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NEW IDEAS FOR INLAND INTERMODAL TRANSPORT

Summary. This article focuses on the competitive disadvantages of existing intermodal rail-road transport compared with road transport. The authors state that the domestic and continental combined freight transport system can be competitive in terms of both time and price with road freight transport. The new container transshipment device contributes to a new terminal structure on the freight rail-road transport market, considering environment protection requirements, and the concept has helped the logistics sector to become cost competitive. The scientific novelty is that the container transshipment robot enables new technical and organizational technology solutions for combined rail-road intermodal freight transport.

1. INTRODUCTION

There are several analyses available in the technical literature to investigate railway and road freight transport issues. One of the prerequisites for continental rail-road intermodal transport is the presence of a relatively dense container terminal network with advanced container handling [1], [2]. In addition to this, the cost of container handling should not impair the competitiveness of intermodal transport. According to experts' conclusions, railway freight transport has a significant competitive disadvantage over single-modal road transport. This statement is true not for rail transport solely, but also for rail-road intermodal transport, which has a competitive disadvantage in terms of price and time compared to road transport. The disadvantage of rail transport in time is caused by the inflexibility compared to single-modal road transport. The views below can be substantial in a paradigm shift in rail-road logistics.

Container handling technology, as proposed in this article, can be of paramount importance, as the European freight transport railway network in the main directions is 100% electrified. As a consequence, container handling under rail is a prerequisite for competitive rail-road intermodal freight transport. Several EU-sponsored developments have also achieved this goal. An efficient container handling under an overhead electric wire is considered to be a significant innovation.

Intermodal road-rail freight transport is often mentioned among the top priorities for steering the European transport system toward a sustainable direction; see, e.g., European Commission (2001, [3]). In this article, a new technical and organizational solution is proposed, which can help to achieve these goals. The aim is to direct attention to new development opportunities and present new perspectives for those involved in the field of intermodal transport.

2. THE CURRENT STATUS OF CONTAINER TRANSSHIPMENT TECHNOLOGY

To set clear expectations on the purpose of this article, it is necessary to describe the current situation. The examples below include the common container handling solutions on overland terminals. The disadvantages of each technical solution are pointed out in comparison to the Horizontal Container Transshipment (HCT) described in the sections below.

The widely used container handling method, shown in Figs. 1 and 2, is called vertical transshipment due to the lifting height.

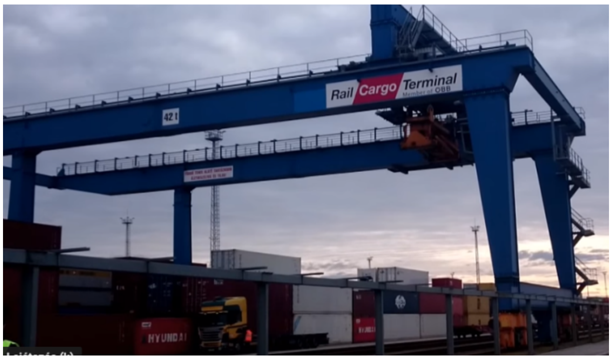

Fig. 1. Gantry crane (source: https://youtu.be/Jcsm3TMT_nM)
Disadvantages:
- high investment costs
- traffic concentration

Fig. 2. Reach stackers (Source: https://www.kalmarglobal.com/equipment/reachstackers/)
Disadvantages:
- requires heavy-duty concrete
- diesel fuel
- requires a large working area

The disadvantage of vertical transshipments is that they cannot be used in the presence of overhead electric wires. This feature has a negative impact on the development potential of the technology. The non-competitiveness of rail-road intermodal transport in time is another negative aspect, especially at shorter distances (less than 300 km). Over the last twenty years, many innovations in intermodal freight transport have been proposed to increase the market share of intermodal transport [4]. Some examples of these innovations are presented here.

Horizontal transshipment is a transshipment procedure of low lifting height that can be used under an overhead electric wire. Some examples of horizontal container transshipment are shown in Figs. 3-7. The latter feature is the main difference, compared with vertical transshipment, as horizontal transshipment can be used under an overhead electric wire too. The development of these procedures began in 1997-98 with the active participation of the Swiss Railways (SBB) [5].

Innovatrain ContainerMover's technology is similar to the Mobilier system, except that it does not need a special container. The common disadvantage of the horizontal transshipment technology is that it requires the simultaneous presence of the railway wagon and the lorry. Typically, they are suitable for goods conveying trains or a direction train system. The Mobiler and ACTS systems can be a proper solution for serving a closed (directional train that carries similar intermodal units) logistics chain.

In connection with the above, it can be stated that the principle of horizontal container transshipment is known, but an example of the widespread use of published equipment is not found in the literature.

The key to increasing the competitiveness of rail-road intermodal container transport lies in the operation of container trains between inland railway terminals much more frequently, and to use effective (automatic) transshipment of containers [2]. These requirements can be met by technical and organizational solutions in punk 4.

