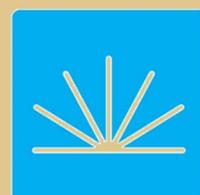
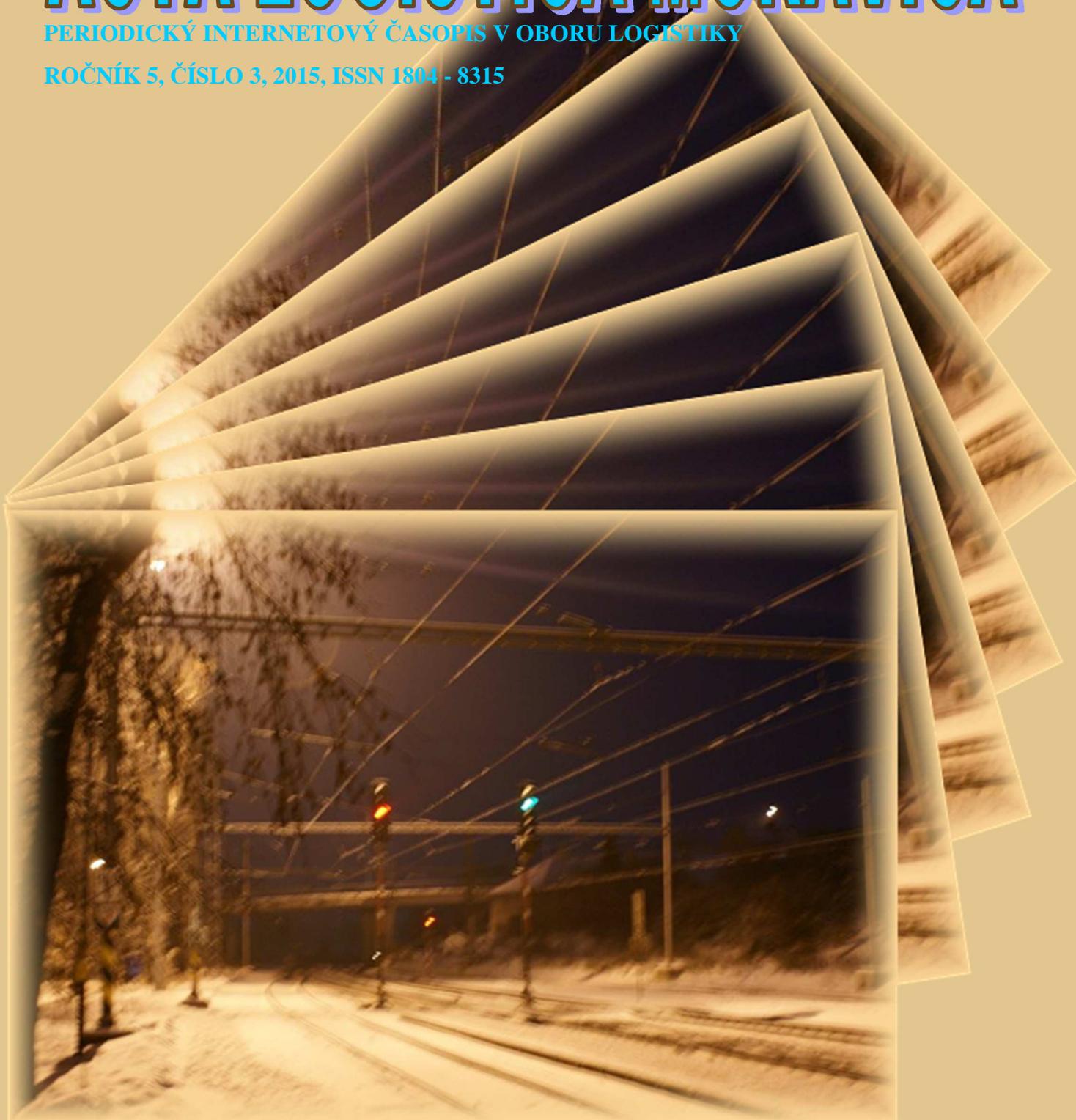


# ACTA LOGISTICA MORAVICA

PERIODICKÝ INTERNETOVÝ ČASOPIS V OBOU LOGISTIKY

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# THE ISSUE OF DETERMINATION OF TRAFFIC VOLUMES ON URBAN ROADS

## PROBLEMATIKA VÝPOČTU INTENZIT DOPRAVY NA MÍSTNÍCH KOMUNIKACÍCH

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### **Abstract**

The paper describes the partial outputs of the project focused on measuring the intensity of transport flows and improvement of the methodology for determining these intensities on roads in the urban areas. The presumption was that the current methodology for determining the traffic intensities cannot be applied to the specific types of traffic on selected urban roads. The aim of the traffic surveys and subsequent analysis was to find ways to adjust the methodology for determining the traffic intensities so that it can be used on urban roads with a specific types of traffic.

### **Abstrakt**

Příspěvek pojednává o dílčím výstupu projektu zaměřeného na měření intenzit dopravy a zpřesnění metodiky výpočtu těchto intenzit na pozemních komunikacích na území města. Je zde předpoklad, že současné technické podmínky, respektive metodika výpočtu intenzit, nelze aplikovat na charakter provozu na vybraných místních komunikacích. Cílem dopravního měření a následné analýzy bylo nalézt rámcové možnosti, jak stávající metodiku výpočtu intenzit upravit tak, aby ji bylo možno použít i na místní komunikace se specifickým charakterem provozu.

### **Keywords**

Traffic Intensities, Urban Roads, TP 189, Annual Average Daily Traffic, AADT

### **Klíčová slova**

Intenzity dopravy, místní pozemní komunikace, TP 189, Roční průměr denních intenzit

## INTRODUCTION

The traffic intensity is the main measure of roadway capacity. Mostly it is given by daily traffic intensity, which represents the number of vehicles that will pass through one point of the road in both directions for 24 hours (in one day). Another important indicator of the traffic intensity is called Annual Average Daily Traffic (AADT) for given section of a road, which is the number of vehicles, which on average will pass through the section of the road in both

directions in the working day for 24 hours. Size indicator of traffic intensity of is AADT [cars / 24h].

In more detail the problems of conducting the surveys, evaluation of surveys, AADT determination, daily intensities or hourly peak intensities are described in the document of Technical condition no. 189 (TP 189) entitled "Determination of traffic volumes on the roads." with the help of conversion coefficients.

Now the current conversion coefficients are given for each category of roads. They appear to be inefficient tool for calculation of intensity in the category of local roads, which reflects the actual state of operation of a different character according to the surrounding buildings and the use of the urban area. Another important document is the technical conditions no. 225 (TP 225) entitled "Prognosis of the intensity of car traffic", which were analyzed as part of the project as well.

## **IMPLEMENTATION OF TRAFFIC SURVEYS**

In November 2014 the measuring of traffic intensity on local urban roads was held in cooperation with company B & C Transport Systems, Ltd. and The Institute of Technology and Business in České Budějovice. The aim of the project was to analyze the present technical conditions, dealing with procedures for calculating the intensity on all roads. Measurements were carried out on local urban roads and selected roads of I. and II. classes in the territory of České Budějovice, together with measurements in other towns.

Realization of measurement and analysis of the achieved data was the basis for evaluation of the existing legislative instruments to determine the output protocol of AADT (annual average daily traffic). An essential tool (and therefore decisive for determining the AADT) is the method of sensing the actual values and their processing in accordance with the procedure defined in TP 189 and TP 225. Both procedures are a fundamental tools for the evaluation of measurement results. Research team conducted planned measurements in selected cities to obtain the real data, which were compiled into the output formats in accordance with the aforementioned "technical conditions". Consequently, they were compared and analyzed. Values in the form of tabular ratio coefficients diverge significantly for different types of vehicles, roads, seasons in city traffic on urban roads. Realized measurement of the traffic intensities and their relevance are the basis for determining the actual traffic volumes. Each measurement must capture the most accurate and verifiable number of vehicles that are passing through the measured section. It is also significant to define measuring section. The selected sections must reflect the current traffic needs and needs of city population and must be generalized in all the selected cities. It regards the establishment of general principles for the selection of the measurement points and the definition of social mobility needs of the population.

Strong emphasis was placed on the verifiability of the measurement and the results. B&C Transportation Systems Ltd. owns measuring devices that are capable of capturing a movements of vehicles at selected road section in provable way. It is a device that based on ultrasound technology captures all passing vehicles. Measuring the intensity is then possible to realize in longer time periods and the results more accurately evaluated. It is mainly the possibility of measuring the intensity in reduced visibility (night period). Authenticity of record of the actual number of vehicles is proved by the timestamp of each passing vehicle and its speed. Thus it is possible to precise allocation of vehicles to defined types, which is required

by the applicable technical conditions TP 189. Realized measurement was planned for a period 12 to 24 hour measurements in order to fully capture the day's traffic volume. The obtained values were analyzed after defined time periods and then compared with the calculation according to Technical conditions. The measured values for a defined period of measurement have become the default for comparing the coefficients defined by Technical conditions for local roads and tertiary roads marked as "M" and the roads adjoining the parking areas by the commercial and business zones (usually a special-purpose roads) marked as "Z".

According to the initial results we can say that the categorization of roadways in towns under the current technical conditions is too general and does not reflect the specifics of the transport system of the city. It is a fact that the current TP 189 and TP 225 are designed mainly to determine the value of traffic intensity on roads defined as categories D, R, I, II - the intercity traffic. Local and special roads generally define roadways in the city, but currently it is necessary to define further the importance of local and tertiary roads. It is obvious that the classic categories of local roads according to law no. 13/1997 is also not an appropriate categorization for the determination of traffic volumes in terms of different traffic characters in the city.

Research team also pays an attention to other factors that affect the transport needs of the population. The basis of preparation of measurement plan was to analyze all major destinations of population mobility. The fact is that the diversification of starting work time in various companies, business hours of shopping malls, working hours of administrative institutions and healthcare facilities significantly affects the whole process of required mobility of the population.

### **ANALYSIS OF DATA FROM MEASUREMENTS OF THE INTENSITY**

Realized measurements were subjected in all points of measurement to detailed analysis of the actual values of the individual coefficients and coefficients according to the TP 189. The results show that there is indeed a significant difference especially for measurements on local roads in cities. A very important factor is the definition of the final destinations of the population mobility and reason of using the local roads.

Primary consideration for selecting local roads for measuring the traffic intensity was the fact that roads in the city each have different specific traffic character according to the town planning and economic character of the surrounding buildings - for example the daily variations of the traffic intensity will be different for special local roads and local roads with mixed traffic, daily variation of traffic intensity will also vary with the local road linking the industrial zones of the city (due to the shift operation) or for local access roads to the schools, student dormitories, administrative institutions etc. We can identify different specific operations on local roads, of which for the initial phase of measurement and subsequent analysis were the following:

- the access roads for shopping centers,
- local roads in residential areas,
- local roads with administrative centers,
- fast local roads,
- local roads linking industrial zones.

Based on the determination of these types of local roads it is necessary to determine the new values of  $p_i^d$ , which will reflect the values relevant to a conversion coefficients according to the actual character of the traffic on the road and it is possible to determine them according to the daily variation of traffic intensity (weekly variations, yearly variations, etc.). It also means the future intervention into the existing methodology – to change current Technical conditions TP 189.

According to the above-mentioned proposal for the distribution of local roads the roadways in the city of České Budějovice were selected on which the pilot measurements were carried out. From the data obtained during the traffic surveys were drawn graphs indicating the number of passing vehicles in dependence on time. From these graphs and measured values can be seen the traffic characteristics specific to the selected roads in the city.

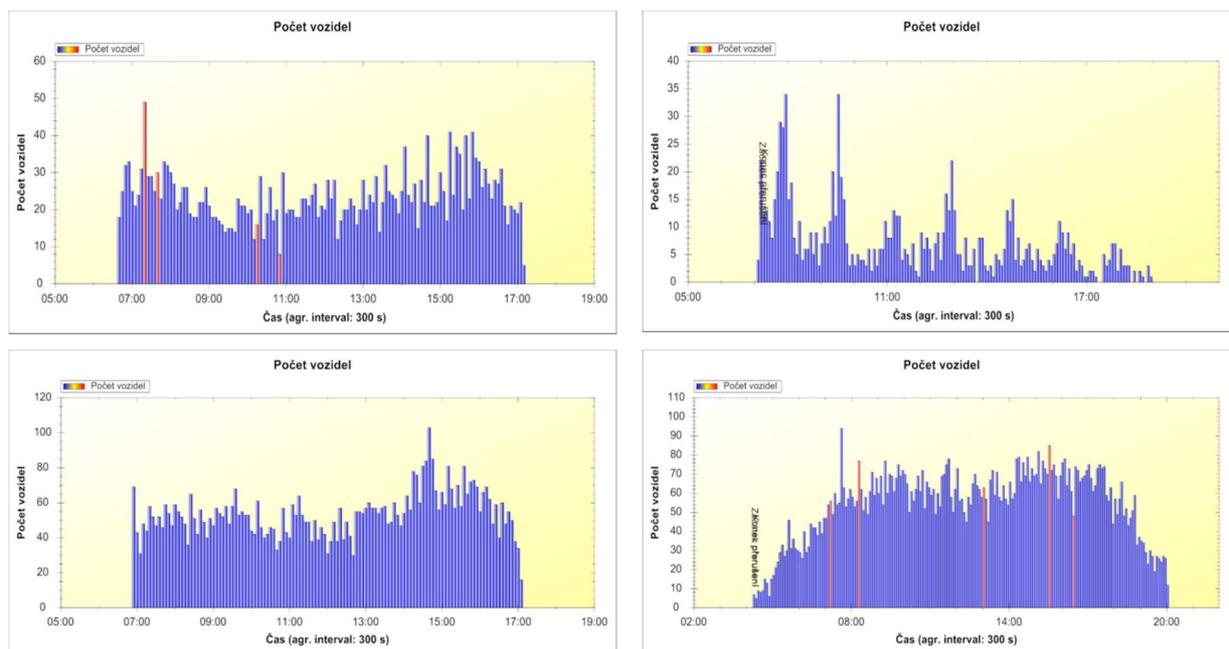


Figure 1 – Graphical output of measurements in the profiles of local roads with different specific characters traffic. Source: Authors

For purposes of analysis of methodology for determining the daily variation of intensities the shares of cars in total course of the reporting period were determined (measurements were carried out according to each hours of the day). These shares indicate to us the conversion coefficients, thanks to which can be determined the daily variation of traffic from the data obtained during the measurement.

The following table and diagram output (Figure 2) shows comparison of converted coefficients from measured data and conversion coefficients set by current methodology (TP 189) for calculations of daily intensities generally on all roads, both in urban and in rural areas. The scheme demonstrates the significant deviation of the set out coefficients and converted coefficients at the measuring points, in this case on a local service road in the residential area.

