ANALYSIS OF INTERMODE CONNECTIONS IN TERMS OF TRANSPORT SYSTEM DEVELOPMENT IN POLAND

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Abstract

Continuous and dynamic development of freight transports, especially in the road sector, results in generation of negative effects on the environment and poses hazards to human health and life and by generating high costs it creates significant economic, social and environmental problems. Therefore, it is necessary to take actions aiming at promotion of development of sustainable and efficient transport systems, integrating different transport branches and technologies. Such requirements are fulfilled by the subsystem of inter-mode transport system, that is, combined transport which is an alternative for a traditional road transport, and can also play a very important role in achieving goals of the European policy for sustainable development of transport. Its promotion can largely contribute to solving present and future problems connected with transport in Europe through relieving excessively loaded roads from a certain portion of freight transports which will result in improvement in the traffic safety and reduction of its negative impact on the humans and the environment. Providing high quality of inter-mode transport operation, especially in terms of reliability, punctuality, safety and keeping delivery terms depends on the infrastructure state, modern equipment of terminals and efficiency and effectiveness of their functioning. It should be emphasized that promoting inter-mode transport provides social benefits on a big scale as shifting a part of international road transports into a combined one inter-mode can have a significant influence on reduction of the road transport external harmful effects. In this paper, there has been made an analysis and assessment of inter-mode transports in Poland, taking into consideration the motor and railway (linear and point) infrastructure. Also, a suggestion concerning the location and construction of terminals for the service of inter-mode transports has been considered. Moreover, a technical-economic analysis of implementation of the discussed solution purposefulness has been made as well.

Keywords: *transport system, operation, inter-mode transport, efficiency*

1. Introduction

Transport plays a very important role in the social-economic life of the society. Benefits from transport are measurable, both in terms of macro-economy and from the point of view of an individual user.

However, operation of transport involves negative effects for the natural environment and life of the humans. Transport, apart from industry and power engineering is considered as one of the causes of the environment degradation, along with a growth of such negative external factors such as: air pollution, noise emission, accidents and congestion of roads.

In order to satisfy the constantly growing demand for transport services resulting from the social-economic development it is necessary to take actions for promotion of development of efficient and sustainable transport systems combining all transport branches and technologies. These requirements are fully satisfied by a subsystem of the so called intermodal transport [7].

The goals of the Polish transport development should take into consideration the requirement of transport branches integration into intermodal transport chains so that the transportation system will be sustainable in social, economic and environmental terms.

2. Basic concepts and definitions

Due to the fact that the notions: combined, intermodal and multimodal are too frequently used inter changeably, below, there are presented their definitions according to international terminology which is unified and commonly applied [6].

Multimodal transport: transport of goods by at least two different branches.

Intermodal transport: transport of goods by the same load unit or a vehicle, with a successive use of different transport branches and without reloading the goods in changing transport means.

Intermodal transport in which the main portion of the transport is carried out by railroad, inland navigation or sea transportation and the initial and final sections are covered by road transport as fast as it is possible.

Combined transport – definition of the European Union [1]: Transport of goods between EU member countries where a truck, trailer, articulated trailer with or without a motor train unit, exchange body or a container use a road in its initial and final parts of travel, and over a distance equal to 100km – use railroad, inland water navigation or sea transport, with the initial and final parts of travel performed in the following way:
- within the radius of 150 km from a land cargo terminal,
- within the radius of 100km. from a land cargo terminal,
- within the radius to 100km from an inland water or sea cargo port,
- within the radius of 100km. from inland water or sea cargo port.

The above quoted definitions imply that multimedial transport covers all possible branches and technologies of transport, and goods can change the load units during the transportation process without distance limits for transport forms involved in the subsystem.

In the intermodal transport goods are carried in one and the same load unit, by at least two transport branches, with no distance limits for transport branches involved in this subsystem [9].

The notion of combined transport – in which the main part of the transport between terminals is carried out by railroad, inland water navigation or short distance sea navigation, whereas, the supply and delivery are carried out by road transport, over possibly short distances - it covers real functional relations between different participants of the transport chain.

In the technology of not accompanying transport, only intermodal transport units are carried, and its share in combined transports in Europe is on average approximately 80% by land and even 90% by water – sea.