Fig. 3. KORAX-MIKON RTS 501 (source: http://www.loxodon.com/en/node/4)

Fig. 4. NETHS [6]

Fig. 5. Mobiler (source: http://www.mobiler.info)

Fig. 6. ACTS [27]

Fig. 7. Innovatrain's ContainerMover (source: http://www.innovatrain.ch/en/containermover/)

3. THE CURRENT PRACTICE OF CONTAINER TRANSPORT

At present, the source and destination container inland terminals are not located in the same country in case of more than 90% of big-container rail transport, i.e. they are mainly used for international transportation (direction train system between a seaport and an inland terminal). The elapsed time between the dispatch and the arrival of the container (about 4 weeks between Asia and Europe) and the applied vertical container handling technology are essential in developing the system. The combined domestic and continental transport of freights can be made competitive and predictable against road transport by the HCT (Horizontal Container Transhipment) and the new logistics system organized on the base of HCT.

Table 1
Disadvantages of the equipment shown in Figs. 3-7

Disadvantages	RTS 501	NETHS	Mobiler	ACTS	CM
The loading machine and lorry must be parallel	X	X	X		X
Inability to stack up	X	X	X	X	X
Cannot handle a swap body	X		X	X	
The container has to be held from the side, which is not the standard	X				
Minimum safety distance from the overhead electric wire		X			
Requires a special container			X	X	
Special vehicle required			X	X	X
Requires a modified railway wagon			X		
Requires a special railway wagon				X	X

Container traffic in Hungary is estimated at 253,000 TEU (in 2016 year) [7, Page 17]. Most of the traffic ends at a single large terminal, BILK (Budapesti Intermodális Logisztikai Központ). This traffic distribution is in line with the international trends, but at the same time, this practice is unable to meet the increasing environmental protection requirements. In addition, it has no impact on domestic freight transport and it is not able to reduce transit traffic.

As an example, we present a new idea in a case study. In this study, a manufacturer from near Miskolc (northeast region of Hungary) delivers automotive parts (e.g. exhaust pipes) to an engine factory at Szentgotthárd (western region of Hungary).

If this transportation is managed by current rail-road intermodal transport (it is an irrational solution under the present circumstances), then it would take 4 to 5 days to transport 1 TEU over 500 km between Miskolc and Szentgotthárd. This is basically because of the current container handling technology: the terminal construction, the freight train organization and the transportation practices. Otherwise, as the container has to be placed on a lorry for the road pre-running, to reduce the transport time, it is better to deliver the freight straight to Szentgotthárd on the same day. Due to the conditions of the roads, currently, in case of relatively short distances, rail transport has a considerable competitive disadvantage compared to road transport.

Price is a very important factor and a sensitive issue in free market conditions. If we take a look at the public date (price list) of some railway companies, of which two are interested in rail transport, we can see that the transport price of a container of goods (16-34 tons) is around 2.5 to 3 EUR/km. [8] If we compare this to the average road transport approx. 1 to 1.5 EUR/km, it is clear that rail transport of containers (for inland less than approx. 500 km) is not considered as competitive. Besides, the freight procurer bears additional costs such as lifting, terminal charges, etc. The attention of the customer, who is responsible for environmental protection, will also use road transport when comparing the above prices.

The result of the above price comparison is that both the market share and the development of inland intermodal transport are still at a very low level. The share of intermodal rail-road transport in the total goods transported by rail is only a low percentage. The major reason for this situation is the lack of an efficient transshipment method.

4. A SOLUTION TO THE PROBLEM

As the old saying goes, in healthcare, if we have the right diagnosis, we have chance for heal. If the diagnosis of the reasons for intermodal freight transport is correct (competitive disadvantage of rail transport in terms of time and costs), then we have a good chance of finding a solution to the problem.

In an ideal rail-road door-to-door transport solution, the goods are moved mainly via railways that are environment friendly and have competitive costs. Accordingly, transportation is divided into three stages: road pre-running, rail transport and road post-running.

The recommended horizontal container transshipment (HCT, shown on Fig. 8.) is a tracked loading robot with 16 degrees of freedom, and its design lifting capacity is 40 tons, which can satisfy the new requirements. Fig. 9 shows the HCT replacing a container from a railway wagon to a truck. The parallelism of the truck and the rail is not required. The 3x3 stacking capability is just a technical option, and the actual demand may be of a maximum of 2x2 stacking in case of deconcentrating (many small container transfer points are needed) of domestic container traffic.

