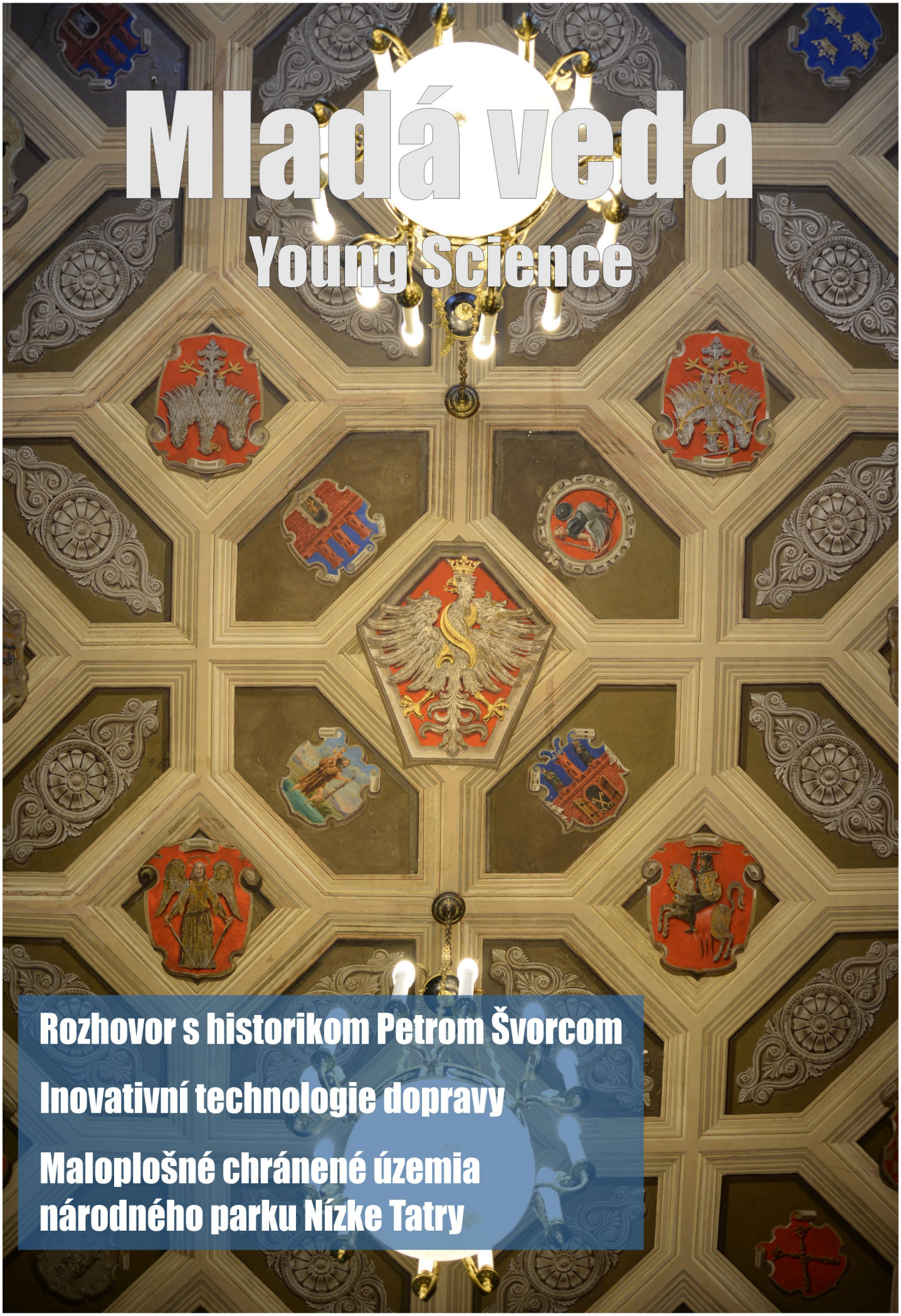
ISSN 1339-3189

Jún 2017

Mladá veda

Young Science



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Inovativní technologie dopravy

