It is the track on which must act the braking force $F_{B1}^{'}$ to carry out the work $\Delta E_K = 200833\,J$.

Braking force must be applied for a period of 103.5 seconds to carry out its work.

To be able to find out the change of braking force it must be ensured the equal actuating force. It will be used during braking the load cell to determine the actuating force to draw the desired braking force. For each repeated measurement will be used the same actuating force as was found out at the first measurement. After each measurement it will be detected the surface temperature of the brake disc of the front brake, the surface temperature of the brake caliper, temperature of pipe the brake fluid at the connection to the brake caliper and it will be read off the braking force at the perimeter of the wheel. [4]

2. The boiling point of the brake fluid

During a dynamic driving tends to increase the temperature of the brake components. Therefore, is the issue of brake fluid boiling point very important. The brake fluid is a highly hygroscopic substance which absorbs moisture from the surroundings and affects its boiling point. During the experiment was the brake fluid placed in the bowl, which has within the cap outlet with diameter 1 mm, figure 2, medium bowl. Thus, stored liquid was exposed to the activity of surrounding (heat, light, change of moisture) for seven months. After this time was reviewed its boiling point by the means of device Bosh BFT 100, figure 3.

Figure 2. Braking fluid

Figure 3. Device for measuring the boiling point of brake fluid

The brake fluid is a highly hygroscopic substance and its boiling point varies with the amount of absorbed moisture. What effect has the moisture on its boiling point has been verified by adding the distilled water. Into 100ml of brake fluid was gradually added one ml of distilled water, this substance was mixed perfectly and then was measured the boiling point. For comparison was measured the boiling point of the new liquid. [3]

DOI: 10.26552/tac.C.2017.1.3

3. Measurements

Is was used to measure the vehicle Kia cee´d 1.6 CVVT and the following measuring devices:

- The roller brake tester Motex 75 19 (Figure 4). It is a diagnostic device that allows to measure and continuously monitor the braking forces at the periphery of individual wheels of one axle. The peripheral speed of the brake cylinders of roller brake tester is 4.8 km/h-1.

Figure 4. Roller Brake Tester Motex 75 19

- Pedometer Corrsys Datron is used to measure the force exerted on the brake pedal. It consists of a sensor, which is attached to the brake pedal (Figure 5), cable and evaluation device. The amount of control force is displayed on the digital display.

Figure 5. Pedometer Corrsys Datron

- Contact thermometer Greisinger GTH 122 (Figure 6). Thermometer has two ranges of measuremet: from -65°C to +199.9°C and -65°C to +1 150°C. The resolution 0.1°C or 1°C, accuracy ± 0.2 % and operating temperature 0 to 45°C.

Figure 6. Contact Thermometer Greisinger GTH 1200

- Seconds counter

4. Measurements results

A) The change of temperature of the brake components

The results of the measurement and the measured values are summarized in the graph at the figure 7.

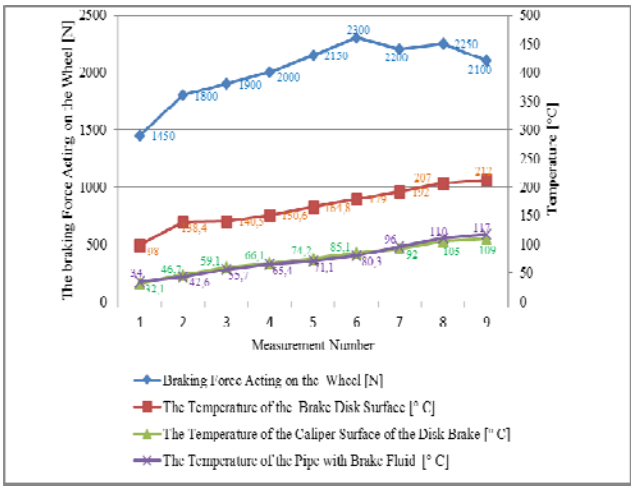

Figure 7. Changing of the braking force as a function of the temperature

In order to compare the change of amount of braking force on the peripheral of the wheel, at each measurement by using pedometer was inferred to the brake actuator the same operating force 350N. So was ensured that the change of amount of braking force has been caused as a result the change of friction properties of lining in changing its temperature. The friction of lining improves with increasing temperature. At the sixth braking cycle has been reached the temperature of brake disc 179°C. At this temperature was measured the maximum braking force of 2 300N. Next braking cycles caused an increase of temperature of the brake components but the inferred braking force has been lower and had a downward trend.