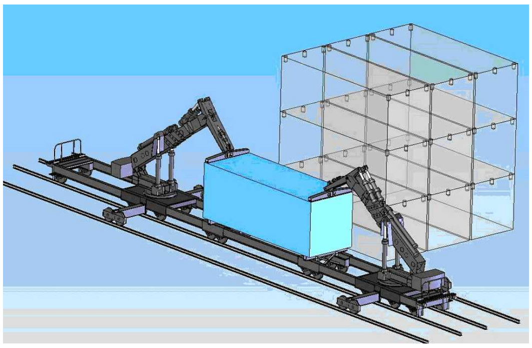

Fig. 8. HCT model (source: http://www.loxodon.com/en/)

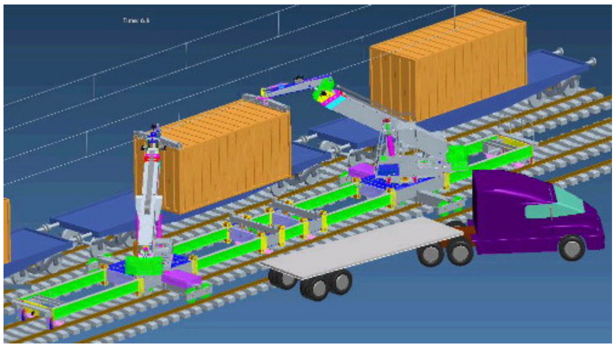

Fig. 9. HCT model (source: http://www.loxodon.com/en/videos)

HCT is a technical solution, protected by an international patent EP1401693 [9]. This invention allows the application of new technical solutions in the field of container transshipment but also contributes to the development of rail-road freight management and the creation of new business models. The essence of the new business model is that the price of intermodal freight transport is competitive. The HCT has several advantages compared with other horizontal container transshipment methods:

- New rail wagon construction is not required.
- New container type is not required; all existing containers can be used for the following:
- ISO 668 Boxing Container,
- Swap bodies according to EN 452,
- Roll-off container with DIN 30722 with the ISO container corner element.

The design of the HCT, the range of motions, is designed to meet the requirements for safe operation under an overhead electric wire. Certain sections of the rules [10] should be reviewed in the light of the technical progress. The construction results in a competitive transshipment time, even under a rail overhead line, which is required, for example, in the FlexCombi system [11].

Fig. 8 shows the image of the HCT model with a 3x3 container stack on the storage side. The 3x3 stacking provides sufficient storage capacity for temporary container storage for a few hours or for repository.

5. COMPETITIVENESS ON TIME WITH ROAD TRANSPORT

The transport of the previously mentioned Miskolc–Szentgotthárd route can be competitive in terms of time if the frequency of the container trains is relatively dense (approx. 2 hours follow-up), preferably in a roundabout. Fig. 10 shows a possible roundabout of container trains in Hungary. In addition, there are stops along the line at 40 to 60 kms, where “containers can be loaded and unloaded”. The environment friendly HCT can help “get on or get off” containers under owerhead electric wire.

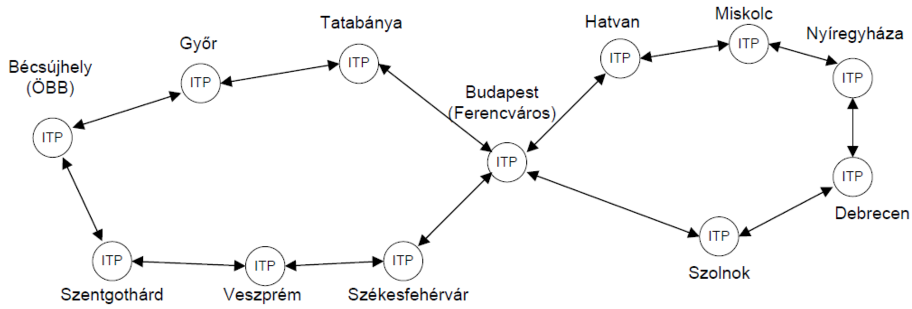

Fig. 10. Train traffic of the East–West goods flow by train traffic in Hungary (source: own editing)

The container handling technology by the HCT is of major importance because it can fulfill the above concept using the HCT under an overhead electric wire and provide efficient container transshipment. Instead of preference to the night jump in [3], the traffic of container trains in during the day time provides predictability. Container train timetables are planned and respected like passenger trains.

6. COMPETITIVENESS IN PRICE

In a questionnaire response [12], [16], freight customers ranked price at third position in the order of priority, but in the case of an actual decision, price is likely to receive a higher rank. Predictability was ranked in the first position, and in the second position was the security of goods. Intermodal freight transport has a competitive price, which includes all the costs incurred between dispatch and arrival. Namely, the basis of the undertaking price is the road distance, similar to the road transport companies. Similar to other literature data, intermodal transport is also compared to road transport [13]. However, we consider the price to be more important, and we propose special cost structure. The price includes the cost of a stand-by, container handling, road pre- and post-running, and actual rail transport. Another important factor is that a proportion of the calculated road toll is returned to the customer as a discount after the actual costs have been calculated. The results are shown in Table 2.

Other articles in the literature reflect different numbers, but show a similar tendency [15]. In addition to the above, many calculation methods exist. Economic models (based on marginal or average costs) can also be examined for the number of rail carriers and their transport performance. There is usually no specific cost or price in the literature to assess price competitiveness.

