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PREVENTING THE NEGATIVE EFFECTS OF THE COVID-19 EPIDEMIC IN INTERNATIONAL FREIGHT TRANSPORT

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Abstract: Measures taken to handle the COVID-19 epidemic in the spring of 2020 have had a significant impact on European supply chains. In terms of freight transport, this has led to a decline and congestion in truck traffic due to different restrictions on the internal borders of the EU. As similar situations cannot be avoided in the future, it is worthy to form supply chains that are less affected by different epidemics. Similarly to the physical internet hubs, distribution hubs can be forward-looking, but only if it helps development of rail-road intermodal freight transport. The article describes the possibility of a rail-road freight transport system that allows the application of radically new solutions through a new container handling technology that can be used in the rail-road relationship. The extension of the idea at the EU level could result in a significant increase in the share of rail freight and a sizeable reduction of the negative impact of epidemics on the supply chains. Among other effects, the solution can have a significant impact on the IT development of rail freight transport. The solution can also have effect to the development of the network of rail-road intermodal trans-shipment points, their automation and ultimately the completion of Logistics 4.0.
Keywords: COVID-19, intermodal rail-road freight transport, container trans-shipment

1. INTRODUCTION

In the first months of 2020, the COVID-19 epidemic also appeared in European countries, the management of which had a significant impact on industry, trade and the transport sector that serves them. The impact on the transport sector was due to the restriction of cross-border passenger traffic and the reduction of industrial production due to the supply chain disruptions. Several articles have been published in the press to analyse the causes. The main reasons for the decline are the restriction of the movement of persons within the country and the cross-border passenger traffic. The Impact of COVID-19 on Logistics [1] by International Finance Corporation includes an analysis covering the period Q1 2020. To prevent similar situations, specialists in the logistics sectors are looking for solutions. In the following we propose a rail-road intermodal freight solution that can reduce supply chain vulnerabilities in situations like the COVID-19 epidemic.

2. IMPACT OF COVID-19 ON WORLD GDP AND ON FREIGHT TRANSPORT

Numerous publications have been published in the international literature to analyse the effects of the COVID-19 epidemic. One of the IMF's analysis (IMF - International Monetary Fund) includes the following statement about world GDP change: “Under the assumption that the pandemic and required containment peaks in the second quarter for most countries in the world, and recedes in the second half of this year, in the April World

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Economic Outlook we project global growth in 2020 to fall to -3 %. This is a downgrade of 6.3 percentage points from January 2020, a major revision over a very short period. This makes the Great Lockdown the worst recession since the Great Depression, and far worse than the Global Financial Crisis." [12].

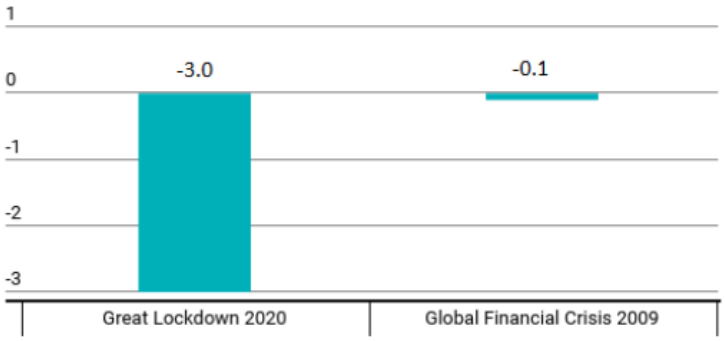

Figure 1. Real GDP growth, year-on-year per cent change [12]

As a result of the epidemic, negative changes can be observed in the world economy, which has also appeared in the logistics sector. Accordingly, the Hungarian logistics sector was forced to record a significant decline.

The Association of Hungarian Freight Forwarders, as advocacy organization, determined the rate of decline in the transport sector for April 2020 using an internet questionnaire conducted among its members. The results of which are shown in Figure 2. The survey is not representative. The rate of decline in the various transport sectors ranged from 15 to 27%.