B) The change of the boiling point of brake fluid

Changes of the boiling point of the brake fluid are shown in Table 1.

Table 1. Changes of the boiling point of the brake fluid [°C]

	Changes of the boiling point of the brake fluid [°C]						
Status of the fluid	New	After 7 months	The added amount of distilled water into 100 ml of brake fluid				
			1 [ml]	2 [ml]	3 [ml]	4 [ml]	5 [ml]
Boiling point	267	162	216	202	186	155	138

5. Conclusions

The experiment verified the change of temperature of braking components in vehicle by repeated braking from high speed and the impact of the temperature to the amount of braking force. The second aim was to find out the change of the boiling point of braking fluid with the time and with the amount of absorbed moisture. That the result was comparable was used constant braking force authenticated by using pedometer. This was adjusted such that the vehicle has reached during the first braking deceleration of 3 m/s^2. From the comparison of the temperature is evident that the repeating braking can leads to the increase of temperature of the braking lining and also to increase in the braking. When the temperature of brake disc reaches the value 179°C it was recorded the decrease of braking force. This decrease lasted until the end of experiment. In terms of operation is important the boiling point of the brake fluid, because at the end of experiment was the temperature of pipe with brake fluid 117°C. During the measurement was verified that by repeated heavy braking of the vehicle and by omissions of braking fluid is realistically achieve the condition, that the temperature of braking fluid reaches the boiling point. In the time to achieve this is significantly reduced the performance of brake.

ACKNOWLEDGEMENTS

VEGA Project No. 1/0331/2014 - ŠULGAN, M. a kol.: The modelling of distribution logistics system could lead to solving problem of distribution of the existing or new projecting of distribution logistics system in company, , ŽU in Žilina, FPEDAS, 2014-2016.

REFERENCES

[1] http://www.minv.sk/swift_data/source/policia/dopravna_policia/statistika_dn/2014/http://www.opel.sk/

[2] Rievaj, V. - Šulgan, M. – Hudák, A. – Jagelčák,J. Automobil a jeho dynamika. 1. Vyd. Žilina: EDIS, 2013. 224 s. ISBN 978-80-554-0627-5

[3] MATĚJKA, R.: *Vozidla silniční dopravy I, 2. vydanie.* Vydavateľstvo Alfa Bratislava 1990

[4] JAN, Z.- ŽDÁNSKÝ, B.-ČUPERA, J. Automobily 1: podvozky. Brno: Avid, 2009. 227 s. ISBN 978-80-87143-03-2

Transport and Communications, 2017; Vol. I.
ISSN: 1339-5130

Zero-fare Transport Services and Its Impact on Segment of Students

Natália Stalmašeková[1], Tatiana Genzorová[2], Lucia Gašperová[3]

[1]Department of Communications, University of Žilina, Žilina, 010 26, Slovakia
[2]Department of Communications, University of Žilina, Žilina, 010 26, Slovakia
[3]Department of Communications, University of Žilina, Žilina, 010 26, Slovakia

Abstract The end of 2014 brought big changes for the Slovak rail passenger transport market. On November 17th, the state began to cover the full cost of tickets for selected passenger groups, which caused a significant increase in passenger numbers from these groups. It is a European rarity. This social initiative made many people happy, but also brought a lot of displeasure. The aim of this paper is to analyse, on the basis of primary research, impacts of zero- fare transport services on the segment of students. The paper also provides an overview of zero-fare transport conditions and basic characteristic of Železničná spoločnosť Slovensko.

Keywords rail passenger transport, students, primary research

JEL L92

1. Introduction

The end of 2014 brought big changes for the Slovak rail passenger transport market. On November 17th, the state began to cover the full cost of tickets for selected passenger groups, which caused a significant increase in passenger numbers from these groups. On December 14th, the Czech private company RegioJet began a service on the Bratislava – Žilina – Košice line. Until that date, Železničná spoločnosť Slovensko was the single carrier in rail passenger transport on this route. The Bratislava - Žilina - Košice route is a key one for rail passenger services in Slovakia, as it connects the eastern with the western part of Slovakia.