Počátek intervalu	Počet vozidel	Podíl [%]	Kum. podíl [%]	Koef. Denni variace TP 189 OA
6:48:41	623	9,4	9,4	4,81
7:48:41	598	9	18,4	6,79
8:48:41	500	7,5	25,9	6,66
9:48:41	506	7,6	33,5	6,36
10:48:41	499	7,5	41	6,28
11:48:41	486	7,3	48,3	6,13
12:48:41	455	6,8	55,2	6,22
13:48:41	619	9,3	64,5	6,51
14:48:41	744	11,2	75,7	7,36
15:48:41	752	11,3	87	8,15
16:48:41	457	7	94	7,92
17:48:41	357	5,4	99,4	7,04
18:48:41	42	0,6	100	5,62

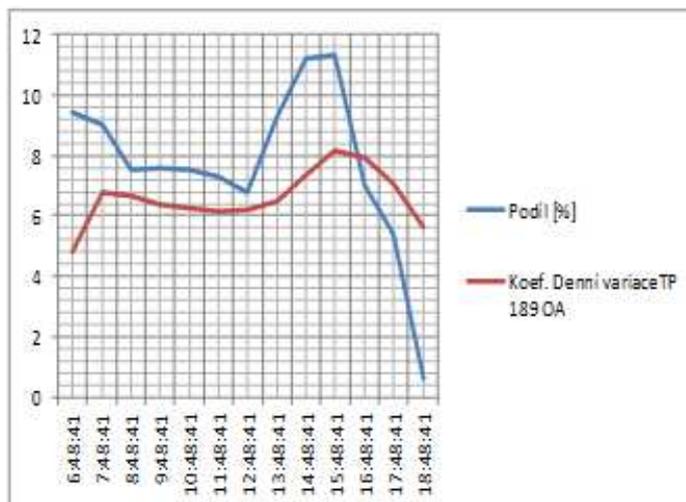


Figure 2 - Table and graph comparing the coefficients of Daily variation - REALITY (blue curve) vs. TP 189 methodology at Jírovcova street in České Budějovice. Source: Authors

### ANALYSIS OF INFLUENCE OF TIME-LIMITED MEASUREMENT OF THE INTENSITY ON THE URBAN ROADS IN ČESKÉ BUDĚJOVICE AND A COMPARISON OF MEASUREMENT RESULTS WITH THE METHODOLOGY OF CALCULATING THE DAILY INTENSITY ACCORDING TO TP 189

From the measurement results (the intensity gained at the relevant time measurement -  $I_m$ ) were compiled tables expressing the frequency of vehicles in hourly intervals. According to the type of communication, day hour of measurement and season were used the values of the shares of intensities for exact hour for vehicles in total (according to TP 189). Using equation (1) the values of conversion factors for each type of local road were determined and the daily traffic volume was then for the "total vehicle" determined according to formula (2). These formulas can be found in TP 189, which directly regulates the calculation methodology for all roads. Values of conversion coefficients  $k_{m,d}$  for any selected time period of the survey is determined by the relationship:

$$k_{m,d} = \frac{100\%}{\sum p_i^d}, \quad (1)$$

where:

$\sum p_i^d$  is the sum of the shares of hourly traffic volumes during the survey on a daily traffic volume [%]. Recommended values  $p_i^d$  are determined for each types of vehicles and traffic characters in annexes of TP 189, where may also be found the coefficients  $k_{m,d}$  for the recommended time of the survey.

Daily traffic intensity is determined for each type of vehicle (or vehicles in total) using the formula:

$$I_d = I_m \cdot k_{m,d}, \quad (2)$$

where:

$I_d$  is a daily traffic volume in the day of the survey [cars/day],

$I_m$  is the traffic volume gained at the time of the survey [cars/time period],

$K_{m,d}$  is a conversion coefficient of traffic intensity at the time of the survey on a daily traffic volume (taking into account the daily variations in traffic according to TP 189).

Mutually comparison of the results of daily intensities for specific time intervals according to TP 189 can be concluded that these values are different, and quite significantly. For example, if we look at the values shown in Table. 1, it is evident that according to the each hour segments can not be applied the conversion coefficients which are used by the TP 189 for calculations of traffic volumes on local roads near commercial zones. Basically, the value of the  $I_d$  for each hour sections should be the same as the value of  $I_d$  in 24 hours, or it is as close as possible (marked in red text in tables). It is similar with other roads in the city, where the values are shown in Table no. 2, 3 and 4. It can be noted that the recommended values  $p_i^d$  of TP 189 (ratio of intensity of each hour  $i$  on a daily traffic volume) can not be applied to certain types of local roads with a specific traffic. This observed deviation may also be caused by several factors, but mainly by the small sample of input data. Measurements will necessary to be repeated several times and measure the passing vehicles for at least 24 hours at each station, to have the opportunity to work with a more representative sample of data. Then the measurement results have a greater explanatory power and would be more objective for the partial conclusions or for further work with the data.

Table 1 - Converted coefficients and daily traffic volume on a local road near commercial zones.

Road/Hour	11. 11. 2014 Commercial zone Globus			$I_d$ [cars/24 h] (M)
	$p_d^i$ (M)	$K_{m,d}$ (M)	$I_m$ [cars/time period]	
7h - 8h	6,79	14,7275405	179	2636,22975
8h - 9h	6,75	14,81481481	476	7051,851852
9h - 10h	6,66	15,01501502	698	10480,48048
10h - 11h	6,56	15,24390244	787	11996,95122
11h - 12h	6,37	15,69858713	933	14646,78179
12h - 13h	6,35	15,7480315	871	13716,53543
13h - 14h	6,69	14,94768311	791	11823,61734
14h - 15h	7,41	13,49527665	918	12388,66397
15h - 16h	7,89	12,67427123	1085	13751,58428
16h - 17h	7,51	13,31557923	1083	14420,7723
17h - 18h	6,61	15,12859304	932	14099,84871
18h - 19h	5,32	18,79699248	550	10338,34586
<b>Cars in total:</b>			9303	
<b><math>K_{m,d}</math> (5h-20h) [cars/ reference period] M:</b>			1,235941169	
<b><math>I_d</math> [cars/24 h] M:</b>			11497,9607	

Source: authors, own findings and data

Table 2 - Converted coefficients and daily traffic volume on the road of II. class - in the city.

Road/Hour	13. 11. 2014 Pražská street			I <sub>d</sub> [cars/24 h] (II-S)
	p <sub>d</sub> <sup>i</sup> (M)	k <sub>m,d</sub> (II-S)	I <sub>m</sub> [cars/time period]	
7h - 8h	6,69	14,94768311	1666	24902,84006
8h - 9h	6,84	14,61988304	1452	21228,07018
9h - 10h	6,6	15,15151515	1399	21196,9697
10h - 11h	6,43	15,55209953	1269	19735,61431
11h - 12h	6,16	16,23376623	1187	19269,48052
12h - 13h	6,28	15,92356688	1297	20652,86624
13h - 14h	6,81	14,68428781	1250	18355,35977
14h - 15h	7,72	12,95336788	1478	19145,07772
15h - 16h	8,22	12,16545012	1586	19294,40389
16h - 17h	7,63	13,1061599	1444	18925,29489
17h - 18h	6,51	15,3609831	1165	17895,54531
18h - 19h	4,98	20,08032129	878	17630,52209
<b>Cars in total:</b>			16071	
<b>k<sub>m,d</sub> (5h-20h) [cars/ reference period] II-S:</b>			1,236552492	
<b>I<sub>d</sub> [cars/24 h] II-S:</b>			19872,63509	

Source: authors, own findings and data

Table 3 - Converted coefficients and the daily traffic volume determined on the road II. class - tangential character of transport in the city..

Road/Hour	12. 11. 2014 – Okružní street			I <sub>d</sub> [cars/24 h] (II-S)
	p <sub>d</sub> <sup>i</sup> (M)	k <sub>m,d</sub> (II-S)	I <sub>m</sub> [cars/time period]	
7h - 8h	6,69	14,94768	1204	3856,502242
8h - 9h	6,84	14,61988	1306	2192,982456
9h - 10h	6,6	15,15152	1277	3878,787879
10h - 11h	6,43	15,5521	1096	1912,908243
11h - 12h	6,16	16,23377	1129	3798,701299
12h - 13h	6,28	15,92357	1512	2738,853503
13h - 14h	6,81	14,68429	1652	2437,591777
14h - 15h	7,72	12,95337	1526	2538,860104
15h - 16h	8,22	12,16545	1391	1849,148418
16h - 17h	7,63	13,10616	1336	3289,646134
17h - 18h	6,51	15,36098	760	2135,176651
18h - 19h	4,98	20,08032	459	2048,192771
<b>Cars in total:</b>			14648	
<b>k<sub>m,d</sub> (5h-20h) [cars/ reference period] II-S:</b>			1,236552492	
<b>I<sub>d</sub> [cars/24 h] II-S:</b>			18113,0209	

Source: authors, own findings and data

Table 4 - Conversion coefficients and the daily traffic volume determined on a local road - near the administrative center of the region.

Road/Hour	12. 11. 2014 – Acces road to VŠTE			$I_d$ [cars/24 h] (M)
	$p_d^i$ (M)	$k_{m,d}$ (M)	$I_m$ [cars/time period]	
7h - 8h	6,79	14,7275405	258	3799,705449
8h - 9h	6,75	14,81481481	150	2222,222222
9h - 10h	6,66	15,01501502	256	3843,843844
10h - 11h	6,56	15,24390244	123	1875
11h - 12h	6,37	15,69858713	234	3673,469388
12h - 13h	6,35	15,7480315	172	2708,661417
13h - 14h	6,69	14,94768311	166	2481,315396
14h - 15h	7,41	13,49527665	196	2645,074224
15h - 16h	7,89	12,67427123	152	1926,489227
16h - 17h	7,51	13,31557923	251	3342,210386
17h - 18h	6,61	15,12859304	139	2102,874433
18h - 19h	5,32	18,79699248	102	1917,293233
<b>Cars in total:</b>			2199	
<b><math>k_{m,d}</math> (5h-20h) [cars/ reference period] M:</b>			1,235941169	
<b><math>I_d</math> [cars/24 h] M:</b>			2717,834631	

Source: authors, own findings and data

Realized measurements were subjected in all points of measurement to detailed analysis of the actual values of the individual coefficients and coefficients according to the TP 189. The results show that there is indeed a significant difference especially for measurements on local roads in cities. A very important factor is the definition of the final destinations of the population mobility and reason of using the local roads.

## CONCLUSION

The authors of the contribution analyzed existing TP 189 and TP 225. These technical guidelines are the basis for the determination and calculation of Annual Average Daily Traffic (AADT). The basic tool is a set of coefficients that are derived from practical measurements. Based on the findings of some shortcomings arising from the analysis the measuring of the traffic intensities was done, which confirmed the primary considerations. It is true that actuality of some values (on which the model of AADT is assembled) does not reflect reality and actually measured traffic volumes, especially in the context of calculations of AADT on local roads.

It was found that both intensities are different for each local communications with the specific character of traffic, and are significantly different even over the day compared to intensities in rural roads. It is all about the intensity of morning and afternoon intensity. The aim of the project was not to make judgments about the values of hourly coefficients of intensity (seet by TP 189), but investigators show that the update of the TP 189 will be required in the future.

## LITERATURE

- [1] TP 189 Determination of traffic volumes on roads (II. edition), EDIP s.r.o., 2012.
- [2] TP 225 Prognosis of intensities of automobile transport, EDIP s.r.o., 2010.
- [3] Law No.13/1997 Sb., o pozemních komunikacích, as subsequently amended.
- [4] Decree of the Ministry of Transport and Communications č.104/1997 Sb., which implements the law on roads, as subsequently amended.

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# POSSIBILITIES OF REVERSE MATERIAL FLOWS SOLUTION

## MOŽNOSTI RIEŠENIA SPÄTNÝCH MATERIÁLOVÝCH TOKOV

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### **Abstract**

The paper deals with the problem of reverse material flows in the production enterprise. The main accent is on the use of wastes from the production process and their reverse use in the production process.

### **Abstrakt**

Príspevok sa zaoberá problematikou spätných materiálových tokov vo výrobnjej spoločnosti. Hlavný dôraz sa kladie na využitie odpadov z výrobného procesu a ich spätné využitie vo výrobnom procese.

### **Key words**

Material Flow, Reverse Material Flow, Waste

### **Kľúčové slová**

Materiálový tok, spätný materiálový tok, odpad

## **INTRODUCTION**

Waste presents an unwanted part of production in every enterprise. There are many ways how to achieve elimination of wastes from the enterprise. But, in recent time, enterprises perceive the waste as a something “positive” because it can bring profit for enterprise. Some commodities of wastes can save funds by the right solution and liquidation or it can present the source of incomes. One of the suitable way how to effectively use wastes is their recycling. The basic idea of recycling is “based on” reverse material flows and reverse logistics.

## **BACKWARD (OR REVERSE) MATERIAL FLOW AND REVERSE LOGISTICS**

Logistics management emphasizes the management of raw materials, supplies flows in the production and also finished products and it ensures the effectiveness of this management (Malindžák et al., 2007). Therefore, for the overall logistics process the material flow and its following management is very important. It is also important the management of material flow from the point of its creation to the point of consumption (Sixta – Žižka, 2009). It can happen the situation when the material in the logistics chain does not flow from the supplier of raw materials by the producer to the consumer, i.e. “by the flow”, but there is a reverse flow. It gains importance in the field of reverse logistics. This flow is created on the one hand by waste, which can be recycled and partially returns to the next use like a secondary raw material, or it can be created by goods under complaint or returned products or products which finished their lifetime. The other part of reverse flows are presented by returnable containers. All these part created a new, important logistics subsystem, namely reverse logistics (Brezina et al., 2009). Reverse

logistics is a part of eco-logistics and it deals with control, support and realization of reverse flows of raw materials, materials in collecting networks at the direction from customers to the point of processing (Husáková, 2015). Evidence of reverse logistics importance is possible to see in the loss of profit for enterprise which are not able to operate with reverse flows and are not prepared to implement reverse logistics into its own management. Implementation of reverse logistics in all sectors of the industry can be follow in the supply chain (Brezina et al., 2009).

## **POSSIBILITIES OF REVERSE MATERIAL FLOW SOLUTION IN THE SPECIFIC ENTERPRISE**

Possibilities of reverse material flow solution were examined by the help of the case study which was realized by the researchers of the Institute of Logistics (Faculty BERG, TU Košice) in the specific enterprise dealing with production of printers, sensors, scanners etc. The enterprise produces various wastes, but the majority part is presented by plastic wastes. The plastic creates more than 60% of the total volume of wastes in this enterprise. This plastic waste is produced at the department of plastic pressroom and by reason of its volume it presents the subject of interest in the enterprise. For recycling are suitable three types of these plastic wastes. The table 1 presents these types of wastes, their yearly “production” and the price of these wastes per 1 kg.

