Research Article

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Economic aspect of combined transport

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Abstract: The article deals with the current issues of combined transport; at the beginning, the crucial terms and definitions are stated. Combined transport is evaluated on the basis of statistics in the Czech Republic. According to these statistics, combined transport has a rising tendency, although the potential has not been fully utilized. The article defines reasons why carriers might choose only road transport. Problems of the utilization of combined transport from the carriers' point of view are mentioned; increased demand for organization and carriage in particular. Furthermore, it focuses on modern trends in combined transport, especially in terms of modern technologies and the utilization of informatics systems. In the conclusion, the article also presents a method of economic evaluation of combined transport on the basis of its cost comparison with road transport.

Keywords: combined transport, logistics, costs, transport units, carrier

1 Introduction

Combined transport is generally defined as a transport system of items (goods) in one and the same transport unit or a road vehicle that gradually uses different modes of transport without handling the items themselves when changing the modes of transport. The prevailing part of the transport route is carried out on the railway or inland waterway and the initial part (collection) and/or the final part (distribution) takes part on the road and it is usually as short as possible. Combined transport is part of multimodal transport which is defined as goods transport by two different modes of transport at least.

Currently, the term of sustainability is very topical and the whole society applies it within many sectors

and many connections. Transport, e.g. in the field of waste management, plays a crucial role, particularly when various regional municipalities are served by different collection companies.

Nowadays, combined or multimodal transport is the most growing segment of railway transport with a high potential to overtake great volumes of freight transport from the road transport to those modes of transport that are much environment-friendlier [1]. Continental combined transport has a great potential as it uses transport throughout the continent without the need of seaway transport.

The introduction of the current trend of supporting the transfer of freight transport from road to rail and the promotion of environmentally friendly modes of transport are based on the European Union's strategic document "White Paper – Roadmap to a Single European Transport Area – Creating a competitive and resource-efficient transport system" (hereinafter referred to as the "White Paper"). At present, it appears that the implementation of the White Paper's objectives in the field of freight transport is not entirely satisfactory [2]. The objective of all EU member countries should be to introduce measures that will increase the competitiveness of combined transport and its share of the freight transport market.

Combined transport must be understood as a complete system – road/rail vehicle, transport unit, transport route, and terminal.

The most commonly used transport units for combined transport are ISO containers, inland and roll containers, swap bodies, and road intermodal trailers. ISO containers were originally developed for sea transport and subsequently were used for land transport. For continental combined transport, swap bodies and road intermodal trailers are mainly used, which are directly transferable to a road vehicle and allow transshipment from road to rail transport [3]. Inland and roll containers are also useful for continental combined transport [4].

2 Definition of combined transport

This section should include sufficient technical information to enable the experiments to be reproduced. In

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theoretical papers comprising the computational analyses, technical details (methods, models applied, or newly developed) should be provided to enable the readers to reproduce the calculations.

Combined transport (combined traffic) is such transport in which one (passive) means of transport is carried on another (active) means of transport. The movement of goods is provided in a single transport unit or container which is successively transported by several different modes of transport, without the goods themselves being handled during the change of mode. Freight transport uses road or water transport in addition to railway transport during one journey – it is a system of transporting goods in one and the same transport unit (large container, swap body, roll container) or road vehicle which also uses rail or water transport on one journey. The road transport of the transport units within the framework of the combined transport is used for collection and distribution from the place of loading or unloading to the combined transport transshipment point or from the combined transport transshipment point to the place of unloading or loading.

The key to the use of multimodal (combined) transport is its economic efficiency from the point of view of the carrier. The parameter examined can then be either the limit transport distance of the rail transport or the limit number of units transported. Of course, this relates to transports where there is the choice between road and multimodal transport [5]. In cases of intercontinental transport, where maritime transport must be used, the use of multimodal transport is a necessity. However, it should be noted that any transport is a highly individual matter and there are several factors that will play a role in the final decision of the carrier and his choice of transport mode:

- connection to the transport infrastructure (access to railway transport),
- route parameters, esp. the distance, where it is generally true that the longer the distance, the more convenient the multimodal transport,

- volume transported, in general, the bigger volume, the more convenient the multimodal transport,
- requirements on means of transport and its price.