2. Goals and methodology

The goal of the paper is to analyse, on the basis of primary research the acceptance of zero-fare transport services by segment of students and identifying consequences of this issue on rail passenger transport in Slovakia. In the survey, we set two hypotheses.

3. Analysis of current situation

ZSSK is a joint-stock company with the seat in the Slovak Republic (SR), founded on 13 December 2004 and incorporated into the Companies‘ Register of the District Court of Bratislava I as of 1 January 2005. Its founder and a 100-percent shareholder is the Slovak Republic, represented by the Ministry of Transport, Construction and Regional Development of the Slovak Republic (MTCRD SR). ZSSK settles its needs and costs from income obtained from its business activities, as well as from foreign resources. For many years it was the only company providing passenger rail transport service in the Slovak Republic. It carries out an average of 1,445 daily train connections, operates services in 69 of the 79 districts of Slovakia and stops at 690 stations and stops in Slovakia. [1]

Types of trains in domestic transport in Slovakia:

- EuroCity (EC),
- InterCity (IC),
- Express train (EX),
- fast train, (R)
- fasten train (RR),
- local train (Os).

Table 1. Important numbers of Železničná spoločnosť in Slovakia

	2012	2013	2014	2015
Transported passengers (mil. person)	43, 445	44, 287	47, 286	57,275
Employees (in thousands)	5 846	5 724	5 841	5 949
Loss (in mil.)	11, 272	7, 105	6, 379	5, 889
Average wage (€)	877,15	886,69	912,58	956,25

3.1. Zero-fare transport services

Železničná spoločnosť Slovensko provides from 17 November 2014 by a decision of the Slovak Government zero-fare transport services for:

- children under 15 years of age,
- full - time students under 26 years age,
- seniors under 62 years of age,
- seniors over 62 years of age.

Passengers entitled for zero-fare transport services are required to register at ZSSK cash desks

Upon registration, they will obtain their rail customer cards that will allow them to get zero-fare tickets for travelling by trains. Zero-fare tickets are passenger-specific and train-specific (for long distance trains only), i.e. the tickets are non-transferable and bound to a specific train. Zero-fare tickets are bound to long-distance trains of R, RR, Ex, EN, EC, SC category. The zero-fare transport is not available on IC trains. [2]

Table 2. Revenue of company

v tis. EUR	2014	2015	Difference
Passenger transport and related revenues	110 043	90 003	-20 040
Compensation from Contract on Transport Services in Public Interest	212 632	226 106	13 474

In Table 2 we see that revenues related to the transport of passengers in 2015 declined about 20 million. Eur. Compensation from Contract on Transport Services in Public Interest, which is provided to the company by State had risen only slightly over 13 million. Eur.

The introduction of free of charge transport divided Slovak passengers into two groups. Those who expressed satisfaction with the strain the budget and the second group, which calls for investments improving train services. To free of charge transport was registered 890,902 passengers in 2015, more seniors than students. ZSSK recorded 461,454 registrations of seniors, it represents 51.8 % of total. Free of charge travel by rail took away part of the passengers from the bus transport. Suburban buses were changed to trains by 3 % percent of passengers, which represent 185 thousand passengers. 17 % passengers left coaches, which represents 395 thousands of passengers. [3]

4. Results

In 2015, we realized a survey on the sample of 391 students. The survey was focused on the student's reactions to the introduction of free transport.

Hypotheses

H1: More than 80 % of students use free of charge transport by Železničná spoločnosť Slovensko.

H2: More than 30 % of respondents think, that support of students could be performed differently than by compensation of rail transport.

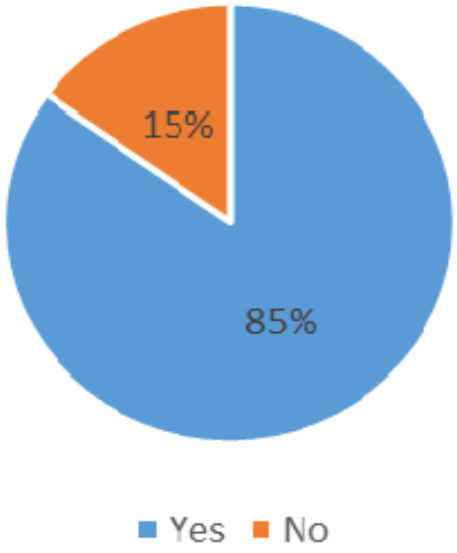

Figure 1. With transporting by Železničná spoločnosť Slovensko, do you use the compensation from the State and therefore transport free of charge?

