Transport technic and technology
Volume XIV Issue 2 Year 2018
DOI: 10.2478/ttt-2018-0004

CONTINUITY OF ACTIVITIES DURING THE CRISIS SITUATIONS ON RAILWAY TRANSPORT BRANCH

Abstract: The continuity of activity field during the crisis situations is a way, how to reduce activities which is harmless for the transport. The goal is ensure minimal demanded level of services performed in the transport branch. This minimal level for performing the transport services are necessary for train operating.

Key Words: Business Continuity management, railway transport, infrastructure manager, train operating company

Dana Rozová[1]
[1]Jan Perner Transport Faculty, University of Pardubice, Studentská 95, 532 10 Pardubice 2, rozovad@szdc.cz
Martin Šustr[2]
[2]Jan Perner Transport Faculty, University of Pardubice, Studentská 95, 532 10 Pardubice 2, martin.sustr@upce.cz

Introduction

The railway transport is part of the complex transport system. The first role in this system represents infrastructure manager. In the transport system are important train operating companies and administrative authorities, too. The individual activities in the railway transport seem to be independent. It is not only following one another, but mutually interconnected. This interconnection also relates to the mutual co-operation of the various railway companies. The reconstruction, boosting or new construction of railway infrastructure in the Czech Republic is organized by infrastructure manager. These include particular repairs of railway lines and stations, timetabling, train path allocation and direct traffic organization. Train operating provide service related to the train running. The railway administrative authorities decide on the classification of the railroad into individual categories, carry out state supervision in the field of railways and building regulations, assess the causes of the occurrence of extraordinary events and approve the type and competence of the technicians and personal competence.

The functioning of the interconnected and coherent activities of all important processes within the railway transport is a basic feature for the safe and regular railway functioning. Every change of any act has impact in other parts. In order to achieve the necessary balance, it is necessary to use different variants of related actions. In every time activities in the railway system is like a live organism and like a live organism it must be in balance.

1. Management of continuity of activities

The Business Continuity Management is applicate in the railway transport for short time. It is a new branch in this field. This new branch is closely related with safety management. The Business Continuity Management is generally aimed at management of all activities in the field in order to ensure maximum functionality and maintain the highest possible performance in the current situation. It is an organization management process that is a tool to reduce the probability of interruption. This process identifies the impacts that threaten the organization and its functioning with aim to create processes and environments that reduce the risk of interruption of activities. In the case of an interruption of train operation, BCM will allow a flexible, efficient and appropriate response and ensure that key processes are restored at a predetermined minimum level and in a predetermined time (Rozová 2015).

In addition to the Business Continuity Management, the management element can be found in Safety Management, Risk Management, and Crisis Management. All relate with the risk management strategy in rail transport, but also it relate with the initial reporting and subsequent emergency response, risk analysis, emergency and crisis planning. They can be taken as four commonly linked components of a unified strategy. The difference and the relationship between them are not commonly understood. Often one concept is changed with the other three. Often, a combination of all four occurs. We can say that they are all important and each of them has a role for decision in dealing with extraordinary situations (Smejkal, Rais 2010).

Safety management in railway transport is the subject of management that solves the safety of resources in the railway companies. It deals with both physical and technological security. It includes operational safety, personal security and administrative safety, safety of information and communication systems, and also the protection of personal data. This area of management is very closely related to the risk management. Thanks to the different methods and tools, individual subjects in the railway environmental create conditions that will help to prevent or reduce identified risks.

The Business Continuity Management is add-on to the Risk management. By concentrating on the consequences of the interruption that this management carries out, it is possible to identify those products on which survival depends, and also to find out what needs to be done for the further functioning of the transport. The Business Continuity Management and the risk management can not be clearly merged or split. Both processes can complement one another.

The crisis management of the European Union and the North Atlantic Treaty Organization members has a different meaning and occupies a different area than in the Czech Republic. This term identifies "controlled" disputes as well as security in post-conflict areas and conflict prevention. (Valášek, Kovařík et al. 2008). The crisis management in the Czech Republic is a set of tools that helps the organization's leadership to manage specific activities in crisis situations and which helps to create conditions for the restoration of the pre-crisis state and it also help with overall coordination of crisis response of organization for avoiding or minimizing damage (Soušek et al. 2010). Individual concepts can be separated after recognizing errors that arise during individual management processes. Safety management error will arise in lower level of security, such as dealing with emergencies, failure to safety information and communication flows, failure of technology without substitution, etc. Uncontrolled or poorly managed risks will not prevent existing and future risks in the future. There will not be solution proposal to eliminate the effect of undesirable effects (Smejkal, Rais 2010). Errors on BCM may be described as faults in the process of packing a parachute. They are not recognizable until it's too late.

These terms are also linked to certain resulting documents. Constraints and differences can then simply be represented on these materials (Figure 1.). The Activity Continuity Plan is linked to the basic reporting of emergencies, risk analysis and crisis management plans and emergency planning. It creates together a comprehensive process of recovery from unexpected events which threaten the stability of rail transport system.

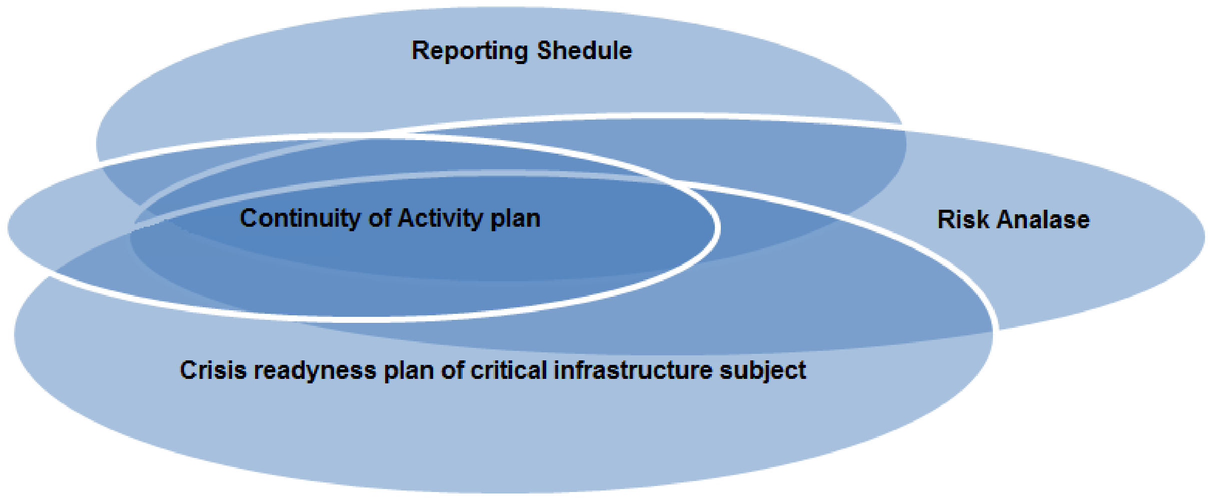

Fig. 1. Connectivity of documents related with crisis management, safety management, risk management and business continuity management Source: authors

2. Business continuity management system in the Infrastructure managers and Train operating companies

Like a first step is necessary start of the Business Continuity Management System (BCMS). One option is a systematic approach to the Business Continuity Management. The systematic approach is a one way to start the continuity management process. In this case, the Business Continuity Management is a set of organizational, personal, material, technical, financial and other measures to provide the necessary resources for the implementation and strengthening processes during extraordinary and crisis situations. The necessary step is that BCMS must be used in all fields in the transport company.

For creating BCMS are important 4 basic processes. The results from these processes are transformed outputs meeting the BCMS requirements and expectations from the surrounding area. It is PDCA (plan do check act). This process is well known like a Deming process, because it was used in 50's years in Japan. W. E. Deming taught Japans made their product in higher quality (Fuchs, Němec, Soušek, Szabo, Šustr, Viskup 2015).

At the start of the BCMS implementation, the person responsible for the Business Continuity Management organization should be identified in the subject. This person has the full responsibility for ensuring success of BCMS. In addition, it is necessary to identify a person or a team to implement and maintain the BCMS. These people may be from different parts of an organization. It depends on the size and organizational structure of company. If the structure of the organization requires it, it is possible to identify in each department the person or persons who will be assisting in the implementation of the Business Continuity Management. All responsibilities, powers and roles in the BCMS of all these designated persons should be listed in the duties descriptions and competency profiles (Soušek, Rozová, Němec, Šustr 2017). It is appropriate that these competencies and responsibilities are also subject to audits. The company should ensure that BCMS is embedded in the workers evaluation policy.

3. Process Analysis

For the BCMS is necessary holistic approach. Holistic mean, that process proceeds from the whole to the parts. First, the overall meaning is explored, and after overall meaning, individual details are explored. It should be noticed that all properties of a system cannot be determined or explained only by exploring parts of it. The "whole" (from the Greek holos) is important to this concept, and each part is usable with the other parts or with the whole system. Because the analysis is generally based on the decomposition of the whole on the elementary part, it is possible to analyse the core of the activity, i.e. the quantum of continuity of activities. The aim of the analysis is to identify the essential and necessary properties of the elementary parts of the whole, i.e. to know their nature and order.

After introduction of continuity politics must be must be fulfilled tasks by the managers. It is necessary for understanding actual processes in the railway company and understanding processes in individual company departments with regarding to the whole system. In addition an analysis of existing processes is required. The goal of the analysis is a deeper understanding of the processes and their parts (parts include activities, connections, outputs, the possible changes and the establishing to the new processes).

There are a lot of processes in the railways that fit each other. It crosses the various components of the organizational structure of the railway company as well as between the various railway transport system subjects. Processes have both influences external and internal. In each activity, inputs and sources are transformed into outputs. The business process can be represented using graphic symbols. The purpose is to define process inputs, sources, process itself, individual activities, goal and outputs associated with goal. Important feedback can be found in this step (ČSN ISO 22301, 2013). A simple tool for process orientation is a process map that should be a clear process schema (model).

The process model for analyse of processes performed on the Czech railway was created. The process model is composed the first and the second level of processes, created for the Infrastructure Manager. In most entities operating on the Czech railway, functional management is implemented with the logic of specialized departments (Rozová, Šustr, Soušek, Šohajek 2018). Each department is responsible for the activity which is performed by it.

The first-level model was designed to capture three basic process groups. Other processes are management and support. The main process is a key area which fulfilling the subject of business, and the main field of business. For the infrastructure manager, processes were included in this group:

- operationabilty of railways;
- organization and control of railway traffic;
- the national property management;
- development and modernization of the railway infrastructure.

Supporting processes for the Infrastructure Manager as support for the main processes are:

- information technologies;
- finance;
- health and safety in the work;
- fire protection;
- human resources;
- environmental contains.

Management processes create conditions for the proper functioning of other processes. They provide corporate governance and integrity, development, or business performance management. The Infrastructure manager management processes are:

- direct management activities;
- methodical management activities;
- audit, documentation, precautionary measures.

In the Figure 2 is map of the Infrastructure manager processes in first level.

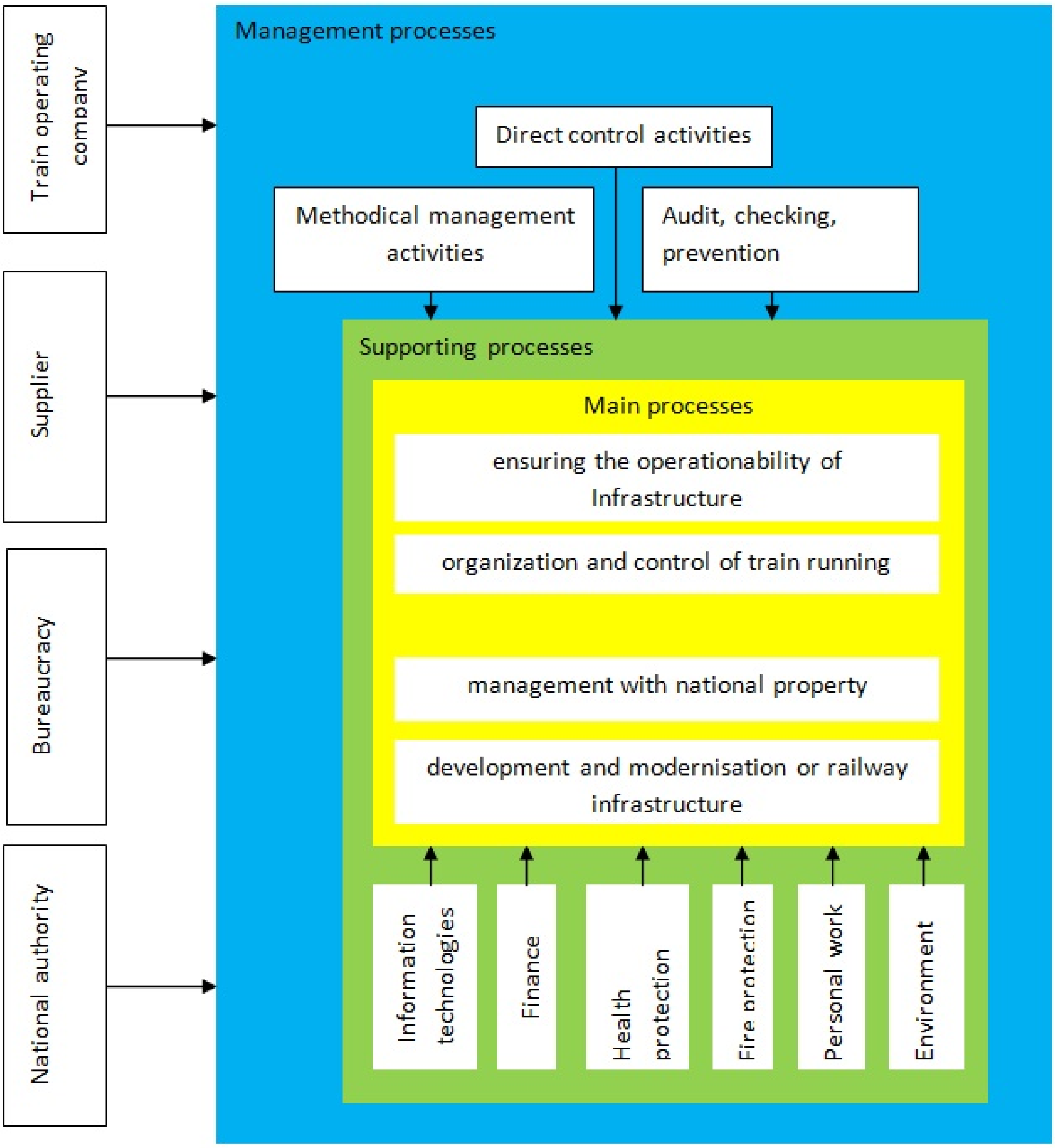

Fig. 2. Map of the Infrastructure manager processes on first level
Source: Authors

The model of second level (Figure 3.) shows the processes at the Infrastructure manager executive units.

