

# Intermodal Transport and Road Transport in Poland – Results of the Study

Robert Walasek, Arkadiusz Grodzki

*The University of Humanities and Economics in Lodz, Poland*

The main objective of the text is to try to carry out the analysis with the predominant objective to try and present in realistic way the factors influencing the choice between a service realised only with the use of a road transport and intermodal transport. The author of the analysis put particular stress on the costs of the carriage service, time of its realisation and CO<sub>2</sub> emission. The analysis also aimed at showing which of the presented technologies of service providing is more friendly to natural environment. This is due to the fact that the market for intermodal transport and road transport in Poland, knowledge of the mechanisms of price formation and the costs are still low. It is often difficult to determine the unit price of transport modes or mechanisms of shaping them. This results primarily from difficulties with the calculation of the actual cost of transport, terminal operations, management and other issues occurring in road transport and intermodal logistics functions.

**Keywords:** Management, supply chain, intermodal transport, optimization.

## 1. INTRODUCTION

No organisation of today operates in a vacuum. Dynamic changes taking place in the environment enhance various processes associated with functioning of enterprises (Gregor, Stawiszyński, 2002, p. 59). The formula of technology entrepreneurship is particularly beneficial for small and medium-sized enterprises that have already achieved a certain level of growth and based on modern technologies are planning further market expansion stages (Matejun, 2016, p. 270). Technological evolution is one of the values of post-modernism era, and it creates new challenges for logistic management, and in particular for transport-forwarding-logistics sector, fast developing on the international market.

In the transport-forwarding-logistics sector transport is one of the most import and economical sectors, as well as the basic link in a logistic chain. The European transport market intensely evolved towards liberalisation and effectiveness of access and towards uniforming economic, financial, technical and social relations, intercooperative growth and consistent rules of inner-branch and intra-branch competition. These activities aim

predominantly at increasing competitiveness inside the transport system and increasing transport effectiveness (Liberadzki, Mundur, 2008, p. 238).

Yet, the increase of volume of transport services affects natural environment. Due to that reason, the eco-technological dimension which involves the use of proper transport technologies gains in meaning. Technological development causes a number of negative consequences, but it also creates new possibilities of reducing harmful effects on the natural environment. The awareness of threats connected with transport leads to searching for new and pro-ecological system solutions, which at the same time serve for better use of resources. From this point of view a special attention should be attributed to intermodal transport which within the framework of transporting an integrated load unit connects together various branches of multi-branch transport, using their specific properties and advantages. The core of the process is the integration of inter-branch transport that enables increase of economic and ecological effectiveness, as well as of safety of the realised transport.

The main objective of the study is to try and analyse the effectiveness of intermodal transport in

relation to the transport realised only by means of road freight, taking into consideration the costs of service providing, its time-lines and accessibility as well as contamination of the natural environment with CO<sub>2</sub>. The authors of the study put special stress to the analysis of intermodal transport realised by means of rail and road.

## 2. INTERMODAL RAIL-ROAD TRANSPORT IN POLAND

Its location in Central Europe makes Poland one of the most important transport trails in Europe. Transit routes from Western to Eastern Europe and towards Eastern Asia, as well as the trail from Northern Europe to the Mediterranean area have their crossroads in Poland. Therefore transport has such a great strategic meaning for the county, not only for its development but first of all for lives of its citizens. And thus transport is the basic factor for spatial density, it activates the development of regions and communities (Liberadzki, Mundur, 2008, p. 239). Currently transportation is dominated by its one branch only – the road transport. Its share in the transportation of commodities systematically and consequently increases, and it reaches today around 84% of all on-land transport counted in tones of carriage.

Yet increasing demand for transport of goods

exerts negative influence on the environment. Therefore most European countries divide realisation of transportation of commodities between various transport branches by using so-called intermodal transport. The development of intermodal transport, connecting together and integrating various branches of transport in order to use their best properties, is one of the ways to build the European sustainable transport system (Stokłosa, 2011, p. 5). Due to the above it is important to promote the transportation joining together various branches of transport that are more environmentally friendly, lead to realisation of the idea of sustainable European transport system and offer an alternative to the road transport.