The following figure shows the percentage growth in combined transport performance. In 2009, the decline is mainly related to the weakening of the economy in the context of the global economic depression. Data from 2020 are not yet available to show the impact of the coronavirus epidemic on intermodal transport (Figure 1).

Last but not the least, the share of combined transport in freight transport as a whole is increasing. In 2019, the share of combined transport reached 5.61%. However, this is still lower than the share usually achieved abroad, especially in Western Europe (Figure 2).

3 Carriers' point of view of combined transport

Enterprises that want to use combined transport must take into account a lot of circumstances. In most cases, they come to the conclusion that combined transport is ineffective for them [6]. The reasons are following:

- lack of intermodal terminals (which can be just a local problem)
- missing railway connection
- higher cost demand (the conclusion of the article contains more information)
- transport time prolonging (generally speaking, a carrier who invested money in the goods does not want to make the transport time longer)
- more requirements for planning and organizing the transport (more requirements on the employees)
- lower flexibility of operation management

Figure 1: Base index of combined transport growth (in tkm) – (%). Source: own calculations.

Figure 2: Combined transport share (in tkm) of the total freight transport (%). Source: own calculations.

A separate issue is the question of the use of combined transport terminals. In practice, it often happens that the owner of a combined transport terminal is also a carrier and consequently they prefer their own transport activities. In this context, we divide terminals into two groups – with public and nonpublic access.

A public access transshipment terminal is a transshipment terminal where the basic services of the transshipment terminal must be provided by the operator to any customer/interested party in using the CT terminal on a nondiscriminatory basis under guaranteed conditions known in advance and at a price set and published by the operator beforehand. The prices set for the provision of the basic terminal services must correspond to the actual operating costs of the transshipment terminal, including a reasonable profit. In the event that the demand exceeds the capacity of the terminal, the requirements shall be reduced equally among all bidders [7].

In 2019, there were 17 private combined transport transshipment facilities operating in the Czech Republic (3 of which are located in the public port of Mělník). These transshipment points currently have at their disposal, according to information provided by their operators, a storage capacity of 68,530 TEU (equivalent to one 20-foot container, i.e. 6 m in length). Nine intermodal transshipment facilities have handling equipment for the transshipment of intermodal road trailers. Three transshipment points have been supported from public funds (the financial settlement of the project has already been made) and have thus become public access transshipment points, which ensures the nondiscriminatory provision of services on the basis of equal conditions and a published price

list that is freely available. It is the transshipment point of PKP Cargo International in Ostrava Paskov (formerly AWT), ČD – DUSS Terminal in Lovosice, and UPLINE CZ in Obrnice. By the end of 2022, further transshipment points supported from public funds, OPD II in particular, will have complied with conditions for public access.

In addition, there are private company transshipment facilities in the Czech Republic that serve the needs of the owners only or one exclusive customer; in general, these transshipment points provide services to various customers on the basis of commercial agreements. The Czech Republic does not operate a public transshipment facility owned by the state or another public institution, as is the case in the neighbouring EU countries.

In the field of combined transport, the Ministry of Transport also cooperates with professional associations and unions such as ŽESNAD.CZ (Association of Rail Freight Carriers of the Czech Republic), ČESMAD BOHEMIA, (Czech Association of Road Transport Operators), the Transport Union, SCHP ČR (Association of Chemical Industry of the Czech Republic), and other experts (Figure 3).

4 Modern technologies of combined transport

“The freight transport concept for period 2017–2023 with prospect till 2030” claims that the network of transshipment points is relatively dense; however, it adds that *“the transshipment points are not usually located on public transport infrastructure, the movement of rail wagons*

Figure 3: Location of container transshipment terminals in the Czech Republic [8]. (1) Praha Uhřetěves, (2) Obrnice, (3) Česká Třebová, (4) Mělník (tři překladiště), (5) Želechovice nad Dřevnicí – Lípa, (6) Brno, (7) Šenov, (8) Nýřany, (9) Paskov, (10) Ústí nad Labem, (11) Lovosice, (12) Děčín – Loubí, (13) Přerov, and (14) Pardubice – Černá za Bor.

between public transport infrastructure and terminals with a possible link to logistics centres located on branch lines represents an additional cost item lowering the competitiveness of combined and multimodal transport lines which are being newly introduced” [9].

The situation where terminals are owned by a freight transport operator is also problematic.