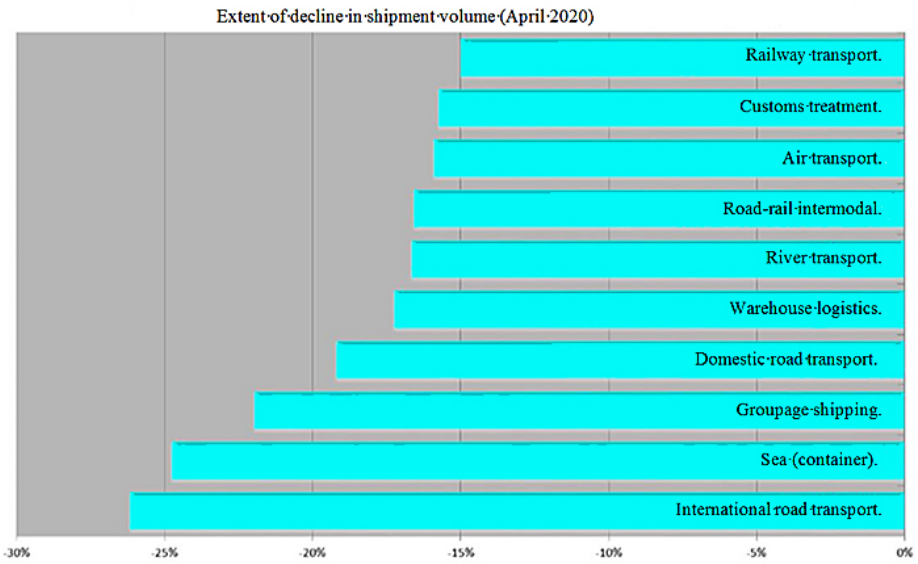

Figure 2. Decline in freight transport [2]

It is noteworthy that the decline in the railway sector was the smallest. Since the rail freight is less affected by restrictions on the crossing of borders, this result can be considered logical. Another unexpected effect of the COVID-19 epidemic was the increase in demand for warehouse buildings [3]. The reason for this phenomenon is certainly the preparation of the companies for the protracted COVID-19 epidemic and similar situations in the future.

A similar trend was identified by the Hungarian Association of Logistics Service Providers (MLSZKSZ). According to the study "the performance of international freight ton-kilometres by road decreased by 33.3 % and its volume by 28.1 % compare to the same period of the previous year" [4]. Regarding the rail freight performance, the article states that "… the volume of goods transported by rail internationally decreased by 1.4 % in the first half of 2020, while the performance of the railway in freight ton-kilometres increased by 7.5 %." [4].

It is also a consequence of the COVID-19 epidemic that freight chains from China to Europe have been disrupted, so European companies are seeking for closer sources for their products, in many cases within Europe. This has a traffic-increasing effect on the European freight sector. As this intra-European supply chain is also cross-border, personal restrictions on crossing borders can also have a negative impact on this supply chain. In an interview with supply chains, A. Chikán stated: “The coronavirus was the spark - or even a lightning strike - that set the overheated global economy on fire. Most of the processes we have seen in the economy since the appearance of the coronavirus have already started earlier. For example, the world's leading powers, economists and politicians have talked for a long while about the need to curb globalization in anticipation of the economic crisis and the need to shorten global supply chains and create alternatives - bringing products closer to the consumer by relocating production, etc.” [5].

3. REDUCING SUPPLY CHAIN VULNERABILITIES

As shown in Figure 2, the statistics show that the decline in rail freight transport was lower than the decline in road freight transport. The reasons for this are probably the following:

- border crossing restrictions on passenger traffic made truck traffic between countries more difficult, in contrast to which rail freight traffic had a significantly smaller effect on rail freight traffic,
- the damage and disruption of supply chains based on intercontinental and road freight transport hindered industrial production and the continuous operation of various product manufacturing plants.

A. Chikán described another trend that could reduce the vulnerability of supply chains. "In order to increase production safety, company executives have begun to revert to the inventory management practices I still know very well in the old " good" times, contrary to the just-in-time systems of the last decade or two where the goal is to keep inventory levels on a minimum." [5].

The International Finance Corporation found that “Logistics has been in the middle of a tech-driven revolution. Companies with robust digital capabilities that allow them to provide cargo visibility / traceability and do business online are at an advantage. This would entail investments in technology, such as the Internet of Things (IoT), cloud computing, automation, and data analytics” [1].