Table 1 Types of plastics wastes suitable for recycling in the researched enterprise

Type of plastic waste	Yearly “production” [kg/year]	Price for kg [Eur]
DELIRIN 500P NAT.NC10	7817,05	2
TERLURAN GP-22 SCH	2015,96	3
ULTRAMID 4355 G5 Natural	3689,24	3

Source: author

### **Analysis of market oriented to the recycling devices**

For the researched enterprise was very important to select a suitable recycling technology for wastes and secondary raw materials processes. Therefore, by the case study we realized a market analysis oriented to these technologies. From the results of this analysis we obtained the summary in the way of knife mills. Knife mills are suitable devices for wastes granulation which have single-sortal character. It is a device which ensures that the output form of the plastic waste has required and right form (by the researched enterprise plastic regranulate) [18].

### **Selection of the suitable device for the recycling process**

For implementation of recycling process to the production at the department of plastic pressroom, it was needed to select suitable technological device by the demands of the enterprise. For this selection was by the case study applied two methods of multi criteria decision making, namely Saaty’s method and method of paired comparison. These methods

were applied also by evaluation of partial utility of variants by the selected criteria. For the selection of suitable variant six criteria were defined. These criteria describe properties of devices. These criteria were the subject of consultation with three employees of the researched enterprise (from the department of quality, logistics and plastic production). Table 2 present the determined criteria for the next solution by the case study. We must emphasize that the partial calculations (comparison of criteria by the selected methods, evaluation of criteria, calculation of the normed scales of criteria, determination of the partial utility by the criteria) are not included in this paper in the results of their extensiveness.

Table 2 Evaluation criteria for the selection of suitable variant

Criteria	Variant No. 1 Knife mill G150/240	Variant No. 2 Knife mill C 17.31	Variant No. 3 Knife mill SG 1628 N
A: Output [kg/h]	15 – 50	25-30	50
B: Fastidiousness of operation	simple	simple	more exacting
C: Equipment	screens	screens	screens
D: Input mouth	197x400 mm <sup>2</sup>	170x310 mm <sup>2</sup>	385x400 mm <sup>2</sup>
E: Service	2	3	1
F: Acquisition price	4600 EUR	3300 EUR	5050 EUR

Source: author

### Calculation of the total utility by the selected methods

For selection of the suitable variant it is needed to calculate the total utility of each variant. The calculations of the normed scales of criteria for knife mills were noticed in the total table of utility also as the normed scales of partial utility for each variant by the defined criteria. This information was needed for realization of calculation for selection of suitable recycling device at the department of plastic pressroom.

From the calculations obtained by Saaty`s method it is evident that the suitable device for this purpose is presented by the variant No. 2, that means, that from the possibilities it was selected the knife mill C 17.31 (by the company Wanner). Table 3 presents the total calculation.

Tab. 3 Calculation of total utility for recycling devices by Saaty`s method

Criterion	Variants Scale of the the criterion	Variant No. 1		Variant No. 2		Variant No. 3	
		Utility		Utility		Utility	
A	0,149	0,623	0,093	0,239	0,036	0,138	0,021
B	0,083	0,283	0,023	0,648	0,054	0,074	0,006
C	0,027	0,107	0,003	0,260	0,007	0,633	0,017
D	0,251	0,260	0,056	0,633	0,159	0,107	0,027
E	0,047	0,072	0,003	0,696	0,033	0,232	0,011
F	0,443	0,379	0,168	0,278	0,124	0,343	0,152
Total utility	1	Σ	0,346	Σ	<b>0,413</b>	Σ	0,234

Source: author, own calculation

For precision of the results it was applied the calculation of the total utility of the devices by the method of paired comparison. This method acknowledge that the variant No. 2 is suitable

for the processing of plastic waste at the department of plastic production. The calculation of the total utility by the method of paired comparison is presented by the Table 4.

Table 4 Calculation of the total utility for the evaluated recycling devices by the method of paired comparison

Criterion	Variants	Variant No. 1		Variant No. 2		Variant No. 3	
		Scale of the criterion	Utility	Utility	Utility	Utility	Utility
A	0,190	0,667	0,128	0,333	0,063	0,000	0,000
B	0,143	0,333	0,048	0,667	0,095	0,000	0,000
C	0,048	0,000	0,000	0,667	0,032	0,333	0,016
D	0,238	0,333	0,079	0,667	0,159	0,000	0,000
E	0,095	0,000	0,000	0,667	0,063	0,333	0,032
F	0,286	0,000	0,000	0,667	0,191	0,333	0,095
Total utility	1	Σ	0,225	Σ	<b>0,603</b>	Σ	0,143

Source: author, own calculation

## SUMMARY OF RESULTS OF BOTH USED METHODS

Results of the calculations of both applied methods were summarized in the Table 5, which presents the total utility of the selected variants. By this table, it is evident, that the variant No. 2 is the best in comparison with the selected variants, namely in the case of both methods.

Table 5 Comparison of the results of used methods

Partial utility	SM	MPC
V1	0,346	0,000
<b>V2</b>	<b>0,413</b>	<b>0,032</b>
V3	0,234	0,095

Source: author, own calculation

## RESULTS AND DISCUSSION

After the analysis of the plastic wastes production at the department of plastic pressroom we obtained the following results:

- definition of the plastic wastes at the department of plastic pressroom;
- definition of plastics production at the department of plastic pressroom and creation of the scheme;
- definition of the current way of plastic wastes elimination from the department of plastic pressroom, this is presented by sale of plastic wastes;
- design of new way of plastic wastes elimination at the researched department, by application of recycling at the department of plastic pressroom and implementation of the recycling process to the scheme of wastes production at this department.

Subsequently, it was realized a market analysis aimed at recycling devices, and by this way it was selected the solution, which is presented by three ways of recycling solution:

- knife mill G 150/240,
- knife mill C 17:32;
- knife mill 1628 N. SG.

After the market analysis for recycling devices were selected two methods of multi criteria decision making, by which it was selected the suitable variant of solution, namely Saaty`s method and method of paired comparison. After the calculation, it was found that the suitable recycling device for this department of plastic production is the variant No. 2, namely the knife mill of the company Wanner (type 17:31).

## CONCLUSION

We can say that reverse logistics is a part of enterprise management. This example was also in the researched enterprise. By the help of the case study it was research the department of plastic pressroom with the definition of the produced wastes, above all plastic wastes. The first step of solution for reverse material flow in this enterprise was the design of the scheme for reverse material flows with the repeated "implementation" of plastic wastes to production process. The designed solution also includes the selection of suitable recycling device for implementation of recycling. For this solution it was realized the market analysis and by the help of consultation with the enterprise it was selected knife mills from three companies. For their comparison were used two methods, namely Saaty`s method and method of paired comparison. These methods were used for precision of results, namely by comparison of results of these methods. After the calculation it was determined that the suitable variant for implementation of recycling process is application of knife mill by the company Wanner (type C 17.31). By implementation of the recycling process at the department of plastic production, the production provides suitable re-granulate for own purpose.

## LITERATURE

[1] HUSÁKOVÁ, N. – TOMKOVÁ, E. 2015. Eco-logistics – new application field of logistics. In: *Logistický monitor*. July, 2015. ISSN 1336-5851.

[2] MALINDŽÁK, D. et al. *Teória logistiky /definície, paradigmy, princípy, štruktúry/*. Košice: KARNAT, 2007. ISBN 978-80-8073-8.

[3] SIXTA, J. – ŽIŽKA, M. *Logistika /Metody používané pro řešení logistických projektů/*. Brno: Computer Press, 2009. ISBN 978-80-251-2563-2.

[4] BREZINA, I. et al. *Modelovanie reverznej logistiky /optimalizácia procesov recyklácie a likvidácie odpadu/*. Vydavateľstvo Ekonóm, 2009. ISBN 978-80-225-2825-2.

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# LOGISTICS AND MARS TERRAFORMATION

## LOGISTIKA A TERRAFORMACE MARSU

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### **Abstract**

The article describes new approach to Mars terraformation. With regard to similarity of chemical composition of the Earth and Mars, two ways of Mars terraformation are presented: driven the fall of Mars satellites Phobos and Deimos, and evaporation of a frozen subsurface ocean with help of solar radiation (the ocean is covered with only about 1 meter thick layer of dust). Hazards associated with the case of driven fall of the satellites are discussed in conclusion.

### **Abstrakt**

Článek popisuje nový přístup k terraformaci Marsu. S ohledem na podobnost chemického složení Marsu a Země jsou diskutovány dvě možnosti, jak terraformaci provést: řízený pád měsíců Phobos a Deimos na Mars a odpaření zmrzlého podpovrchového oceánu s využitím slunečního záření (oceán je pokryt jen asi 1 metr silnou vrstvou navátého prachu). V závěru práce jsou diskutována rizika řízeného pádu měsíců.

### **Keywords**

Mars, terraformation

### **Klíčová slova**

Mars, terraformace

## INTRODUCTION

Terraformation could be considered as an essential and challenging and final aspect of planetary exploration. For Mars landers, the constraints of mass, volume, power and energy typically limit their communications capabilities on the long-distance link back to the Earth. By deploying relay spacecraft in Martian orbit, these landers can achieve much greater data return and can obtain contact opportunities at times when Earth is not in view. Currently, both NASA and European Space Agency (ESA) have pursued this strategy, deploying relay payloads on their Mars science orbiters. This relay infrastructure has significantly benefited the science return from the 2003 Mars Exploration Rovers and is poised to support the Phoenix Lander and Mars Science Laboratory missions later this decade. Longer-term plans call for continued growth in relay capability, greatly increasing data return from the Martian surface to enable exciting new Mars exploration concepts and advance our understanding of our planetary neighbour. This article presents the new approach to the terraforming of the planet Mars, using current telecommunications technologies.

## HOW TO ADAPT ATMOSPHERE OF MARS IN NEAR FUTURE

Contemporary state of telecommunication development enables us to drive spacecrafts on Mars orbit or Mars surface very precisely. Recent successful landing of Curiosity rover on Mars is serious evidence of it. The only limitation is light velocity. Every signal from the Earth to Mars or a signal in opposite direction flights around 15 minutes depending on the actual distance of Mars. However, this limitation is solved with automatization of more complicated tasks in most situations.

The planet Mars is an attractive destination for various spacecrafts. Now, the spacecrafts are automatic, and they obtain data about Mars surface, physical processes, Mars weather, and indirectly even about the interior of Mars. However, the humankind will not be satisfied with this state. It will colonize Mars in coming decades with great probability. The specific date of manned mission to Mars is constantly postponed due to many problems. Sparse atmosphere of Mars and low temperature on Mars surface belong to them.

Particular projects try to increase Mars atmosphere density with different methods, for example microorganisms, vegetation, mirrors (in orbit around Mars). Mars has giant water reserves in subsurface frozen ocean with dimensions 800×800 km, discovered in 2005. We can use it for our benefit.

### MANAGEMENT AND ORGANIZATION OF THE DRIVEN FALL OF MARS

#### SATELLITES TO MARS SURFACE

It seems that the fastest way to make the atmosphere denser is to transfer Mars satellite Phobos or Deimos (or both) to descending trajectory and cause the fall of the satellite to Mars. If we aim the satellite or both satellites just to that ocean, big amount of water will sublimate, and surface air pressure and temperature will increase. The highest temperature increase will happen on the place of the fall; however, consequences of the fall will affect the whole planet. Global higher temperature will probably also cause evaporation of frozen carbon dioxide. Although part of carbon dioxide and water steam escape Mars or will be dissociated by solar radiation, the process will be relatively slow. For the first several decades or centuries after the fall, the atmosphere will stay denser than now. This fact will help mankind with Mars colonisation.



**Picture 1** Moon Phobos

(source: Exoplanety.cz, [www.exoplanety.cz](http://www.exoplanety.cz))



**Picture 2** Moon Deimos

(source: [www.astro.cz](http://www.astro.cz))

The crucial question is how to change trajectory of Mars satellite to descending trajectory. Probably the simplest method is to use rocket motors. Contemporary Saturn V rocket has a thrust of 34 meganewtons (first stage) for 150 seconds. It can be presumed that propulsion unit much more powerful than contemporary Saturn V will be available after 2050.

Let's analyze the problem closer.

Both Mars satellites circulate in near circle orbits almost sharp in Mars equator plane. Parameters of the satellites and their orbits are following:

satellite	Phobos	Deimos
orbital radius $r_0$ [km]	9 380	23 460
orbital velocity $v_0$ [km/s]	2.138	1.352
orbital period $T$ [day]	0.319	1.262
mass $m$ [kg]	$10.659 \times 10^{15}$	$1.476 \times 10^{15}$

The energetically least demanding way how to manage the fall of a satellite to Mars, is to decrease the original orbital velocity  $v_0$  to a new velocity  $v_1$  so high, to the satellite enters a new, elliptic orbit with its farthest point in a distance of the original circle orbit  $r_1 = r_0$  and with the narrowest point in distance  $r_2$  which is equal to Mars radius. Mars radius is 3402.5 km. We start from energy conservation law

$$E_{k1} + E_{p1} = E_{k2} + E_{p2} ,$$

where  $E_{k1} = \frac{1}{2} m v_1^2$  is kinetic energy of the satellite after slowing down in the farthest point of the new orbit,

$$E_{p1} = - \kappa m M / r_1$$

is potential energy of the satellite in the farthest point of the new orbit,  $E_{k2} = \frac{1}{2} m v_2^2$  is kinetic energy in the narrowest point of the new orbit (it means in distance of Mars radius from the center of Mars)  $r_2$  , and

$$E_{p2} = - \kappa m M / r_2$$

is potential energy in the narrowest point of the new orbit (it means in distance of Mars radius from the center of Mars)  $r_2$ . Next, we use law of angular momentum conservation which can be written in scalar form

$$r_1 m v_1 = r_2 m v_2 ,$$

so

$$r_1 v_1 = r_2 v_2 .$$

We considered the mass of Mars  $M = 6.4185 \times 10^{23}$  kg as much greater than the masses of Mars satellites. However, Mars also rotates, and the direction of Mars rotation is the same as direction of satellites orbital movement. One Mars rotational period is 24 h 52 min long. Rotational velocity on Mars equator is  $v_{rot} = 0.239$  km/s. It is necessary to subtract this velocity from the satellite velocity in the narrowest point  $v_2$ . Velocity of tangential fall is  $v_2' = v_2 - v_{rot}$ . It would be enough to slow down the satellites a bit less. The narrowest point would not be on the surface but somewhere above – but in Mars atmosphere, and braking effect

of the atmosphere would slow down the satellite so much that the satellite would fall to Mars after several circuits.

Resultant velocities are in following table

satellite	Phobos	Deimos
v1 [km/s]	1.559	0.680
v2 [km/s]	4.298	4.689
v2' [km/s]	4.059	4.450
Ek2' [J]	8.781×10 <sup>22</sup>	1.461×10 <sup>22</sup>

Ek2' is “effective” kinetic energy of the satellite movement in the moment of the fall to Mars. We can suppose that most of this energy transforms to heat (less part affects deformation and destruction of surface rock on Mars, rotation velocity can negligibly change, etc.).