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MEDZINÁRODNÝ VEDECKÝ ČASOPIS MLADÁ VEDA / YOUNG SCIENCE

Jún 2017 (číslo 2)
Ročník piaty
ISSN 1339-3189
Kontakt: info@mladaveda.sk, tel.: +421 908 546 716, www.mladaveda.sk
Fotografia na obálke: Krakow 2013. © Branislav A. Švorc, foto.branisko.at

VYDAVATEĽ
Vydavateľstvo UNIVERSUM, spol. s r. o.
www.universum-eu.sk
Javorinská 26, 080 01 Prešov
Slovenská republika

Mladá veda
Young Science
ISSN 1339-3189

Vol. 5 (2), pp. 39-48

INOVATIVNÍ TECHNOLOGIE DOPRAVY

INNOVATIVE TECHNOLOGY OF TRANSPORT

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Xenie Lukoszová působila jako školitelka na Obchodně podnikatelské fakultě Slezské univerzity v Opavě. V současnosti působí jako docentka na Vysoké škole technické a ekonomické v Českých Budějovicích. Jiří Dvořák působí jako výzkumný pracovník Ústavu podnikové strategie Vysoké školy technické a ekonomické v Českých Budějovicích. Ve svém výzkumu se zaměřuje na problematiku inovačních procesů a jejich efektivnosti.

Xenie Lukoszová worked as a supervisor at the Silesian University in Opava. At the present she is working as an associate professor at the Institute of technology and business in České Budějovice. Jiří Dvořák is a researcher at the Institute of Business Strategy Institute of Technology and Economics in Czech Budejovice. He focuses on issues of innovation processes and the effectiveness in his research.

Abstract
The main goal of this article is to find principle relations between theory of innovations and transport innovative technologies to make a summary of the innovative technology of the horizontal loading efficiently usable in prevailing conditions on the European Union market. Furthermore, the authors develop practical methods of selecting sophisticated innovative transport technology highly suitable for the customers of the transport company.
Key words: innovation, transport, logistics, supplies

Abstrakt
Hlavním cílem tohoto článku je nalézt principiální vztahy mezi teorií inovací a inovačními technologiemi v dopravě, aby bylo možné shrnout inovační technologii horizontálního zatěžování, která by byla efektivně využitelná v převažujících podmínkách na trhu Evropské unie. Autoři dále vyvíjejí praktické metody výběru sofistikované inovativní dopravní technologie, která je vhodná pro zákazníky dopravní společnosti.
Klíčová slova: inovace, doprava, logistika, zásoby

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Introduction

The authors refer to the secondary information provided by experts of the research company for a combined transport (SGKV) published in scientific and research articles and books, which deal with transport innovative technologies.

They analyse and compare advanced technologies of the horizontal loading. The general layout of the optimal innovative transport technology is based on successfully employing the statistical method of multi-criteria evaluation.

The criteria related to selection of optimal combined transport technology within postulated example are determined based on primary information gained via inquiry research among clients of transport firms and companies between 2014-2016. The study preparation based on the above-mentioned research results was being done since 2016 (the second half) up to March 2017.

Kernel

The authors modify innovation documents presented by Association of innovative Business in Czech Republic and introduce the most sophisticated innovative technologies of combined transport with the horizontal loading; the technologies employed in order to increase the efficiency of the goods transport within the European market. At the same time, the careful attention is directed to the present-day technologies of combined rail transport, RoLa, Modalohr, Cargobeamer and Flexiwaggon in particular. These existing technologies are compared to one another at the end of the article. In addition, a reliable method of a careful selection of the optimal technology of combined transport suitable for a customer is introduced. Research/practical implementation: collected primary and secondary information and adopted methods are extensively employable in normal conditions, mainly the conditions of logistics centres.

A set of recognized and accessible secondary information resources concerned to innovations, innovation levels related to transport technologies with horizontal loading and a set of adequate statistic methods, which might be applied for optimal evaluation of variants, represent the first part research results achieved by that paper authors. Afterwards, a set of significant parameters related to selection of an appropriate innovative technology with respect to views of customers who utilized services of selected transport firms or companies have been determined and connected to the above mentioned set of secondary information resources as well, while those parameters have been discovered as a result of this paper authors primary research work.