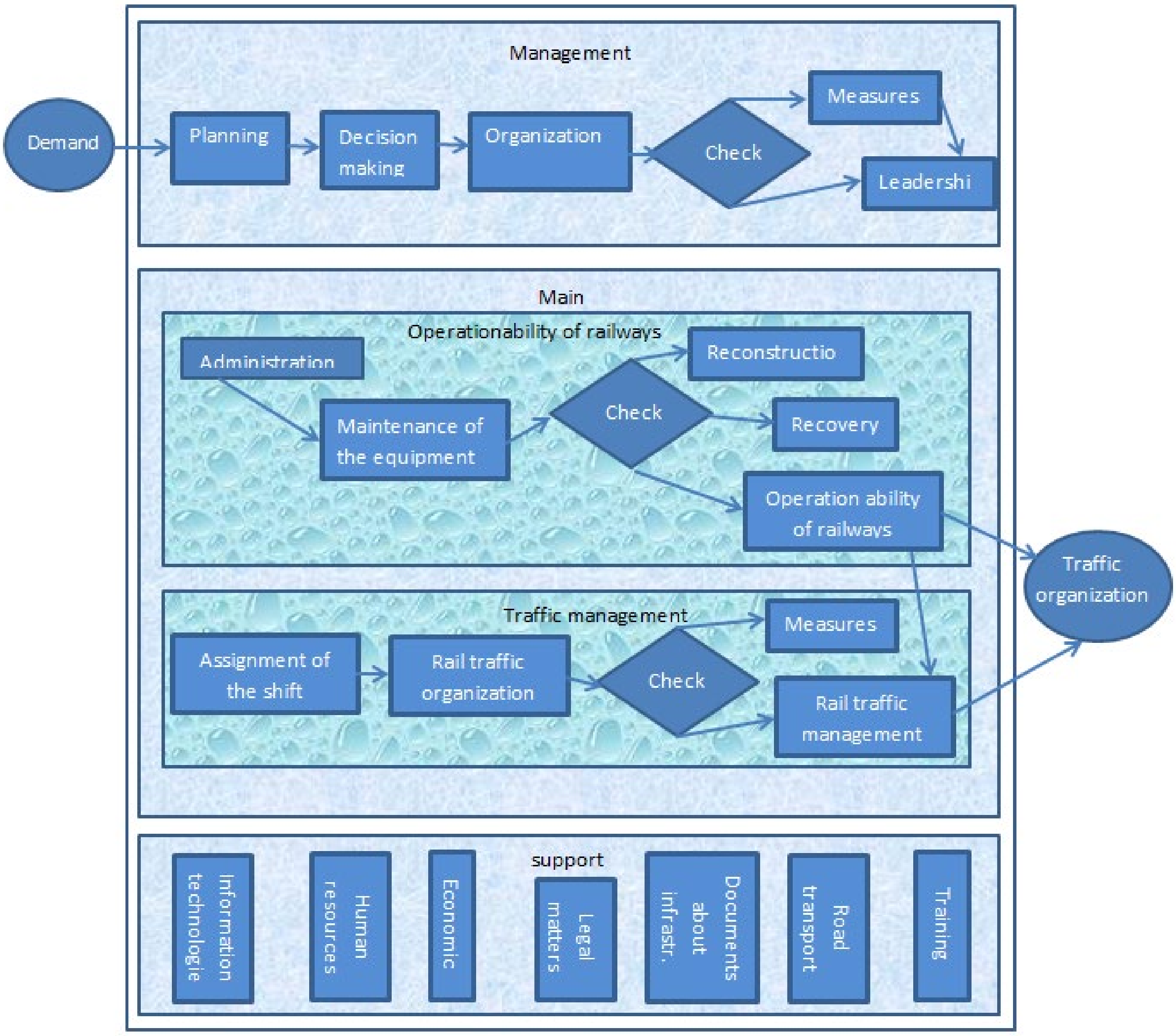

Fig. 3. Map of second level of Infrastructure manager processes
Source: Authors

4. Criteria for evaluation of Activities

The choice of criteria relevant to the evaluation have affects the outcome. Individual activities can be evaluated according to the monitored parameters. Partial values can be used for the overall evaluation of the department, section or enterprise.

Creating a purposeful set of criteria for the continuity assessment of activities is an important step that can significantly influence the final results (Sharp 2009). The specified set of evaluation criteria should therefore meet certain requirements. The set of criteria should be such as to allow assessment of all significant long-term and short-term both - positive and negative, direct and indirect impacts. Each criterion must be clearly and conclusively defined. Furthermore it must be also defined the way it is going to be measured. Each aspect should only come into the evaluation once, the criteria should not overlap. It is most important to choose the correct number of criteria (properties). Too many features can make it difficult or even impossible to find solutions. If there is too few of them, there is a risk of omitting some important aspects vital for valid evaluation. It is therefore essential to find a sufficient number of characteristics with sufficient information and discernment. The rationality of creating assessment criteria depends on the thorough knowledge of the assessed object, on the structural as well as functional system of understanding.

The system analysis shows that the partial value of the continuity h activity depends on the questions:

- how much it can be done in extraordinary event (e. g. crisis events);
- how long the activity being evaluated does not have to be carried out without the consequent problems;
- how many activities are interconnected with the disturbing activities;
- it is possible to replace the activity, if this activity can be performed by another worker or at another workplace;
- how much is required the specialization of resources for activity;
- there are effective measures, steps or practices addressing risk reduction.

To assess the continuity of activities, 6 basic criteria are proposed, which are relevant to the previous concerns. Table 1 lists the individual criteria for with their label.

Table 1. Criteria for evaluation of activities continuity

Criterion name	label
Fulfilment of Activity	*p*
Continuity of Activity	*k*
Interconnectivity of Activity	*v*
Reachability of Activity	*d*
Difficulty of Activity	*n*
Vulnerability of Activity	*z*

Source: Authors

Fulfilment of an activity p is the parameter that evaluates the overall use of the activity in any situation, both in the normal state and in crisis situations. The value of the Fulfilment of an Activity p can indicate that the activity is suitable only for a normal situation, a normal day-to-day regime without the possibility of its use in emergency situations or crisis situations. Under normal circumstances, all activities are valued equally because they meet the essential requirements for the outcome of the activity resulting from the expected benefit of performing the activity. In crisis situations, this standard expected performance requires more effort which is positively related to increasing intensity of the crisis. The value of this criterion of given activity is directly linked to individual crisis situations. For the actual evaluation of the value of the continuity of activities, a direct link to non-military crisis situations has been used.

The continuity of activity k is the very essence of continuity of activity, the basic observed parameter. It is assessed by the time lag between termination of the activity and the renewal of the performance without any subsequent problems.

The interconnectedness of the activity v indicates a number of previous and subsequent activities in general. For this evaluation, only a two-member causal chain was used in the sense of the cause (the activity under consideration) and the consequence (the amount of follow-up activities per activity evaluated).

The reachability of activity d is understood here as the representation of a worker who normally carries out the work by a worker from another, from another department, section, enterprise or outside the enterprise. In other words, it is about the substitution or substitutability for the worker who performs the activity and which, in the event of an emergency, would not be able to perform the activity himself. The term "reachability" was chosen from the point of view of its letter d, because letters z and n are already used for following parameters. In the short term, the job performed by one worker can be divided among other workers who perform the same work in parallel workplaces. In the long-term absence, workers cannot be overloaded, as their fatigue would negatively influence their job performance. Therefore, it is also possible to consider the possibility of substitution of a worker who has been absent for a long time with a worker from a different workplace who would be able to perform the activity after a short period of training. In the partial evaluation of Reachability of Activity d, the required quality of representation can be expressed by the weight of the criterion, depending on whether a worker from the workplace is required (by increasing the weight of the criterion) or whether the worker can work from external sources (by reducing the weight of the criterion).

Criterion the Difficulty of activity n is characterized for this purpose as the number of workers involved for achieving this activity. If the number of people performing the activity is dropped consequently the performance is reduced and the desired result is not achieved. The value of this parameter can be extended by the financial cost, possibly space requirements for its implementation.

The Vulnerability parameter is z is reduced by rules, steps, or procedures. Measures to eliminate risks can only be partial or complex, depending on the degree of practice and their form.

The relationship between the criteria is also important for evaluation. It is also important to find the possible interdependencies or similarities between the various aspects of the assessment.

The basic concept for examining the relationship between two characters is their independence. The two criteria are independent if the assessment of the first one does not depend on the value achieved by the latter.

There is interconnection between Activity p and the continuity of activity k. It has its justification both in its normal state in terms of meeting its expected benefit and speed and the need for its use. It has its justification both in its normal state in terms of meeting its expected benefit and speed and the need for its use. If the activity is fulfilled even in crisis situations when the time demands for the activity are usually increased, then the period of possible interruption of the given activity should be one day at the most, in order to avoid the risk of delay. Therefore, if the p performance of the p activity is highly valued, there should not be too long interruptions, so the value of Continuity of activities k should be also high. Otherwise, there is a logical disproportion.

Indirectly there is also relation between the parameters of the activity Interconnectivity v the

Fulfilment activity p. The low value of the activity p leads to the assumption of the low connectivity to the surrounding activities, in other words, the greater the demand for performing the activity, the more other activities require such an activity and the more requirements for the results of given activity. It is not a direct link with any exceptions; however the general trend the connection is significant. Therefore, it can be generally assumed that the higher the value of the Fulfilment activity p higher the Interconnectivity activity v.

The Reachability activity d has a direct link to the Fulfilment Activity p; therefore, the activity p can be maintained in the long-term even in crisis situations. There is also another parameter for the need for the performance of the activity. If the activity is not sustained and continuously claimed, the activity is less necessary and for this reason it is not necessary to provide substitution.

There was no immediate link between the Fulfilment Activity p and the Difficulty Activity n. Both parameters are independent of each other. However, if the number of workers carrying out the activity in normal condition is reduced to a smaller number of workers in a crisis situation, the difficulty in performing the activity will consequently increase.

If the Vulnerability of activity z is defined like a resulting effect of the threat elimination procedures, is quite obvious that the performance of the activity p is fully independent on it.

The continuity of activity k influences the relevance of activity v and vice versa. An activity that has several previous and sequential activities is clearly more required and has a higher requirement for continuity of activities k. The more people participate in the performance, the more difficult is to achieve the imperceptibility of such activity. Changes in the performance of the original activity can happen if the conditions change. The severity of activity n is therefore indirectly dependent on Continuity of activity k.

Indirect dependence is also between the Vulnerability of Activities z and the Continuity of Activities k, because the more the risk is eliminated, the less the activity is interrupted. It is an indirect dependence.

The link between Achievements of Activity d and Continuity of Activities k is quite obvious. The more the activity is substitutable, the less interruptible it becomes. There is a direct relationship here. On the other hand, no direct relationship has been found between the parameters of the Fulfilment activity v and the Difficulty activity n, between Interconnectivity activity v and Reachability activity d, Interconnectivity activity v and the Vulnerability activity z. If the activity is limited or stopped as a result of the negative impact, then it will disturb or fully stop the follow-up activities, respectively, their number will be limited according to their priority.

The Difficulty activity n has no direct relation to the Reachability activity d. It is possible to replace the employees with the full required number; the difficulty of the activity must remain on the same level.

The vulnerability activity z does not have direct effect on the Difficulty activity n. In the case that the substitution is full within required scope, it will fulfil given activity and thus there is no direct link between the parameters of Reachability activity d and the Vulnerability activity z. Table 2 shows the relationships between the criteria.

Table 1. Relation between criteria

	p	*k*	*v*	*d*	*n*	*z*
p	-	Direct	Direct	Direct	-	-
k	Direct	-	Direct	Direct	Indirect	Indirect
v	Direct	Direct	-	-	-	-
d	Direct	Direct	-	-	-	
n	-	Indirect	-	-	-	-
z	-	Indirect	-		-	-

Source: Authors

Conclusion

Continuity is actually a process that is characterized by time, flow, and unity. The continuity of rail transport activities should ensure the ability of each individual participant to strategically and tactically plan, respond appropriately to extraordinary circumstances, maintain or resume operations.