Various proposals have been made in the international literature to reduce the impact of COVID-19 and other epidemics on the logistics system. One of the suggestions made in the Deloitte study on the subject is: “Evaluate alternative outbound logistics options and secure capacity. With significant port congestion, a significant decrease in air freight capacity, and truck driver shortages, there is a significant backlog in logistics that will take some time to resolve as logistics operations gradually come back to normal.” [6]. Solutions such as intercontinental rail freight can also be included in the process improvements.

The Deloitte study [6] also found that the digitalization of supply chains can reduce the impact of a pandemic. In the case of the digital supply chain, there is a significantly more complex network between the elements, which can reduce the supply risk (Figure 3).

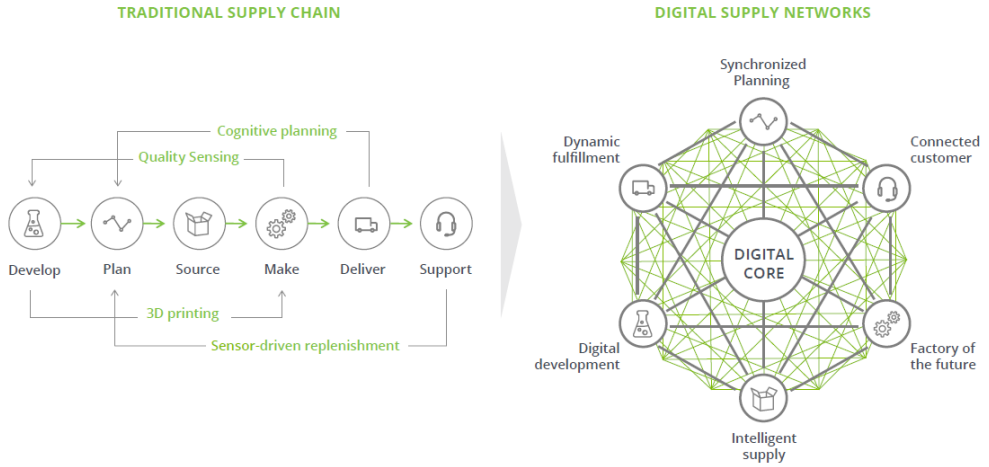

Figure 3. Circular rail freight model [6]

One concrete way to improve the reliability of European supply chains is to divert goods from road to rail. This requires partly rail traffic and partly container handling technology development. As European rail freight is essentially electrified, modern unit load (container) handling should also be applicable under the overhead contact line. This is a strictly technical approach. The modern robotic container handling necessitates a review of railway safety rules in line with the state of the art.

If a freight transport solution would be introduced in Hungary and Europe that uses rail transport, the vulnerability of supply chains will be decreased in case of a pandemic or extreme weather situation. This can be achieved by a rail-road intermodal freight transport system that meets the following conditions:

- container trains run in a roundabout with a short tracking time (1-2 hours), according to regular schedule,
- the loading and unloading stations or "get off and on the train" of the containers are 40 to 80 km apart, in industrial and manufactory centres,
- electric traction container trains stop for a short time to "get off and on the train " of loading and unloading the containers and do not use a conventional terminal,

According to J. Woxenius et al “The speed of trains, 100-160 km/h, is important for keeping the schedule, for mixing with fast passenger trains during daytime and for covering

long distances overnight." [7]. This goal is best achieved by split propulsion (bogies with electromotor), which has already been widely used for passenger trains. For freight trains, split propulsion is still a novelty. The development of rail rolling stock and the technological development of container trans-shipment together can lead to efficient rail-road intermodal freight transport.

Intermodal rail-road freight transport that meets the above conditions can be competitive in time compared to purely road transport. As there is significantly less personal involvement in the transport chain described above, the negative impact of pandemic situations may also be moderate. In addition, as transport is mainly by rail, with road pre- and post-running not exceeding 10-15% of the total transport distance, extreme weather events have a smaller impact on the functionality of the transport chain.