Mars atmosphere will be thickened mainly by carbon dioxide CO<sub>2</sub> (it constitutes 95% of planet atmosphere already now) and water steam H<sub>2</sub>O which will sublimate into atmosphere in a big amount.

Exact amount of H<sub>2</sub>O on Mars is unknown and estimations are changing according to new explorations of cosmic space probes. Now, the amount of H<sub>2</sub>O on Mars is being estimated to 5×10<sup>6</sup> km<sup>3</sup> (5×10<sup>18</sup> kg) [2]. Most of water ice is located in polar caps but approximately 6×10<sup>4</sup> km<sup>3</sup> (6×10<sup>16</sup> kg) of water ice is situated in middle latitudes (as a part of permafrost). 3×10<sup>-2</sup> km<sup>3</sup> (3×10<sup>10</sup> kg) sublimates to the atmosphere and deposits back to the ground seasonally. Water nearly cannot exist in liquid state on Mars because average pressure on Mars is only 0,610 kPa. This pressure is approximately equal to pressure in Earth's atmosphere in height of 30 km over sea level.

Average temperature on Mars is -63 °C. If the frozen ocean should be sublimated after the fall, the low temperature ice must be heated to melting temperature 0 °C first. Then latent heat of sublimation must be given (latent heat of melting, heat necessary to warming to boiling temperature, and latent heat of boiling respectively).

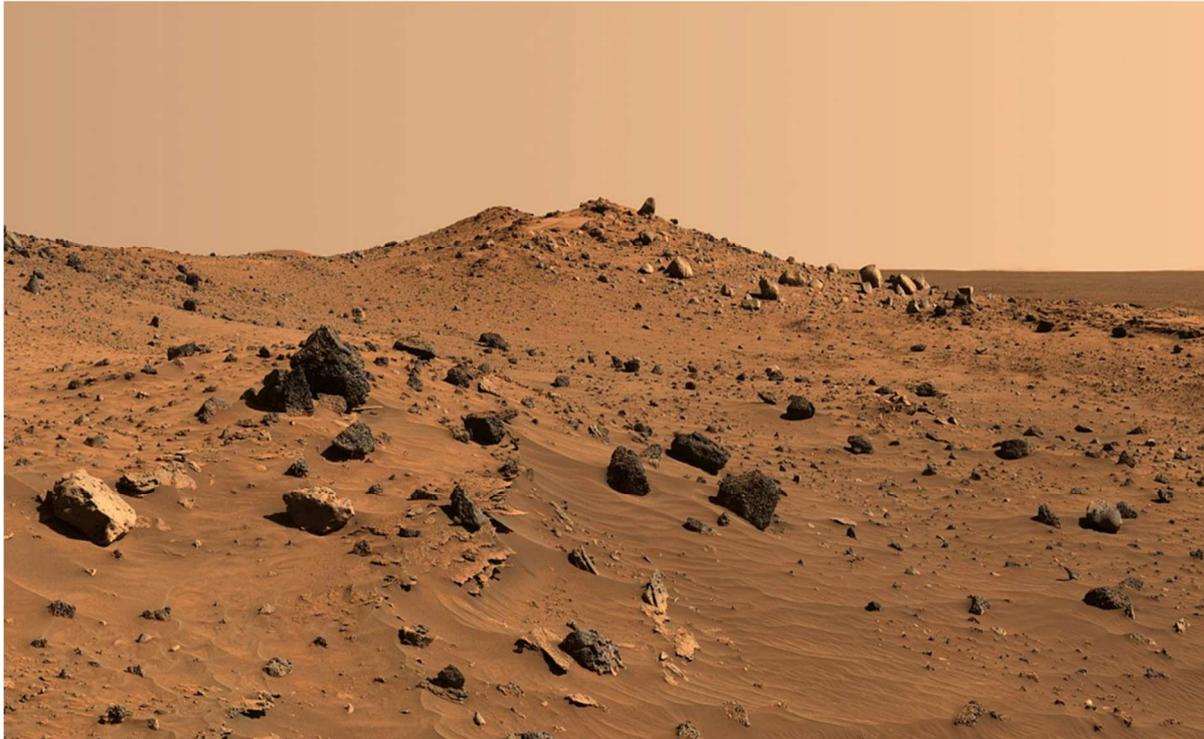
Next layer which will be disengaged to atmosphere is CO<sub>2</sub>, which exists in solid state in polar areas. A part of CO<sub>2</sub> sublimates and deposits as a consequence of seasonal rhythm. CO<sub>2</sub> sublimates by -78 °C temperature.

If all kinetic energy of both satellites transforms to heat this heat would be enough to warming and sublimation of 3.308×10<sup>16</sup> kg of H<sub>2</sub>O, it means approximately 0.7% of total water on Mars. It remains as a question, how high steam would spread. Mars atmosphere consists of three main layers: low (to height 45 km), middle, where jet stream flows (45 – 110 km), and upper (over 110 km).

Layer height	45 km	10 km	5 km
Density of water steam	0.005 kg/m <sup>3</sup>	0.223 kg/m <sup>3</sup>	0.436 kg/m <sup>3</sup>

The density of air on Earth is 1.28 kg/m<sup>3</sup>.

However, it is a great unknown variable what would really happen. Surely, not all kinetic energy of the moons would be utilized to sublimation of H<sub>2</sub>O. Also CO<sub>2</sub> would sublimate partially. Bigger amount of CO<sub>2</sub> and H<sub>2</sub>O in atmosphere would strengthen greenhouse effect, which would lead to further temperature growth and further sublimation, especially CO<sub>2</sub>. Till now, we have only a very rough imagination of Mars interior (the Mars InSight space probe which should explore it will launch in 2016). The fall of Mars satellites could cause volcanic activity which would thicken Mars atmosphere more.



**Picture 3** The surface of the planet Mars (source: Exoplanety.cz, www.exoplanety.cz)

### **LET'S THE SUN TO WORK**

The whole project of frozen ice ocean sublimation could be realized alternatively without throwing down Phobos and Deimos to Mars surface. Ice ocean is hidden under regolith layer about only about 1 m thick. [3] If we are able to mine it and transport anywhere the 800×800 km large ice ocean would sublimate as a consequence of solar radiation. This “mining version” could be also less energetically demanding. But it would be also slower and would contend with the problem of dust storms which would cover the uncovered ice areas with dust again. Also ice sublimation would be slower.

The development of convenient bulldozers for Mars could be significantly simpler than development of stronger rocket motors. Successful rover Curiosity which is as big as two cars gives hopes that “heavier equipment for Mars” can be developed relatively soon, maybe in 10 years.

In any case, this version of the project would be very demanding. Such a large project of coordinated transport of big amount of soil was not realized on the Earth.

## CONCLUSION

The atmosphere on Mars is relatively thin and is composed mostly of carbon dioxide (95.32 %). There has been interest in studying its composition since the detection of trace amounts of methane, which may indicate the presence of life on Mars, but may also be produced by a geochemical process, volcanic or hydrothermal activity.

The atmospheric pressure on the surface of Mars averages 600 pascals (0.087 psi), and ranges from a low of 30 pascals (0.0044 psi) on Olympus Mons's peak to over 1,155 pascals (0.1675 psi) in the depths of Hellas Planitia. This compares to Earth's sea level pressure of 101.3 kilopascals (14.69 psi), making the average surface pressure on Mars about 0.6 % of Earth's mean sea level pressure. Mars atmospheric mass of 25 teratonnes, compares to Earth's 5148 teratonnes. However, the scale height of the atmosphere is about 11 kilometres (6.8 mi), somewhat higher than Earth's 7 kilometres (4.3 mi). The composition of the Mars atmosphere is 95 % carbon dioxide, 3 % nitrogen, 1.6 % argon, and contains traces of oxygen, water, and methane, for a mean molar mass of 43.34 g/mol. The atmosphere is quite dusty, giving the Martian sky a light brown or orange colour when seen from the surface; data from the Mars Exploration Rovers indicate that suspended dust particles within the atmosphere are roughly 1.5 micrometres across.

The presented article demonstrates the approach how to change the atmosphere of Mars towards the Earth atmospheres parameters.

## LITERATURE

- [1] ŠTĚDRŮŇ, B.: *Forecast for Artificial Intelligence*, FUTURIST (USA), March-April 2004, pp. 24-25, ISSN 0016-3317.
- [2] ŠTĚDRŮŇ, B. – LOCHMAN, M.: *Mars se zemskou atmosférou v blízké budoucnosti?*, Technický týdeník 1/2006.
- [3] CHRISTENSEN, Philip R.: *Water at the Poles and in Permafrost Regions of Mars*, Elements, Vol. 2, pp. 151-155, June 2006.
- [4] ANTONENKO, I.: *Large Amounts of Water Ice Found Underground of Mars*, [dostupné online], Universetoday.com, 27. 1. 2012, <http://www.universetoday.com/93059/large-amounts-of-water-ice-found-underground-on-mars/>.
- [5] [http://en.wikipedia.org/wiki/Mars\\_Telecommunications\\_Orbiter](http://en.wikipedia.org/wiki/Mars_Telecommunications_Orbiter)
- [6] <http://trs-new.jpl.nasa.gov/dspace/bitstream/2014/22350/1/97-0831.pdf>
- [7] <http://www.astrosurf.com/luxorion/qs1-mars-communication3.htm>
- [8] <http://www.space.com/1038-mars-telecommunications-orbiter-interplanetary-broadband.html>

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# THE CONCEPTUAL PREPARATION OF THE SOLUTION TO THE FLOOD CONTROL MEASURES IN THE CATCHMENT AREA OF THE RIVER BEČVA-CONSTRUCTION WORKS SKALIČKA

## KONCEPČNÍ PŘÍPRAVA ŘEŠENÍ PROTIPOVODŇOVÝCH OPATŘENÍ V POVODÍ ŘEKY BEČVY - VÝSTAVBA VODNÍHO DÍLA SKALIČKA

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### Abstract

Floods and their consequences are one of the most common situations for us. One of the tasks of State administration and self-government is to deal with the crisis situation that has arisen. In relation to each crisis situation are important preventive measures. The article deals with the role of State and local authorities in relation to preventive measures for flood protection in the river Bečva.

### Abstrakt

Povodně a jejich následky jsou jednou z nejčastějších krizových situací u nás. Jedním z úkolů státní správy a samosprávy je řešit krizovou situaci, která vznikla. Ve vztahu ke každé krizové situaci jsou důležitá preventivní opatření. Článek se zabývá problematikou úlohy státní správy a samosprávy ve vztahu k preventivním opatřením pro povodňovou ochranu obcí v povodí řeky Bečvy.

### Keywords

flood protection measures, protection of the population and territory of the Bečva River basin, water-work Skalička

### Klíčová slova

protipovodňová opatření, ochrana obyvatel a území v povodí řeky Bečvy, vodní dílo Skalička

## INTRODUCTION

The catchment area of the river Bečva is a territory which is one of the most vulnerable flood risk in the Czech Republic. Disastrous floods in July 1997 had a devastating effect on the seat in the basin and in the downstream section of the Bečva river Morava. One of the most affected municipality was the village of Troubky. This consequence of the floods with the designation "hundred years ' water" was the impetus for the search of the concept of the protection of this area before the flood. During flood events in 2010 again showed that you can't let up in the efforts to search for and implement a set of effective preventive measures that would lead to the reduction of flood risk. Although the flood nearly reached the parameters of the flood of 1997, caused serious damage, and again significantly affected a large number of the population. One of the possible preventive measures under consideration was to build a dry polderu Now here is a variant of construction of water works Skalička.

## THE ROLE OF PUBLIC AUTHORITIES IN CONNECTION WITH A FLOOD-PROTECTION IN THE BASIN OF THE RIVER BEČVA

An important task in preventing and preparing for a crisis situation to State administration bodies, bodies of territorial self-government and the physical and legal persons. The competence and powers of State authorities and bodies of territorial self-governing units and the rights and obligations

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of legal entities and natural persons not only in preparing for emergencies, but also in their solution, the law No. 240/2000 Coll. on crisis management.

Among State administration bodies include:

- the Government,
- ministries (Ministry of the Interior, the Ministry of health, Ministry of transport, Ministry of industry and trade, etc.),
- other central administrative authorities.

Among the institutions and regional authorities include:

- the authorities of the region and other authorities with jurisdiction in the territory of the region,
- the authorities of the municipality with extended competence,
- the authorities of the municipality. [1]

In the context of flood protection in the basin of the river Bečva is on preventive measures and participated in various organs of:

- the Government,
- Ministry – agriculture, environment, transport and finance,
- The regional authority of the Olomouc region,
- authorities of the 15 municipalities concerned.

An equally important role in the flood control measures in the basin of the river Becva river basins of the Morava is a State enterprise that carries out the administration of the river basin of the Morava River, including the river Bečva.

## **CONCEPTUAL FEASIBILITY STUDIES [2]**

The sponsor and the Coordinator of the work on the nationwide conceptual feasibility study is the basin of the Morava, in cooperation with the Olomouc region, the Ministry of agriculture, Ministry of environment, Ministry of transport, Ministry of finance, and especially with all the 15 municipalities concerned. A study of Pobečví in scope (the territory of 45 km in length from the confluence of the Morava and Becva rivers after the planned dry tank Skalička) has consolidated all existing local proposals into one nationwide of a mathematical model, in which were included the limits and requirements for flood protection of all of the above entities. Subsequently, an assessment of each of the flood control measures due to their effect, feasibility (technical, economic, and financial), conflict of interest (such as protection of nature) and repeated negotiations with all of the above bodies was achieved by all parties accepted the conceptual solution, both in the form of technical nature and close to the action.

The Government in 2015 approved the initiation of the preparation and implementation of flood control measures in the basin of the river Bečva and close by means of technical measures, including dry tank Skalička. Preparation and implementation of flood protection in the basin of the river Bečva was divided into two stages. In the framework of the phase will be implemented technical and nature nearby measures ensuring transfer of flow in the range of 650-750 m<sup>3</sup>/s (i.e. approx. Q<sub>50</sub>). In II. the stage will be carried out aiming at increasing the water work Skalička flood protection at the level of the flood of 1997 (i.e. Q > 100).

Recommended a specific variant of the property compensation for the realization of the planned works, Skalička imposed by the Minister of agriculture, in cooperation with the 1. Deputy Prime Minister for economy and Finance Minister, the Government and handle to the 31. 10. the draft principles for the 2015 settlement rights to immovable things planned realisation of the works concerned, Skalička. Material approved by the resolution of the question of the Government also recommend changing the name of the forthcoming works on a Teplice water work Skalička (upcoming water work already does not interfere with territorial cadastral territory of Teplice nad Bečvou). For this reason, is no longer in the present material used strictly the new name – water work Skalička.

Whereas the determination of the amount of compensation for the establishment of servility is, according to spilt of the new civil code, a relatively new Institute and the experience with it, the only gain, it is proposed the establishment of a compensation deal for spilt to servility in the second phase of the property compensation works Skalička. This solution will allow the securing of additional supporting documents, in particular the elaboration of expert opinions and taking into account all of the context of the application of the Institute. The determination of fair and reasonable compensation, in particular, will be able to reflect the experience gained after the 1. 1.2016 when addressing compensation for restriction of ownership rights under the provisions of section 59a of the water law.