The following problems can then arise:

- reluctance of other carriers to use such a terminal,
- the setting of high prices by the terminal owner,
- preference for the terminal owner’s activities when there is a lack of terminal capacity,
- high transshipment prices (e.g. compared to Germany)

When it comes to transshipment, we mainly refer to various technologies, so-called horizontal transshipment, which do not require a crane or other handling equipment and the transport unit is in permanent contact with the ground or the means of transport. Examples of such technologies include ModaLohr, which takes place in specially adapted terminals with pivoting loading ramps, where the platform of the low-level rail car is pivoted by 30° during transshipment, the road trailer is driven onto it, the intermodal unit is disconnected, and the rail car is pivoted to its original position. [10] The estimated investment costs for one terminal, depending on its length, will be between 15 and 20 million EUR [11] (Figure 4).

However, a significant limitation of horizontal transshipment technology is its application mainly for complete trains and the high initial investment, which for

example for the ModaLohr system for one rail and one railcar can be around 500 million CZK. This is a significant barrier to the development of these transshipment technologies. In practice, it turns out that the efficiency of these systems is not great and they cannot do without operating subsidies. The technological shortcomings of the system are also a matter of concern, and its use is thus currently very limited.

An important factor for the efficiency of combined transport is the length of freight trains. In general, the longer the train, the lower the cost of transporting one container. According to European Commission Regulation 1315/2013, the capacity of terminals and main lines is formulated by a train length of at least 740 m in the 2030 time frame. The undeniable economic advantage of such long trains is countered by an operational disadvantage – the small number of so-called intermediate stations, where crossing or overtaking is problematic for such long trains. Trains must therefore be arranged to pass through stations where this length of a track does not exist. A length of 650–700 m is therefore recommended, which means 80–100 TEUs/train when there are different combinations of carriages.

5 Economic evaluation of combined transport

In this section, we deliberately abstract from the fact that there will be a number of factors involved in whether a

Figure 4: Horizontal transshipment technology ModaLohr, zdroj [12].

carrier uses combined transport and we will only address the question of what parameters are needed to make combined transport economically advantageous compared to road transport. From an economic point of view, the objective is to find the limit number of units transported or limit distance of the part of the transport that is carried by rail transport so that combined transport is acceptable to customers as far as costs are concerned. We follow the equation

$$N_{RT} = N_{CT}, \quad (1)$$

where N_{RT} , transport costs using road transport; N_{CT} , transport costs using combined transport.

Road transport costs [10] will depend on the number of transported units, distance, and road transport unit cost:

$$N_{RT} = p \cdot n_{km}^R \cdot L_{R1}, \quad (2)$$

where p , number of transported units (pcs); n_{km}^R , rate per kilometer made on roads (CZK/km); L_{R1} , number of kilometers made on roads – roads transport (km); n_{km}^T , rate per kilometer made on the freight railway line (CZK/km).

Part of combined transport costs [13] will be created by railway transport cost and transshipment (we suppose it will be done twice, i.e. road transport will be used both at the beginning and at the end of the process), it is also necessary to add up the final transport that is performed by road transport, that is:

$$N_{CT} = n_{km}^T \cdot L_T + 2 \cdot p \cdot n_p + p \cdot n_{km}^R \cdot L_{R2}, \quad (3)$$

The following equation will be used for the calculation:

$$p \cdot n_{km}^R \cdot L_{R1} = n_{km}^T \cdot L_T + 2 \cdot p \cdot n_p + p \cdot n_{km}^R \cdot L_{R2}, \quad (4)$$

where L_{R2} , number of kilometres made on roads – combined transport (km); L_T , number of kilometers made on the freight railway line (km); n_{km}^T , rate per kilometer made

Figure 5: Transport distance of combined transport. Source: ref. [14].

on the freight railway line (CZK/km); n_p , transshipment costs per one transport unit (CZK/transshipment)

From formula (4), we can express the number of units transported as an unknown quantity and the result is a relation for the limit number of units transported, which is the minimum for the use of combined transport in terms of cost-effectiveness p_M :

$$p_M = \frac{n_{km}^T \cdot L_T}{n_{km}^R \cdot L_{R1} - 2 \cdot n_p - n_{km}^R \cdot L_{R2}}. \quad (5)$$