The innovation technologies applied in traffic represent a new approach to solutions related to manipulation processes (Gan, L., 2003). An implementation and providing of innovation technologies enables more efficient material loading, transition and landing, without using any supplementary devices e.g. derricks. However, applying innovative technologies in traffic means a positive change with respect to innovation theory as well. In general, the innovations create an integral part of so called innovation directives, which determine their implementation and operation or providing (Švejda, P., 2007).

Transport innovations

Lowering of transport, supply and storage costs as well as shorter time of material delivery and improvement of services for customers create an integral part of effects and contributions related to implementation of new technologies in traffic. However, this is not concerned with providers of logistic services; it is concerned to customers who utilize those services as well (Lukoszová, Polanecký, 2016). The following description of innovations has been prepared based on actually valid innovation directives and their attributes postulated by Association of innovative Business in the Czech Republic (see also Table 1):

Innovation Directive	Innovation Directive Title	Attribute	Description
No.1	Quantity Change	Small change within transport (traffic) process or technology.	Small change implementation of the small change, while all existing attributes remain unchanged.
No.2	Quality Change.	Great change within transport technology.	The difference between previous and existing status is observed in intensity of progress related to provided operations.
No.3	Organization Change	Small change within transport (traffic) process or technology.	New organizational interactions within appropriate operations.
No.4	Qualitative adjustment.	Great change within transport (traffic) process or technology.	A qualitative adaptation among transport (traffic) factors, e.g. accommodation of transport facilities to materials to be transferred.
No.5	Creation of a new variant.	Small change within transport (traffic) facility concept.	Modifications concerned to basic construction solutions.
No.6	Creation of a new generation	Great change within transport (traffic) facility concept.	New construction of transport (traffic) facility, however the existing type or class attribute remains unchanged as well.
No.7	Creation of a new class	Small changes within functionality principles of actual transport (traffic) facility.	Discontinuous and radical innovation, a new type of transport facility is being created.
No.8	Creation of a new type (family).	Great changes within functionality principles of actual transport (traffic) facility.	Discontinuous and radical innovation in a maximal measure, however a trunk membership concerned to macro-technologies remains unchanged.
No.9	Creation of trunk	Transition to macro-technologies.	Macro and micro technologies.

Table 1: Description of transport innovation types
Source: (Švejda, P. et all, 2007, modified)

When looking at Table 1, we can make a partial conclusion that the furthermore described transport innovative technologies create an integral part of higher innovation level and are closely related to technological changes of principle importance, assigned to level no.6, in most cases.

Combined transport technologies utilized within EU market

The combined transport does not need no revolutionary discoveries related to its further development, as experts of Combined Transport Research Society (hereinafter known as CTR Society) say. The combined transport as an objective should stress to optimization of its existing

or current structures (SGKV, 2010). A set of studies prepared by CTR Society in 2010 postulate seven principal recommendations for further transport development within EU countries, while they are directed to improvement of efficiency related to intermodal system. They might be postulated as follows:

1. Transport infrastructure long-term development with respect appropriate and growing needs.
2. Enforcement the strategy concerned to interconnection between seaports and inland.
3. Allocation of further financial facilities to research of optimization related to technologies and processes
4. Improvement of free competition at market and further support of railway transport competitive capability in order to lower transport costs.
5. Supporting of further terminal building within entire European Union.
6. The European transport systems should be based on interoperability.
7. It is necessary to invest in further education and development of specialized staff interested in building of powerful intermodal chains.

At present, an intermodal transport is considered to be the most popular and fully standardized type of transport. It is a transport process implemented and operated with the use minimum two types of transport, while one integrated manipulation unit is maintained via the entire transport road and only one operator organizes it. Those conditions correspond to semantic content of the term denoted as intermodal transport postulated within UNECE, EDCMT lexicon and EU lexicon issued in 2011 (Słownik pojęć, 2011).

The intermodal transport shall be determined via one treaty only related to entire road and only one price is valid simultaneously, while this price is independent of transport facility type. This approach makes a lot of disasters and does not correspond to EU recommendation concerned to loading of transporters from cost point of view, incl. internationalization of external transport cost. The intermodal transport postulates a set of technologies, which implement at least three common process levels because of potential threats of the above-mentioned problems. A technical integration is being implemented and operated via unified manipulation unit represented by container or saddle semi-trailer.