Intermodal transport as such is a system that uses two or more branches of transport (compare Fig. 1) for carrying an intermodal transport unit or an engine vehicle within an integrated logistic chain in „door – to door” system (Stokłosa, 2011, p. 5). Although in economic practice the notion of intermodal transport is often used interchangeably with the notion of multimodal or combined transport, according to the assumptions and terminology developed by the United Nations Economic Commission for Europe, each of the notions is differentiated and defined in a different

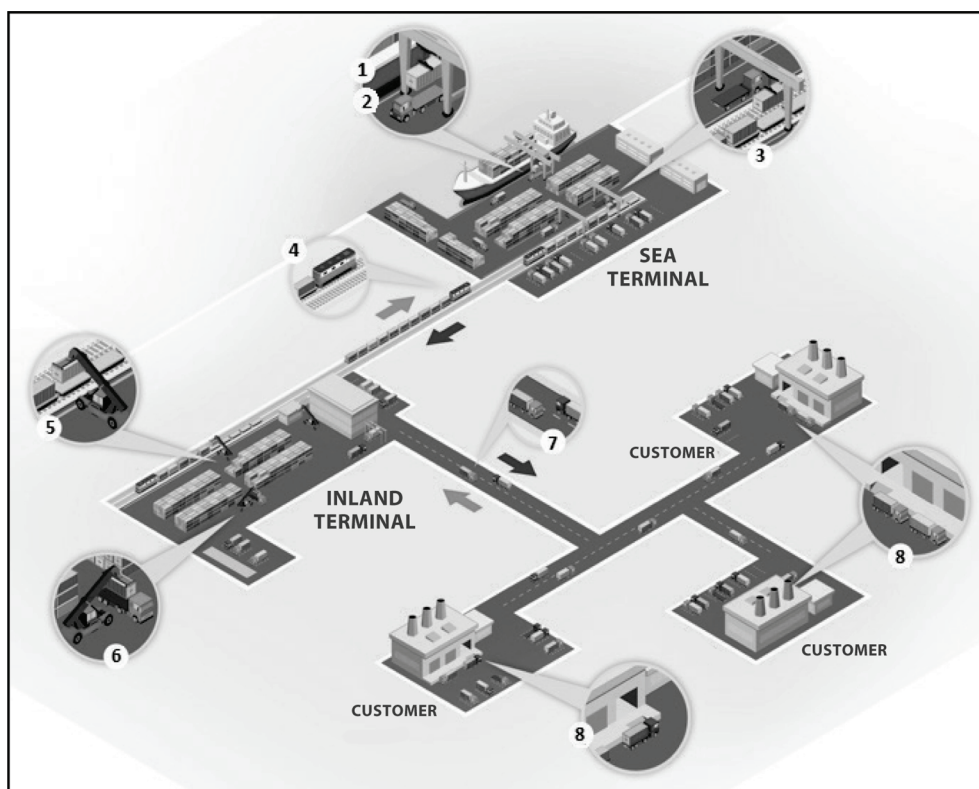


Fig. 1. Scheme of an intermodal transport process.  
Source: (Świeboda, 2015, p. 4837).

way. Intermodal transport is one of the most advanced forms of transportation, in which goods are transported from the point of shipment to the point of delivery with the use of a number of means. The most important advantage of intermodal transport is the use of integrated load units, thanks to which the freight is moved with the use of special transshipment – manipulation devices, without the need to violate the goods inside. In the whole process the main activities are associated with transporting the freight by different means of transport, operations of loading, transshipment, unloading and storage in terminals or sea harbours.

The choice of proper technology of a transport process depends to a large extent on aptness of a given freight to a specific transport, which results from its physical-chemical properties or the form it has been given. The type and the form of the load have a decisive influence on the choice of appropriate technical means. The carried load should reach the client in a given time and in untouched quality and quantity. Due to the above load unitization has the most profound significance in intermodal transport. The unitization in this

transport. Swaps and semitrailers are less common. The main reasons for this situation in Poland are high costs of purchase of appropriate wagons, as well as the fact that only a few percent of the used semitrailers have a properly strengthened construction enabling vertical transshipment and an indentation needed for clamps. Lack of proper equipment of transshipment terminals for Modalohr system is an additional limitation (high financial expenditures on rebuilding of the existing terminals).

In Poland, like in the rest of Europe, intermodal transport is realised to a large extent with the use of railway-road transportation (compare Fig..2). The core of railway-road transportation lies in the fact that the main section of car transport (by a truck, a tractor with semitrailer, a semitrailer or a swap-body) together with the load uses the transport service of railway (Nejder, 2008, p. 118). Joining together the road transport and railway transport in one transit process enables benefiting from advantages of both the branches, with a simultaneous elimination or reduction of their negative features.