Figure 1 shows the percentage of students who used the opportunity of free of charge transport. Figure 1 also confirms the hypothesis No.1. In hypothesis, we assumed that more than 80% of the students use free of charge transport by Železničná spoločnosť Slovensko.

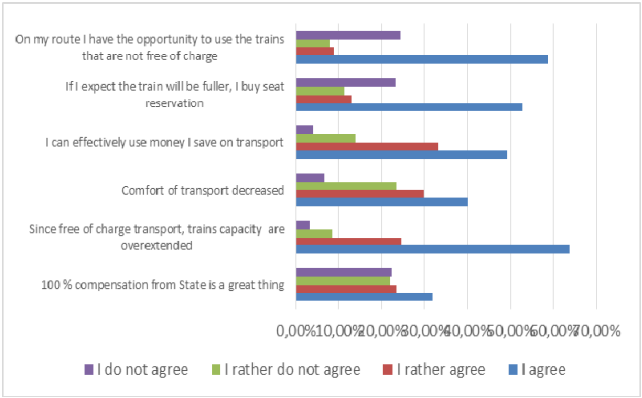

Figure 2. Give your opinion about following statements.

In Figure 2 we can see six statements. Respondents should give their opinion about them on the scale of answers. Scale included answers: I agree, I rather agree, I rather do agree, I do not agree on which respondents were asked on a scale of responses express their opinions.

- 100 % compensation from State is a great thing.
- Since free of charge transport, trains capacity are overextended.

DOI: 10.26552/tac.C.2017.1.4

- Comfort of transport decreased.
- I can effectively use money I save on transport.
- If I expect the train will be fuller, I buy seat reservation.
- On my route, I have the opportunity to use the trains that are not free of charge.

Comprehensive view of Figure 2 shows us that free of charge transport for students and pensioners has brought several changes for passengers. It means, that 63.7% of respondents think that the trains are fuller, since the entry of free of charge transport and 40.1% of respondents said that comfort of travelling fell. Only few percent of respondents do not agree with this argument. Nearly 50% of respondents claim that they can effectively use the money which they save on traveling, although only 31.9% of respondents believe that free of charge of transport was a good idea. 22.4% of respondents disagree with the statement and 22% tend to disagree with it. 24.4% respondents do not have opportunity use other train as the trains of ZSSK and 58.7% of respondents have the option of using another train, but obviously prefer trains of ZSSK.

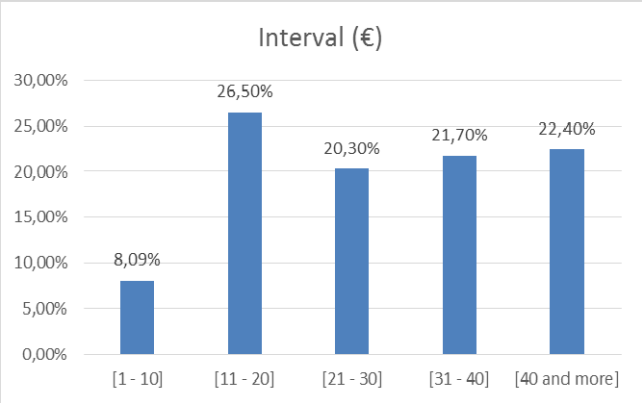

Figure 3. Please estimate how much money per month you save with free of charge transport.

We were interested in what impact had grant from the state to the economic situation of the respondents. They were asked to estimate about how much per month will save on travel. The values of the responses were divided into five intervals. Most responses remained in the range from 11 to 20 €. Mode, the value that occurred most frequently among responses is 20 €. Average savings of respondents of free charge transport is 33 € and the highest value of what respondents said, was 100 €.