The types of transfer applied within this process and within appropriate distance should correspond to intermodal transport principals. We can say, the main part of transport is being implemented and operated via alternative related to road transport, where a railway or water transport plays a role of significant importance. However, there is a possibility to apply sea transport for pre-defined cases and localities (the Mediterranean or Baltic Sea), while the distance shall be longer than 100 kilometers bee-line. The materials are being transferred to loading terminal and from loading terminal to end user station is done with the use of road and car transport.

A multimodal transport is being applied as the other technology of combined transport. This type of transport is oriented to existence of more transport types applied within one transport process, while those types are interconnected via one contract, manipulation unit or price. When considering the combined transport the ratios and types of integrated transport are determined via appropriate contracts and legal documents and the manipulation unit within entire transport process as well. This interpretation corresponds to the document approved by

EU Economy Commission (UN/ECE), European Conference of Transport Ministers (ECMT) and European Commission too (EC) (Lukoszová, X. a kol., 2012).

The commode system enable implementation so called co-modality idea, which has been postulated within Transport White Book in 2006 and dealt with middle-term overview (Bílá kniha, 2006). The previous provisions related to transport area supported intermodal technologies in transport. However, analysis and evaluation of implementation level concerned to intermodal transport required a development of alternative systems, which more liberal related to road transport as well.

The aim of co-modal transport is an efficient and optimal utilization of accessible types of transport related to appropriate technical parameters, which represent a significant function of transport economy. The transport system orientation is being changed, while substitutional systems are being replaced by complementary and synergic ones. As a result of that, the accessible individual or integrated forms of transport should be applied for those purposes, while they need not minimize the road transport participating especially.

In that case, the co-modal transport might be implemented via more types of combined transport, while the main aim of that transport type is an optimal and efficient operation. As a result of that, the firms and companies have to apply appropriate planning check and control adequate systems of transport processes in order to provide a set of balanced efficiency analysis with respect to specific criterion, while the costs, time and ecology might represent of those criteria.

An overview and a brief description of alternative technologies concerned with combined transport categorized by adequate manipulation units

However, the manipulation technologies might be categorized with respect to organization units as well (Široký, 2014). This creates bases for specifications of technologies related to appropriate manipulation systems (see also Fig.1).

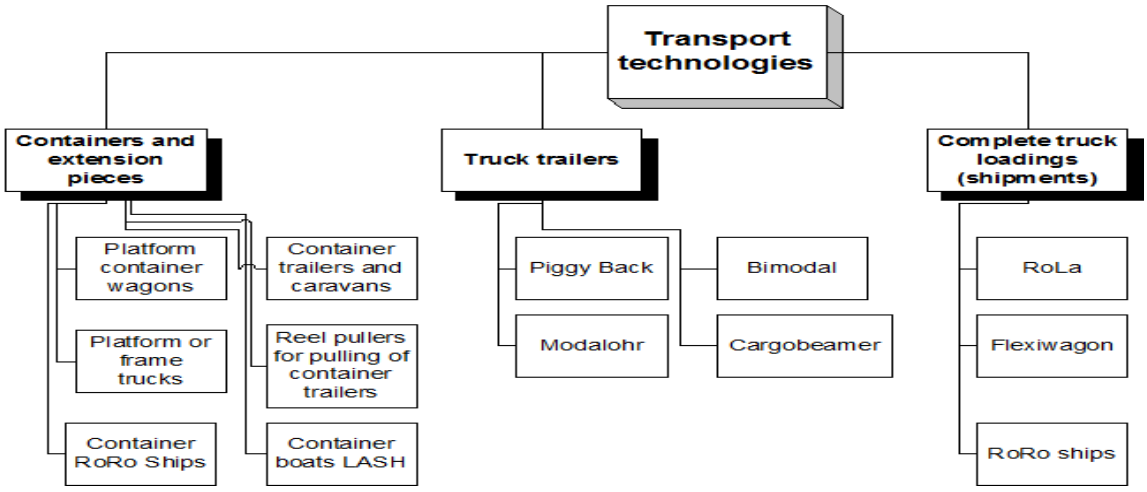

Fig. 1 Overview of technologies applied within combined transport
Source: Lukoszová, X. et. al, 2012