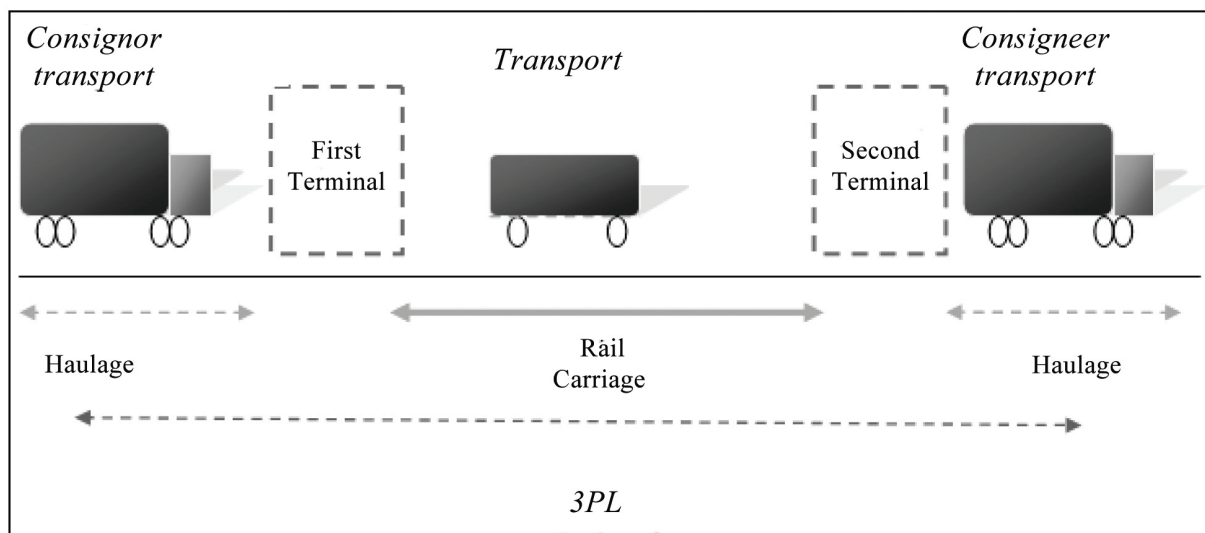


Fig. 2. Scheme of the railway – road transport

Source: J. Stokłosa, op. cit., p.12.

case means setting of a specific amount of the load in one entity with the use of proper auxiliary means or transport devices and then carrying it in intermodal load units (UTI). The load units are dealt with by transport devices together with transport means. Road carriage of replaceable trailers is realised by car transport, whereas the railway transport is realised on wagons-platforms or container wagons. In practice containers are used most often for carriage of loads in intermodal

Intermodal road-railway transport in Poland (if chosen for realisation of a given transportation) is most often selected from the point of view of development of transport branches. Dropping-delivery transport realised with the use of road vehicles results from the fact that currently in Poland the network of roads is well developed and guarantees possibilities of fast and direct supply of goods to client. Whereas the profound part of the transportation is realised by railway, which with its

average speed of approx. 26 km/h is still perceived as an ineffective and unattractive means of commodities transport. Still examples from other countries show that railway is able to offer high quality transport services. At present the railway transport of goods is under transformation and becomes more and more often appreciated and more and more often chosen by shippers and speditors. To a large extent the above is caused by economical as well as by environmental factors.

Yet the above clearly shows that in Poland intermodal transport is still considerably uneconomic compared to road transport. Therefore time has to be an important factor in its favour. (compare Fig. 3). In case of railway – road transport proper organisation of transport for load units, distribution and number of terminals as well as the network of railway and road connections are crucial. These factors connected together will enable achieving time advantage over the road transport.

of transportation. According to the scheme during the intermodal transport the cargo is twice transshipped, which causes time losses. A compensation of the lost time should take place during the railway transportation when a train develops higher speed than a car and no stops are required, unlike in case of drivers in road transportation. By additionally improving the transshipment system in terminals, the transportation time can be additionally reduced. Thus intermodal railway-road transport has a chance to achieve time advantage over the road transport when the following conditions are fulfilled: (Krawczyk, 2011, p. 359):

- distance of the route covered by means of railway transport will be properly selected,
- train will reach high speed during transport,
- proper organisation in terminals will enable efficient transshipment,
- transshipment terminals function decently.