The continuity of railway company activities is an activity that aims to minimize the recovery period so as to avoid the development of a crisis situation. The severities of a crisis situation usually increase exponentially, depending on the interruption time. The continuity of activities also helps solving possible critical situations that can disrupt the operation of the transport company.

The transport company BCMS with right calibration have optimal boundary. Thanks to the optimization of the BCMS is possible to ensure required continuity of individual activities and reduce the possibility of disrupting the transport service on the area.

Everything that helps live and survive in a competitive environment can be valuable to rail transport. Thanks to the new technologies and modern management methods, the rail transport market share in the transport branch can be higher and the competitive advantage of rail transport can be expected to be more significant. A competitive advantage is also the introduction the continuity management of activities into the railway environment.

References

ČSN ISO 22301. 2013 Ochrana společnosti – Systém managementu kontinuity podnikání – Požadavky. Praha: Úřad pro technickou normalizaci, metrologii a státní zkušebnictví, 2013. 40 p. Třídící znak 01 2306.

Fuchs, P., Němec, V., Soušek, R., Szabo, S., Šustr, M., Viskup, P. 2015 The Assessment of Critical Infrastructure in the Czech Republic. In: 19th International Scientific Conference on Transport Means: Transport Means - Proceedings of the International Conference. Kaunas, Lithuania: Kaunas University of Technology, 2015 p. 418 – 426. ISSN: 1822-296X

Rozová, D. 2015 Hodnocení klíčových činností kontinuity za krizových situací. Pardubice, 2015. 92 p. Diploma Thesis. University of Pardubice, Jan Perner Transport Faculty.

Rozová, D., Šustr, M., Soušek, R., Šohajek, P. 2018 Crisis management in the railway transport and their additions. In. 22nd International Scientific on Conference Transport Means 2018 – Proceeding of the International Conference, Trakai, Lithuania, Kaunas University of Technology, 2018 p. 1043 – 1049. ISSN: 1822-296X

Sharp, J. 2009 Jak postupovat při řízení kontinuity činností: Naplnění požadavků BS 25999 = The route map to business continuity management. Praha: Risk Analysis Consultants, 2009. 117 p. ISBN 978-80-254-3992-0.

Smejkal, V., Rais, K. 2010 Řízení rizik ve firmách a jiných organizací. 3. vyd. Praha: GRADA, 2010. 360 s. ISBN 978-80-247-3051-6.

Soušek, R., et al. 2010 Doprava a krizový management. Pardubice: Institut Jana Pernera, 2010. 260 p. ISBN 987-80-86530-64-2.

Soušek, R., Rozová, D., Němec, V., Šustr, M. 2017 Business continuity management system in the transport. In: 21st World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI 2017), Orlando, United States, 2017 p. 185-190. ISBN: 978-194176364-3

Valášek, J., Kovařík, F., et al. 2008 Krizové řízení při nevojenských krizových situacích. Modul C. Praha: MV-generální ředitelství Hasičského záchranného sboru ČR, 2008. 159 p. ISBN 987-80-86640-93-8.

Transport technic and technology
Volume XIV Issue 2 Year 2018
DOI: 10.2478/ttt-2018-0005

THE ENERGY EFFICIENCY OF ELECTRIC ENERGY AS A TRACTION USED IN TRANSPORT

Abstract. The article deals with the problem of electric power production in terms of environmental impact, in particular the energy efficiency of its production to utilize primary sources. The efficiency of its production directly depends on the composition of primary sources and technologies used. Difference in efficiency by converting various forms of energy into electrical power and their ratio in the use directly affect the resulting efficiency, production of emissions and thus the environmental impact. Electric traction, its production, is burdened less efficient than other types of tractions used in transport, but at the final reconciliation of their consumption in vehicles, this difference decreases or delays because the vehicles themselves work with different conversion efficiency of its traction on mechanical work, vehicle driving.
Keywords: production efficiency, electric traction, primary sources, well-to-wheels, carbon fuel

Tomáš Skrúcaný[1]
[1] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia. +421 41 513 3518; tomas.skrucany@fpedas.uniza.sk
Saša Milojević[2]
[2] Faculty of Engineering, University of Kragujevac, Sestre Janjić 6, Kragujevac, Serbia. + 381 34 335990; sasa.milojevic@kg.ac.rs
Štefánia Semanová [3]
[3] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia. +421 41 513 3535; tomas.skrucany@fpedas.uniza.sk
Tomáš Čechovič [4]
[4] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia. +421 41 513 3434; tomas.cechovic@fpedas.uniza.sk
Tomasz Figlus [5]
[5] Faculty of Transport, Silesian University of Technology, Kraśinskiego 8, 40 019 Katowice, Poland. +48 32 603 41 18 tomasz.figlus@polsl.pl
František Synák [6]
[6] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia. +421 41 513 3523; frantisek.synak@fpedas.uniza.sk

Introduction

The current economic situation is directly dependent on transport. Without having the possibility of transporting goods or without transport service provision to the population, it would not be possible to carry out other follow-up activities aimed at creating the value of products or services which satisfy the society or an individual.

In the transport process, the input energy is converted into the movement of transport vehicles which provide the required spatial relocation of goods and persons. Therefore, transport is dependent on energy supply. Today's transport is largely dependent on oil because the majority of transport vehicles is propelled by engines combusting petroleum products – hydrocarbon fuels. This particularly relates to road, air and water transport. Most of transport vehicles of rail transport are currently powered by electric traction motors. Therefore, the degree of dependence of this type of transport on oil is lower than in the case of previously mentioned transport modes. However, the fact is that electric energy is produced by using petroleum products or coal in most states. All these natural resources are non-renewable and their stocks are constantly decreasing. Given to the mentioned facts, there is the effort to make transport more efficient in the field of energy dependence (Rybicka, I. et al. 2018, Milojević, S. et al. 2018, Milojevic, S., Pesic, R. 2012, Milojević, S. 2017, Ližbetin, J., Hlatká, M., Bartuška, L. 2018).

1. Standard EN 16258: 2012 and its using in calculations

This European Standard specifies general methodology for calculation and declaration of energy consumption and greenhouse gas emissions (GHG) in connection with any services (cargo, passengers or both). It specifies general principles, definitions, system boundaries, methods of calculation, allocation rules (allocation, assignment) and recommendations on information to support standardized, accurate, reliable and verifiable declarations regarding energy consumption and greenhouse gas emissions associated with any freight services. It also contains examples of these principles use. The calculation for one given transport service must be performed using the following three main steps (European standard EN 16 258:2012):

- Step 1: Identification of the various sections of the service;
- Step 2: Calculation of energy consumption and greenhouse gas emissions for each section;
- Step 3: Sum the results for each section.

The standard does not consider only the production of the secondary emissions and energy consumed during the combustion of the fuel (energy conversion from fuel to mechanical energy) but as well as primary, incurred in the extraction, production and distribution:

- e_W - well-to-wheels energetic factor for defined fuel;
- g_W - well-to-wheels emissions factor for defined fuel;
- e_t - tank-to-wheels energetic factor for defined fuel; and
- g_t - tank-to-wheels emissions factor for defined fuel.

Well-to-wheels is "well on wheels" and also covered primary and secondary emissions and consumption. This factor is somewhere also called as LCA (life-cycle-analysis).
Tank-to-Wheels factor is thinking only of secondary emission and consumption.

This Standard specifies general methodology for calculation and declared value for the energetic factor and factor in greenhouse gas emissions must be selected in accordance with Annex A (European standard EN 16 258:2012).

Table 1. Energy factors of chosen fuels

Fuel type	Energy factor				Emission factor					
	Tank-to-wheels (e_t)		Well-to-wheels (e_w)		Tank-to-wheels (g_t)			Well-to-wheels (g_w)		
	MJ/ kg	MJ/l	MJ/ kg	MJ/l	gCO_2e/ MJ	$kgCO_2e$/ kg	$kgCO_2e$/l	gCO_2e/ MJ	$kgCO_2e$ /kg	$kgCO_2e$/l
Gasoline	43.2	32.2	50.5	37.7	75.2	3.25	2.42	89.4	3.86	2.88
Diesel	43.1	35.9	51.3	42.7	74.5	3.21	2.67	90.4	3.90	3.24
CNG	45.1		50.5		59.4	2.68		68.1	3.07	

Emission gases are composed of several individual components (gas). Each of them have different chemical and physical properties, so they otherwise participate in environmental degradation. In order to compare emissions from different activities, fuels, vehicles where emissions have different impact, one representative unit used in the comparison must be designated (Lizbetin, J., Stopka, O., Nemec, F. 2016, Stoilova, S. 2016). This is the CO_2 equivalent which is a measure of the impact of specific emissions and likens it to the impact of CO_2. The label is CO_{2e} (equivalent).

2. Well-to-wheels energy and emission factors

Well-to-wheels factors used for electricity must be ones of the following data, provided that the selected data involves all previous operating processes in accordance with the objectives of this standard or they are corrected in order to take into account the contribution of missing processes and gases. This list is given by the following order:

- the value specified by the electricity supplier for purchased electricity from the certified production,
- the value of purchased electricity, specified by the electricity supplier for its production in the relevant electrical distribution system within which the transport is carried out,
- as the last option – the average value for electricity supplied to consumers in the relevant electrical distribution system within which the transport is carried out.

In order to avoid double counting in, the electricity supplier should deduct the electricity sold from the certified production from the remaining average selling electricity. The relevant electrical distribution system may be either national or one of several unconnected systems in a country or the system utilized by several countries. The relevant units should specify the identification of relevant electrical distribution systems (at least in Europe) (European standard EN 16 258:2012, Skrucany, T., Gnap, J. 2014, Technical annex to the SEAP template instructions document: The emission factors).

Tank-to-wheels energy factor (e_t) for electricity equals to 3.6 MJ/kWh and tank-to-wheels emission factor (g_t) for electricity is equal to zero (European standard EN 16 258:2012).

3. Energy production

Energy and emission factor (WtW) takes into account the partial losses in the production and distribution of electricity in the chain:

1. composition of energy sources used in the electricity production;
2. efficiency of the electricity production from individual sources;
3. efficiency of the transmission (distribution) of electricity to the final consumer.

Based on the above, it can be concluded that efficiency of electricity is directly dependent on the electricity production technology, composition and shares of individual sources and distribution efficiency.

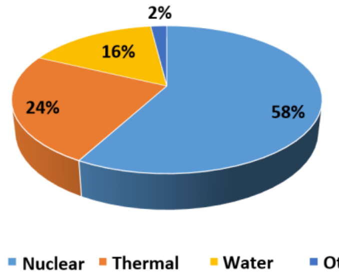

Fig. 1. The share of primary sources in electricity production in Slovakia in 2015 (Eurostat)

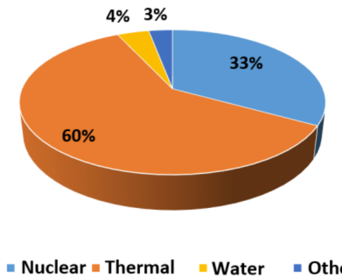

Fig. 2. The share of primary sources in electricity production in the Czech Republic in 2015 (Eurostat)

Energy efficiency in electricity production can be calculated as the weighted arithmetic mean of the shares of primary sources and the efficiencies in production of electric energy of individual sources. The weights of values represent the shares of individual sources. The values of efficiency were chosen based on the national regulation which prescribes their height (Vyhláška č. 88/2015 Z.z.).

The power produced is delivered to the consumer through the transmission system. This process is realized with losses and the efficiency of electricity transmission in the grid of the Slovak Republic was at the level of approximately 93 % (Report of the company SPS, a. s.).

Other losses in the electricity transmission onto the wheels of the transport vehicle lie in its own efficiency. The losses in the transport vehicle are caused by the transmission through trolley poles or pantograph (trolleybuses and locomotives, respectively) or from batteries (electric vehicles) to the control system, engine, gears and wheels. The efficiency of this process depends on the powertrain technology, but it is usually about 90 % (without taking into account the efficiency of electric motor consumption in relation to its speed).

Thus, the overall energy efficiency of delivered electricity in transport is:

$$\eta = \eta_{Prod} \cdot \eta_{Trans} \cdot \eta_{Veh} = \frac{\sum(\eta_{Si} \cdot p_{Si})}{\sum p_S} \cdot \eta_{Trans} \cdot \eta_{Veh} \quad (1)$$

Where:

η overall energy efficiency (-)
η_{Prod} efficiency of electricity production (-)
η_{Trans} efficiency of electricity transmission (-)
η_{Veh} efficiency of vehicle (-)
η_{Si} efficiency of a particular primary source (-)
p_{Si} share of a particular source in the electricity production (-)
p_S sum of partial shares of individual sources (-)

Given to the above mentioned fact and the partial share of individual efficiencies on the overall efficiency, the electricity production is normally burdened with the efficiency of 30-50 %. This means in some cases that three times more energy is used in electricity production than the final consumer consumes. The overall efficiency is to the greatest extent burdened with primary sources and electricity production technology. The consumer is often unable to determine the efficiency of the transport vehicle; however, it is reflected in the final consumption (e.g. when recharging batteries). If we neglect this efficiency and consider the electricity taken from the grid, thus in addition to the efficiency of electricity production, the electricity transmission has only minimal losses (around 7-8 %). The efficiency of electricity production is directly dependent on the used primary sources and technology their transformation into electricity. In the absence of declaration of electricity production efficiency, the calculation on the basis of the data on the shares of individual sources and technology is possible. For electricity production in the SR, the data from the Decree regulating the lowest efficiencies of operated power plants were used as inputs (Vyhláška č. 88/2015 Z.z.). The selected values of efficiency are given in Table 2.