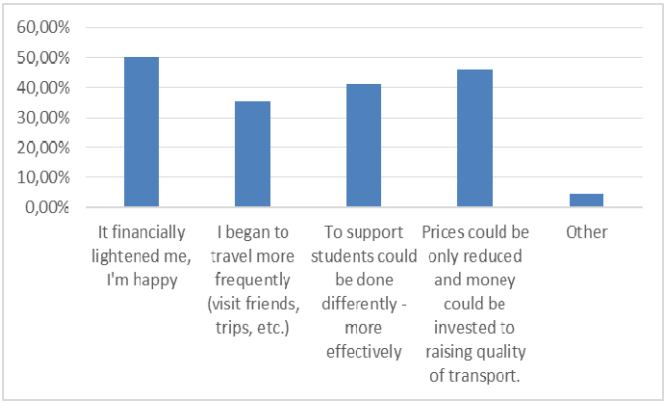

Figure 4. How would you evaluate free of charge transport?

As the survey began in October 2015, respondents have already had the opportunity to travel free of charge, that is why we wanted to find out how respondents evaluate this possibility. Respondents had the option to mark more than one answer.

50.2% of the respondents in stated in their response that free travelling lightened their finances and so they are satisfied. The positive effect of free travel, we can mainly see in the potential for traveling to see family, friends and making trips general more often.

35.3% of the respondents marked this answer.

46% of respondents agreed with the claim that enough would be to subside only part of the price of ticket and rest invest into the quality of traveling services.

41.1% of respondents agree with the statement that supporting students could have been done differently than with a free train transportation.

4.5% of the respondent marked another option.

Thanks this question we have confirmed the hypothesis number 2, also that at least 30% of the respondents think that students could be supported in other way than by subsidizing train transportation.

5. Conclusions

Free of charge transport for specific segments of citizens is European rarity. This social initiative made many people happy, but also brought a lot of displeasure. Free of charge transport is not actually free of charge, but is paid from State budget. In table 1 and 2 we can see while the number of passengers increased almost by 10 million, revenues from transport decreased and State compensation is growing. In the survey, we asked students to express the experience with free of charge transport, their satisfaction or dissatisfaction.

The results showed that comfort of transport declined and the trains are much fuller. Up to 84.9 % of respondents use free of charge transport and it will save them 20 € on average per month.

Although respondents admit that the free of charge transport financially lightened their budget and they are satisfied, they also agree with the statement that the prices

could be only reduced and students could be supported differently.

REFERENCES

[1] Online Available: http://www.slovakrail.sk/en/about-us/profil-en.html

[2] Online Available: http://www.slovakrail.sk/en/zero-fare.html

[3] Online Available: http://spravy.pravda.sk/ekonomika/clanok/386188-statne-vlaky-vlani-prepravili-o-10-milionov-ludi-viac/

Transport and Communications, 2017; Vol. I.
ISSN: 1339-5130

Measurement of Impact of Air Filter Cleanness on a Change of Engine Speed Characteristics

František Synák[1], Vladimír Rievaj[2]

1 Faculty of Operation and Economics of Transport and Communications, University of Zilina, Slovakia
2 Faculty of Operation and Economics of Transport and Communications, University of Zilina, Slovakia

Abstract The paper is focused on the impact of clogged air filter on a change of speed characteristics of spark-ignition engine 1.4 MPI, 16V, 74 kW. The clogged air filter can cause deterioration in engine charging. Less air means the possibility of burning smaller amount of fuel, and thus less energy brought to the engine. This should cause a change in the size of engine torque and its power.

Keywords air filter, engine torque, inlet manifold, engine power

JEL R40

1. Introduction

The role of air filter is to absorb impurities that could cause wear of engine above the permissible extent [6]. The internal combustion engine for its operation needs to intake a certain amount of air. How much fuel is injected into engine depends on the amount of intake air. It is ideal for spark-ignition engines to maintain air-fuel ratio λ close to 1. However, the intake air must be free of any mechanical impurities that would cause faster engine wear. These impurities are absorbed by filter and they deteriorate the air flow through filter. This leads to deterioration in engine charging. In order to maintain optimum air-fuel ratio λ, a smaller amount of fuel injected into cylinder can be used. The result during fuel combustion is less released heat and lower engine power. The aim of measurement is to find the impact of clogged filter on a change of speed engine characteristics. The paper offers results of measurements of both, vehicle with new unclogged filter and vehicle with clogged filter after driving 60 000 km. Both results are shown as a graph.