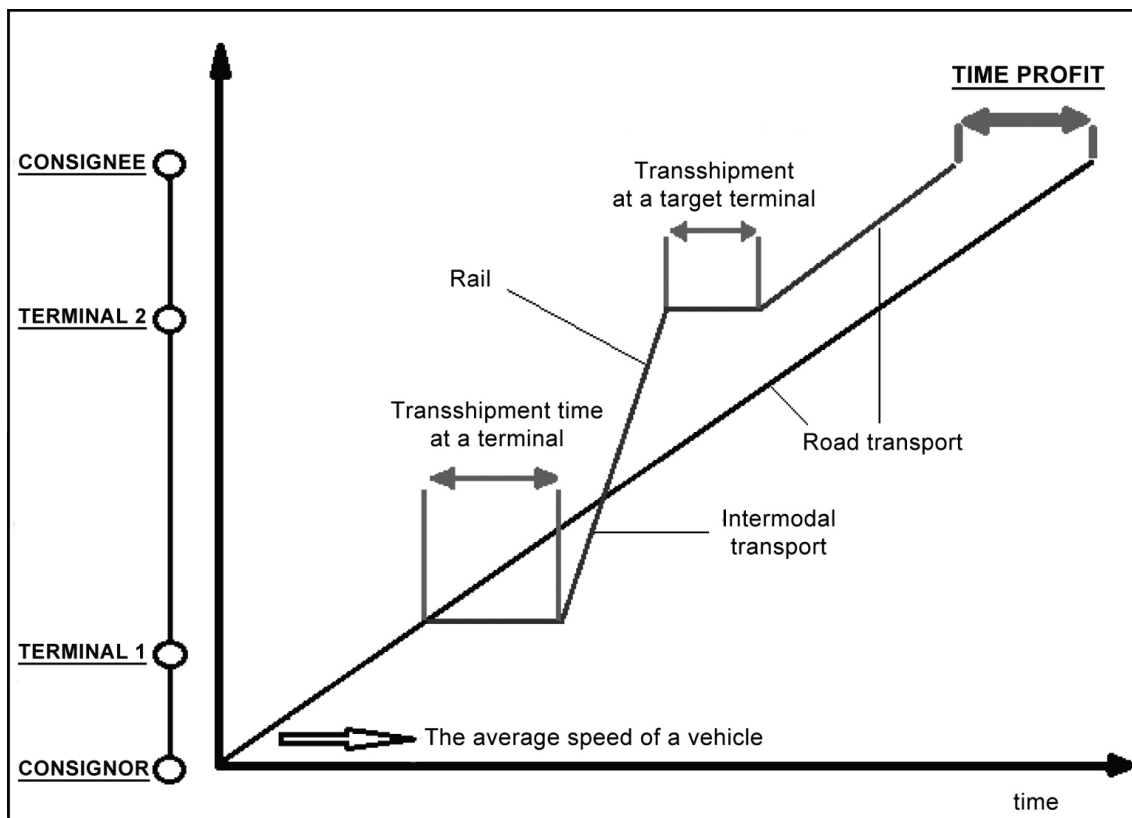


Fig. 3. Comparison of the time of road transport and rail-road transport.

Source: (Krawczyk, 2011, p. 358).

In the system of intermodal transport the task of road transport is limited to delivering the freight from the warehouse to the first terminal and receiving it from the second terminal and transporting directly to the final destination. Railway transport is the main and the longest part

### 3. COMPARISON BETWEEN INTERMODAL AND ROAD TRANSPORT IN AN OVERLAND ROUTE BETWEEN GDAŃSK AND BIELSKO-BIAŁA THROUGH THE TERMINAL IN GLIWICE

Numerous entities are engaged in realisation of intermodal transport chains. The entities include: shippers, carriers, infrastructure managers, terminal operators, intermodal transport operators, etc. Transport activities related to intermodal transport are comprehensive, and each time they are properly adjusted to the needs of the route and the cargo as well as to the clients' requirements. The relation between the cost and price in the intermodal transport system is not transparent enough, additionally there occurs also diversity of tariffs between operators or transport corridors and market segments. The prices associated with intermodal services production are possible to estimate, yet this requires obtaining reliable information and data from the market. Still it has to be noticed that establishing of a realistic price for intermodal and road transport is possible only for selected routes, and forecasting of this type of results should not influence the whole transport market, in the international as well as in the state or regional scale (Gońka, Wiśnicki, 2010, page 1). Therefore it seems reasonable to carry out an analysis with the predominant objective to try and present in realistic way the factors influencing the choice between a service realised only with the use of a road transport and intermodal transport. The authors of the analysis put particular stress on the costs of the carriage service, time of its realisation and CO<sub>2</sub> emission. The analysis also aimed at showing which of the presented technologies of service providing is more friendly to natural environment and at the same time more economic for a potential client from the perspective of realisation time and costs. The choice of sample for the analysis was purposeful. The authors performed the analysis for two operators of intermodal transport: PCC Intermodal and PKP CARGO Connect. Next, the more advantageous results obtained in intermodal transport were set up with the road transport. The analysis included the route of cargo from DCT Gdańsk to Bielsko Biała. The load was carried in a 40' container.