Innovative technologies concerned to combined railway transport

The RoLa Modalohr, Cargobeamer and Flexiwaggon systems are considered to be innovative technologies applied within railway transport, where horizontal loading systems are being applied (Deakin, 2009). However, the innovative transport technologies should respect a logistic infrastructure, which exists in the territory, where they are being applied (Sehnalová, 2011). The main principles, advantages and disadvantages of the above technologies are described within subsequent sections.

The RoLa Technology

The term RoLa technology is derived based on German expression „*Rollende Landstrasse"*, which might be translated into English as *the moving road.* This system is based on principles related to manipulation and transport technologies, the road transport vehicles or trucks are being transported with the use of low-floor railway wagons, while maximum loading space of RoLa trucks might rich up to 0, 65 m over the crown of railway track.

It enables constructing wagons with small diameter of reels, e.g. 360 mm. As a result of that small diameter of reels require loading lowering related to the whole system. The reason is a unit loading problem, while such system loading limit is 7,5 tone. This is a reason, why the construction of wagons should contain more axes. However, the RoLa represents an example, when the active road transport facility (e.g. semi-trailer or truck) becomes a passive participant of railway transport as well. The main transport subject (cargo) is not manipulated and it is interconnected with truck during railway transport.

An entrance of truck with cargo to railway transport facility is being done along longitude axis of the truck. The last wagon is equipped with drive-up ramp which enables transferring of trucks to railway wagons in an appropriate sequence. The fact, that two active facilities create an integral part of the transport process is considered to be the main disadvantage of that transport technology from economic point of view. The trailer or the truck makes no live transport activity and generates no productivity effects, while each of those passive systems creates fixed costs for actual transport firm or company. You can see the RoLa transport technology in Fig.2.

Fig. 2: RoLa Technology
Source: http://spz.logout.cz/provoz/rola2003.html

The Modalohr System

The Modalohr system (see also Fig.3) is considered to be an innovative transport solution denoted as road-railway transport system within horizontal system (*Ro-Ro, Roll in-Roll out*), where a driver makes a navigation of trailer to an appropriate railway wagon. The terminal with adequate equipment and wagons with rotating platforms enable wagon platform rotating in angle from 30 up to 45^{o} towards wagon axis. These aspects enable the system (truck and trailer) entrance to the wagon. As a result of that the loading may be provided along the entire train and this concerned to be the system advantage.

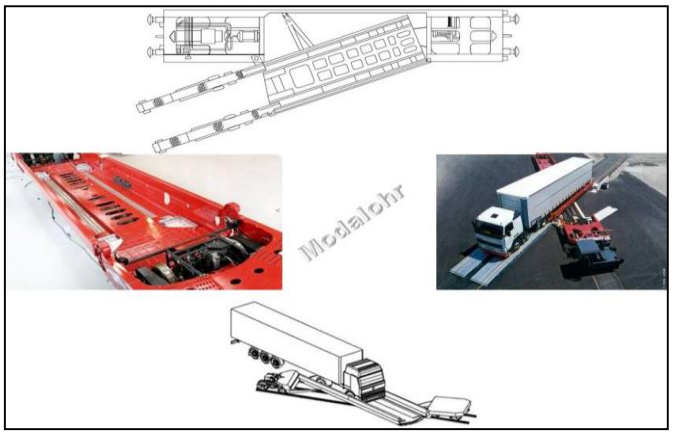

Fig. 3: The Modalohr System
Source: Lukoszová, X. a kol., 2012

The Cargobeamer System

The Cargobeamer System similarly like the Modalohr system enables providing integration of road and railway transport, when the horizontal system Ro-Ro is applied within trans-loading. The fact that the platform is not rotating in an appropriate angle to axis and the material is loading along the axis represents a difference between Modalohr and Cargobeamer system. This technology is being automatized, in a lot of cases, and after having completed entrance of truck and disconnection of trailer a trans-loading might begin.