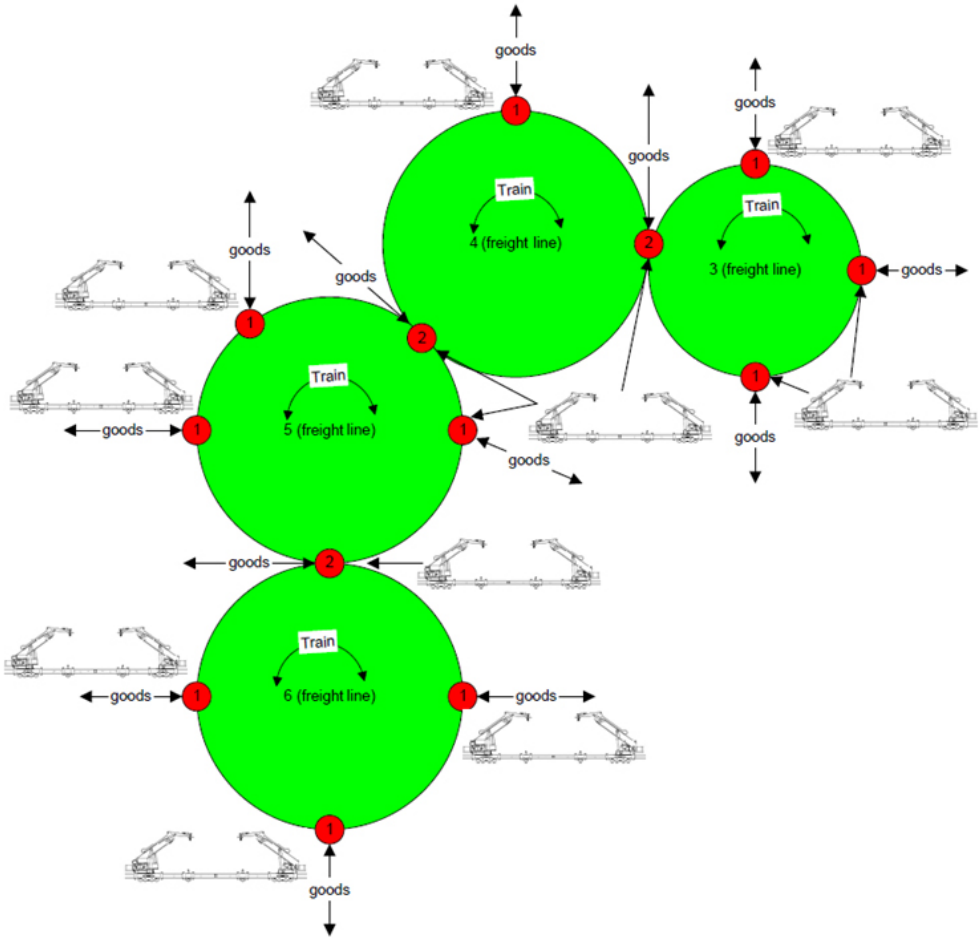

Figure 4. Circular rail freight model
1 – loading and unloading station points of containers;
2 – container trans-shipment between freight wagons;
3 to 6 railway roundabouts

In the freight model shown in Figure 4, a container trans-shipment device is used at the "get off and on the train" or loading and unloading station points 1, which allows the moving of containers even under catenary.

The material flow model shown in Figure 4 is similar to an in-plant material handling where freight routes 3-6 form a "conveyor track". At nodes 1, the goods enter or exit the material flow system using the suitably designed container handling equipment (Figure 4). At point 2, at the junction of the "conveyor tracks", it is possible to move the containers from one track to another, from one train to another, using the appropriately designed container handling equipment too (Figure 5).

4. HUB OR ITP

The literature names the material flow system as Physical internet [8], the distribution points of which are called HUBs. The way of transporting the goods is indifferent in these material flow models. Different modes of transport (road, rail, water) meet in the HUBs furthermore other logistics services (distribution of goods, warehousing) can be performed too.

The essence of the proposed idea is that the freight is transported by rail, with road pre- and post-running representing a low proportion of the total transport distance. The name of the hub of the freight transport described above is ITP (Intermodal Trans-shipment Point), which indicates the hub between the rail and road transport [9]. ITP does not carry out any logistics activities related to the distribution or storage of goods. The aim of the development of ITP, the container handling technology, is an intermodal service that is competitive with road freight transport in time.