For the transport realised by PCC International it is PCC terminal in Portowa street that serves as transshipment terminal. Whereas the cargo transported by PKP CARGO Connect was

transhipped on the company's own container terminal in Gliwice located in Reymont street. The distance from the station Gdańsk Port Północny to the station Gliwice is 533 km (information obtained from [www.pkpcargo.com](http://www.pkpcargo.com), 2016). Unlike the other operator, PCC Intermodal has no direct connection with the terminal in Gliwice. The connection is realised through an intermediate terminal in Kutno. As a result the distance is slightly longer, and it equals 582 km. The section of the route to the destination from the terminal belonging to PCC Intermodal and the one of PKP CARGO Connect is respectively 97 km and 84 km. The freight is a 40-foot container with inner dimensions of 12,032 mm in length and 2,352 mm in width containing automotive parts placed on Euro-pallettes with the dimensions of 1 200x800x1600 mm. The load unit of 24 tones consists of 25 palletes, with each of them weighting 960 kg gross. The railroad passage of the intermodal train from DCT Gdańsk to Gliwice realised by PKP CARGO connect is possible thanks to using the lines with the respective numbers of: 226, 9, 265, 730, 735, 131, 686, 61, 685, 152, 132, 135, 137, 168, 200.

In the map the railway was marked grey (compare with Fig. 4). The main part of the route is performed on the line 131, which is the longest, two-way electrified trunk line managed by PKP PLK, having the state-wide and European significance, being a part of line C-E 65. The line belongs to the VI European Transport Corridor. The Corridor is a transport line with an international significance assigned to it based on AGC – the European agreement on the main European railways and AGTC – the European agreement on the key railways for the combined transport together with the accompanying facilities. The length of the route from DTC Gdańsk to Bielsko Biała by road transport is 594.5 km. The route passes through the transport corridor VI, which is the most significant for the maritime economy, as it joins together the north and the south of Europe. In the area of Poland this corridor connects the communication line harbours-Silesia (compare Fig. 5). The route by road transport goes via the points: E75/91 – A1/E75 – A2/E30 – DK14 – A1/E75 – E75/1 – E75/1/46 – E75/1 (PTV Map&Guide, 2016). The route was developed in such a way that the time of passage through them fits into a ten-hour prolonged time of a driver's work, and the time of daily work is in accordance with the Law on working time of drivers.