Table 2. Energy efficiency values of energy conversion for electricity generating devices

Electricity generating device	Fuel	Electrical power (MW)	Year of introducing the device into operation: till 1998	1998 – 2012	2013 - 2015
			efficiency (%) operational		
			-	-	-
Combustion device and condensing steam turbine	black coal	to 15	36	36	38
		from 15 including to 50	38	38	40
		50 and higher	39	39	41
	brown coal	to 15	35	35	37
		from 15 including to 50	37	37	39
		50 and higher	38	38	40
	natural gas	to 10	38	38	40
		from 10 including to 35	40	40	42
		35 and higher	41	41	43
	heavy fuel oil	to 15	36	36	38
		from 15 including to 50	38	38	40
		50 and higher	39	39	41
Heat source and condensing steam turbine	nuclear	to 500	31	31	32
		from 500 including to 1000	31	31	32
		1000 and higher	31	31	32
	heat from industrial processes	to 10	36	36	36
		from 10 including to 35	36	36	36
		35 and higher	36	36	36
Combustion engine	Natural gas	to 0.05	29	29	29

Source: (Edict no. 88/2015 Z.z., author)

Based on the above values of efficiency and composition of primary sources, the electricity production efficiency was 42 % in the SR in 2015 and 37 % in the Czech Republic. This means that if the final consumer consumed 100 kWh of electricity, the actual consumed energy was at the level of 240 kWh in the SR and 270 kWh in the Czech Republic. As mentioned, this value of overall efficiency significantly differs according to the used primary sources whose own efficiency are different. The efficiency of energy conversion to electricity in steam turbines is approximately 30 % for nuclear power, 35 % for coal and 40 % for natural gas. Photovoltaic cells achieve the efficiency of around 10-20 % (it depends on the technology and sunlight). However, hydroelectric power plants are the most efficient because they operate only with losses of about 20 % (smaller plants) (Electropedia, Decarbonisation Pathways). Thus, if a country used only this source of energy, the efficiency of electricity production would achieve the level of around 80 %. From this reason, the counties using the energy of watercourses for electricity production utilize the least burdensome energy in terms of energy intensity as well as CO_2 production.

Table 3. Comparison of energy intensity of fuels

Fuel	direct energy consumption (MJ)	direct energy consumption (kWh)	Weight unit (kg)	Volume unit (l)	Overall energy consumption (W-t-W) (kWh)
Petrol	100	28	-	3.1	32.8
CNG			2.2	-	31.4
Diesel			-	2.8	33.3
Electricity			Country		-
			CZ		75.7
			SK		66.7

Source: (European standard EN 16 258:2012, Technical annex to the SEAP, Skrucany, T., Gnap, J. 2014, Eurostat)

Table 4 compares fuel types or traction of transport vehicles in terms of their energy intensity. The same amount of consumed energy i.e. 100 MJ or 28 kWh is used for the comparison. Subsequently, the quantities of liquid and gaseous fuels in which this amount of energy is present are given. The right column of the table contains the calculation of the total energy of individual types of traction, i.e. the energy contained in the unit quantity together with the energy needed to its production. The right column shows the effectiveness of individual types of traction; however, it represents a comparison of their energy efficiency in terms of their physical properties and technological processes of their production (Jurkovic, M., Kalina, T., Teixeira, A. F.

2017, Petro, F., Konecny, V. 2017) During the consumption i.e. energy conversion to mechanical work in the transport vehicle, the process is realized with different efficiency. Transport vehicles propelled by petrol, diesel or CNG operate mostly with the efficiency of 30-45 % while transport vehicles using electric traction achieve the efficiency of 80-90 % (see the table below) (Skrucany, T., Gnap, J. 2014, Vyhláška č. 88/2015 Z.z., Knez, M. et. al. 2014, Kalina, T., Jurkovic, M., Grobarčíková, A. 2015).

Table 4. Calculation of energy consumption and GHG production of chosen passenger car

Fuel	Ø fuel consumption (l. kg. kWh/100km)	T-t-W			W-t-W	
		Energy consumption (MJ/km)	Energy consumption (kWh/km)	Production of CO_{2e} (g/km)	Energy consumption (MJ/km)	Production of CO_{2e} (g/km)
Petrol	8.07	2.60	0.72	195	3.04	232
CNG	5.17	2.33	0.65	139	2.59	159
Diesel	6.12	2.20	0.61	163	2.61	198
Electric*	21.04	0.76	0.21	0	1,8/2,05	74/178
Hybrid**	5.4	1.74	0.48	131	2.04	156

Source: (Electropedia)

* this applies only for consumed electricity produced in the SR or (/) CZ

** variable value, it greatly depends on the vehicle operation (city, highway), the type of hybrid technology used

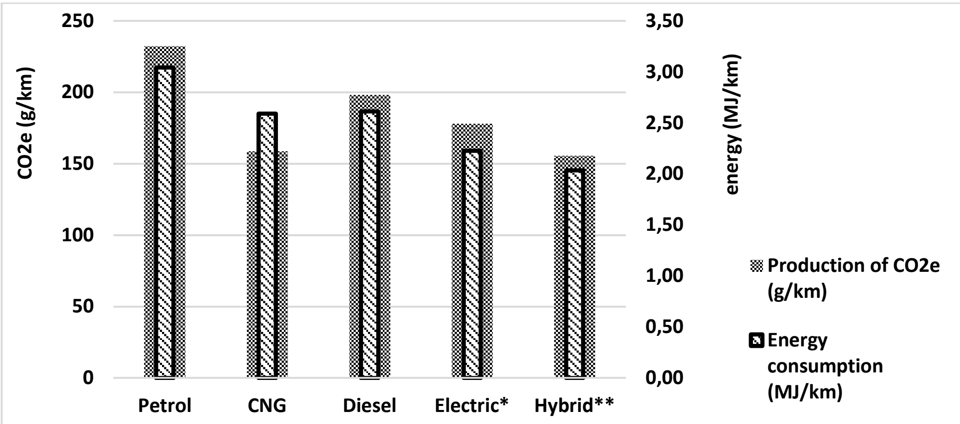

Fig. 3. Results of energy consumption and GHG production of chosen passenger car

The results presented in the table represent the energy consumption and GHG productions from global perspective i.e. primary as well as secondary impacts are considered. The results of electric energy consumption (column "Electric") are introduced in this graphical expression only for one evaluated country – the Czech Republic – not for Slovakia. When considering hydrocarbon fuels, the CNG propulsion is the cleanest in terms of GHG production.

This results are calculated from values of fuel and energy consumption of vehicles operated in real driving conditions. These values of consumption were used form database of almost 1200 vehicles - passenger cars with gross vehicle 1.9 t operated in Europe (Database of real vehicle fuel consumption). The vehicle database consists of two different marks and types which are sold in all type of engines.

However, it represents less efficient fuel in terms of energy consumption, even though it is fuel whose production is not subjected such procedures as in the case of petrol or diesel. This is caused by a high energy content in 1 kg of CNG, so engines combusting CNG achieve less efficiency than engines combusting petrol or diesel (Polcar, A., Cupera, J., Kumbar, V. 2016, Šarkan, B. et al. 2017, Hlatká, M., Bartuška, L. 2018).

Conclusions

Different types of traction used in transport are specific in their characteristics which are manifested during their consumption. Each type has its advantages and disadvantages. As it is with electric traction, which production is less effective compared to gas or oil fuels (Table 3), but efficiency of vehicles is higher, therefore the final energy consumption is at a level similar to the comparison of fuel (Table 4 and Fig. 3). Electricity production efficiency as well as its emissions production are directly dependent on the use of primary sources (Fig. 1, 2 and Fig. 3), therefore the countries should take into account their composition and especially the use of technology. If they use the right composition and new technology of electricity production, they can produce actually constitutes acceptable electrical traction for the environment that is not a casual case today. Hydropower plants have the highest efficiency of electricity generation. They also produce minimal emissions, almost none. They are therefore considered to be the most acceptable form of energy production in keeping the right integration into the country, unhindered migratory routes of animals. Therefore it can be considered as a "green" electric traction in countries such Norway, Sweden, Austria and Switzerland. In contrast, countries as Estonia, Poland and Greece mainly use fossil fuels to generate electricity. Electric traction, its production is burdened less efficient than other types of tractions used in transport, but it is true only if we compare the energy efficiency due to their physical properties and technological processes for their production. During of their consumption, that is the conversion to mechanical work in vehicles, this phenomenon has a different effectivity. Vehicles driven by oil and gas products work mostly with effectivity from 30 to 45 %, vehicles used electric traction force reached 80-90 %, so the difference in the efficiency of their production is ultimately suppressed.

References

Database of real vehicle fuel consumption; https://www.spritmonitor.de

Decarbonisation Pathways, publication of Eurelectric (iniciative of energy industry in Europe, December 2018; https://cdn.eurelectric.org/media/3457/decarbonisation-pathways-h-5A25D8D1.pdf

Electropedia – Battery and Energy Technologies – Energy Efficiency; https://www.mpoweruk.com

European standard EN 16 258:2012 Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers).

Eurostat, Europan statistics portal

Hlatká, M., Bartuška, L. 2018 Comparing the Calculations of Energy Consumption and Greenhouse Gases Emissions of Passenger Transport Service. *In: Nase More*, Dubrovnik: University of Dubrovnik, Vol. 65, Issue 4, p. 224-229. ISSN 0469-6255.

Jurkovic, M., Kalina, T., Teixeira, A. F. 2017 Possibilities of using alternative fuels for transport solution in Brazil. *In: Proceedings of the 21st international scientific conference Transport means 2017*, Kaunas, Lithuania, 2017, p. 724-728.

Kalina, T., Jurkovic, M., Grobarcikova, A. 2015 LNG - Great Opportunity for the Inland Water Transport. *In: Proc. of the 19th intern. scientific conference: Transport Means 2015*, October 22-23, Kaunas University of Technology, p. 489-492.

Knez, M. et. al. 2014. The estimation of a driving cycle for Celje and a comparison to other European cities. *In. Sustainable cities and society*, Vol. 11, p. 56-60.

Lizbetin, J., Stopka, O., Nemec, F. 2016 Methodological Assessment of Environmental Indicators in Combined Transport in Comparison with Direct Road Freight Transport. *In: Proceedings of the 20th international scientific conference Transport means 2016*, Kaunas, Lithuania, p. 151-155.

Ližbetin, J., Hlatká, M., Bartuška, L. 2018 Issues concerning declared energy consumption and greenhouse gas emissions of FAME biofuels. *In: Sustainability* (Switzerland), 10(9).

Milojevic, S., Pesic, R. 2012 Theoretical and experimental analysis of a CNG cylinder rack connection to a bus roof, *In: International Journal of Automotive Technology*, Vol.13, No.3, p. 497-503, ISSN 1976-3832, DOI: 10.1007/s12239−012−0047−y

Milojević, S. 2017 Sustainable application of natural gas as engine fuel in city buses – benefit and restrictions, *In: Journal of Applied Engineering Science*, Vol.15, No.1, p. 81-88, ISSN 1451-4117, DOI: 10.5937/jaes15-12268

Milojević, S. et al. 2018 Alternative drive systems and environmentaly friendly public passengers transport, *In: Applied Engineering Letters*, Vol.3, No.3, p. 105-113, ISSN 2466-4847, DOI: https://doi.org/10.18485/aeletters.2018.3.3.4

Petro, F., Konecny, V. 2017 Calculation of emissions from transport services and their use for the internalisation of external costs in road transport. *In: 12th International scientific conference of young scientists on sustainable, modern and safe transport, High Tatras, Slovakia, Procedia Engineering*, Vol. 192, p. 677-682. DOI: 10.1016/j.proeng.2017.06.117.

Polcar, A., Cupera, J., Kumbar, V. 2016 Calibration and its use in measuring fuel consumption with the can-bus network. *In: Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. 64, Issue 2, p. 503-507.

Report of the company SPS, a. s., transmission network operator in Slovakia

Rybicka, I. et al. 2018 Application of the methodology related to the emission standard to specific railway line in comparison with parallel road transport: a case study, *In: MATEC Web of Conferences 244*, 03002 (2018), https://doi.org/10.1051/matecconf/201824403002

Skrucany, T., Gnap, J. 2014 Energy intensity and greenhouse gases production of the road and rail Cargo transport using a software in simulate the energy consumption of a train. *In: Telematics - support of transport : 14th international conference on Transport systems telematics, TST 2014*, Berlin: SPRINGER-VERLAG, ISBN 978-3-662-45316-2. - p. 263-272.

Stoilova, S. 2016 Study of the efficiency of motorail trains as a factor in transport development. *In: SGEM 2016, BK 2: Political sciences, law, finance, economics and turism conference proceedings*, Vol. V. Book Series: International Multidisciplinary Scientific Conferences on Social Sciences and Arts. p. 627-634. Technical annex to the SEAP template instructions document: The emission factors. Document of The European Commission.