If the driver does not accompany the container, the transportation personnel costs can be decreased compared to escorted shipments. This is a well-known fact that has a positive impact on the competitiveness of the price. A significant difference between the rolling resistance features of the two technical devices is an important factor that has an influence on the rail and road transport costs. Approximately 30% of the diesel fuel used by road freight vehicles goes toward combating rolling resistance. In the case of railway vehicles, the loss due to rolling resistance is significantly lower. In addition, the price competitiveness of rail freight is improved by the source of the energy used. According to the current technology, the energy source of road transport is mainly mineral oil, which is the subject of international stock market movements. Rail transport in Europe has been powered exclusively by electric power on the main lines, which is produced at very favorable prices in nuclear power plants and, nowadays, in increasingly environment-friendly wind power plants and/or photovoltaic power stations.

The price structure of the recommended logistics system is such that nearly 60% of the freight fee is received by the owner and operator of the railway infrastructure for a service with a very low cost share. Numerically, this means that according to the preliminary calculation, the intermodal logistic operator company, with a turnover of some €156 million from domestic freight transport, pays about €94 million to the owner or operator of the infrastructure, i.e. MÁV (Hungarian railways).

Table 2

Specific price/cost of intermodal units

Transport method	specific price/cost
The specific **cost** of rail-road freight transport with HCT, according to the author’s calculation, by the TCO (total cost of ownership) method.	€ 0,72-0,75 TEU/train km
The specific price by “CD MÁV_2018-2019.pdf” [14] and RCH Commodity Rate [8], which does not include the cost of transshipment on the terminal, and transporting cost of the intermodal unit to the terminal.	€ 1,7 TEU/train km

7. GOODS SAFETY AND SECURITY

The damages of accompanied or unaccompanied transportation caused by various causes are a very important issue. The freight security factor in the choice of the means of transport is ranked second by the customers [16], [17]. If goods are in the not trustworthy lockable container or semi-trailer, theft may occur, either on the terminal or on the waiting train. If the driver is resting the goods are also quite vulnerable, especially in the curtainsider trailer. The other non-negligible damage is the damage caused by road accidents, which are mitigated by various insurance schemes by the shipping companies. The security of the goods is granted by the short stop on the ITP and continuous movement of the train. The container, picked up from the dispatching place, will be shipped within a short time, i.e. 2 hours. The motion of the train is continuous, with intermediate stops lasting 15 to 20 minutes. The safety of goods against road accidents is ensured by the significantly better accident statistics of the rail transport company.

8. CHANGE IN THE TERMINAL CONSTRUCTION PRACTICE

The proposal of this work for improving the combined logistics may contribute to the development of a new terminal structure in the liberalized transport market, meet the environmental requirements, and improve the competitiveness of the sectors charged with logistics costs. The Intermodal Transshipment Point (ITP) developed with HCT has the following benefits:

- There is no need to build a new freight terminal; it is sufficient to install transfer points in the existing areas at relatively low installation costs.
- HCT is able to stack up containers, which improves utilization of the area.
- The simultaneous presence of a railway train and a road transport vehicle is not required.
- It allows the deconcentration of traffic, necessary 20 - 30 km road distance for pre- and post-running (between the dispatching place and the train station as well as the train station and the delivery place); hence, transportation is performed by rail.

The term “physical internet” has emerged in the logistics literature, the nodes of which have been named HUB. If the physical internet is the flow of goods, than ITP is a logistic hub that creates possibilities of using new modular boxes or pallets for fast-moving consumer goods [18]. Container handling by HCT offers possibilities of organizing a new intermodal logistics system (physical internet) that can change terminal building practices. A small network of ITPs (or HUBs) can be created instead of a few large terminals that perform the concentration of traffic as presently. This change would be in line with the trend of operational deconcentrating of the production-service enterprises with the appearance of several market players, taking into account economic efficiency. Some conditions for creating and operating ITPs for combined transport include the following:

- Scheduled transport of container freight trains in both international and domestic traffic; train operation by the railway operator of the region; and trains traffic according to the timetable, with short tracking time, and container can be on train within 2-3 hours after taking from the freight sender.

- Establishment of a system of intermodal (rail-road) transshipment points under the management of a logistics company, which is not only able to handle the containers but also manage the customs administration of goods from outside of the EU. In case of Hungary, 22-23 (the authors' suggestion) such ITPs may be required.
- The interest of the road transport company in the operation of ITPs, as well as in road pre- and post-running.

In all cases, the new ITP has an overhead electric wire. Along the railway track, about 0.5 hectares (5,600 m^2) of land (14 m wide, 400 m long) can be used for storing approx. 500 TEUs (approximately 250 pieces of 40-feet containers).

Figs. 11-14 illustrate a realization of an ITP or HUB equipped with HCT that meets various technical and capacity requirements. Depending on traffic, container handling is provided by 1 or 2 HCT machines. The aim is to ensure that the train continues to run within 15 to 20 minutes. If 2 HCTs are used, then they can move on the same rail track. Arrangement of containers for loading onto a railway wagon or servicing the road vehicles can take place when there is no train at the ITP.