**Picture 1 Hranicko – flood of 1997**

**Source: Fire Rescue Corps of the Olomouc region**

The proposed material suggests rules for setting up the laws to properties affected by the planned realisation of the water dam Skalička in the first phase of property compensation (without element split). In this phase are solved also compensations for purchase of all constructions in this area affected by increasing of water dam, plots under the construction and plots in area supposed full damming at spot height 256,00 m (e, g, approx. In the range of Q20 – area made up by increasing the water dam while leaving the supposed parameters Problems with compensation for arranging of easement split will be properly analyzed and in term to 31.3.2017the rules for setting up of property laws to immovable property affected by planned realisation of water dam Skalička – second phase of property compensation will be introduced to government.

## WATER WORK SKALIČKA

Study of the Pobečví clearly and definitively confirmed the need for the construction of water works Skalička as an important measure to transform the "major" flood flows.

Water work should be located mostly in the left – bank part of the floodplain of the river Bečva Valley. The main barrier is the same profile that was designed for large tanks, where appropriate, variations of the dry tank, and is supplemented by a side led by dykes along the railway line. Fencing the area works, therefore, consists of two-roadway embankments, and the side of the Valley. The design of the perineum are both addressed as sprinkled with predominantly from local materials – alluvial gravel obtained in the area of floods. The construction works would achieve in a given territory flood protection on the level of the flood of 1997 (i.e.  $Q > 100$ ). The implementation of the proposed water works (with the retention volume of up to 35 million m<sup>3</sup>) would transform the floods of 1997 on max. Q<sub>50</sub>, which at 950 m<sup>3</sup>/s led to the protection of more than 100,000 inhabitants.

Regulating runoff provides "functional", which allows you to convert a certain flow rate and flow in the onset of the flood, as well as the safe transfer of the design flooding upon failure or blockage of dnových released. The capacity of the dnových pass at the maximum level in the tank is about 1 700 m<sup>3</sup>/s (without safety tinting) in and of itself so it covers roughly the untransformed culmination flow  $Q_{10\ 000} = 1\ 720$  m<sup>3</sup>/s limited capacity when the malfunction of one object field reaches 1 360 m<sup>3</sup>/s and with reserve untransformed culmination flow  $Q_{1\ 000} = 1\ 290$  m<sup>3</sup>/s (IE. that this work according to the current proposal complies with all regulatory requirements for its safety during the transfer of large water). For normal operation, it is assumed the capture of flood flows over the value of about 660 m<sup>3</sup>/s, i. e. approximately Q<sub>20</sub>. The manipulation can be customized according to the current situation on the Morava River and possibly delay the captured water in water works well into the flood flows below the confluence of the Morava.

The population of the protected water work is scheduled around 110 thousand. The calculation is made according to the number of the affected population in the towns and villages in the flood of 1997 and taking into account the areas where are reflected the positive effect of the transformation of the flood water. The extent of the affected territory between water and the confluence with the Bečva Moravia is 7 270 ha, in the basin of the Morava in the section from the junction with the meat processing plant after Duke Spytihněv is 13 260 ha. The extent of the territory of a protected work is scheduled in the basin water Skalička Bečva after confluence with Moravia is 5 800 ha. The extent of the territory in the basin of the Morava-protected below the confluence with Bečvou you cannot quantify the variability due to the effect of the flow-through conditions. [3]

**Table 1 - Estimated technical parameters of the water works of Skalička**

Water work Skalička		
Maximum height of dam above the ground	m	12.5 *
The volume of Earth Dam	million m <sup>3</sup>	1.5 *
Max. retention levels	m n m (B.p.v.)	264 *
Flooded area at max. the surface of the	HA	623 *
The retention volume at max. the surface of the	million m <sup>3</sup>	35
The cost of realization of the works	mill. Czk without VAT	2 687 *

*the value is based on the investment plan of the year 2012*

Source: Ministry of Agriculture of the Czech Republic

When the flood in July 1997 have exceeded the damage to property to the State, municipalities, of legal and physical entities in the catchment area of the Bečva district Přerov 2.8 billion. CZK.

Realization of itself works will be financed from Skalička State budget. The security of own funds from the State budget for implementation of this measure in the future will be dealt with by a separate Government material.

### **FINANCIAL SETTLEMENT OF THE IMMOVABLE PROPERTY CONCERNED THE IMPLEMENTATION WORKS SKALIČKA**

Financial settlement of the immovable property concerned the realization of any works or water works is a very sensitive issue. This is no different for the proposed flood measures. Financial settlement for construction works Skalička will cover seven cadastral territory.

### **THE SELECTED VARIANT OF PROPERTY COMPENSATION SOLUTION**

The Government has recommended a variation of the property compensation for the realization of the planned works Skalička-purchases of all buildings in the territory of the raising works, the land under the building works, the ground and the land in the area of the anticipated standing horny on dimension 256.00 m (i.e. in the range of approximately Q20 -area resulting from the raising of the water works in the maintenance of the existing proposed parameters and swamped capacity of about 3 million m<sup>3</sup>). The settlement of other land concerned will be dealt with in the form of easement of spilt (area of approx. 3.9 million m<sup>2</sup>). On these grounds will be allowed to continue farming.

In the case of flood, when water work will use his retention capacity (beyond standing horny), will cause the flooding of land, on which will be negotiated in the so-called. Ministry of spilt. The land will be used for the provisions of § 68 of the Water Act and the related payment of refunds (the territory intended for controlled spilt flood).

Bought up area of predicted permanent damming will be most affected in terms of editing programs. The management here will be very limited, and rather will serve as a "wildlife corridor" with revitalizationi elements.

### **DETERMINATION OF UNIT REFUNDS**

The amount of the refunds for the settlement of the rights to immovable things concerned in connection with the realisation of the works Skalička is dependent on unit prices for mass valuation of immovable property. The construction works will affect seven Skalička cadastral territory.

The resulting margin unit refunds based on the expert opinions for the determination of unit prices for bulk pricing for individual types of immovable property in specific cadastral areas, which the investor (the river basin of the Morava, s.p.) had to handle for the following types of immovable property (see table 2):

- Family House, cottage and vacation holiday house
- holiday cottage, Garden Cottage
- the side of the building
  - the stables
  - the barn
- buildings for business
  - buildings for trade and services
  - shed for storage

- land building
- land other

In the territory, according to the investment plan of the year 2012 is a total of 43 buildings, of which 23 habitation, 11 objects to a family recreation and 9 other objects (agricultural, etc.).

The principles for the settlement of the property compensation phase (without servility of spilt) based on the specified unit of refunds for individual types of immovable property and the annex No. 1 of the proposed Government resolution. Unit replacement cost includes real, according to the expert's report and the incentive compensation (for loss of profit, move, move, business activities, etc.). The resulting refund the purchase for a specific thing to culture will always be fixed individually on the basis of the expert's report. The proposed procedure is similar as in the implementation of the water works of Nové Heřminovy.

The total financial resources required for the implementation of the proposed property compensation (without servility spilt) should be in the range of between 410-579 million. CZK. With regard to the current state of the immovable property concerned is recommended earmarking of funds on this phase property compensation to the amount of 520 miles. CZK.

**Table 2 – the Margin per unit of refunds for the financial settlement of the water works of Skalička – stage I majetkoprávního settlement (without servility rozlivu)**

Type of real things (current use)	Total acreage	Simp.	The unit replacement (min.-max. CZK/mj *)	The cost of the implementation of the property compensastinzh (min.-max. CZK)
Family House, cottage and vacation holiday house	21 000	m <sup>3</sup>	5 552-7 842	116 592 – 164 682
holiday cottage, Garden Cottage	1 050	m <sup>3</sup>	2 407-5 982	2 527-6 281
secondary buildings (stables + barn)	9 400	m <sup>3</sup>	1 625-2 308	15 275-21 695
construction (buildings for trade and services + Hall for storage)	22 600	m <sup>3</sup>	2 034 – 6 448	45 968 – 145 725
land (building)	43 500	m <sup>2</sup>	457-722	19 879 – 31 407
land (other)	2 228 766	m <sup>2</sup>	94	209 503
<b>A total of</b>				<b>409 747-579 294</b>

\* values are given including VAT

Source: Ministry of Agriculture of the Czech Republic

With regard to saving financial resources, it is proposed to implement the gratuitous transfer of the immovable property, which is owned by the State and will be without prejudice to the implementation of the planned works, the rights to manage Skalička State undertaking River basin of the Morava, s.p. The total area of land owned by the State concerned, the planned water work is about 67 ha. Without land, with which it has the right to manage the river basin of the Morava, s.p. the total acreage of State land is approx 27 ha. In preparation for the implementation of the property compensation works Skalička geometric plans are processed, which shall specify the plot concerned the maximum spilt. On the basis of these geometric plans will use on free land transfer, or their parts in the area. In the event that this procedure will appear as a more efficient, may be transferred free of charge to the whole plot, for which there is no prejudice to the full maximum spilt.

It is assumed also that you won't need to buy about seven parcels owned by the Olomouc region, which could be inserted into upcoming events such as the promotion of the Olomouc region prepared measures to anti-flood arrangement

### **SECURITY FUNDS ON REALIZATION OF PROPERTY COMPENSATION**

To the realization of the security of the proposed property compensation works Skalička will use funds from the budget of the operation State of financial assets in the total amount of the 520 miles. CZK for the period 2016-2023. The premise of drawing see table no. 3. Funding for the year 2016 it will be necessary to ensure, in the framework of the Ministry of agriculture in the form of transfer of funds from the budget already approved chapter Operations of State financial assets. From the year 2017 will be subsequently released financial resources on the basis of the request of the Ministry of agriculture in his budget for the basin of the Morava, s.p., and provided that the financial resources will be included in the medium term the chapter Operations of State financial assets.

**Table 3 – the assumption of pumping in the years 2016-2023 – stage I property compensation (without servilityof spilt)**

<b>Year</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>
<b>Cost (million. CZK)</b>	20	90	100	90	80	70	40	30

Source: Ministry of Agriculture of the Czech Republic

### **CONCLUSION**

Submit a proposal for the policy of settlement rights to immovable things concerned planned the realisation of the works was the resolution of the Government of Skalička day 1. July 2015, the Minister of agriculture, in cooperation with the 1. Deputy Prime Minister for economy and Finance Minister, saved the Government and handle to the 31. October 2015, submit a draft policy for the settlement of the rights to immovable things planned realization of the works concerned, Skalička.

Whereas the determination of the amount of compensation for the establishment of servility is, according to spilt of the new civil code, a relatively new Institute and the experience with him, the only gain, it was suggested that these replacements will be addressed in the second phase of the property compensation works with the date of submission of the Government of Skalička until 31 December 2006. 3.2017. This material contains the phase property compensation, when they are dealt with compensation for the buy-out of all buildings in the territory of the raising works, land under construction works and zemníků and the land in the area of the anticipated standing on the Hill of horny 256.00 m (i.e. in the range of approximately Q20 -area resulting from the raising of the water works in the maintenance of the existing proposed parameters).

It was proposed to allocate the financial resources of EUR 520 million. CZK for the realization of property compensation of buildings and the land concerned by the proposed measures.

With regard to the saving of the funds was also designed to realize the gratuitous transfer of the immovable property, which is owned by the State and will be without prejudice to the implementation of the planned works, the rights to manage Skalička State undertaking River basin of the Morava and until 31 December 2007. December 2017.

In order to ensure savings funds in the implementation of their own purchases are stored to ensure the blocking state land in the jurisdiction of the State Land Office in the management of cadastral territories concerned planned the realisation of the works, to Skalička 31. December 2015.

It was also designed to ensure consideration of the process of settlement of the immovable things affected the realization of the planned works with Olomouc and Zlín Skalička region and other relevant bodies of self-government.

## LITERATURE

- [1] Act No 240/2000 Coll. on crisis management
- [2] Ministry of Agriculture of the Czech Republic. [online]. 2015 [cit. 2015-11-14]. Available from: <http://eagri.cz/public/web/mze/ministerstvo>
- [3] Basin of the Morava. The Catchment Area Of Moravia [online]. 2015 [cit. 2015-11-14]. Available from: <http://www.pmo.cz/>

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# USING THE WINQSB SOFTWARE IN CRITICAL PATH ANALYSIS

## UŽITÍ PROGRAMU WINQSB V ANALÝZE KRITICKÉ CESTY

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### **Abstract**

In the beginning of the paper is briefly introduced the Critical Path Method. This method is also part of the course Theory of systems in both forms of study and therefore the contribution is focused on the usability of the WinQSB in the teaching process of the subject Theory of systems. The paper presents our first experience with its use, as well as the advantages and disadvantages of this product. Using of the software is demonstrated in a case study with the solution of the Critical Path Method.

### **Abstrakt**

V úvodu příspěvku je stručně představena metoda kritické cesty. Tato metoda je také součástí náplně předmětu Teorie systémů v obou formách studia, a proto je příspěvek zaměřen na využitelnost programu WinQSB při výuce předmětu Teorie systémů. V příspěvku jsou prezentovány první zkušenosti s jeho užíváním, dále výhody a nevýhody tohoto produktu. Použití softwaru je demonstrováno na případové studii s využitím řešení pomocí metody kritické cesty.

### **Key words**

CPM, critical path analysis, crisis management, logistics, project

### **Klíčová slova**

CPM, metoda kritické cesty, krizový management, logistika, projekt

## **INTRODUCTION**

The Critical Path Method (CPM) belong to the basic deterministic network analysis methods. Its aim is to determine the duration of the project on the basis of length called: a critical path, which is a sequence of interdependent activities with the least time to spare. CPM enables to facilitate the effective temporal coordination of each successive project activities.

The critical path is defined as the time-longest possible route from the start point to the end point of the directed graph. Each project has at least one critical path. Each critical path consists of a list of activities which the project manager should be most focus to if he/she wants to ensure the timely completion of the project. The completion date of the last task on the critical path is also the date of completion of the project. The total slack time of the critical tasks equals zero. This means that delays the start of the task or extend its duration will affect the final date of the project. The critical path is reflected into time scheduling and project management and in all phases of the project lifecycle.

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<sup>2</sup> externí doktorand FBI v Žilině

This method can serve as a tool particularly for estimating the duration of the project. Used by linear projects where the duration can be estimated with a high degree of accuracy, e.g. building industry. Duration of the project activities are usually known by past experience and knowledge of data on past projects. Durations of all activities are not statistically determined. The method can also be used in logistics, crisis management and transport. [5]

An educator who teaches students in the combined form of study is required to provide the students with special learning materials that allow study themselves. Not every problem can be easily studied remotely. In the course Theory of systems we solve case studies from practice. Students have to build a mathematical model based on the analysis of the problem. There is the complexity of calculation and time-consuming in the manual solution of this model. It is very inefficient in today's era. [4]

Tasks of this field are challenging. A great tool for calculations is the teaching on computers. We were looking for the software that is not difficult to control and which is not expensive for students. The third criterion was to use the software also in other subjects. And we found WinQSB.