2. Methodology

Vehicle description

- Vehicle: Škoda Fabia 1.4 MPI, 16V, 74 kW, 1390 cm^3.
- Number of forward gear is 5 [1].
- There were used new filter and clogged filter with driving 60 000 km for measurement, see Figure 1.

Figure 1 Filters used during measurement

Measuring device description

For measurement, it was used a dynamometer MAHA MSR 500 V, Figure 2. The accuracy is ± 2%. During measurement, humidity, pressure and air temperature are being recorded and the computer is communicating with an electronic control unit. The computer records actual data from engine, especially its temperature and revolutions. The device is also able to measure a vehicle with four-wheel drive, with maximum axle load 2 500 kg and maximum power 1 000 kW, with drawbar pull max. 7 000 N. Maximum speed of measurement is 210 km.h-1.

Figure 2 Dynamometer MAHA MSR 500 V

Measurement procedure

Before measurement, new air filter was inserted into inlet manifold and visual inspection of completeness of inlet manifold was conducted followed by verification of air intake system tightness and checking of tire inflation. After checking, the vehicle was set on cylinders and secured against displacement by means of belt tensioners. The engine control unit was connected to computer of measuring device. The vehicle identification, fault memory checking, measurement parameters setting and devices calibration were conducted. After that came the measurement of speed engine characteristics itself, in the 4th gear. The measurement was carried out at full pressing on accelerator pedal with full-open throttle. Finishing of the first measurement was followed by replacement of new filter by clogged filter and the measurement of speed engine characteristics was carried out again. At the end, the measurement result was printed in the form of a graph, see Figure 3.

3. Measurement results

The measurement result can be seen in the graph, Figure 3. Thick lines are curves of new filter; thin lines are curves of clogged filter.

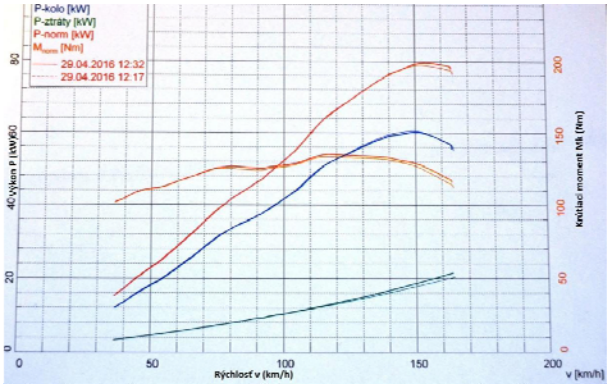

Figure 3 Measurement results

Engine power curves, in red, have the same course in both filters in the speed range from 37 km.h-1 almost up to 149 km.h-1. From speed 149 km.h-1 up to the end of measurement, speed of 164 km.h-1 stands the power curve measured using a clogged filter slightly below the power curve measured using new filter. Maximum difference is almost 2 kW.

The course of engine torque depending on a vehicle speed as well as engine revolutions is the same in the range from 37 km.h-1 up to 78 km.h-1. The engine with clogged filter has at the higher speeds the lower torque. The decrease of engine torque became evident almost at the mean engine revolutions. It can be assumed that it is a consequence of deteriorated engine charging caused by clogged air filter. Maximum difference is 1.8 Nm.

Measured differences are relatively low. There is no assumption that they could be seen by the driver owing to their placement in engine revolutions which are usually not used. The reason of low differences is the offset of change in the permeability of filter for engine control electronics. In the inlet manifold, there is a pressure sensor which sends the data to engine control unit [4]. The control unit on the basis of intake air pressure, its temperature and flow velocity assesses the air quantity and converts to it the adequate amount of fuel that is adjusted through the interference of injection length. The correct composition of fuel mixture with air is also checked by lambda probe [2]. Lambda probe is placed in the exhaust pipe and evaluates the amount of unburnt oxygen in exhaust gases. In the case of too rich or too lean mixture, the engine control unit adjusts the injection length as well as the composition of mixture.