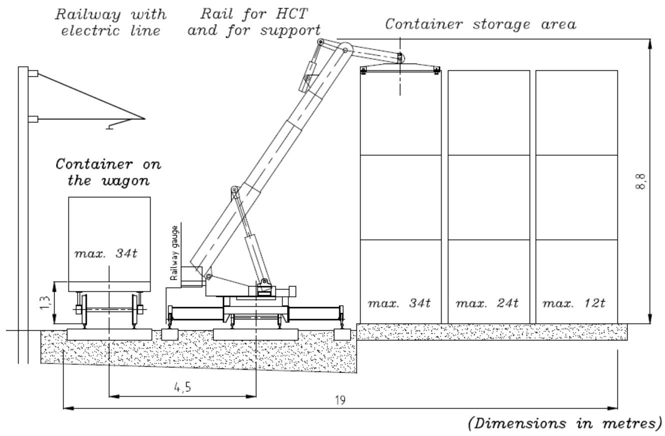

Fig. 11. ITP profile with HCT (source: own editing)

Figs. 12-13 illustrate the arrangement of ITPs for medium and low capacities. The most important feature of the proposed ITP is the significantly smaller base area compared with the current terminals.

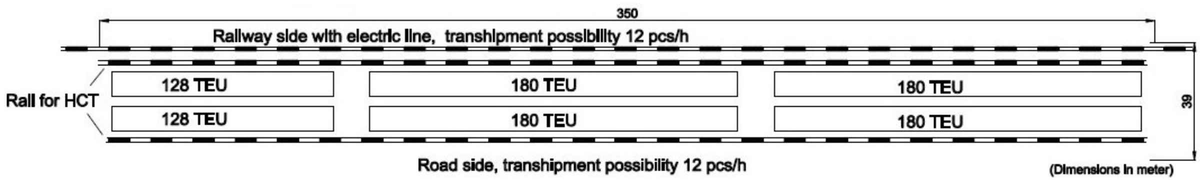

Fig. 12. Medium intermodal transshipment with 2 HCTs (source: own editing)

Due to the smaller size of ITP, they can be installed in the idle railway cargo terminals that were built (in Hungary) in the cities decades ago. Thenks to we do not seek to concentrate freight traffic, the increase the road traffic in the neighborhood area is not significant.

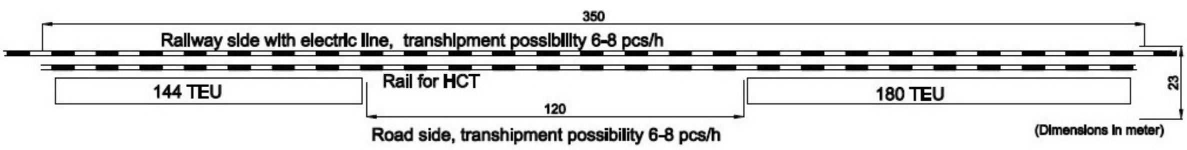

Fig. 13. Low-capacity intermodal transfer point with HCT (source: own editing)

The container handling capacity of the HCT equipment is 10 to 12 units/hour, which means 36,000 to 37,000 units of container transshipment capacity per year.

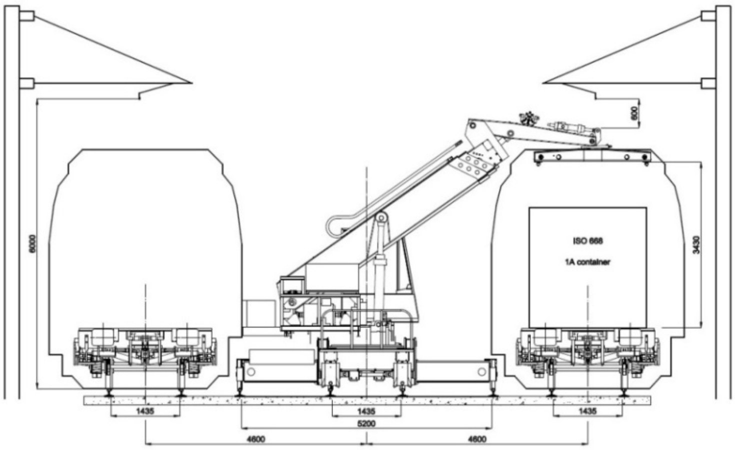

Fig. 14. Cross section of a railway junction equipped with HCT at the same or different track gauge (source: own editing)

Fig. 14 shows an ITP cross section where the transshipment is of the same or different gauge from one railway wagon to another. Such transshipment can take place at a point of contact of container trains running in different directions. In Ferencváros and Rákos (in Budapest), such freight stations can be set up to service the east–west direction of Hungary. Different track gauges are located in the Záhony (east Hungary) region, especially when serving the "Silk Express". At the transshipment location, shown above, reloading of a train with 40-50 pcs containers can be completed in less than 120 minutes, which is comparable time what is necessary for administration of the border crossing documents. Therefore, the transshipment at the border station does not cause any additional time loss. This can be a competitive solution for linking the different gauge rail freights in Europe. It may be a more cost-effective solution because it does not require the construction of a new standard-gauge railway track.