### WINQSB

The QSB (Quantitative Systems for Business) is developed and maintains by Yih-Long Chang. This software package contains the most widely used problem-solving algorithms in Operations Research and Management Science (OR/MS). The WinQSB is the Windows version of the QSB software package.

The WinQSB is freely downloadable on the Internet. It contains not only modules for solving linear programming problems, but also modules from other areas of operational research under this breakdown: [4, 6]

- Decision Analysis
- Dynaming Programming
- Facility Location and Layout
- Forecasting and Linear Regression
- Linear and Integer Programming
- Markov Process
- Material Requirements Planning
- Network Modeling
- Nonlinear Programming
- PERT and CPM
- Quality Control Chart
- Job Scheduling
- Queuing Analysis
- Queuing System Simulation

Like every freeware has WinQSB its advantages and disadvantages. The following table summarizes the most important ones.

**Table 5 Main advantages and disadvantages of using WinQSB**

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• it is free to use,</li> <li>• very easy to handle,</li> <li>• automatic solutions,</li> <li>• quite wide spectrum of methods and processes</li> <li>• lots of videos about WinQSB on YouTube.</li> </ul>	<ul style="list-style-type: none"> <li>• limited methods to use,</li> <li>• limited with Windows XP Mode,</li> <li>• quite old (limited color palette),</li> <li>• no upgrades and improvements,</li> <li>• graphical outputs could not be affected.</li> </ul>

Source: own.

**FINDING A CRITICAL PATH**

There is thus a large number of publications in which this method is clearly and distinctly described (e.g. [2], [3]). Given the focus of the article and space limitations, it is appropriate to recall the fundamental elements of the CPM. In applying the CPM, there are several steps that can be summarized as follows:

1. Define the required tasks and put them down in an ordered (sequenced) list.
2. Create a flowchart or other diagram showing each task in relation to the others.
3. Identify the critical and non-critical relationships (paths) among tasks.
4. Determine the expected completion or execution time for each task.
5. Locate or devise alternatives (backups) for the most critical paths.

In general, there are two basic methods of solution. The first is to use only directed graph and calculate the required variables directly in this graph. The critical path is often shown in a different color (often red). Although this process is rapid, but the representation is not always legible. An alternative is to use tables, which enumerate to any desired value. It's difficult to calculate, but the representation is more readable. Both of the above described procedures allows the WinQSB (compare Fig. 1 and Fig. 2).

Both methods, however, have a common Gantt chart as the final presentation of the found solutions. For the CPM is the most important finding critical paths and activities on them. But it is needed to look for that activities of the project, which are not on the critical paths. These activities, we should not forget and focus in their commentaries on them also, because of the possible optimization of individual project activities (Fig. 4). It is quite challenging to legibly construct a Gantt chart and if we could use some recovery programs we work on this issue much easier.

**CASE STUDY**

An Assignment can be seen in the following table. This is an opening of the new branch of the company. All activities are described in the table and you can also find durations and sequences of the activities.

An input table in the WinQSB is absolutely identical with Tab. 2, but we do not need to input the names all activities. We just need write abbreviations, sequences and time allotments of the activities. By double clicking the mouse the program solves and finds a critical path, without having to render a directed graph. After that we get a table (Fig. 1) with all necessary

variables and with the solutions whether the activities are on the critical path. Of course we will know the number of critical paths in our problem.

**Table 6 An assignment**

	<b>Name of activity</b>	<b>Abbreviation</b>	<b>Sequence</b>	<b>Time in weeks</b>
1	Identify a suitable country	A	-	4
2	Find a site	B	A	4
3	Get trade permit	C	A	2
4	Buy a site	D	B, C	10
5	Modify buildings	E	D	8
6	Find local suppliers of furniture	F	D	2
7	Purchase furniture	G	F	2
8	Recruit local manager	H	B	4
9	Recruit local staff	I	H	4
10	Install furniture	J	E, G	2
11	Advertise the product	K	C	4
12	Open for business	L	I, J, K	4

Source: <https://www.youtube.com/watch?v=dDetfOCCMqo>.

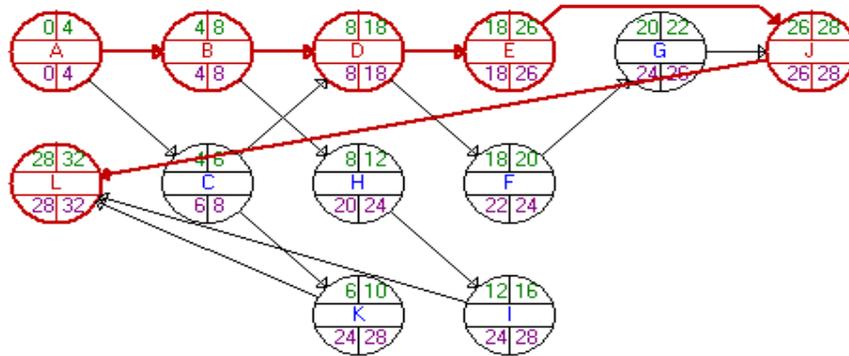
**Figure 1 The solution in WinQSB**

09-26-2014 14:16:27	<b>Activity Name</b>	<b>On Critical Path</b>	<b>Activity Time</b>	<b>Earliest Start</b>	<b>Earliest Finish</b>	<b>Latest Start</b>	<b>Latest Finish</b>	<b>Slack (LS-ES)</b>
1	A	Yes	4	0	4	0	4	0
2	B	Yes	4	4	8	4	8	0
3	C	no	2	4	6	6	8	2
4	D	Yes	10	8	18	8	18	0
5	E	Yes	8	18	26	18	26	0
6	F	no	2	18	20	22	24	4
7	G	no	2	20	22	24	26	4
8	H	no	4	8	12	20	24	12
9	I	no	4	12	16	24	28	12
10	J	Yes	2	26	28	26	28	0
11	K	no	4	6	10	24	28	18
12	L	Yes	4	28	32	28	32	0
	<b>Project Completion Time</b>		=	32	<b>weeks</b>			
	<b>Number of Critical Path(s)</b>		=	1				

Source: own in WinQSB

If you desire for plotting directed graphs then WinQSB can quickly and automatically render it by a single click. Unfortunately the program seeks to found the critical path always a single row. That is the reason why WinQSB moves the activities at the expense of readability. There should be some crossing edges very often. The program does not know dummy activities with the fictive edges. All plotting is based on the activity-node graphs (Fig. 2).

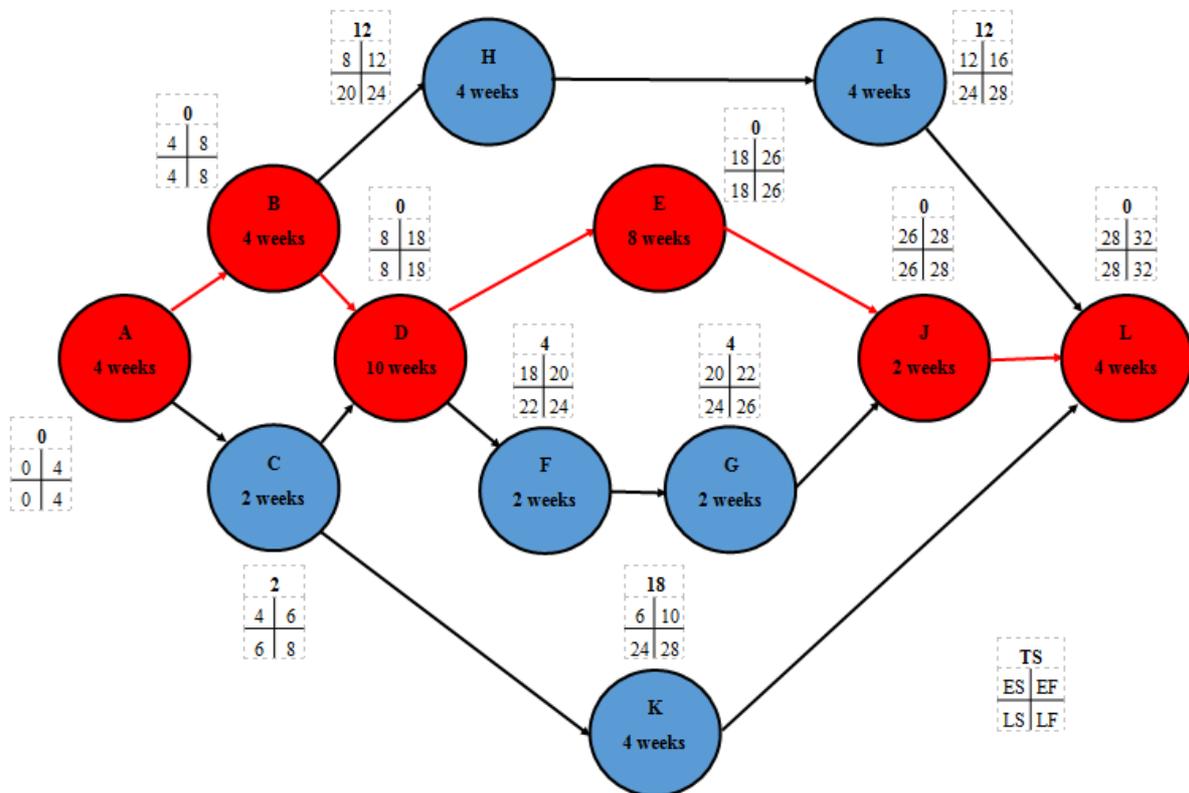
**Figure 2** An automatically generated directed graph with marked critical path (red colour) in WinQSB



Source: own in WinQSB

On the other hand the plotting is very fast and simple. A perceptive user can handle and create a directed graph with no errors manually with the pattern of automatically generated directed graph in WinQSB (Fig. 3).

**Figure 3** A hand-created generated directed graph with marked critical path (red colour)

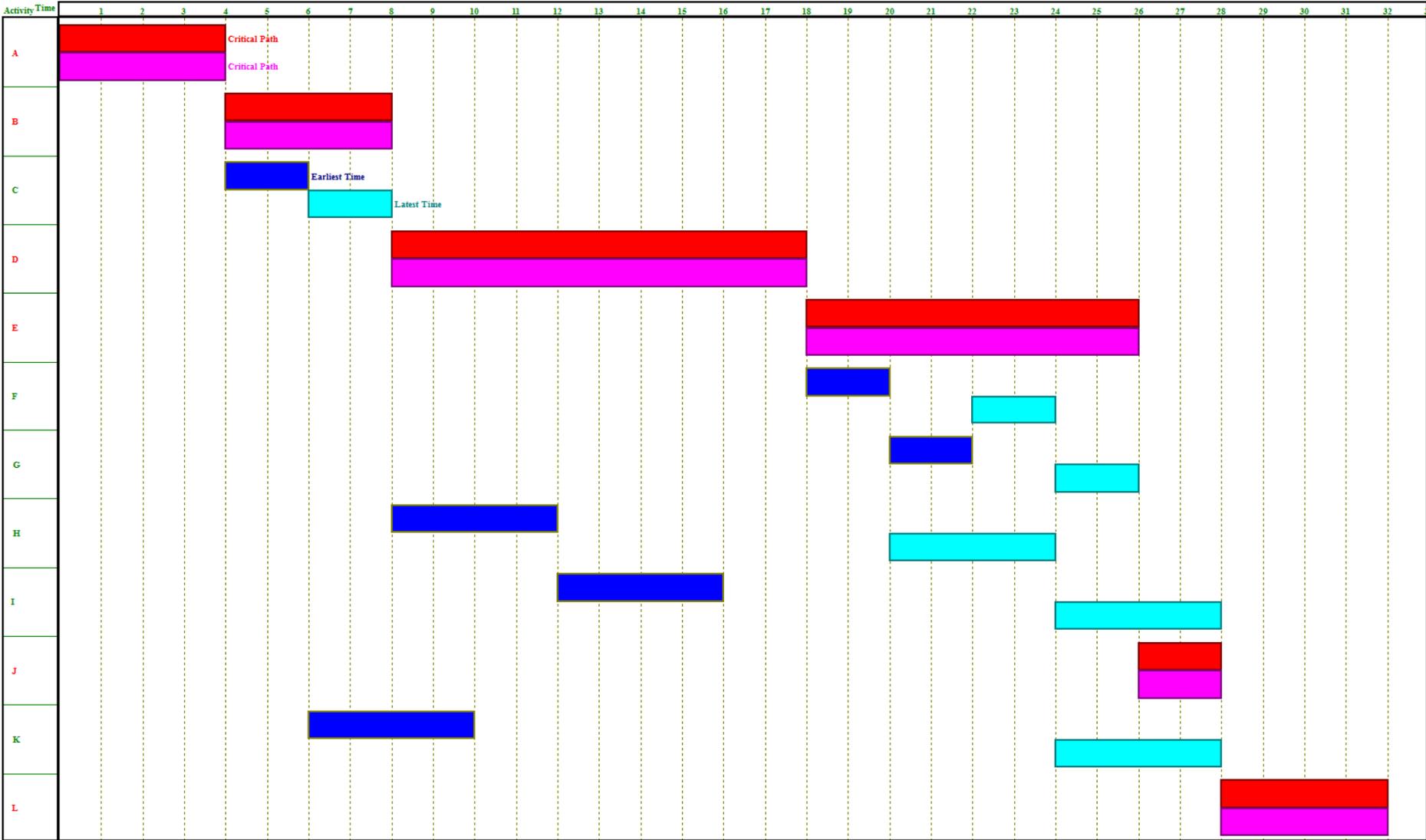


Source: own

## **CONCLUSION**

This article summarizes the basic knowledge concerning the using freeware software of WinQSB. The main sources were my own experiences with this helpful tool in finding solutions of the logistic problems. Working with this program is very simple. Without using a specialized program will be teaching of the subject Theory of systems like a mere demonstration. Using of this program is documented with an example of solved case study. There are also some advantages and disadvantages of using WinQSB in the paper. The main advantage of WinQSB is the complexity. We can use this software in many others subjects. The graphic page is not at a good level but WinQSB is a helpful tool in the solving many problems. If you want to try this software, you can find it on the Internet and download it for free. Hopefully this sample will be beneficial for teachers and other readers who are engaged in operations research (mathematical optimization, simulation, etc.).