Similarly, we can express the limit distance of rail transport at which combined transport will be more cost-effective than road transport L_{TM} :

$$L_{TM} = \frac{p \cdot (n_{km}^R \cdot L_{R1} - 2 \cdot n_p - n_{km}^R \cdot L_{R2})}{n_{km}^T}. \quad (6)$$

It is necessary to mention that the quantification will vary for every transport; however, the following conclusions will be valid:

- the higher the number of units transported, the lower the cost of rail transport and thus the more advantageous the use of combined transport,
- the advantage of combined transport increases with greater transport distance,
- of course, economically the synergistic effect of both factors is the most effective, i.e. large transport volume and a long distance
- the ratio of the distance covered by rail and road transport is also important; in this respect, we can introduce the coefficient for which it is valid that, the larger it is, the more advantageous combined transport will be:

$$\gamma = \frac{L_T}{L_{R2}}. \quad (7)$$

In fact, the above-stated relationships can be illustrated with official statistics that indicate the distance over which combined transport takes place. The following graph shows that transport activities over 600 km dominate, and in recent years, transport activities over 900 km have even reached a share of over 50% (Figure 5).

6 Conclusion

Combined transport is on the rise in the Czech Republic, despite the fact that it is still not exploiting its potential. This can be supported by several factors, e.g. increasing the capacity of the rail network (the construction of high-speed lines, on which part of the rail freight transport can be realized in the future and which will also reduce the load on the rest of the rail network, may be an important

help) or modernizing combined transport terminals and increasing their capacity. A separate factor is the approach of carriers to the choice of transport mode. It is natural for small- and medium-sized enterprises to choose road freight transport for their needs. However, for larger enterprises, where material flows are more intense, combined transport may find a more significant application. In this context, there is an opportunity to deepen the marketing and awareness of multimodal transport to improve cooperation between manufacturing companies and operators, freight forwarders, and transport companies.

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References

- [1] Poliak M, Poliakova A. Sustainability of trucks parking in European Union. EAI Endorsed Trans Energy Web. 2021;8(32):1–6.
- [2] Lizbetin J, Stopka O, Nemec F. Methodological assessment of environmental indicators in combined transport in comparison with direct road freight transport. Transport Means – 20th International Scientific Conference on Transport Means, Juodkrante, Lithuania: Kaunas University of Technology; 2016. p. 151–5. ISSN 1822-296X.
- [3] Lizbetin J, Vejs P, Stopka O, Cempírek V. The significance of dynamic detection of the railway vehicles weight. Nase More. 2016;63(3):156–60. doi: 10.17818/NM/2016/SI15.
- [4] Dočkalíková I, Cempírek V, Indruchová I. Multimodal transport as a substitution for standard wagons. Transp Res Proc. 2020;44:30–4.
- [5] Kubáňová J, Kubasáková I, Jagelčák J, Jurga L. The possibility of using an intermodal transport. Transport Means – Proceedings of the International Conference, 2019; 2019 Oct. p. 872–8.
- [6] Kubáňová J, Otáhalová Z, Senko Š. Advantages and disadvantages of intermodal freight transportation. Commun Comput Inf Sci. 2020;1289:285–95.
- [7] Koncepcie nákladní dopravy pro období 2017–2023 s výhledem do roku 2030. Ministry of Transport of Czech Republic; 2016.
- [8] Cempírek V, Vrbová P, Zákorová E. The possibility of transferring the transport performance on railway transport MATEC Web of Conferences. Vol. 134; 2017. p. 00006.
- [9] Kubáňová J, Kubasáková I, Špruncová K. The impact of the telematics systems using in the road freight transport business. Transport Means – Proceedings of the International Conference, 2020; 2020 Sept. p. 767–72.
- [10] Valdman S. Technologie překládky jednotek kombinované přepravy. Vědeckotechnický sborník ČD, 39/2015.
- [11] Šíroký J, Cempírek V, Hlavsová P, Chalupová Vohánková H. Aspekty rozvoje kontinentální kombinované dopravy v ČR, Perners Contact, ročník XI, číslo 1; 2016.
- [12] Říha Z, Tichý J. The Costs Calculation and Modelling in Transport Transport Means – Proceedings of the International Conference, 2015; 2015 Jan. p. 388–91.
- [13] <https://www.railwaypro.com>.
- [14] <https://www.ioda.cz>.