The mobile platforms transfer trailers with the use mechanism directed to railway wagon. However, the specialized railway wagons with hinged leading side-walls, where the Jet is entering, together with special structured terminals (*Cargogate*), see also Fig. 4, create an integral part of the above-mentioned system as well.

Fig. 4: The Cargobeamer System
Source: (http://logistika.ihned.cz/c1-50419100-cargo-beamer-na-startu)

Technologie Flexiwaggon

Flexiwaggon (na Fig. 5) je dalším příkladem technologie horizontální překládky používané v kombinované dopravě železnice - silnice. Na rozdíl od jiných technologií tento systém nejenže umožňuje nakládku integrovaných manipulačních jednotek, ale i celých silničních souprav (tahač a návěs). K nakládání se používají speciální plošiny umístěné na železničních vagónech, které jsou schopné vykonávat horizontální rotace otáčením se ve směru k podélné ose vagónu.

The Flexiwaggon Technology

The Flexiwaggon Technology represent further example of technology, which enables horizontal trans-loading and is being applied within combined transport technology denoted as road-railway. This system enables loading of integrated manipulation units and complex road transport systems (truck and trailer), what represents the difference, when comparing tha technology with another ones.

However, the specialized platforms located at railway wagons are applied for those purposes as well, while they enable horizontal rotating via revolving towards longitude axis of wagon.

Fig. 5: The Flexiwaggon Technology
Source: http//:www.flexiwaggon.se

The wagons are equipped by hinged ramps, which enable entrance of road systems. As a result of that, no further loading facilities and special terminals are needed, because material might be loaded without any supplementary conditions, however a surface in an appropriate place should be reinforced and fixed. This type of loading technology might be applied within RoLa systems successfully (Lukoszová, 2016).

Selection of optimal technology for horizontal loading

A set of key parameters related to the above-mentioned types of combined transport is considered to be the main result of investigation, which was made. This enables helping the clients to judge those parameters. The selected parameters of integrated technologies with horizontal loading could be found in Table 3.

Parameter/Technology	**RoLa**	**Modalohr**	**Cargobeamer**	**Flexiwaggon**
Bearing capacity (tones)	44	38	38	**66**
Loading time(min.)	45	30	**10**	**10**

Max. speed (km/h)	120	120	120	120
Terminal operation investments and costs	mil. CZK	mil. CZK	mil. CZK	**0**

Table 3 Selected parameters of appropriate technologies concerned
to combined railway transport with horizontal loading
Source: The Authors

Conclusion

This paper deals with presentation of innovative theory applied to innovative technologies for combined transport. A creation of transport technologies is an integral part of principal changes, it means to high level innovations.

However, a set of research information closely related to identification and description of innovative combined transport technologies within EU fair creates an important integral part of that paper as well. On one hand, applying a suitable combined transport technology enables rational managing transport costs. On the other hand, the above-mentioned applying represents a contribution to optimization of logistic costs within firms and companies.

It is recommended to set the weights of appropriate transport parameters and to assign them adequate filling values and to apply statistical methods of multi-criterial evaluation of variants, when calculating weighted average values with respect formula:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i p_i}{\sum_{i=1}^{n} p_i} = \frac{x_1 p_1 + x_2 p_2 + \ldots + x_n p_n}{p_1 + p_2 + \ldots + p_n}$$

where:
x…value,
p…weight (Giovannini, 2010).

It enables selecting the optimal innovative technology.

The innovative combined railway transport technologies, which enable horizontal loading and require no further investment related to manipulation facilities are considered to the most suitable from client's point of view.

The system of original Swedish truck based on Flexiwaggon technology, which enables loading of integrated manipulation unit and needs no further transport facilities existing within two transport areas is considered to be optimal for that client who does not want invest into building and operation of any terminal.

Tento článok odporúčal na publikovanie vo vedeckom časopise Mladá veda: Ing. Ladislav Šolc, Ph.D.

Studie vznikla v rámci vědecké činnosti na Vysoké škole technické a ekonomické v Českých Budějovicích.

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