**Figure 4** The automatically created Gantt chart in WinQSB



Source: own in WinQSB

## LITERATURE

- [1] Gantt Chart Excel Demo - YouTube. YouTube [online]. 2012 [cit. 2015-01-15]. Dostupné z: <https://www.youtube.com/watch?v=dDetfOCCMQo>.
- [2] JABLONSKÝ, Josef. Operační výzkum. 3. vyd. Praha: Vysoká škola ekonomická v Praze, 2001, 305 s. ISBN 80-245-0162-7.
- [3] RÁLEK, Petr, Josef NOVÁK a Josef CHUDOBA. Metody užívané v logistice [online]. Liberec, 2010 [cit. 2015-02-23]. Dostupné z: [http://www.nti.tul.cz/cz/images/0/0a/Mul\\_skripta\\_101101.pdf](http://www.nti.tul.cz/cz/images/0/0a/Mul_skripta_101101.pdf).
- [4] KOLČAKOVÁ, Alena. Ukázka využití programu WinQSB při výuce předmětu Kvantitativní metody v rozhodování. Linuxexpres [online]. 2011 [cit. 2015-02-16]. Dostupné z: <http://www.linuxexpres.cz/okenko-do-oken/ukazka-vyuziti-programu-winqsb-pri-vyuce-predmetu>.
- [5] Metoda kritické cesty - CPM (Critical Path Method) [online]. Wilmington: ManagementMania.com LLC, 2015 [cit. 2016-02-16]. Dostupné z: <https://managementmania.com/cs/metoda-cpm>.
- [6] Amariei Ioana Olga, Doina Frunzaverde, Gheorghe Popovici, Codruta Oana Hamat. WinQSB simulation software – a tool for professional development. Procedia - Social and Behavioral Sciences, Volume 1, Issue 1, 2009, s. 2786-2790. ISSN 1877-0428.

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# ASSESSMENT OF THE WORKING CONDITIONS OF PROFESSIONAL DRIVERS

## POSOUZENÍ PRACOVNÍCH PODMÍNEK PROFESIONÁLNÍCH ŘIDIČŮ

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### **Abstract**

The paper deals with the working conditions of professional drivers in international road transport. At the beginning, given the legislative conditions related to this issue and the conditions necessary for the operation of this profession. Subsequently, an analysis of the current situation and suggested measures to improve the situation.

### **Abstrakt**

Příspěvek se zabývá pracovními podmínkami profesionálních řidičů v mezinárodní silniční dopravě. Na začátku jsou uvedeny legislativní podmínky vztahující se k této problematice a podmínky nutné k provozování této profese. Následně je zpracována analýza současného stavu a navrhnuty opatření ke zlepšení situace.

### **Key words**

Road Transport, Working Conditions, Professional Driver, Survey

### **Klíčová slova**

Silniční doprava, pracovní podmínky, profesionální řidič, dotazníkové šetření

## **INTRODUCTION**

International road transport is currently in the field of transport very important place and its significance will be increasing populations continue to grow in the future. This is primarily due to the advantages that road transport offers over other transport modes. The core group of road transport are truck drivers. Long ago are the days when the phrase "professional lorry driver" meant something, drivers spend long periods standing at border crossings, telephone connection worked only via landlines, vehicles are not equipped with surveillance systems was not as advanced design.

Currently, the majority of vehicles equipped with surveillance systems that are able to record not only the location of the vehicle, but with new and technical condition of the vehicle (oil pressure, fuel level, fuel consumption, etc.) and the driver's style (correct order, use the engine brake, etc.). Work truck driver is currently very unpopular, time-consuming and often mentally and physically demanding, particularly for international road transport. Currently, truck drivers placed a great responsibility in the form of compliance with deadlines, handling a variety of documents, compliance with regulations and prohibitions in different states and adherence to the operating mode. Demands of the profession is also associated with separation from family when the driver spends most of his time in a month in the cab of the truck and his family spend a few days a month.

## **CHARACTERISTICS OF WORKING CONDITIONS OF PROFESSIONAL DRIVERS**

Within the road it is to follow consistent social conditions, especially working mode drivers. Observe these systems leads to unnecessary accidents of trucks and the loss of lives. A driver who fails to comply with those provisions, whether by choice or coercion from their employer, threatens not only themselves but also other road users. Operating modes of drivers are very detailed process and using supervisory bodies intensively monitored.

### **LEGISLATIVE FRAMEWORK**

During the course of his work has to truck drivers and their employers observe the following laws, decrees and regulations:

- act no. 361/2000 Coll., on the road,
- act no. 111/1994 Coll., on road transport,
- regulation of the European Parliament and the Council (ES) no. 561/2006,
- european agreement concerning the work of Crews of Vehicles Engaged in International Road Transport (AETR),
- government Decree no. 589/2006,
- act no. 262/2006 Coll., the Labour Code,
- act no. 56/2001 Coll., on conditions for operating vehicles on roads,
- regulation of the European Parliament and Council Regulation (ES) no. 165/2014,
- decree no. 522/2006 Coll., on State Supervision and inspection of road transport.

### **OBTAINING A DRIVING LICENSE**

In terms of the requirements for obtaining a driving license category C+E applicants must meet the following conditions:

- age 21 years,
- valid medical examination,
- successfully finished the final exam in driving school,
- the applicant holds a driving license category C,
- habitual residence in the territory of the Czech Republic or study in the Czech Republic for at least 6 months,
- must have a driving ban or may not have collected 12 points in the drivers' points system,
- must have driver's license from another EU Member State.

### **MEDICAL FITNESS DRIVERS**

Medical fitness of drivers of motor vehicles is one of the basic conditions of safety on the roads. Therefore, the medical fitness of drivers of motor vehicles pay attention not only

in this country but also in all EU countries and other civilized countries. Within the EU, the conditions of medical fitness unified regulations of the European Communities (Directive 2009/112/ES amending Council Directive 91/439/EHS on driving licenses, and the Commission Directive 2009/113/ES, amending Directive of the European Parliament and Council 2006/126/ES on driving licenses).

The Czech Republic is the procedure for assessing fitness to drive motor vehicles regulated by Act no. 361/2000 Coll., On Road Traffic and on Amendments to Certain Acts (Road Traffic Act), as amended (hereinafter the "Law on Road Traffic ") and Decree no. 277/2004 Coll., on the medical fitness to drive motor vehicles.

### **PSYCHOLOGICAL SUITABILITY DRIVER**

Traffic psychological examination and neurological examination including electroencephalographic (hereinafter referred to as "EEG"), shall be subjected to a holder of a driving license for categories C, C+E and C1+E, which drives a truck with a maximum mass exceeding 7 500 kg or a special car for maximum mass exceeding 7 500 kg, or vehicle combination, which is made up of a lorry with a trailer or a special vehicle and a trailer whose maximum allowable weight exceeds 7 500 kg.

### **PROFESSIONAL COMPETENCE OF THE DRIVER**

Since 1 April 2008 enactment of Act no. 378/2008 Coll., Which regulates the conditions for the acquisition and improvement of professional competence to drive motor vehicles intended for freight or passenger services. This law requires drivers of motor vehicles for which management is required driver's license C1 and C, the obligation to hold a certificate of competence. This Act puts into practice the provisions of the Directive of the European Parliament and Council Directive 2003/59/ES.

Drivers who want to drive a vehicle whose management is necessary to be holder of a driving license of category C1 and C, must attend initial training in the range of 140 hours or 280 hours of extended range. Initial training is done by means of education and training, culminating in an examination of the professional driver. Training and teaching under the Act can only be performed by an accredited organization that is a guarantee for the fulfillment of the provisions of the Act.

### **OPERATING MODES DRIVERS**

Operating modes for drivers in Europe is governed by Regulation (ES) 561/2006 or AETR. If we manage during transport by Regulation (ES) 561/2006 or AETR itself depends on the transport route:

- If the entire transport route lies within the ES (European Community), we will be guided by Regulation (ES) 561/2006 (eg. Transport from the Czech Republic to Germany, irrespective of the country of registration of the vehicle).
- If driving route does not lie completely on ES territory, it means that at least part of the route lies in the territory of a Contracting State AETR, which is not a member of the ES, transportation must follow the rules AETR (eg. Transport from the Czech Republic to Russia for a vehicle registered in the Czech Republic).

- Transportation on the territory of a State which is not a member of the ES has not signed an agreement AETR shall be governed by the law of that State (there is a non-European countries).

## **OBLIGATIONS DRIVERS**

Act no. 361/2000 Coll., On Road Traffic and on Amendments to Certain Acts (Road Traffic Act) provides for the vehicle driver a wide range of duties, among other things, to use a vehicle that meets the technical conditions laid down by special legislation) in Section 5, paragraph . 1 point. a). This means in practice that, before every ride, the driver must inspect the vehicles it intends to use for the ride, and find out about his perfect technical condition.

Driver (along with the operator of the vehicle) is also responsible for the proper functioning of the recording equipment (tachograph) and must observe the rules for handling the memory card driver. In connection with this driver is also responsible for compliance with labor regime. Nobody (except police authorities) not directing drivers to break the law by example. Fails to comply with safety break like.

Other responsibilities of the driver is responsible for the proper storage and fixation of the cargo loading area. With effect from 1. 1. 2011 in the amendment to Decree no. 341/2002 Coll. provides that the lashing and clamping sets must match the number and position of EN 12195-1. Standard specifies the method of calculating the forces acting on goods on vehicles for different types of loads and different types of slings. Control authorities will therefore be able to use this generally binding regulation at roadside checks required number of clamping sets after the driver's request.

## **CHARACTERISTICS OF THE CURRENT STATE**

Working conditions in the road freight sector are difficult, as evidenced by the low attractiveness of the sector. Among the reasons for this include: flexible nature of the activities of road transport and a large amount of time spent outside the base, hence the home. Among other risk factors include the fact that drivers often work in isolation, there are also requirements of customers, leading to heavy workload, work on sites of third parties, the increasing use of remote monitoring and complex technology, workplace design, accessibility of facilities and services (hygiene , food and health), the risk of infectious disease, violence and assaults, prolonged sitting, the risk of accidents during loading and unloading and road safety risks associated with the work on the road. Another factor is atypical working hours in a sector that has a negative impact on drivers. Overall, however, the number of accidents involving heavy goods vehicles is declining, and leads to improvement in compliance with the provisions on driving time and rest periods.

This section will feature the reasons why it is currently insufficient number of drivers in the Czech Republic, especially in international road transport.

## **PROFESSIONALIZATION OF THE CZECH ARMY**

On the missing numbers of drivers in the Czech Republic also participates professionalization (1 January 2005), which still driving within the military services to the market partially delivered. Before 1989 work within the organization Svazarm (Association for cooperation with the army) driving schools in preparation for future military recruits driver. Of the so-called. "Short courses for drivers' graduates proceeded relatively high-quality training for heavy vehicles in categories C and E, but also went through some practice.

## **AGE TRUCKS**

The effort of each transport companies is that you have the newest fleet. Newer trucks do not require time-consuming maintenance and can have higher profits than older vehicles. Each company therefore takes into account whether they are a particular vehicle is still worthwhile to maintain in working order or you prefer to discard.

Another positive newer vehicles can be a competitive advantage. Unless, for example, a company that entered the tender for its carrier receives from its potential carriers very similar to the offer (price, delivery time, etc.), Can choose the right company that frequently rotated its fleet. Drivers in deciding on future employers, among others prefer to choose a company with a more recent average age of the fleet, because they do not want to spend their working time to service. Another reason is more modern and better amenities truck cabins, where drivers spend most of their time. In the case of domestic freight transport drivers make do with older cars because they do not spend many nights in the cab as in the case of international traffic.

## **LACK OF PROFESSIONAL DRIVERS**

He currently works in the Czech Republic about 300 thousand drivers, and current estimates is missing in the Czech Republic around 5000 drivers. The worst situation is in the border areas with Germany. German carriers offer about 10-15 thousand higher wages. Drivers also have the opportunity to get a monthly child allowance of 180, -Euro, which it may not. German carriers can in most cases offer a newer fleet with better service. In the event of serious disturbances road trains Czech hauliers abroad for financial reasons chosen, for example. Services in Germany as a last option. Most major Czech carriers have their own well equipped service vehicles exit, which may make possible defects in foreign repaired on the spot and cheaper.

## **FLUCTUATIONS PROFESSIONAL DRIVERS**

Turnover rate, trying every company doing business in transportation have as low as possible. In most companies, each driver assigned to your vehicle, which cares for and who is responsible. It's quite logical that if one car will rotate several drivers, so the vehicle will not for several months in a worse condition than if they drove with him one driver. In the interest of each transport companies should be treated the process of transfer of technology in the event of a substitution drivers in one vehicle.

Reasons for the fluctuation of drivers:

- disagreement with the employer (eg. the dispatcher),
- the salary,
- technical condition of the fleet employer
- attractiveness workload (eg. change of vehicle soaring into the box),
- time-consuming work,
- termination of employment by the employer (eg. a gross breach of discipline, theft of fuel, inappropriate behavior by the driver, etc.),
- also we must not forget health reasons and a proper retirement.

## **SALARIES OF PROFESSIONAL DRIVERS**

Pursuant to Art. 10 of the European Parliament and Council Regulation (ES) no. 561/2006 carrier shall not give drivers it employs or whose services are used, either a bonus or wage supplement, related to distances traveled or amount of goods carried if that payment could lead to endangering safety on the road or encourages infringement of this Regulation and shall not use such a method of remuneration of work, the use of which would result in increasing employment outcomes endangering the safety and health of workers as provided in § 103 paragraph. 1 point. k) of the Act no. 262/2006 Coll., the Labour Code.

Practice, however, is different. Subsequently, a few examples rewarding drivers:

- basic salary + additional charge for mileage (the most common case),
- basic salary + percentage of invoicing,
- basic salary + bonus vague.

Taking into account that a driver with a basic salary of 11.200 CZK gets even extra for mileage or percentage of invoicing, although earns a total of about 35.000 CZK, but in the event of sickness or retirement calculation is based on just the basic salary. In these cases, the state should intervene consistently and apply more sanctions. Czech government adopted at its meeting of 15 September 2014 government decree no. 204/2014 Coll., Which was changed above-mentioned regulation on the minimum wage. With effect from 1 January 2015 to increase the base rate of the minimum wage to the amount of weekly working time of 40 hours 9.200, - CZK per month, or 55 CZK per hour. Any amount higher than the minimum wage is determined by the contractual agreement between the two parties, namely employers and employees that both parties confirm the signing of a contract of employment or relevant payroll assessment.

## **LIFESTYLE PROFESSIONAL DRIVERS**

The driver of the freight transport is mostly male reproductive age. These years have the greatest impact on how long and how cool they live. This often hurried occupations include lack of quality sleep, smoking, unbalanced diets, which are among the most frequent causes of serious diseases. Errors in eating habits can lead to heart disease, cancer, cerebrovascular disease, hypertension, diabetes, obesity, osteoporosis and others. Irregular and inadequate physical activity increases the risk of many serious illnesses, physical, but also mental. During the procedure applied to the driver's numerous stress factors in the form of a long journey, lack of sleep, improper temperature in the cab, noise, etc.). Further, in the driver's stress can cause a variety of situations as traffic congestion, ice, high traffic density, poorly signposted diversion route, etc.

## **TRUCK ACCIDENT RATE**

Another negative factor which occupations are traffic accidents. In 2014, most accidents were caused by drivers of trucks category up to 3.5 tons of the total number of people killed in these accidents involved more than 46%. Drivers of trucks over 3.5 tonnes category caused a total of 5,169 accidents (53% of the total) and they caused accidents account for 37 fatalities (ie. 53.6% of the total number).