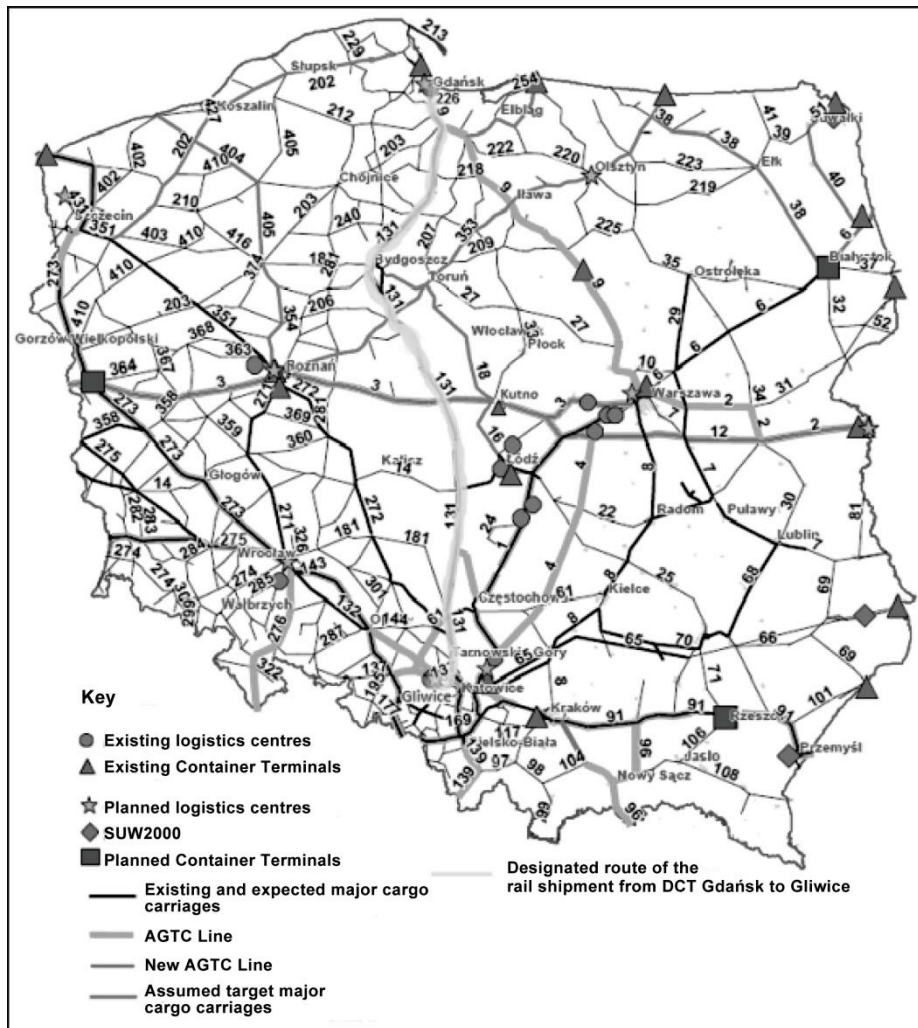


Fig. 4. The route of the railway connection between DCT Gdańsk and Gliwice Terminal.  
 Source: on the basis of [http://siskom.waw.pl/komunikacja/Konferencja\\_Lodz.pdf](http://siskom.waw.pl/komunikacja/Konferencja_Lodz.pdf) [2016]



Fig. 5. The route of the road connection between DCT Gdańsk and Bielsko Biała.  
 Source: the author on the basis of: PTV Map&Guide.

In the analysed example of a 40 feet container transport from the sea container terminal DCT Gdańsk through the on-land terminal in Gliwice to the final recipient in Bielsko Biała the following stages of intermodal transport realisation can be differentiated (Kaczor, 2015, p. 2049):

- **stage I (transhipment):** transhipment of UTI From storage yard DCT Gdańsk to a means of railway transport,
- **stage II (railway transport):** transport of a load unit by rail to an on-land transhipment /transfer terminal in Gliwice,
- **stage III (transhipment 2):** transhipment of a load unit from the railway transport to the road transport, two transfer movements: railway – storage yard, storage yard – lorry,
- **stage IV (road transport):** transport of a load unit by road means of transport to Bielsko Biała,
- **stage V (unloading):** the last stage of the realisation in intermodal transport system – unloading of the load unit.

example the rate for the major transport for PCC Intermodal was 1,150 PLN, while for PKP CARGO Connect the rate was 1,000 PLN, which included two transhipment movements on its own terminal. In practice in Polish container terminals a transhipment of an intermodal load unit is accounted for as two movements: railway-yard, yard-car or the other way round, that is each of the movements by PCC Intermodal performed on its own yard costs 90 PLN, whereas in case of PKP CARGO Connect for each transhipment not included in the railway rate 75 PLN is charged. In charging for handling delivery and carrying away PCC Intermodal uses the rate per kilometre covered in both directions, i.e. for carrying a loaded container as well as an empty one. The rate is 4.5 PLN per kilometre, infrastructure fees not included. In domestic traffic PKP CARGO Connect uses the table of flat rates for the distance of 145 km for carrying away or delivery of a load unit from/to a terminal. In this case the price depends on the container dimensions and the net weight of the carried freight. In the analysed case

Table 1. Comparison between costs, time and CO<sub>2</sub> emission in intermodal transport performed by PCC Intermodal and PKP CARGO Connect on the route Gdańsk – Bielsko Biała.