Šarkan, B. et al. 2017 Composition of exhaust gases of spark ignition engines under conditions of periodic inspection of vehicles in Slovakia = Skład spalin z silników o zapłonie iskrowym w warunkach okresowych badań pojazdów na Słowacji. *In: Przemysl Chemiczny*. Vol. 96, No. 3, p. 675-680. DOI: 10.15199/62.2017.3.36

Vyhláška č. 88/2015 Z.z. Ministerstva hospodárstva Slovenskej republiky, ktorou sa ustanovuje rozsah hodnotenia, spôsob výpočtu a hodnoty energetickej účinnosti zdrojov a rozvodov energie (in Slovak)

Transport technic and technology
Volume XIV Issue 2 Year 2018
DOI: 10.2478/ttt-2018-0006

ANALYZING OF CUSTOMER REQUIREMENTS TO ERIC MOBILE APPLICATION

Abstract. Users in transport, forwarding and logistics companies use the mobile technologies for connect to existing information systems. By solving the ERIC Mobile project, these services will also be available on mobile devices. The article is aimed at lancing the requirements of all types of customers for the ERIC Mobile app. After the basic characteristics of the mobile device, the operation systems, the application development typology, the authors focus on the developing application "ERIC Mobile". The aim of the article is to provide relevant requirements for further research and development of the software application of the rail freight information centre in Europe for end users of mobile devices such as smartphones and tablets.
Keywords: applications for mobile devices, transportation a forwards companies, ERIC Mobile,

Juraj Čamaj[1]
[1] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia. +421 41 513 3423; juraj.camaj@fpedas.uniza.sk
Jaroslav Mašek[2]
[2] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia. +421 41 513 3423; jaroslav.masek@fpedas.uniza.sk
Martin Kendra[3]
[3] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia. +421 41 513 3429; martin.kendra@fpedas.uniza.sk

Introduction

The purpose of using a mobile phone is no longer as limited as a few years ago. Today's devices no longer have the slightest problem with full browsing, navigation, or video recording. Their success stems from the simplicity of processing, the sleek design, the modern technologies, but a significant part of the success is also attributed to the operating system.

The article addresses customer requirements for the developing ERIC Mobile application. After the general definition of mobile devices and their general user features, the authors focus on the creating ERIC Mobile application. The requirements for this app come from an existing ERIC desktop application. Preferences vary depending on the diversity of subjects in the transport market and their preferences.

1. Mobile Devices

A mobile device (or handheld computer) is a computing device small enough to hold and operate in the hand. Typically, any handheld computer device will have an LCD flat screen interface, providing a touchscreen interface with digital buttons and keyboard or physical buttons along with a physical keyboard. Many such devices can connect to the Internet and interconnect with other devices such as car entertainment systems or headsets via Wi-Fi, Bluetooth, cellular networks or near field communication (NFC). Integrated cameras, digital media players, the ability to place and receive telephone calls, video games, and Global Positioning System (GPS) capabilities are common (Tengler – Abramović – Achimský, 2018). Power is typically provided by a lithium battery. Mobile devices may run mobile operating systems that allow third-party apps specialized for said capabilities to be installed and run.

Early smartphones were joined in the late 2000s by larger, but otherwise essentially the same, tablets. Input and output is now usually via a touch-screen interface. Phones/tablets and personal digital assistants may provide much of the functionality of a laptop/desktop computer but more conveniently, in addition to exclusive features. Enterprise digital assistants can provide additional business functionality such as integrated data capture via barcode, RFID and smart card readers. By 2010, mobile devices often contained sensors such as accelerometers, magnetometers and gyroscopes, allowing detection of orientation and motion. Mobile devices may provide biometric user authentication such as face recognition or fingerprint recognition (Ihnát – Gašparík, 2008).

There are many kinds of mobile devices, designed for different applications (Čamaj – Gašparík, 2011). These include:

- mobile Internet devices;
- tablets/Smartphones;
- laptops;
- wearable computers;
- calculator watches;
- smartwatches;
- head-mounted displays;
- personal digital assistants;
- enterprise digital assistants;
- ultra-mobile PCs;
- etc…

2. Mobile Operating System

An operating system (OS) is system software that manages computer hardware and software resources and provides common services for computer programs.

Time-sharing operating systems schedule tasks for efficient use of the system and may also include accounting software for cost allocation of processor time, mass storage, printing, and other resources. (Čamaj, 2018)

A mobile operating system (or mobile OS) is an operating system for phones, tablets, smartwatches, or other mobile devices. While computers such as typical laptops are 'mobile', the operating systems usually used on them are not considered mobile ones, as they were originally designed for desktop computers that historically did not have or need specific mobile features. This distinction is becoming blurred in some newer operating systems that are hybrids made for both uses.

Mobile operating systems combine features of a personal computer operating system with other features useful for mobile or handheld use; usually including, and most of the following considered essential in modern mobile systems; a wireless inbuilt modem and SIM tray for telephony and data connection, a touchscreen, cellular, Bluetooth, Wi-Fi Protected Access, Wi-Fi, Global Positioning System (GPS) mobile navigation, video- and single-frame picture cameras, speech recognition, voice recorder, music player, near field communication, and infrared blaster. Android alone is more popular than the popular desktop operating system Windows, and in general smartphone use (even without tablets) outnumber desktop use. (Tengler – Kolarovszki – Kolarovszka, 2017)

Mobile devices with mobile communications abilities (e.g., smartphones) contain two mobile operating systems – the main user-facing software platform is supplemented by a second low-level proprietary real-time operating system which operates the radio and other hardware. Research has shown that these low-level systems may contain a range of security vulnerabilities permitting malicious base stations to gain high levels of control over the mobile device.

Mobile operating systems have majority use since 2017 (measured by web use); with even only the smartphones running them (excluding tablets) more used than any other kind of device. Thus traditional desktop OS is now a minority used kind of OS; see usage share of operating systems. (Tengler – Abramović – Achimský, 2018

As the most popular mobile OS we can selected:

- Android;
- iPhone OS;
- Windows Phone;
- Symbian;
- BlackBerry.

The following graph show the shares of the phone operating systems in the period 05/2017 – 04/2018.

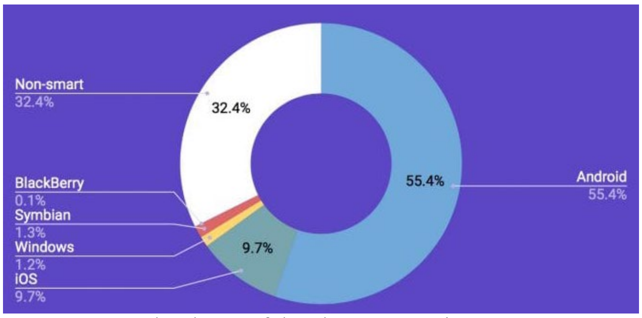

Fig. 1. The shares of the phones operating systems
Source: Menšík, 2018

3.1. Operational system Android

Android is a mobile operating system developed by Google. It is based on a modified version of the Linux kernel and other open source software, and is designed primarily for touchscreen mobile devices such as smartphones and tablets. (Tengler – Kolarovszki – Kolarovszka, 2017)

Android is also associated with a suite of proprietary software developed by Google, called Google Mobile Services (GMS) that very frequently comes pre-installed in devices, which usually includes the Google Chrome web browser and Google Search and always includes core apps for services such as Gmail, as well as the application store and digital distribution platform Google Play, and associated development platform. These apps are licensed by manufacturers of Android devices certified under standards imposed by Google, but AOSP has been used as the basis of competing Android ecosystems, such as Amazon.com's Fire OS, which use their own equivalents to GMS. (Android – operating system, 2018)

Android has been the best-selling OS worldwide on smartphones since 2011 and on tablets since 2013. As of May 2017, it has over two billion monthly active users, the largest installed base of any operating system, and as of June 2018, the Google Play store features over 3.3 million apps. (Android – operating system, 2018)

The Android platform itself provides not only an end-user operating system but also a complete operating system deployment solution (driver specification, etc.) for mobile operators and device manufacturers, and, last but not least, for application developers, provides effective tools for their development - Software Development Kit.(Tengler – Kolarovszki – Fabuš – Fabušová, 2018)

Android is divided into 5 layers where each layer has its purpose and need not be separated from the other layers. They are:

- the core;
- libraries;
- Android Runtime layer;
- application framework layer;
- the Layer of elementary applications.

3.2 iOS

iOS (formerly iPhone OS) is a mobile operating system created and developed by Apple Inc. exclusively for its hardware. It is the operating system that presently powers many of the company's mobile devices, including the iPhone, iPad, and iPod Touch. (Tengler – Kolarovszki – Kolarovszka, 2017) It is the second most popular mobile operating system globally after Android.

Originally unveiled in 2007 for the iPhone, iOS has been extended to support other Apple devices such as the iPod Touch (September 2007) and the iPad (January 2010). As of March 2018, Apple's App Store contains more than 2.1 million iOS applications. (iPhone OS, 2018)

The iOS user interface is based upon direct manipulation, using multi-touch gestures. Interface control elements consist of sliders, switches, and buttons. Interaction with the OS includes gestures such as swipe, tap, pinch, and reverse pinch, all of which have specific definitions within the context of the iOS operating system and its multi-touch interface. Internal accelerometers are used by some applications to respond to shaking the device (one common result is the undo command) or rotating it in three dimensions (one common result is switching between portrait and landscape mode). Apple has been significantly praised for incorporating thorough accessibility functions into iOS, enabling users with vision and hearing disabilities to properly use its products. (iPhone OS, 2018)

Major versions of iOS are released annually. On all recent iOS devices, iOS regularly checks on the availability of an update, and if one is available, will prompt the user to permit its automatic installation. iOS is composed of the following four layers:

- Core OS (system core);
- Core Services (Basic Services);
- Media layer;
- Cocoa Touch layer (user interface or GUI and its API).

3.3. Operational system Windows Phone

Windows Phone (WP) is a family of discontinued mobile operating systems developed by Microsoft for smartphones as the replacement successor to Windows Mobile and Zune. Windows Phone features a new user interface derived from Metro design language. Unlike Windows Mobile, it is primarily aimed at the consumer market rather than the enterprise market. It was first launched in October 2010 with Windows Phone 7. Windows Phone 8.1 is the latest public release of the operating system, released to manufacturing on April, 2014. (Windows Phone, 2018)

Windows Phone was succeeded by Windows 10 Mobile in 2015; it emphasizes a larger amount of integration and unification with its PC counterpart—including a new, unified application ecosystem, along with an expansion of its scope to include small-screened tablets.

In January 2019, Microsoft announced that support for Windows 10 Mobile would end on December 10, 2019, and that Windows 10 Mobile users should migrate to iOS or Android phones. (Windows Phone, 2018)

3.4. Operational system Symbian

Symbian is a discontinued mobile operating system (OS) and computing platform designed for smartphones. Symbian was originally developed as a closed-source OS for PDAs in 1998 by the Symbian Ltd. consortium. Symbian OS was a descendant of Psion's EPOC, and ran exclusively on ARM processors, although an unreleased x86 port existed. Symbian was used by many major mobile phone brands, like Samsung, Motorola, Sony Ericsson, and above all by Nokia. It was also prevalent in Japan by brands including Fujitsu, Sharp and Mitsubishi. As a pioneer that established the smartphone industry, it was the most popular smartphone OS on a worldwide average until the end of 2010 – at a time when smartphones were in limited use, when it was overtaken by Android, as Google and its partners achieved wide adoption. (Symbian OS, 2018)

The Symbian OS platform was formed of two components: one being the microkernel-based operating system with its associated libraries, and the other being the user interface (as middleware), which provides the graphical shell atop the OS. The most prominent user interface was the S60 (formerly Series 60) platform built by Nokia. Another interface was the MOAP(S) platform from carrier NTT DoCoMo in the Japanese market. Applications of these different interfaces were not compatible with each other, despite each being built atop Symbian OS. (Symbian OS, 2018)

3.4. Operational system BlackBerry OS (RIM)

BlackBerry OS is a proprietary mobile operating system developed by Canadian company BlackBerry Limited for its BlackBerry line of smartphone handheld devices. The operating system provides multitasking and supports specialized input devices that have been adopted by BlackBerry for use in its handhelds, particularly the trackwheel, trackball, and most recently, the trackpad and touchscreen. (BlackBerry OS, 2018)

The BlackBerry platform was perhaps best known for its native support for corporate email, through Java Micro Edition MIDP 1.0 and, more recently, a subset of MIDP 2.0, which allowed complete wireless activation and synchronization with Microsoft Exchange, Lotus Domino, or Novell GroupWise email, calendar, tasks, notes, and contacts, when used with BlackBerry Enterprise Server. The operating system also supported WAP 1.2.

Updates to the operating system may be automatically available from wireless carriers that support the BlackBerry over the air software loading (OTASL) service. (BlackBerry OS, 2018)

Third-party developers can write software using the available BlackBerry API classes, although applications that make use of certain functionality must be digitally signed.

4. The type of applications in mobile devices

The mobile applications can be selected to tree basic groups:

1. Native apps
2. Hybrid apps
3. Web apps

4.1. Native apps

Such apps are developed for a single mobile operating system exclusively; therefore, they are "native" for a particular platform or device. App built for systems like iOS, Android, Windows phone, Symbian, Blackberry can not be used on a platform other than their own. In other words, you won't be able to use Android app on iPhone. (Tengler – Kolarovszki – Kolarovszka, 2017)

Main advantage of native apps is high performance and ensuring good user experience as developers use native device UI. Moreover, an access to wide range of APIs that puts no limitation on app usage. Native applications are distinctly accessible from app stores of their kind and have the clear tendency to reach target customers.