9. RAIL-ROAD TRANSPORT FROM DOOR TO DOOR

MÁV (Hungarian Railway) used to have a door-to-door service in a very different economic environment. In the current multi-player logistics market, the goal is to build up a service, where goods are transported basically by rail, and this is partly comparable to the above-mentioned door-to-door service. Some conditions to run the proposed collecting-and-distributing system, i.e., a door-to-door logistics system, are as follows:

- Self-loading cars, container trucks, what transported containers from the customer's to the ITPs. Due to the smaller transport distance, one road haulage unit carries out more turns per day.
- Goods for just-in-time production are not on the truck near the destination; they are at the nearest ITP in containers (or ILU, Intermodal Logistic Unit).

The proposed goods flow system is illustrated in Fig. 14. Scheduled freight trains run with low tracking time. Running of the trains does not depend on momentary occupancy (similar to passenger trains). At ITPs, HCT machines load and unload the containers to and from the trains. The possible routes between the departure and the destination can be determined after analyzing traffic data. The proposed concept is an open logistic system in which not only marine-based but also continental container types (swap body, roll-off container) can be used.

In the goods flow system shown in Fig. 15, ITPs can be located at different distances and the railway traffic connections are shown by freight circuits 2 to 5.

The current domestic intermodal traffic in Hungary does not require an extensive intermodal network. However, the increasing demand for competitive combined transport, at the time and price based on the HCT, may also enable a larger and more economical network.

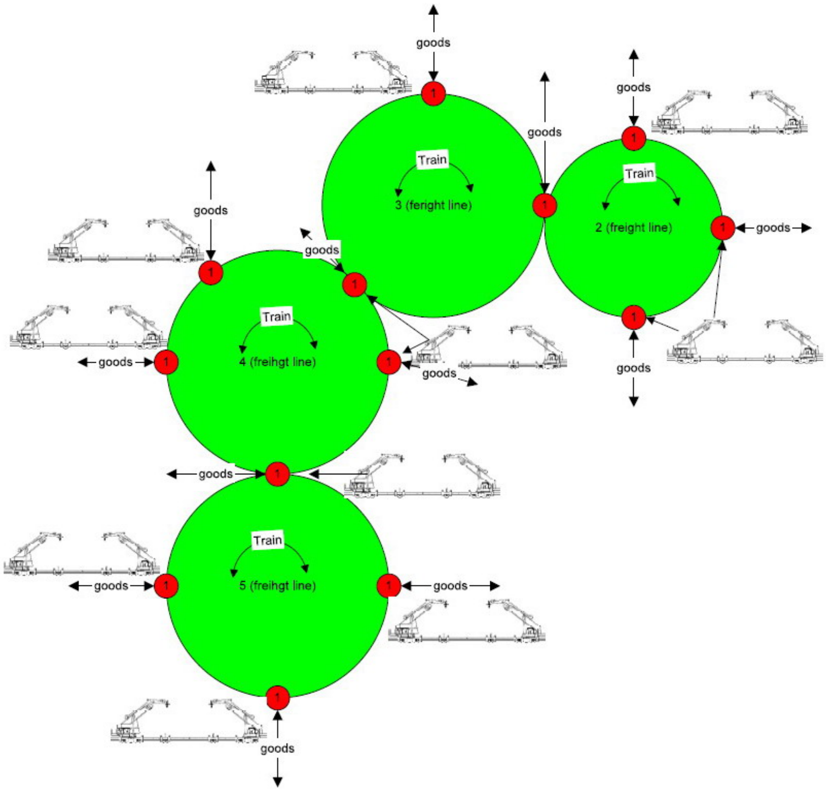

Fig. 15. Railroad roundabout and entry and exit points for goods in the system (source: own editing)

Figs. 16-18 illustrate, for the above example, the possible placement of intermodal transshipment points in case of circulating container railway trains. The average road distance between the ITP and the loading and unloading station is about 20 to 30 km. Let us call this distance "pre- and post-running distance", as shown in the literature [19].

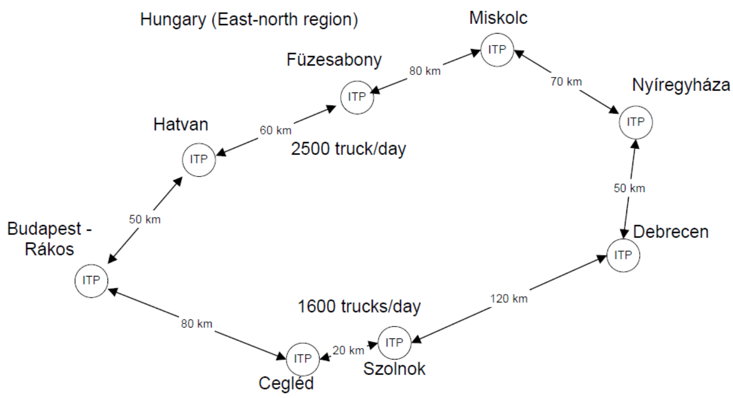

Fig. 16. Intermodal freight network that can be formed in North-East Hungary (source: own editing)