Due to a technical defect of the vehicle was 467 in 2014 caused by accidents (ie. 0.54% of the total number of accidents). The most common cause was improper stowage

- a total of 107 incidents, followed by so-called. Other technical defect (eg .: exhaust falling, shattering the windshield, etc.) - 93 accidents, followed by dropping or loss of wheels - 76 accidents, 1 death of a person and a flat tire caused by a sudden puncture or leak air - 68 accidents.

## **SUPPORT PROFESSIONS DRIVER**

In 2006 came Česmad Bohemia association with the project, whose main aim was to improve the image of road called "We-in-it-together". The first step was the most visible billboard campaign, whose main message was that road trains do not go there for fun, but provide essential services to society. Followed by an explanatory campaign in the press refuting the myths of road transport and correcting some cliché. People often do not realize that with their increasing material needs, increases the need for transport, and in the Czech Republic is still Freight yet still flexible and efficient mode of transport.

Lack of drivers currently escalation so that some transport companies would gladly bought new vehicles, but because they have no one to drive vehicles buy and offers transportation renounce. Association Česmad Bohemia, whose approximately 2 000 members operate more than 25 000 vehicles, thus trying in this situation. Association Česmad Bohemia realizes that obtain the appropriate license, certificate of professional competence and even find out what the profession entails the driver, is not easy. Through a subsidiary company Institut road offers visitors assistance in the form of workshops, during which the candidate learns what and how to get to the profession, and where and how to look for a suitable job, then offers assistance and obtaining seats at some of its member transport companies.

## **ANALYSIS OF THE CURRENT STATE**

For processing specific analysis of quantitative research was chosen by anonymous questionnaire. This questionnaire was completed by 238 people working on the position of drivers of international freight, all men. There were assembled 7-understand questions, conceived as closed (can only be answered yes or no). Questionnaires were filled in the questionnaire survey earlier this year at the annual mandatory health and safety training and professional driver training.

The first question will be discussed parking problems and shut combinations. The second and third questions will involve eating and drinking habits. Other issues are in the field working mode drivers. In addition to the questionnaire will be even more initiatives designed to improve the situation in this area.

## **AGE STRUCTURE OF PROFESSIONAL DRIVERS**

Age structure we obtained from the sample of 238 drivers in international transport with driving license category C+E. Each age group were divided over 10 years (see Tab. 1). A total of 238 drivers were 15.5% (37 drivers) in the age group up to 30 years in the group 31-40 years, 33.6% of drivers (80 drivers) in the group of 41-50 years, 29.8% of drivers (71 drivers) in the group of 51-60 years, 17.6% of drivers (42 drivers) and in the group 61 years and above was 3.4% of drivers (8 drivers).

Tab. 1: Age distribution of drivers

Age group	Absolute frequency [-]	Relative frequency [%]
to 30 years	37	15,5
31-40 years	80	33,6
41-50 years	71	29,8
51-60 years	42	17,6
61 years and over	8	3,4

Source: Authors

### PARKING AND SHUT TRUCKS

The answers to the first question is "Do you consider the Czech Republic a sufficient number of parking spaces for trucks?" (Tab. 2) shows that the vast majority of drivers would welcome a larger number of parking spaces.

Czech Republic is a transit country and the traffic intensity is increasing every year. One of the reasons the modernization of the D1 motorway is to increase its capacity. The D1 motorway is around 50 rest areas, which would seem to be enough (at about 350 km of motorway), however, is a problem that not all the landing are parking spaces trucks. Rather, it depends on the skill of the driver and the planned route, which may reach up to ensure lawful and decent parking. There is a conflict of interest of the employer, who is trying to take advantage of the driver's driving to the maximum in order to higher profits, and a driver who was trying to park his vehicle without having to violate such regulations. Standing at the forbidden section. Although dispatcher driver plans the route can't count on unpredictable events, such as traffic accidents, congestion, etc. Some of the older parking areas for road trains have capacity enough, and unfortunately there is not an effort, mainly for financial reasons, those parking expanding.

Tab. 2: Evaluation of the first question

Answer	Absolute frequency [-]	Relative frequency [%]
Yes	53	22,27
No	185	77,73

Source: Authors

### ADHERENCE TO A REGULAR DIET

From the scant number of drivers who answered yes to the second question "Do you maintain regular meals during the day?" (Tab. 3), we can say that these are people who are home-sufficient food supply. However, even if the driver was ever so stocked well in most cases, not during his nine-hour drive option regularly distributed food. Drivers are forced to eat while driving, which greatly endangers the safety of others as well. So there are more cases when a driver to daily driving time parking the vehicle combination on a daily rest period and then puts their first proper meal.

Tab. 3: Evaluation of the second question

Answer	Absolute frequency [-]	Relative frequency [%]
Yes	18	7,56
No	220	92,44

Source: Authors

### COMPLIANCE WITH DRINKING MODE

The third question "Do you have sufficient space during the day drinking schedule?" Somewhat related to the previous, but the need to drink more often than with food. Keep drinking regime behind the wheel is a must, otherwise there is a body fatigue, poor concentration, and thereby slow reactions of the driver. Some of these facts, however, underestimate the fact that when you drink a lot more has to stop the vehicle. Many drivers also unhealthy drinks, morning dismiss strong coffee, which dehydrates the body more, and behind the wheel after drinking unhealthy sugary drinks, which give them excessive amounts of carbohydrates.

Tab. 4: Evaluation of the third question

Answer	Absolute frequency [-]	Relative frequency [%]
Yes	138	57,98
No	100	42,02

Source: Authors

### DAILY DRIVING TIME

A slim majority of drivers who responded to the question "Are you in favor of the longer daily driving time?" Negatively regarded simultaneously set the length of the daily driving time is sufficient. Any extension would surely have been trapped more accidents due to fatigue and unnecessary physical power switch drivers. Those who answered yes, they are obviously influenced by the prospect of higher earnings in the case of higher transport performance. It is due to the fact that many carriers rewards drivers according to mileage, which is prohibited. Another factor that influenced positively the corresponding driver, may be the fact that for a long time, management will quickly return home.

Tab. 5: Evaluating fourth question

Answer	Absolute frequency [-]	Relative frequency [%]
Yes	138	57,98
No	100	42,02

Source: Authors

### DAILY REST PERIOD

The evaluation question "Are you for a reduction in daily rest periods?" Shows that drivers do not want to shorten the daily rest period. In case of a reduced daily pause 9 o'clock,

it's a real minimum. Taking into account that the driver comes to parking, vehicle checks, letters of operational documents, eat out, make personal hygiene, and sleep had left some 7-8 hours. It is understood that after 9 hours daily rest employer expects that the driver again pulls away. But in those nine hours the driver must catch the above activities and a morning training, which includes re-morning hygiene and breakfast.

Tab. 6: Evaluating fifth question

Answer	Absolute frequency [-]	Relative frequency [%]
Yes	92	38,66
No	146	61,34

Source: Authors

### SAFETY BREAKS

Safety break 45 minutes after 4.5 hours of driving is a necessity that can't be had otherwise lumbering, rather the contrary. The evaluation of this question, "Are you for shortening the safety breaks?" It is obvious that the drivers are fully aware of the necessity of this break. Often it is only a pause in the day when the driver can eat, relax and refresh. Unfortunately, it happens in practice that this pause is misused for other activities (loading, unloading, vehicle repairs, refueling, etc.).

Suitable alternative could be the adjustment of daily working mode driver means a 3 hour drive - 30 minutes pause - 3 hours drive - 30 minutes pause - 3 hours drive (then could follow in the event of an extension to 10 hours of driving another 30 minutes pause). These would be in the case of driving by only 9 hours 15 minutes pause in addition. The driver would have more time to relax and allow him to observe regular eating and drinking habits. The ideal diet is a 5 meals a day (breakfast, brunch, lunch, snack, dinner), which this system, unlike the current, fully respected and enabled. Unfortunately, however, closely related to the need for more frequent parking.

Tab. 7: Evaluation of the sixth question

Answer	Absolute frequency [-]	Relative frequency [%]
Yes	37	15,55
No	201	84,45

Source: Authors

### SUGGESTIONS FOR IMPROVEMENT

Based on the findings, it is necessary to propose measures that will contribute to improving the working conditions of professional drivers.

### IMPROVEMENT OF SANITARY FACILITIES

An essential element that should be obvious is the availability of social facilities at the loading/unloading. For smaller companies, at least toilets and larger firms where drivers wait to load even a few hours should be automatically shower. Some large companies in Germany, it is normal unless the driver to wait a long time for loading the drivers not only have access to

toilets and showers, but it is for them to set up a rest room with a coffee maker. Unfortunately, many companies in the Czech Republic, the availability of social facilities at the loading / unloading considered.

### **IMPROVE PAY CONDITIONS**

According to Government Regulation no. 567/2006 Coll. which is a division of employees into groups, among drivers of vehicles over 3.5 tonnes in 5th-6th grade. Low basic salaries of professional drivers pose a big problem on the issue of social and from among truck drivers could become a socially disadvantaged group of population without social security, or only minimal. On the field of transport are linked, of course, other disciplines such as. Agriculture, food processing, textile, etc. Each of these disciplines within the competitive struggle trying to save in every way, including transportation.

### **RELIEVE STRESS AUTOGENIC TRAINING**

Each driver several times daily encounters with stressful situations as traffic congestion, technical issues, problems with loading or unloading, and the like. Therefore it would be appropriate to incorporate into regular training for drivers short training autogenous training. It is the best known method of relaxation in the world developed by German physician, neurologist and psychiatrist Johannes Heinrich Schultz (1884-1970).

This relaxation technique uses imagination and autosuggestion to induce such a state that leads to relaxation of mind and body. It has wide application and helps the practitioner to man handle stressful situations better today. It is based on practicing relaxation, imagination, and the six basic steps. You can exercise while lying on your back or naturally upright sitting position in a chair in a quiet environment with adequate temperature. The average length of the exercise is about 5 minutes. The method can be practiced every day (recommended 3 times a day - morning, noon and evening).

### **SUPPORT FOR VOCATIONAL COURSES FOR LEARNER DRIVERS**

The state should encourage as many schools that offer apprenticeship professional driver. These schools offering this subject, partly replace the gap that was previously Svazarm organization, and military service. So far, however, only a few of them (in Krnov, Jablunkov and Holic). Mostly it is a field associated with the field mechanic. The issue raises the question of how many graduates in these disciplines in the finals really boards a career as a professional driver.

At the College of automobiles, machinery and business in Krnov started in 2007 training new field of auto mechanic - professional driver. The field is operated for financial support for local hauliers, the company DAF Trucks for the Czech Republic and Slovakia Ltd., Regional Office of the Moravian-Silesian Region and the company Česmad Bohemia. It is an up courses of 1.5 and a condition of acceptance is leading to graduation education, physical fitness, and driving license group B. Successful graduates will receive a driving license C, D, C+E and D+E, a valuable experience in operating transport companies , vocational certificate in the field mechanic. Thus trained graduate certainly will not have a problem getting on the labor market.

## **FINANCIAL SUPPORT FOR NEW DRIVERS**

Hardly any person who wants to become a professional driver has sufficient funds to obtain a driving license and obtain a professional qualification. Currently, some carriers offer the possibility of co-financing the extension of the license that the candidate with the employer shall make a contract for a longer period of time to invest in the driver's carriers back in time.

People who are registered at labor offices, can take advantage of the courses, financed by the state. However, it must meet the entrance qualifications, eg. On the driving license C medical fitness.

## **TECHNICAL MEASURES**

Modern vehicles can be equipped with independent heating, independent air-conditioning unit and refrigerator. Drivers then these cabins have their own complement its discretion by television, satellite receiver, etc. Provided the vehicle has to meet the conditions of international transport, it should be mandatory to have independent heating, independent air conditioning and refrigerator. Often on this equipment, however, decided by the owner of the vehicle - carrier. Therefore, it should be obvious to equip these vehicles also according to the requirements of drivers and not leave the decision to the carrier and its economic situation.

## **WASHER AND DRYER IN PARKING LOTS**

Another thing that should be at least on a large parking lot for trucks of course there is a washing machine and clothes dryer. In Western countries are washing machines and dryers in the parking lots for granted that our car parks are currently lacking.

## **RAMPS SNOW**

One of the dangerous situations on the road driving a truck, which is on the roof of the trailer layer of fallen snow. This layer eg. When passing a bridge on the highway can easily break off and cause for a vehicle traveling behind him a very dangerous situation. Drivers will benefit from the law (calculated on an amendment to the Road Act) specifically stipulated obligation cleaned before driving the windshield and front side windows from ice, snow and other debris. Likewise, they will have to remove before driving the vehicle and cargo chunks of ice and snow, which could loosen during driving. Unfortunately, there are built ramps to snow removal, which are eg. In Austria or Germany completely normal part of parking lots for the combination.

## **CANCELLATION OF HOLIDAY DRIVING BAN**

Compared with court states have introduced during the summer holiday driving ban trucks from Poland (in 18-22 hours) and Czech Republic (within 17-21 hours). This ban drivers very complicated at this time to return home and embark on regular weekly rest, despite the lack of parking spaces.

It would be better for the EU to consistently take the model, which is applied in Germany and the Slovak Republic, where the ban applies to trucks only on Sundays (and holidays) from 0.00 to 22.00 and in addition during the holidays even on Saturday from 7.00 to 20.00 hours.

## CONCLUSION

Currently works driver in international road transport very unpopular and good drivers are and will be in short supply. In our country now, although a large percentage of the unemployed, but not all of them are suitable for this position (only about max. 15% of the total unemployed). From this group of potential drivers, but not everyone wants to be for more money than they would get from the state, to do the work. Attempt should be made not only the state, but also of the carriers to make this sector more attractive. Unfortunately, current trends go against this effort. Great demands on drivers' work, high penalties for violations of road laws hectic working hours, poor diet, low level negotiations with drivers and salary conditions create negative factors that will improve the profession be best removed.

Consistent control of carriers' compliance with the operating modes of drivers and control the correct payment of wages is one of the main priorities in this area. Furthermore, the state should invest more in parking areas for trucks and the necessary facilities (toilets, showers, ramps, snow removal, etc.), unless he wants certain things sanction. By changing the operating mode drivers should have more space to regular meals. Unification bans in the EU would also contribute to higher satisfaction drivers.

## LITERATURE

- [1] HAVLÍK, K.: Psychologie pro řidiče: zásady chování za volantem a prevence dopravní nehodovosti. - *Portál*, 2005. ISBN 80-7178-542-3.
- [2] BŘEZINA, J.: Přehled předpisů v silniční nákladní dopravě - *Repronis s.r.o.*, 2010. ISBN 978-80-7329-239-3.
- [3] KAHODA, J.: Řidičova knihovna – Pracovní režimy řidičů – *ČESMAD*, 2011. ISBN 978-80-87304-20-4.
- [4] FRANC, J.: Práce řidiče v mezinárodní silniční dopravě. – *Vysoká škola logistiky o.p.s.*, 2015 (*Diplomová práce*).

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