Some cons to native apps are higher cost compared to other types of apps – due to the need of creating app duplicates for other platforms, separate support and maintenance for different types of apps resulting in bigger product price. (Tengler – Kolarovszki – Fabuš – Fabušová, 2018)

4.2 Hybrid apps

They are build using multi-platform web technologies (for example HTML5, CSS and Javascript). So-called hybrid apps are mainly website applications disguised in a native wrapper. Apps possess usual pros and cons of both native and web mobile applications. (Tengler – Kolarovszki – Kolarovszka, 2017)

Hybrid multi-platform apps are fast and relatively easy to develop – a clear advantage. Single code base for all platforms ensures low-cost maintenance and smooth updates. Widely used APIs, like gyroscope, accelerometer and geolocation are available.

On the other hand, hybrid applications lack in performance, speed and overall optimization in comparison to native apps for instance. Also, there are certain design issues due to app inability to look in exactly same way on two or more platforms. (Tengler – Kolarovszki – Fabuš – Fabušová, 2018)

4.3 Web apps

These are software applications that behave in a fashion similar to native applications. Web apps use a browser to run and are usually written in HTML5, JavaScript or CSS. These apps redirect a user to URL and offer "install" option by simply creating a bookmark to their page. (Tengler – Kolarovszki – Kolarovszka, 2017)

Web applications require minimum of device memory, as a rule. As all personal databases are saved on a server, users can get access from any device whenever there is internet connection. That is why the use of web apps with poor connection would result in bad user experience. The drawback is access to not that many APIs for developers, with exception of geolocation and few others.

Apps content is only a wrapper on the used device while most of data should be loaded from a server.Performance is inextricably linked due to browser work and network connection. Only up to 14% of time users spend on mobile websites. And just some of device APIs may be used (such as geolocation) (Tengler – Kolarovszki – Fabuš – Fabušová, 2018)

5. Subjects on transport market and their interaction

The technological processes of rail transport management are based on the availability of correct and accurate information. In the management of rail transport, it is important to find out how to get the information "at the right time and in the right place"

In the modern area of the liberalized rail transport market, is especially particularly important the criterion of the classification of information systems according to the entity, which expresses the division of competencies, operational responsibility, information and information systems between the infrastructure manager (IM) and the railway undertaking, (RU). (Ihnát – Gašparík, 2008) (Gapšarík – Zitrický, 2010)

In the rail transport market, the railway undertaking offers transport services for the transport of persons and goods, in space and time. On the demand side, the customer is a natural or legal person requesting the relocation of the goods (object of transport) to the destination. The customer may be the carrier himself, for whom the service is need, or an intermediary, such as a forwarder. Customer buys transport performance – transportation.

There are other actors in the rail transport services market – in particular infrastructure managers from which railway undertakings buy railway infrastructure capacity and regulatory authorities. Perfect co-operation between individual entities involved in the final product is therefore important because the final customer (transporter) perceives the quality of the shipping process as a whole. In rail transport, this means mainly the coordination of the infrastructure managers 'and carriers' technological processes. (Technological activities and processes of infrastructure manager, railway undertaking, forwarder, the wagons holders, state organs, etc.)

6. Background and user preferences for created ERIC Mobile application

6.1 The background for ERIC Mobile apps

Schedule of transport is crucial not only to question the place of loading and unloading as well as direction for transportation. The specificity of rail freight traffic is obvious, and road planning has not supported any planning tool available to road hauliers on the Internet. Despite the efforts of the railway companies, it is not easy for the carrier to obtain all the information about the parameters of the transport route. One of the main sources that clearly help in determining traffic parameters is a detailed rail map. (Čamaj, 2018)

As part of this basic task, an electronic railway map of Europe has been developed to provide complete information on a total of 23,000 stations in 40 countries. Likewise, the RailMap platform allows you to instantly provide information and the current location of individual wagons according to carrier requirements. With the growing importance and support of international rail freight, users now have quick access to all relevant information in order to simplify the use of the rail network and can continually ask for the current status of the shipment.(Čamaj – Gašparík, 2011)

The map and the resulting information are a very good basis for displaying additional information, whether transporting the character (current position of trains, wagons and shipments) as well as the technical character of the transport infrastructure (tracks levels, arc radii, transition profiles, etc.).

The map background worked as part of the ERIC platform (European Railway Information Centre). ERIC represents a modular and continuously updated information databank on railway freight transport in the form of an application. The application forms a core with more than 250 individually licensable modules, which provide information about the goods catalogues, railway stations, tariff distances and prices, shipping documents, transport regulations and railway infrastructure. Updated information is provided in electronic form from a processing centre, in various forms and several languages depending on the users´ needs.

The fundamental aspect of an electronic information system lies in a well-established centre for data gathering. Information is collected from various sources coming from railway freight in Europe and part of Asia. The original data is processed into a computer format, translated and made accessible to all railway users in the form of single application ERIC. (Camaj – Mašek, 2013) The system is designed for customers and users as the local application for PC equipped with MS Windows.

The ERIC enabled comprehensive information for all users based on the installation and purchased access data. Work with ERIC was therefore bound to a desktop workstation. (Čamaj, 2018)

INFORMATIONS

In the information section, the customer can find all the information about:

- NHM list of goods – goods nomenclature in 21 languages;
- RID list of dangerous goods – table A and B and connection with the appendix II to SMGS (list of dangerous goods for CIS and Baltic states);
- ETSNG list of goods – list of goods for CIS and Baltic states;
- list of stations and tariff distances (16 carriers);
- information about technical equipment of stations (15 carriers);
- information about track classes LOCA (former regulation RIV II/3);
- information about border stations ENEE (former regulation LIF);
- information about terminals of intermodal transport;
- goods catalogues ETSNG – tariff list of goods for railways of CIS and Baltic states;
- TR6 list of stations – list of stations including comments for railways of CIS and Baltic states;
- freight wagon catalogues of carriers and wagon owners including broad gauge vehicles (20 catalogues);
- a module with a search function according to specified parameters.

The Figure 2 shows the print screen of the basic information about railway wagons.

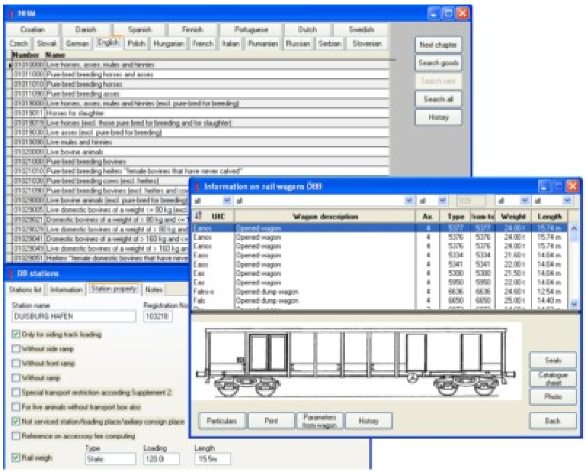

Fig. 2. The basic information about wagons

Source: Čamaj, 2018

INFRASTRUCTURE

In the section about infrastructure the customer can find the information about>

- database of railway infrastructure parameters for Europe and part of Asia (approx. 50000 track sections);
- information on track sections (track number, length, traction system, number of rails, track class, axle load, gauge, etc.);
- geographic information about the location of approx. 43000 railway stations in Europe and Asia;
- railway network graph of Europe and Asia with a search function for optimal route according to given constraints;

- calculation of price for usage of rail path for 11 infrastructure owners;
- display of railway infrastructure in RailMap railway map module;
- display of rail corridor in the module of rail map (corridors AGTC, OSZD, TEN-T, RFC);
- calculation of mileage based on railway infrastructure of a specified list of positions of the rail vehicle/traction vehicle.

The Figure 3 present the elementary description of infrastructure in the list view and table view.

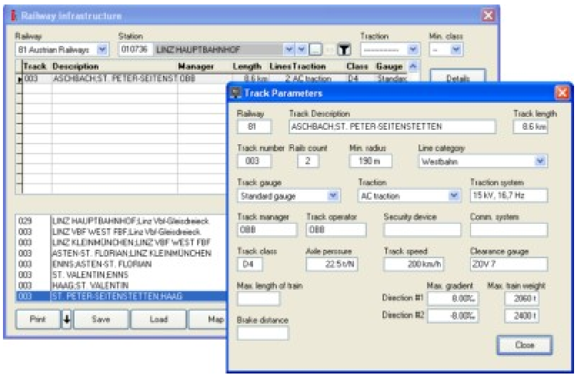

Fig. 3. The technical characteristic of selected track
Source: Čamaj, 2018

THE TRANSPORT PRICE CALCULATION

The part of the ERIC desktop application can be used for orientation calculation of transport price. For this calculation can be used:

- tariff calculations according to carrier tariffs including additional charges (70 basic and union tariffs);
- module for entering and editing of custom price lists;
- price calculation according to custom price lists or carrier tariffs with the option to enter discounts and/or surcharges;
- OPTIM module – search for the cheapest route based on custom and/or tariff price list;
- calculation of transport tariffs including routing according to TP SNG tariff (CIS and Baltic countries);
- tariff distance calculation (distance tables, calculations of export/import/transit distances according to DIUM and TR-4). (See Figure 4.)

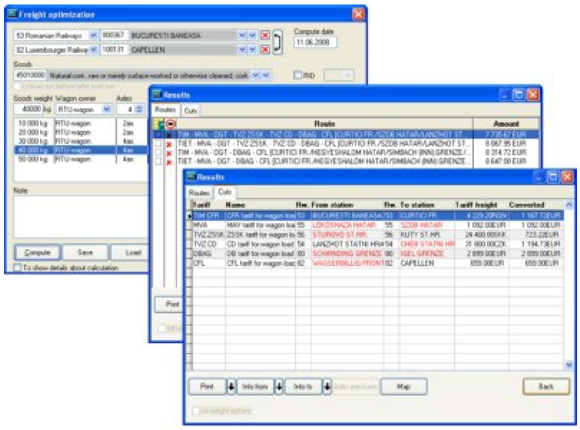

Fig. 4. Calculation of transportation costs
Source: Čamaj, 2018

LIBRARY

For the basic function of the ERIC desktop application are helpful the library of all international and national regulations and standards for railway transportation**.**

These are:

- national and international tariffs (in the languages of their publication) – text version of tariffs processed into electronic form for simple search;
- guides for filling of consignment notes CIM/CUV, CIM/SMGS;
- regulation for transport of dangerous goods RID in several languages;
- variety of regulations and laws – text version of regulations and laws concerning freight transport.

INTERACTIVE RAILMAP

For the final planning of the transportation route the user can use the interactive railmap. Specially the user can find and display the information about:

- display of the location of selected railway station;
- display of the location of border stations;
- display of railway infrastructure with indicated traction type and number of rails;
- display of selected rail corridor (AGTC, OSZD, RFC, TEN-T);
- context menu with function for display of nearest railway stations, information on the nearest station, information on the nearest track section;
- user custom tags (insert and edit tags, select tag icon, add a link to the tag);
- option to selectively display/hide layers of the map (roads, rivers, settlements, railways, etc.);
- freightage according to countries in the corresponding currency including VAT (if required);
- option to display transit routes from tariff modules and railway infrastructure module.

The Figure 5 present the printscreen of interactive railmap.

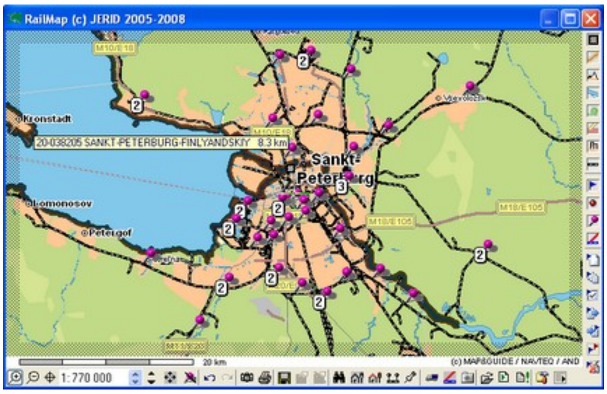

Fig. 5. Rail Map

Source: Čamaj, 2018

6.2 The user's preferences for ERIC Mobile apps

Customers' requirements for the developing ERIC Mobile application can be broken down according to the role represented by individual customers in the transport chain.

A large set of application requirements are the same requirements across all customer groups. However, each customer group also has its specific requirements that other groups consider to be marginal.

Common requirements can be included:

- application for all type of mobile operating systems in mobile devices;
- user authentication when signing in to an application (not on installation);
- first download of purchased libraries and application features after logging in;
- application modularity for multiple types of users
- as an off-line application for selected app features (without having to open online libraries on central web-hosting);
- the on-line tracking of shipments;
- the price calculation.

The Railway undertaking requirements to the ERIC Mobile application can be included:

- automated data collection directly into the database (using RFID technology);
- determination of shipment route and calculation of shipping price;
- traffic and transport restrictions on the transport route (temporary and permanent);
- loading and fixation specifications for individual goods.

Among the requirements of forwarders can include:

- the use of multimodal cargo units and the infrastructure to it (terminals, routes);
- calculation of shipping prices;
- load and fixation specifications.

Conclusions

The map and the resulting information are a very good basis for displaying additional information. It is the transport of the character (current position of trains, wagons and consignments) as well as the technical character of the transport infrastructure (track levels, arc radii, transition profiles, etc.). Under the conditions of rail freight, at each step of the transport chain, one of the trio elements of the train, wagons or shipment is to be identified. And this triad of information gives us comprehensive information on any part of the transport chain.

The major problem of rail freight is the fact that at the outset most of the information on the three elements is entered into the information systems manually and with a time delay. Therefore, the quality of this information is mostly statistic, not the nature of the information for operational management and monitoring.