In the case of Hungary, due to the well-developed railway infrastructure, the routes of the scheduled container trains can be formed in a very varied way. There can even be four roundabouts:

- North-east: Budapest - Szolnok - Debrecen - Nyíregyháza - Miskolc - Füzesabony - Hatvan - Budapest (used by IC trains, Fig. 16.)
- South-east: Budapest - Cegléd - Kecskemét - Kiskunfélegyháza - Kiskunhalas - Kiskőrös - Budapest
- Southern Transdanubia: Budapest - Székesfehérvár - Lepsény - Nagykanizsa - Gyékényes - Kaposvár - Dombóvár - Pusztaszabolcs - Budapest
- Northern Transdanubia: Budapest - Győr - Hegyeshalom - Vienna - Graz - Szentgotthárd - Szombathely - Székesfehérvár – Budapest.

As a result of the model calculations, the annual turnover from the above-mentioned four roundabouts could reach € 150-160 million (with over 30 million tons of goods). The amount of investment is around € 50-55 million with a payback period of 4-5 years.

There are numerous intermodal transport corridor concepts in the literature that contribute to the development of freight transport. The economic potential of modern intermodal solutions can significantly affect the economic development of the countries concerned. [20].

Figs. 17-19 show examples of the international applicability of the proposed logistics system. Several regional or local roundabouts can be connected to the main directions shown in Figs. 17-19 considering the economic needs.

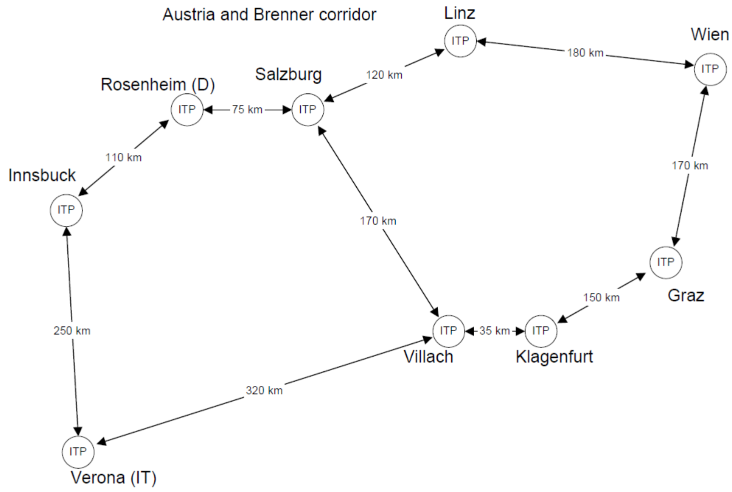

Fig. 17. Possible major roundabouts for container trains in Austria and at the Brenner Pass (source: own editing)

The load of the Brenner Pass HGV (Heavy Goods Vehicles) exceeds 2.25 million a year [21], which means about 6,000 HGVs per day on average.

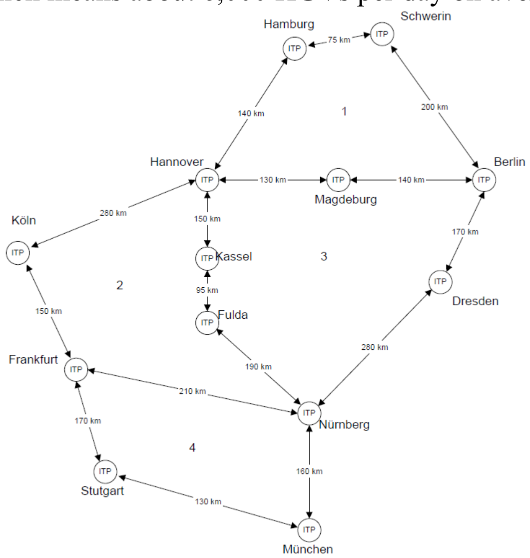

Fig. 18. Possible major roundabouts for container trains in Germany (source: own editing)

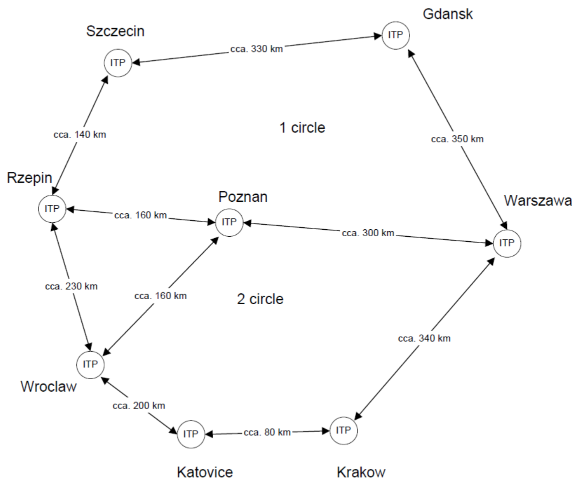

Fig. 19. Possible major roundabouts for container trains in Poland (source: own editing)

10. REDUCTION OF THE DEPENDENCE OF THE NATIONAL ECONOMY ON EXTERNAL FACTORS IN HUNGARY

While the dependence of the national economy on external factors, such as shipping options, has rarely been considered, it is worth paying attention to the issue.