INTERMODAL TRANSPORT MODEL								
PCC Intermodal					PKP CARGO Connect			
Section	Distance [km]	Time [h]	CO <sub>2</sub> emission [kg]	Cost [PLN]	Distance [km]	Time [h]	CO <sub>2</sub> emission [kg]	Cost [PLN]
DTC Gdańsk – transhipment on the yard /rail	-	0:05	-	154.8*	-	0:10	-	154.8*
DCT – rail – Gliwice (terminal)	582	29	310	1150	533	24	270	1000
Terminal transhipment 2 movements	-	0:10	-	2×90	-	0:10	-	Included in the freight cost
Gliwice – transport to Bielsko Biała	97	1:55	110	2×436.5	84	1:36	95	770
Bielsko Biała - unloading	-	3	-	-	-	3	-	-
<b>Total</b>	<b>679</b>	<b>34:10</b>	<b>420</b>	<b>235.8</b>	<b>617</b>	<b>28:56</b>	<b>365</b>	<b>1924.8</b>

Source: the authors

\* Euro exchange rate Table no 076/A/NBP/2016 of 2016-04-20, 1€ = 4.30 PLN (32€ = 154.8 PLN)

The above analysis performed for the railway transport realised by two different operators indicates that PKP CARGO Connect is more competitive than PCC Intermodal. The level of the total price for intermodal transport depends on the rates for the major transport (in this case the railway freight), transhipment charges and fees for handling delivery and carrying away by means of road transport from/to the terminal. In the analysed

the charges for handling delivery – carrying away of a 40-foot container by road transport were respectively 873 PLN in PCC Intermodal and 770 PLN in PKP CARGO Connect. For PCC Intermodal the transport distance was longer because in the railway transport trains pass through an additional terminal in Kutno, therefore, unlike in the case of PKP CARGO Connect, it is not a direct connection.

In container transport performed with the use of road systems (a tractor unit with a container trailer) carriage of loads is realised directly from the place of shipment to the destination point (*door-to-door*). A mono-modal transport is characterised by a smaller number of indirect operations compared to intermodal transport. Frequently the operations taking place during the whole transport increase the total costs of a transport process. The activities performed during a continuous transport divided into particular stages include:

- **stage I** – transshipment from the storage yard DTC Gdańsk onto an articulated vehicle,
- **stage II** – road transport,
- **stage III** – unloading of the unit in Bielsko Biała.

In order to achieve a clear presentation the results have been set up in Table 2 presenting the successive phases of the process and criteria assumed for the analysis of a load unit transport.

Table 2. Cost, time and CO<sub>2</sub> emission in the road transport of a load unit on the route: Gdańsk – Bielsko Biała.

ROAD TRANSPORT MODEL				
Section	Distance [km]	Time [h]	CO <sub>2</sub> emission [kg]	Cost [PLN]
DCT Gdańsk – transshipment yard/car	-	0:05	-	154.8*
DCT Gdańsk – road transport-Bielsko Biała	594.5	11:20	770	2150**
Bielsko Biała-unloading	-	3	-	-
Total	<b>594,5</b>	<b>14:25</b>	<b>770</b>	<b>2304,8</b>

Source: the authors

\* Euro exchange rate Table no 076/A/NBP/2016 of 2016-04-20, 1€ = 4.30 PLN (32 € = 154.8 PLN)

\*\* Euro exchange rate Table no 076/A/NBP/2016 of 2016-04-20, 1€ = 4.30 PLN (500€ = 2150 PLN)

The road freight from Gdańsk to Bielsko Biała together with transshipment and unloading activities and two breaks for the driver resulting from the driving time prolonged up to 10 hours equals 14 hours and 25 minutes. The shipping rate for the road transport of the freight was established on the basis of the information from the transport company X specializing in transporting integrated load units (containers). The price of a "pure" road transport was 2 150 PLN. This rate is the basic cost in road transport.

Table 3. Comparison between the road and intermodal transport on the route Gdańsk - Bielsko Biała.

TRANSPORT SYSTEM							
Road transport				Intermodal transport			
Distance [km]	Time [h]	CO <sub>2</sub> emission [kg]	Cost [PLN]	Distance [km]	Time [h]	CO <sub>2</sub> emission [kg]	Cost [PLN]
594.5	14:25	770	2304.8	617	28:56	365	1924

Source: the authors

The results of the simulation-comparison calculations for the process of road transport in intermodal transport show that rail-road cargos are competitive compared to road transport. The price difference in the freight from Gdańsk to Bielsko Biała is 380 PLN. Clients who do not insist on a short delivery time will certainly choose intermodal transport, which is cheaper and more pro-ecological. Whereas in *Just in Time* supplies the intermodal system would be *déclassé* by road transport in which delivery time is half shorter. Carbon dioxide emission in intermodal rail-road transport is 53% lower. Therefore it can be stated that the intermodal transport at an average distance for this particular route can be an alternative to the road transport. As any transport system that transport has its pluses and minuses. Intermodal transport could increase its advantage by subjectifying external costs that in the railway transport are mainly incurred by the carrier and in the road transport by the whole society.