The importance of the information lies not only in their use in the transport process on the part of the sending railway undertaking. The information also serves to improve and speed up the handling of requirements resulting from the crossing of state borders and to inform all external entities involved in the exchange of information in a timely manner.

The introduction of new approaches to the use of mobile devices for all subjects in the transport market helps to increase the speed and accuracy of the information transmitted and thus partly also helps to increase the competitiveness of rail transport.

Acknowledgment

The paper was supported by the project EUREKA E!11 156- ERIC Mobile - "European Rail Information Centre in Freight Transport for End-users on Mobile Platforms" at Faculty of Operations and Economics of Transport and Communication, University of Žilina, Slovakia.

References

Android (operating system). Available at: https://en.wikipedia.org/wiki/Android_(operating_system)

BlackBerry OS. Available at: https://en.wikipedia.org/wiki/BlackBerry_OS

Čamaj, J. 2018. Information systems to promote efficient management in the field of railway freight transport. Habilitation thesis. 2018. Žilina. 113 pages.

Čamaj, J. – Gašparík, J. 2011. Information and Communications technologies in Railway transport. Žilina: University of Žilina, 2011. 179 pages.

Čamaj, J. – Mašek, J. 2013. Možnosti využitia RFID technológie v dopravných službách. In: Railway transport and Logistic. Vol. 9, No. 2 (2013), Pages 9 – 13.

Gašparík, J. – Zitrický, V. 2010. Manažment kapacity železničnej infraštruktúry. Žilina: EDIS University of Žilina, 2010. 130 pages.

iPhone OS. Available at: https://en.wikipedia.org/wiki/IOS

Ihnát, P. – Gašparík, J. 2008. Information and telecommunication stechnologies in transport. Interoperability of Railways. Žilina: EDIS University of Žilina, 2008. 163 pages.

Menšík, M. 2018. Smartfóny už využívajú dve tretiny Slovákov, dominuje Andorid. Available at: < https://www.mojandroid.sk/smartfony-vyuzivaju-dve-tretiny-slovakov/

Symbian Operating System. Available at: https://en.wikipedia.org/wiki/Symbian

Tengler, J.; Abramović, B.; Achimský, K. 2018. IoT communication in logistics In: Company diagnostics, controlling and logistics: proceedings. - Žilina: Žilinská univerzita, 2018. Pages 251-257.

Tengler, J.; Kolarovszki, P.; Fabuš, J.; Fabušová, V. 2018. Smart services through smart item agent In: SENSORCOMM 2016: the tenth international conference on sensor technologies and applications: Nice, France. Pages 71-76.

Tengler, J.; Kolarovszki, P.; Kolarovszka, Z. 2017. Identification and localization of transport units for selected company In: Procedia Engineering. Vol. 178 (2017), Pages 491-500

Windows Phone (WP). Available at: https://en.wikipedia.org/wiki/Windows_Phone

Transport technic and technology
Volume XIV Issue 2 Year 2018
DOI: 10.2478/ttt-2018-0007

CASE STUDY OF THE IMPACT OF THE CO_2 EMISSIONS TREND FROM TRANSPORT ON THE EXTERNAL COSTS IN SLOVAKIA AND SLOVENIA

Abstract. Transport is one of the human activities that increases the amount of greenhouse gases in the air. CO_2 is the main cause of global warming and contribute for around 80 % of all greenhouse gas emissions. The paper presents CO_2 production based on the amount of sold fuel in Slovakia and Slovenia. Based on the obtained data, the calculations about the production of CO_2 according to the type of fuel was made. The conducted research has focused on the issue of traffic congestion and to reduce CO_2 emissions by 15 % in total by 2030, as Slovakia and Slovenia concluded an agreement with other EU members in 2009. External costs calculation was made with average price of 1 tonne emission credit in 2016 and with presumed average price in 2019. The case study takes into account the consumption of the gasoline and diesel in transport throughout all Slovakia and in Slovenia.
Keywords: CO_2 emissions, the cost of CO_2 from transport, traffic congestions, traffic management

Milan Škorupa[1]
[1] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia; +421 41 513 3434; milan.skorupa@fpedas.uniza.sk
Tomáš Čechovič[2]
[2] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia; +421 41 513 3434; tomas.cechovic@fpedas.uniza.sk
Martin Kendra[3]
[3] Faculty of Operation and Economics of Transport and Communications, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia; +421 41 513 3429; martin.kendra@fpedas.uniza.sk
Borut Jereb[4]
[4] University of Maribor, Mariborska cesta 7, 3000 Celje, Slovenia;+386 3 428 53 62; borut.jereb@um.si

Introduction

Globalization is the main reason for increasing mobility in the world, thus also result in significant costs. Next to all the impacts on the environment and human health, that was the main reason for the formation of this article.

The increase in transport has many negative impacts on the environment like air pollution problems that are caused by Burning of Fossil Fuels, Agricultural activities, Exhaust from factories and industries and some other activities. Global climate changing has become a severe problem in the world nowadays. The temperature of the atmosphere is increasing because the heat waves are becoming more intense and more frequent. Global warming and air pollution are largely caused by greenhouse gas emissions from traffic and Fossil Fuels (Kakouei et. al., 2012).

A Stanford scientist details how each increase of 1 degree Celsius caused by CO_2 would annually lead up to upward of 20 000 air-pollution-related deaths (Whitty, 2008). GHG include Fluorinated gases, Nitrous oxide (N_2O), Methane (CH_4) and the most problematic Carbon dioxide (CO_2). Carbon emissions are the most significant of greenhouse gas emissions that cause global warming (Dosio et. al., 2018). Increased concentration of CO_2 can lead to various health problems, these are: headache, dizziness, restlessness, difficulty breathing, sweating, fatigue, high blood pressure, suffocation and other (Department of Health Services). The effects of CO_2 on an individual are dependent on the concentration and duration of exposure. At the same time, other factors have influence on this, those are: age, health, physiological composition, lifestyle and others (Rice, 2003).

Carbon dioxide is a colorless and non-combustible gas at room temperature. It is naturally present in the air, so it is inhaled at a concentration of about 0.037% (Health and Safety Executive).

Levels of CO_2 emissions in the air are:

a) 250-300 ppm - normal amount of exterior spaces;
b) 350-1000 ppm - normal amount of indoor spaces;
c) 1000-2000 ppm - rate associated with fatigue;
d) 2000-5000 ppm - rate associated with headaches, poor concentration and increased heart rate;
e) > 5000 ppm - unusual air conditions (Department of Health Services).

The industrial revolution has caused a significant increase in CO_2 emissions. CO_2 accounts for 72 % of all greenhouse gases. It is the main cause in addition to PM particles for global warming. It takes 100-200 years for CO_2 to decompose from the atmosphere, due to this fact, because of that CO_2 accumulates in the atmosphere, which leads to an increase in surface temperatures and increasing fluctuations in weather. For this reason, the European Union has made a directive that the atmosphere should not be heated by more than 2 degrees Celsius, which on the other hand means a significant reduction in CO_2 emissions. Transport planners and founders of transit and real estate were from the very beginning interested in those markets, which were supportive of transit services, especially in the field of public transport. The expansion of the automotive industry between and after industrial revolution, almost broke the development of the railways with the comfort and ease of a car (Feigon et.al., 2003)

Many organizations strive for efficient supply chains because of enormous mass production of raw materials, goods and products for the customers' needs. Today's production of goods is formed based on customer satisfaction (Jereb et. al., 2016). To make business processes more effective and efficient we must to reduce time and costs. This is achieved by well-organized transport. Because of this reason, the increase on transport is reflected in all modes of transportation: road, rail, sea and air (Jereb et al., 2017), (Jennings, 2006).

On the other hand, we have a smart traffic management in the transport field, where users can choose new and more clever ways of transport such as public transport, car sharing, hybrid vehicles, electrical vehicles, etc. On the side of the member states of the EU is to regulate the legislation in the field of transport, or just to implement the smart traffic management such as green waves. By implementation of such management we decrease fuel consumption, emissions of CO_2 and the impact on the environment. The correlation is always proportional, as the fuel consumption increases, so do emissions and the impact on the environment (Jereb & Čeh, 2017).

The European Union wants to reduce the amount of greenhouse gas emissions by 20 % (European Commission - 2020 climate & energy package). They want to reach a reduction with the strategy called European 20/20/20 objectives. The strategy was set by EU leaders in 2007 and has three targets to achieve: 20 % increase in energy efficiency, 20 % reduction of CO_2 emissions and 20 % renewables by 2020. Whit this set of binding legislation, they want to ensure improvements on climate and energy sets (Lodi et. al., 2018), (Erixon, 2010).

The first clear EU demand of emission trading was in 2000 when the EU issued a Green Paper on greenhouse gas emissions trading. Such a system of restriction and trading of emission credits (A "cap and trade" system) was established in the EU in 2005, primarily for the achievement of the Kyoto Protocol of 1997 when it was signed (Ellerman A. D. et al., 2015). The Kyoto Protocol was signed by industrialized nations and stipulates that greenhouse gas emissions will be reduced by 5 % between 2008 and 2012 compared to 1990. The second target period was adopted in 2012, known as the modification of the Doha Convention Protocol (CNN Library, 2018).

The objective of establishing an emission trading scheme is to allow market mechanisms to drive industrial and commercial processes towards lower emissions of carbon dioxide and other greenhouse gases, as in the case of processes where the price for discharges is not determined. It is a trading that represents the right to release 1 ton of CO_2 or any other gas of the same weight. Limiting the amount of greenhouse gases is determined by the installations that are covered by the system. Within these limits, such companies may receive or buy these credits. If the company reduces emissions during the year, it can maintain or sell the reserve emission credits (European Commission - EU Emissions Trading System (EU ETS)). This way of an emission trading is then reflected in the prices. We can check it with the financial models, such as the OMEGA, where the basic information about the vehicle such as weight, aerodynamic drag, map engine, etc. It is used to predict fuel consumption and CO_2 emissions within a specific driving cycle. OMEGA was developed to correspond requirements of the manufacturers:

a) cost of the technology paid by the consumer,
b) the value which the consumer is likely this place on improved fuel economy,
c) the degree to which manufacturers are prepared to go to meet the CO_2 emission target (EPA, 2009).

The EU framework by 2030 contains the targets for reducing CO_2 emissions by at least 40 % since 1990, which will allow the EU to take cost-effective steps towards achieving long-term targets (2050) for reducing CO_2 emissions by 80-95 % within the framework of emergency reductions based on the Paris agreement (European Commission - 2030 climate & energy framework). The European Union dictates that CO_2 emissions should be reduced to 20 gigatons of CO_2 by the year 2050 (Rohrer, 2007).

Low carbon economy of the EU suggests:

- the EU must reduce GHG by 80 % of the values measured in 1990 by 2050,
- - 40 % by 2030 and 60 % by 2040,

all sectors must be included, - low-carbon transition is feasible and at the same time accessible (European Commission - 2050 low-carbon economy).

These regulations are covered by the White Paper, which also lists several other measures to reduce traffic in the EU. Among them are introduction of more integrated and efficient transport system, accelerated introduction of modern technologies for vehicles and fuel, promoting the use of cleaner modes of transport (European Commission - Transport: EU transport white paper).

Presumed average price of 1 tonne emission credit in 2019 is up to 25 € (energie-portal).

1. Fuel consumption in transport in Slovakia

The year 2016 was the tenth year when both keys motor fuels - gasoline and diesel were sold in Slovakia with bio-components. In particular, due to the efforts of member companies, SAPPO Slovak Republic has fulfilled the stated goal of the Government of Slovakia in the area of biofuel share of fossil motor fuels

The only producer of motor fuels in Slovakia is Bratislava refinery SLOVNAFT. Compared to previous years, the market position of SLOVNAFT products didn´t changed. Export was dominating with the share of almost 70 % in the total sales of main products (gasoline, diesel, primarily plastics). Most of SLOVNAFT's products end on foreign markets. The products of the Slovak refining industry have found their outlets in particular in the

Czech Republic, Austria, Poland, Germany, Romania, Italy, but also in Serbia, Croatia and the Netherlands.

Last year were processed 5.6 million tons of oil. which dropped 3.2 % year-on-year. As a result of lower oil processing, the production of motor fuels decreased year-on-year by 11 000 tonnes to a total of 4 441 thousand tonnes.

The production of automotive gasoline reached the level of 1 388 thousand tonnes (which was 41 thousand tonnes less than in the previous year), representing a year-on-year decrease of 2.9 %. In 2016, the manufacture of diesel fuel amounted to 3 052 thousand tonnes, (which was about 30 000 tonnes more than year ago), translating into a 1 % year-on-year increase. Table 1 shows domestic refinery and petrochemicals production of Slovakia in 2016 and in 2017. (Výročná správa Slovenskej asociácie petrolejárskeho priemyslu a obchodu, 2017)

Table 1. Domestic refinery and petrochemicals production in Slovakia (ths.tonnes)

Type of fuel	year 2016	year 2017	17/16
Gasoline	1 430	1 388	-2.90 %
Diesel	3 022	3 952	1.00 %

Source: Výročná správa Slovenskej asociácie petrolejárskeho priemyslu a obchodu, 2017 – edited by the authors

In 2016, 1 855 000 tonnes of diesel and 540 000 tonnes of gasoline were sold in Slovakia, but in 2017, 1 928 000 tonnes of diesel where sold, resulting in an increase of 3.90 % compared to 2016 and 548 000 tonnes of unleaded 95 octane fuel, whose consumption grew by 1.50 %.