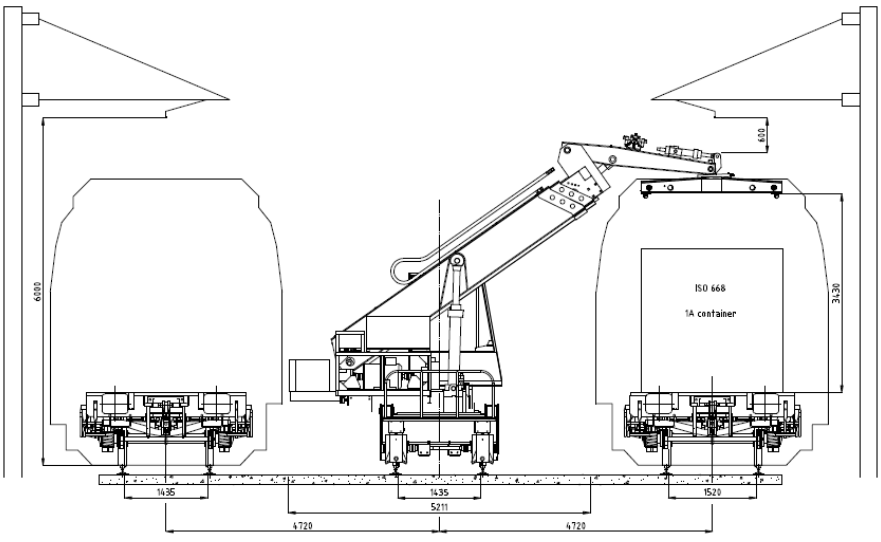

Figure 5. Wagon-to-wagon trans-shipping with HCT

Figure 5 shows a trans-shipment section with HCT (Horizontal Container Trans-shipment) where the rail freight roundabouts meet and it is possible to transfer the container from one

train to another. Figure 6 shows an ITP cross section where containers can be moved from a wagon to a wagon, and vice versa. Temporary storage of containers is also possible on these ITPs. ITP's work schedule is designed to give priority to the train service. That is, the containers are sorted or the road transport vehicles are serviced when there is no train at the ITP.

The possible design of the ITP according to Figure 5 at the junction of railway tracks with the same and different gauges. There may be a trans-shipment point between different railway tracks at the Záhony in Hungary, at the Terespol in Poland, at the French-Spanish border in the Cerbere / Portbou area. As in the examples mentioned only the unaccompanied goods cross the border, there is less chance of restricting the movement of goods in pandemic situations.

The space requirement of the ITP design shown in Figure 6 is 1.2-1.5 hectares. The capacity of HCT is 10-15 trans-shipments per machine and per hour. Due to the small footprint and the quiet operation, it can also be developed close to densely populated areas.