The amount of fuel used for road transport cannot be accurately determined. However, with the approximation method, the share of freight transport of the fuel consumption of Hungary can be estimated. The dates of KSH (Hungarian Central Statistical Office) for the year 2017 were used for the calculation [22]. The following fuel consumption has been calculated for a truck or a trailer (semi-trailer) with over 10 tons of load capacity.

In 2018, diesel consumption in Hungary was 2.3 billion liters [23]. The total diesel fuel consumption of the two categories (lorries 10 t and higher, and trailers) is 846,069 tons (average specific weight of diesel fuel 0.83 kg/l), some of which come from non-domestic refueling stations. Hungary's annual mineral oil distillation capacity is 7.2 million tons, of which 792,000 tons (11%) of diesel fuel can be obtained. 80% of Hungarian crude oil consumption is imported from Russia. The assessment should take into account the fact that both transport statistics and actual crude oil use constantly change. In addition, the part of the fuel used by the transport companies appearing in the transport statistics can be decreased.

Table 3

Use of fuel in the transport sector (source: ksh.hu and own calculation)

Vehicle type	Lorry (pcs) [22]	Running performance (millions km) [22]	average fuel consumption (l/100 km)	diesel fuel consumption (liter)
10 t and higher	10,158	320	25	80,000,000
Trailer	35,955	2,472	38	939,360,000

If we can divert 100% of the deliveries of over 10 tons goods into a combined transport chain, where transport is taken by the environment-friendly (electric) train, then vulnerability of Hungary in the energy source market can be reduced by up to 80%. In principle, the possible reduction of the energy consumption and the rate of the crude oil from Russia are nearly the same. A 100% diversion rate (shown in Table 3.) is not realistic because it is not possible to avoid road pre- and post-running. If 50% of goods are diverted by market and administrative means, then vulnerability of Hungary to fossil energy imports can be reduced by 40-50%.

The intermodal freight transport system proposed in this article could significantly reduce the use of fossil energy in the transport sector and contribute significantly to the European carbon-neutral target.

11. REGULATORY ENVIRONMENT IN HUNGARY

The introduction of the ideas described above has numerous legislative prerequisites. Without being exhaustive, some unfavorable factors (in Hungary) are as follows:

- The railway transport currently fulfills its delivery obligations if the freight train reaches 200 km distance every 24 hours. In addition, the submission and release days are not included in this period. This rule must be changed, as the rail carrier is not encouraged to provide a competitive service against road transport.
- The liability of the railway operator undertaking shall be limited to the level of the transport charge [12]. Based on this, the damage caused by delayed delivery cannot be reimbursed to the freight procurer. These rules and other Hungarian laws [24], [25], [26] must be changed to have common legal transactions between the companies regulated by the civil law.
- Passenger trains have priority over freight trains in the allocation of railway track capacity and organizing the rail even if transfer of a freight train results in significantly higher revenue to the railway infrastructure management company. This rule, as well as the railway traffic management practice, must be changed so that sector neutrality prevails. That train will have priority, what provides higher revenue to the infrastructure management firm [11].

- We suggest establishing the rail connection points of intermodal transport to be located on unused and abandoned freight-yards. This is an important factor that allows system deployment with low deployment costs. At the same time, the railway classification of these areas generally does not allow the establishment of a transshipment point, as they are typically part of the public service network. The relevant rules should be modified so that the affected areas can be removed from the public transport network by a simple procedure and rented out for business activities.
- It is a well-known fact that a fee needs to be paid after each kilometer of track used in rail transport. The higher road toll offers a chance to the rail freight transport.

According to the literature, reform measures in other countries, in Europe, may also counteract the performance of continental rail-road intermodal transport. The goal is to ensure that intermodal freight transport is of the same quality as road transport.

12. THE STATUS OF THIS INNOVATION IN HCT

In 2008, Loxodon Ltd. built the prototype of HCT equipment within the framework of the Irinyi János Innovative Ideas Competition application. According to the test report, the prototype fulfilled the most important technical requirements and was able to prove the feasibility of the construction. They were not able to find the proper professional investor to construct the system after closing of the application. Due to the depletion of self-sustained development resources, we had no opportunity to apply the ideas under actual railway conditions described in this article. We have not yet found any rail and road freight company that has invested in the new freight system.

Currently, the HCT prototype is not working and is disassembled at the manufacturer's site.

13. CONCLUSIONS

New engineering solutions for container handling can provide new opportunities for rail-road intermodal freight transport. Reliable container handling even under an overhead electric wire is not a business success at the moment. Because intermodal freight transport is interdisciplinary from technical, organizational and legal points of view, there is a need for collaboration among professionals in many areas.

It is possible to develop rail–road intermodal transport, which is competitive in transportation time and price compared to road transport.

Scientific analysis of known container handling technologies, robotic solutions and the creative application of technical knowledge may result in a new container transshipment facility that can radically transform the inland intermodal freight system.

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