From the Slovak Associacion of Petroleum Industry and Trade of the Republic of Slovakia were obtained data on the tonnes of fuel consumed in Slovakia, which are shown in Table 2.

Table 2. Total domestic consumption of selected refinery products in Slovakia (ths.tonnes)

Type of fuel	year 2016	year 2017	17/16
Gasoline	540	548	1.50 %
Diesel	1855	1928	3.90 %

Source: Výročná správa Slovenskej asociácie petrolejárskeho priemyslu a obchodu, 2017 – edited by the authors

Imports to Slovakia jumped 7.8 % in diesel imports and 10.2% in gasoline imports compared to the year 2016. Total of 758 000 tonnes of diesel and 166 000 tonnes of gasoline were imported in 2016. Total values in thousands of tonnes are shown in Table 3.

Table 3. Imports of key motor fuels in Slovakia (ths.tonnes)

Type of fuel	year 2016	year 2017	17/16
Gasoline	166	183	10.20 %
Diesel	758	817	7.80 %

Source: Výročná správa Slovenskej asociácie petrolejárskeho priemyslu a obchodu, 2017 – edited by the authors

2. Fuel consumption in transport Slovenia

Since there are no oil deposits in Slovenia as well as refineries for the processing of crude oil, petroleum products used as energy products, including motor fuels, we import them into the territory of Slovenia or acquisition petroleum products from any country, regardless of whether it is a member of the European Union or a third country. Gasoline and diesel are imported from abroad. Due to the geographical location of Slovenia and especially access to the sea, imports from abroad do not represent major obstacles and related costs. Imports into Slovenia are done through wholesalers selling to different customers who sell motor fuels to end users or other market participants through various sales channels (Javna uprava Republike Slovenije za varstvo konkurence, 2017).

In 2016, 1 651 977 401.13 liters of diesel were sold in Slovenia and 566 994 926.89 liters of unleaded 95 octane fuel, or so-called gasoline in Slovenia (Statistični urad RS: Bilanca trdnih, tekočih in plinastih goriv, Slovenija, letno, 2017).

Subsequently, this data was used in calculating of CO_2 emissions and the related value of CO_2 emissions arising from traffic in Slovenia.

3. Calculation and results

To calculate the emissions of CO_2 from the quantity of sold fuel it is necessary to know the amount of CO_2 emissions that are dropped into the atmosphere when consuming 1 liter of diesel and 1 liter of gasoline. So, if you use a liter of diesel, it will produce 2.67 kg of carbon dioxide. Gasoline has a lower carbon content and thus produces 2.42 kg of CO_2 (EN 16258, 2012).

Calculated in tonnes in 2016, CO_2 emissions from diesel and gasoline together amount 7 709 550 tonnes in Slovakia and 5 782 907 tonnes in Slovenia, where approximately 80 % of emissions are produced by the diesel vehicles and 20 % by gasoline.

The average price of the emission credit in 2016 was about 5,76 € for 1 tonne (Ministrstvo za okolje in proctor: Register emisijskih kuponov, 2017).

External costs from transport according to the amount of CO_2 produced in 2016 were 44 407 008 € in Slovakia and 33 309 547 € in Slovenia (Table 4).

Table 4. External costs from transport according to the amount of CO_2 produced in Slovakia and Slovenia in 2016

	External Costs (€)		
	Gasoline	Diesel	∑
Slovakia	10 108 800	34 298 208	44 407 008
Slovenia	7 903 456	25 406 091	33 309 547

Source: Calculation by the authors

Based on the data from the literature on the reduction of CO_2 emissions by 15 % in Slovakia and Slovenia by year 2030, was calculated what a reduction in external costs would be achieved with implementation of the smart industry and using cleaner energy sources. The costs shown below are external costs from CO_2 emissions and are not tied to individuals.

Calculated in tonnes by 15 % reducing of CO_2 emissions from diesel and gasoline together amount 6 553 118 tonnes in Slovakia and 4 915 471 tonnes in Slovenia.

The external costs for reduced amount of CO_2 emissions calculated by presumed average price of 1 tonne emission credit for 2019 (25 €) are in Table 5 and Fig. 1.

Table 5. External costs of 15 % reduced CO_2 emissions from transport in Slovakia and Slovenia calculated by presumed price for 2019

	CO_2 emissions (tonnes)	External Costs (€)
Slovakia	6 553 118	163 827 938
Slovenia	4 915 471	122 886 782

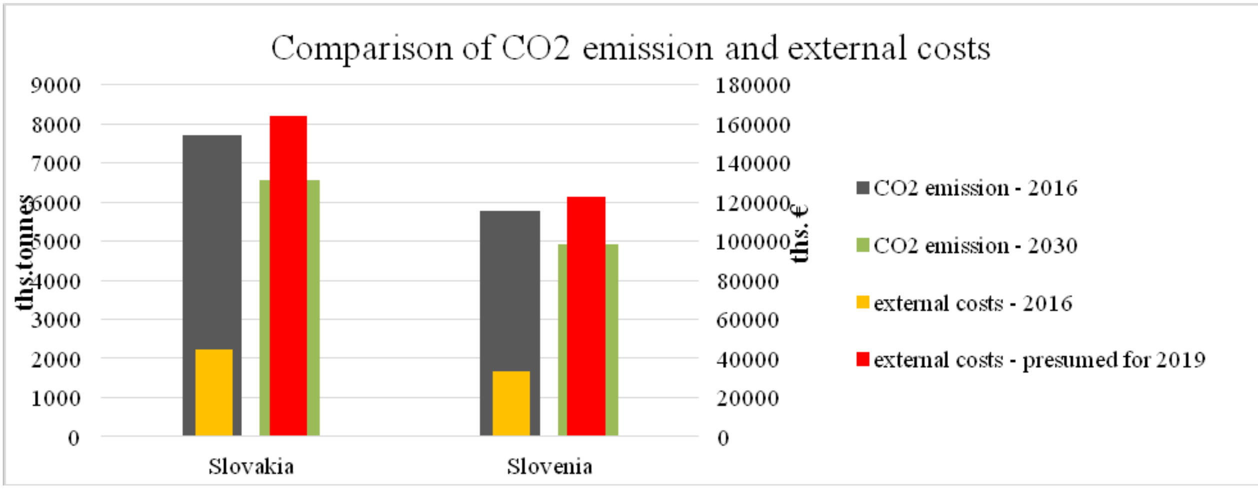

Fig. 1. External costs of 15 % reduced CO_2 emissions from transport in Slovakia and Slovenia calculated by presumed price for 2019

Conclusion

CO_2 is one of the main causes of global warming, which is a major problem in today's world. A substantial proportion of the CO_2 is produced because of exhaust gases in traffic.

It is known that the amount of sold fuel is increasing every year, so the question is, what number of CO_2 production, will be achieved in the next 10 years?

It is known that CO_2 causes many health problems in humans, so it is necessary to be aware of their consequences. How big will these problems be, if the production of CO_2 continues to increase in the coming years.

In the context of the Kyoto Protocol, which was adopted in 1997 with a view to reducing emissions, countries started trading in emission credits. In 2016 the average price of the emission loan was 5,76 €, but it changed drastically from year to year. Presumed average price for 2019 is 25 € for 1 tonne.

Price increasing of 1 tonne of emission credit is faster than reducing of CO_2 emissions in transport, so however emissions of CO_2 by transport decrease, external costs increase.

References

CNN Library (2018). Kyoto Protocol Fast Facts [available at: https://edition.cnn.com/2013/07/26/world/kyoto-protocol-fast-facts/index.html, access August 15, 2018]

Department of Health Services (2018). Wisconsin department of health services: Carbon dioxide [available at: https://www.dhs.wisconsin.gov/chemical/carbondioxide.htm , access May 19, 2018]

Dosio, A., Mentaschi, L., Fischer, E., Wyse, K. (2018). Extreme heat waves under 1.5 °C and 2 °C global warming [available at: http://iopscience.iop.org/article/10.1088/1748-9326/aab827/meta , access May 5, 2018]

Ellerman A. D. et al. (2015). The European Union Emissions Trading System: Ten Years and Counting [available at: https://academic.oup.com/reep/article-pdf/10/1/89/.../rev014.pdf , access August 15, 2018]

EN 16258, 2012 (2012). Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)

Energie-portal, Cena CO_2 povoleniek sa môže vyšplhať až na 100 eur/t do roku 2020 [available at: https://www.energie-portal.sk/Dokument/cena-co2-povoleniek-sa-moze-vysplhat-az-na-100-eurt-do-roku-2020-104516.aspx access January 28, 2019]

EPA [U.S. Environmental Protection Agency] (2009). EPA optimization model for reducing emissions of greenhouse gases from automobiles (OMEGA) [available at: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100G70Q.PDF?Dockey=P100G70Q.PDF , access May 25, 2018]

Erixon, F. (2010). The Europe 2020 Strategy: Time for Europe to Think Again [available at: http://journals.sagepub.com/doi/full/10.1007/s12290-010-0120-8 , access May 18, 2018]

European Commission: 2020 climate & energy package [available at: https://ec.europa.eu/clima/policies/strategies/2020_en , access May 19, 2018]

European Commission: 2030 climate & energy framework [available at: https://ec.europa.eu/clima/policies/strategies/2030_en , access May 19, 2018]

European Commission: 2050 low-carbon economy [available at: https://ec.europa.eu/clima/policies/strategies/2050_en , access May 19, 2018]

European Commission: EU Emissions Trading System (EU ETS) [available at: https://ec.europa.eu/clima/policies/ets_en , access August 15, 2018]

European Commission: Transport: EU transport white paper [available at: https://ec.europa.eu/clima/policies/international/paris_protocol/transport_en , access May 19, 2018]

Feigon, S., Hoyt, D., McNally, L., Mooney-Bullock, R. (2003). Travel matters: Mitigating Climate Change with Sustainable Surface Transportation, Transportation Research Board [available at: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_93.pdf , access May 26, 2018]

Health and Safety Executive: General hazards of Carbon Dioxide [available at: http://www.hse.gov.uk/carboncapture/carbondioxide.htm , access May 19, 2018]

Javna uprava Republike Slovenije za varstvo konkurence (2017). Razisava trga pogonskih goriv [available at: http://www.varstvo-konkurence.si/fileadmin/varstvo-konkurence.si/pageuploads/Novice/Porocilo_o_raziskavi_trga_pogonskih_goriv n ezaupna_.pdf ,access May 24, 2018]

Jennings, L. (2006). The Effects of Globalization on Freight Transportation [available at: https://uahcmer.com/wp-content/uploads/2006/05/The-effects-of-globalization- on-freight-transportation.pdf access May 15, 2018]

Jereb, B., Čeh, I. (2017). The effect of traffic management on CO_2 production, XXII International Conference on Material Handling, Constructions and Logistics, Zrnić, N., Bošnjak, S., Kartnig, G., Dragovič, B., Papadimitriou, S. Faculty of Mechanical engineering, Belgrade, 4th-6th October 2017, p. 161-163

Jereb, B., Čeh, I., Kamplet, M. (2017). The effect of traffic management on CO_2 production [available at: http://www.mhcl.info/activities/submitted-abstracts/285-the-effect-of-traffic-management-on-co2-production , access May 4, 2018]

Jereb, B., Kumberščak, S., Bratina, T. (2016). The Impact of Traffic Flow in the Urban Environment [available at: https://www.researchgate.net/publication/323249700_The_impact_of_traffic_flow_ on_fuel_consumption_increase_in_the_urban_environment , access May 4, 2018]

Kakouei, A., Vatani, A., Kamal, A. (2012). An estimation of traffic related CO_2 emissions from motor vehicles in the capital city of, Iran [available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3561082/ , access May 5, 2018]

Lodi, C., Seitsonen, A., Paffumi, E., Gennaro M., Huld, T., Malfettani, S. (2018). Reducing CO_2 emissions of conventional fuel cars by vehiclephotovoltaic roofs [available at: https://reader.elsevier.com/reader/sd/06B97658021746555534D41EB2E86B290AA DEC7FC31442709D31BC78A23189F1416F30D0E9B519E4729FCC7D6EB0379B, access May 18, 2018]

Republika Slovenija, Ministrstvo za okolje in rpostor (2014). Operativni program ukrepov zmanjšanja emisij toplogrednih plinov do leta 2020 [available at: http://www.mop.gov.si/fileadmin/mop.gov.si/pageuploads/zakonodaja/varstvo_okolj a/operativni_programi/optgp2020.pdf access August 15, 2018]

Rice, S. A. (2003). Health effects of acute and prolonged co2 exposure in normal and sensitive populations [available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.464.2827&rep=rep1&typ e=pdf , access May 19, 2018]

Rohrer, J. (2007). Time for change: CO_2- the major cause of global warming [available at: https://timeforchange.org/CO_2-cause-of-global-warming , access May 19, 2018]

Statistični urad RS (2017). Bilanca trdnih, tekočih in plinastih goriv, Slovenija, letno [available at: http://pxweb.stat.si/pxweb/Dialog/varval.asp?ma=1818002S&ti=&path=../Database/ Okolje/18_energetika/04_18180_goriva/&lang=2 ,access May 31, 2018]

Výročná správa Slovenskej asociácie petrolejárskeho priemyslu a obchodu, 2017

Whitty, J. (2008). CO2 emissions kill people [available at: https://www.motherjones.com/politics/2008/01/co2-emissions-kill-people/ , access May 23, 2018]