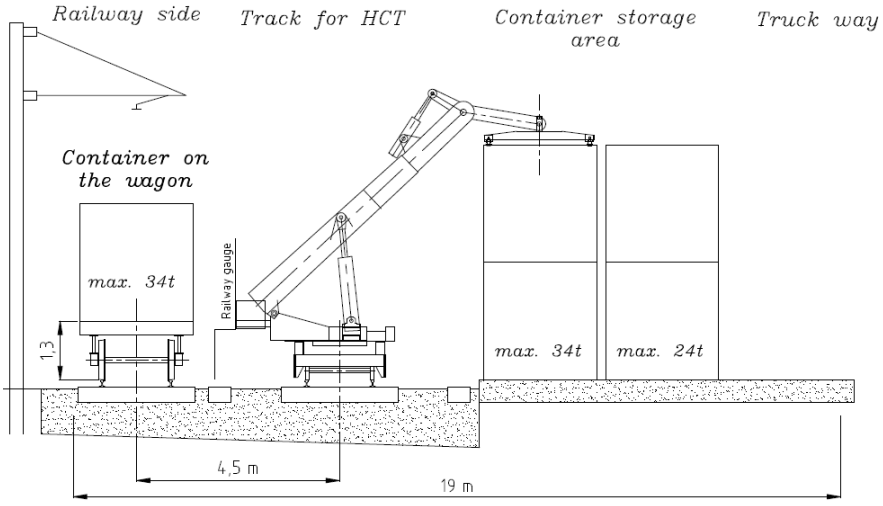

Figure 6. ITP cross section with HCT

5. HCT AS A REVOLUTION

New material flow systems cannot be developed without new ideas and new technological solutions to handle unit loads. HCT (Horizontal Container Trans-shipment) is a device that can meet the functional needs outlined above. The proposed state-of-the-art container handling solution correlates with the article by S. Behrends & J. Flodén. According to them, the development of intermodal freight transport is inconceivable without modern trans-shipment technology. By S. Behrends & J. Flodén "Intermodal line-trains with intermediate stops between start and end terminals are regularly advocated by intermodal transport researchers as a means to compete with all-road transport on small volumes and short distance markets. A prerequisite for line-trains are innovative trans-shipment technologies facilitating fast and efficient trans-shipments, which is likely to increase the terminal costs." [10].

As Europe's main rail transport lines are electrified, and container trans-shipment solution that can handle unit load under catenary, may be appropriate. With the support of the European Union, a number of technical solutions have been developed to promote the development of intermodal rail-road freight transport. Based on the statistical data and the level of road freight traffic, it can be stated that the attempts so far have not yielded satisfactory results. By analysing the technical solutions as well as the unit loads, it is possible to determine the functions that a properly designed container handling technology must satisfy. The functions to be fulfilled can be identified as follows:

- safe applicability under catenary (even under voltage),
- trans-shipment of MSZ ISO 668 containers (20-40-45 feet),
- trans-shipment of class "C" swap bodies according to MSZ EN 284,
- electrically driven for environmental purposes,
- partially or fully automatic (even without operator) operation.

Figure 7 shows a horizontal rail container loading device [11] it has the features identified above. Accordingly, at the ITP (Figure 6) or at a rail-to-rail meeting point (Figure 5), it is able to ensure the "getting on and off" of the containers on the railway wagon or on the truck.

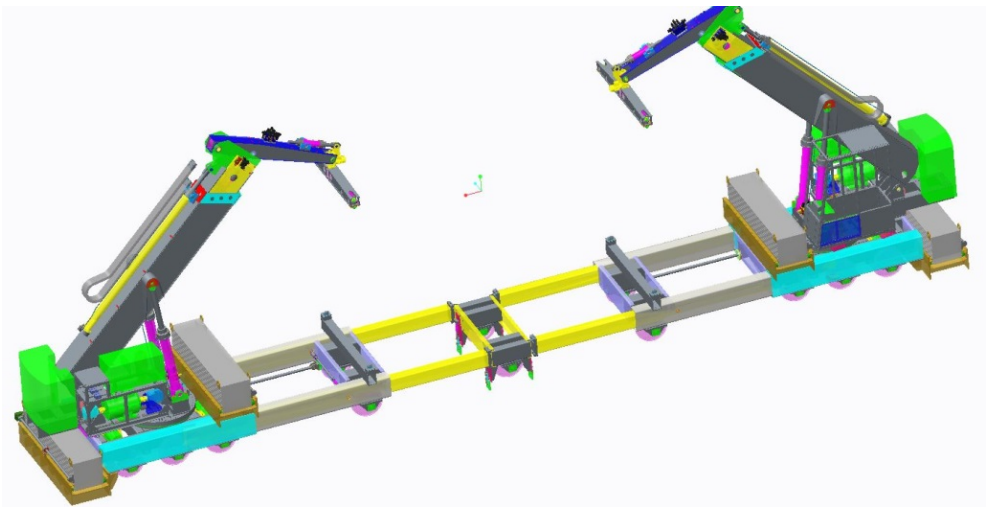

Figure 7. Model image of the HCT device

6. CONCLUSIONS

Regarding the recovery of the economy, including logistics, A. Chikán stated: "The development of supply chains actually depends on the growth potential of individual economies and, through it, the global economy, as they are very closely linked to GDP production. If growth starts sooner and runs up a steeper track, it will pull logistics." [5].

The container handling process presented in this article, as well as the rail-road intermodal freight service it serves, as well as the IT improvements needed for efficient application, make it possible to reduce the impact of the epidemic and other extreme situations on the supply chain. In addition, the proposed solution could lead to the

development of a time- and price-competitive intermodal freight transport that can generate more profits. On the other hand very important that the significant reduction in CO_2 related to the road freight traffic can lead to a sustainable freight transport system.

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