The change of intake and exhaust resistance leads to the change of engine pressure conditions for which the timing of intake and exhaust valves is proposed. From that, it can be assumed that even in the case of removing of inlet manifold and in-taking air right from throttle body, it would lead to cutting down of engine power and torque [2]. The reason is the setting of control unit in vehicle design and making formulas and values stored in the control unit. The resistance and losses in the manifold with using of serial air filter is also taking into account. It would lead to decrease of power loss, if the values in control unit were changed by diagnostic equipment.

More significant changes in engine speed characteristics due to clogged filter could be presupposed in an older type of vehicle without air weight, or without pressure meter in manifold, and without lambda probe [2]. The increased resistance in inlet manifold, and thus lower air flow could cause rich mixture and lower engine power and torque. These changes would produce higher fuel consumption and they would adversely affect the vehicle emissions [3].

The measurement results can be also applied into consideration about suitability for using of sport filter. The low differences in values indicate the pointless in changing serial for sport filter due to increasing of engine power for regular operation. The result would be only an increased

DOI: 10.26552/tac.C.2017.1.5

engine noise since the serial filter acts also as a silencer [2]. In the case of using low-quality sport filter, there is a risk of intake of increased number of dust elements which cause when mixed with oil an excessive wear of moving engine parts.

4. Conclusion

The aim of measurement was to determine the impact of clogged filter on speed engine characteristics. The clogged filter causes deteriorated charging of engine. The measurement result is that the engine torque became lower almost at mean engine revolutions and a noticeable decrease of engine power became evident almost at maximum power engine. The change of these parameters will evince in worse vehicle dynamics and weaker acceleration. More clogged air filter would mean more evident decrease of engine power than our measured 2 kW decrease. The vehicle would not reach its maximum speed specified by the manufacturer. The clogged filter will be probably reflected in the increased vehicle consumption [2].

REFERENCES

[1] Althaus, Rainer. 2004. *Škoda fabia.* Praha: Kopp nakladatelství. 2004. ISBN 80-7232-229-0

[2] Horníček, Jan. 2007. *Jezdíme ekonomicky*. Praha: ComputerPress. a.s. 2007. 149 p. ISBN 978-80-251-1624-1

[3] Matěj, Juraj. 2012. *Spotreba paliva motorového vozidla*. In: Posterus. y. 5, 2012. n.5. [online]. 2012 [cit. 2016-09-03]. Available at: <http://www.posterus.sk/?p=13033 >

[4] Němec, Vladimír. 2013. *Nepřímé vstřikování benzínu Mono-Motronic* [online]. 2013 [cit. 2015-09-21]. Available: <http://www.sps-vitkovice.cz/texty/texty/SIV/Mono-Motronic -UT.pdf>

[5] Schwarz, Jiří. 2014. *Škoda felicie.* Praha: Grada publishing a.s. 2014. ISBN 978-80-247-3657-0

[6] Zdeněk, Ján. – ŽDÁNSKÝ, Bronislav. 2009. *Automobily 3, Motory*. Brno: Avid, 2009. ISBN 80-90-36711-9

[7] Zogbaum, Emil. 2015. *Poradnik mechanika samochodowego.* Varšava: Wydawnictwa Komunikacji aj Łączności WKL, 2015. ISBN 978-83-206-1222-6

TRANSPORT AND COMMUNICATIONS

Scientific journal intended to combine theory and practice in the field transport and communications and thus advancement of transport and communications sciences.

Each paper was reviewed by two reviewers. Authors hold responsibility for linguistic quality (language as well as grammar accuracy) of the article.

The Scope of Journal: Transport and postal policy, Public passenger transportation systems, Quality of transport and post services, Demand and supply in transport, post and telecommunications, Logistic systems, Road transport, Rail transport, Water transport, Air transport, The business environment in the SR, The cross-border cooperation.

Journal is excerpted in **Index Copernicus** database.

Frequency of publishing: Twice per year.

Publishing language: English

Publisher: The Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 1, 010 26 Žilina, Slovakia

Printed: EDIS – Printing House of the University of Žilina, Univerzitná 1, 010 26 Žilina, Slovakia

IČO 00 397 563

Edition: 50 pc

Registered No: EV 4902/13

Tel: ++421/41/5133051

Email: tac@fpedas.uniza.sk

Web: http://tac.uniza.sk

May 2017

DOI: 10.26552/tac.J.2017.1

ISSN 1339-5130

ISSN 1339-5130

DOI: 10.26552/tac.J.2017.1