#### 4. SUMMARY

A growing number of containerized cargos transhipped by Polish sea harbours, continuous development of container terminals infrastructure and increasing importance of energetic efficiency of particular branches of transport (a system advantage of railway transport) opens new possibilities to the intermodal transport. At the same time the intermodal transport has become more effective and more strongly oriented towards the clients' needs thanks to opening of the market, growing competition, and thus to the emerging variety of offers.

Intermodal transport is the basis of alternative solution in case of limitation of road transport. Yet the realisation of intermodal transport system requires not only a good knowledge of advantages and disadvantages but first of all of a strong integration of a number of means of transport, offering higher quality of services and more



economically effective solutions than the one the road transport offers. It is even more important because intermodal transport should play a significant role in trade services within the country, export and import, in particular in services for increasing quota of containerized cargos in on-land – sea terminals. Intensification of intermodal transport development can be reinforced by the transit location of Poland additionally supported by preferential rates for access to railway infrastructure. Transport development stimulates and is stimulated by the development of world economy and continuously growing international exchange of good. Yet further economical development requires continuous investments in development of transport infrastructure in Poland. Thanks to the European Union funding Poland has a chance to modernise and adjust its transport infrastructure to the EU standards in a considerably short time. Yet transport modernisation should be organised in a sustainable way without giving a privilege of one branch over the others, unlike in case of road transport. In order for the transport to be maximum effective numerous of its branches have to be developed, and intermodal transport is one of the most prospective branches.

The results obtained from the comparison of intermodal and road transport for a given distance enable stating that effectiveness of railway-road transport is influenced by 17 % lower internal costs than the ones of road transport and by lower emission of carbon dioxide above 50%. The companies taking into consideration external factors of transport will choose intermodal transport. Whereas the attractiveness of road transport still lies in its shorter time and the flexibility of provided service.

## REFERENCES

- [1] Gońka M., Wiśnicki B., 2010, Analiza porównawcza kosztów połączenia intermodalnego Niemcy- Włochy, „Logistyka”, No. 3.
- [2] Gregor B., Stawiszyński M., 2002, Marketingowe aspekty wykorzystania Internetu w przedsiębiorstwie turystycznym, [w:] Electronic Commerce. Teoria i zastosowania, edited by. A. Tubielewicz, Politechnika Gdańska, Gdańsk.
- [3] <https://www.pkpcargo.com/pl/strefa-klienta/odleglosci-taryfowe>
- [4] Kaczor G., 2015, Modelowanie i ocena niezawodności systemu transportu intermodalnego. „Logistyka”, No. 3.
- [5] Krawczyk S., 2011, Logistyka. Teoria i praktyka. Vol. I. Difin, Warszawa.
- [6] Liberadzki B., Mundur L., 2008, Zarys polityki transportowej państwa, [in:] Nowe wyzwania – nowe rozwiązania, Conference materials of Polski Kongres Logistyczny „Logistics 2008”, Biblioteka Logistyka, Poznań.
- [7] Matejun M., 2016, Barriers to development of technology entrepreneurship in small and medium enterprises, Research in Logistic and Production, Vol. 6, No. 3.
- [8] Neider J., 2008, Transport międzynarodowy, PWE, Warszawa.
- [9] PTV Map&Guide <http://www.mapandguide.com/en/service/support/pv-mapguide-desktop/2016/>
- [10] Stokłosa J., 2011, Transport intermodalny. Technologia i organizacja. Wydawnictwo Naukowe Wyższej Szkoły Ekonomii i Innowacji w Lublinie, Lublin.
- [11] Świeboda J., 2015, Charakterystyka czynników wpływających na operatorów maszyn w intermodalnym węźle przeładunkowym. „Logistyka”, No 3.

Date submitted: 2016-09-19

Date accepted for publishing: 2016-09-21

---

**Robert Walasek**  
**The University of Humanities and Economics**  
**in Lodz, Poland**  
**rwalasek@ahelodz.pl**

**Arkadiusz Grodzki**  
**The University of Humanities and Economics**  
**in Lodz, Poland**  
**arekgrodzki@interia.pl**