In the technology of accompanying transport a complete road unit enters a special wagon through a “low floor platform” so it can be referred to as horizontal reloading. At the destination terminal the driver takes over the road unit and continues the travel. The driver can take a rest during the journey and the time of journey by train – according to the EU regulations – is treated as a break which is consistent with the European Agreement AETR on the driver work time and rest.

The above mentioned subsystems of intermodal transport can be applied in two basic chains:

- by land: railway-road, road-inland water or railway-inland water when these are the railway and inland water navigation that perform the main transports whereas road transport carries out supply-delivery operations – to/from land and water terminals.
- water-sea: railway sea transport or road –sea transport, where sea transport in combination with railway carry out the main transports and road transport performs supply-delivery operations to and from sea ports or to/from land terminals.

These chains integrate all transport forms which are involved in the whole transport process through adjusting load and transport technologies to the possibilities of their utilization by the means of transport.

3. Basic transport technologies

In intermodal transport there can be distinguished three basic transport technologies [9]:

- „Piggyback" technology,
- "Rolling Motorways" technology,
- "Biomodal" technology.

The "Piggyback" technology – means carrying intermodal transport and load units on special train cars, the so called 'pocket wagons'

Loading and unloading of saddle trailers, containers or exchange bodies takes place at an intermodal terminal in a vertical manner by means of cranes and self- propelled cargo handling facilities.

Technology "Rolling motorways" means carrying saddle trailers together with trucks (articulated vehicles), trucks with trailers (road units) by train cars of special structure with the so called low floor. Loading and unloading is performed with the use of their own power through entering a head platform fixed to the first train car and riding through all the successive unloaded cars, to the first empty one. Apart from expenditure on low-floor train cars the technology does not require investing in expensive infrastructure (terminals). It is though significantly more expensive than the "Piggyback" technology. This is because one transport means (road unit) is carried by another transport means which involves too heavy gross weight of both transport means in relation to the total mass of the load. Additionally, the road vehicle driver travels together with it in a different train car which also involves costs. Nevertheless, application of this technology is justified for transports over distances where there occur obstacles connected with natural land shape, e.g. the Alps. Combined transports in technology "Ro-La" can be found mainly in Austria and Switzerland thanks to the budget subsidies within government programs supporting the combined transport.

Bimodal technology – is carrying a special bimodal semi-trailer by car and train t without reloading its content. It is adjusted to being moved on rails with the use of special carts. For this purpose, the trailers are additionally equipped with a special catch to be fixed to the carts. In this way, this special trailer carried by car to a terminal, after having lifted its wheels and being set on the cart, becomes a train car, included in the usual rake of a freight train. The operations of the trailer lifting and setting do not require a crane (servomotors being part of the trailer equipment are employed to perform the operation) and they are operated by the driver.

4. Analysis of intermodal transport in Poland

On the Polish freight transport market there have been noted significant changes in the years 1995-2006, which include:

- increase in the road transport share (in tkm) from 42.2 to 71.3%,
- decrease in the share of rail transport (in tkm) from 56.9 to 28.0%.

This means that the share of road transport in the Polish transport market is higher than its share in the market of freight transport in the European Union countries which was at the level of 44.2% in 2005, with the share of train transport at the level of 10.0%.

Below, there has been shown a presentation of the amount of transport work performed on the Polish market [4].

Tab 1. Amount of transport work performed on the Polish market

	1995	**2000**	**2002**	**2004**	**2006**
Road transport	51200	75023	80318	110481	136490
Railway Transport	69116	54448	47756	52232	53623
IntermodalTransport	612	925	931	939	1334

In Poland Intermodal transports have not exceeded 2% of the whole mass of loads transported by train since the beginning of the 90s. It should be stressed that in the countries of western Europe the share of intermodal transports in train freight transportation, in 2005, was at the level of 15% on average, and according to predictions this share will rise to 40% in 2020. Moreover, intermodal transports over the distance of 18 transport routes in Europe will reach the quantity of 115 million TEU in 2015, that is, twice more than in 2000 [5].

Generally, there can be distinguished two basic intermodal terminals in Poland: land, that is, railway- road and sea- land ones. At the end of 2006 there were 21 terminals in use, including the so called container points. Taking into consideration heir character, their location and access to train networks under the AGTC agreement, the following main nodes of intermodal terminals can be distinguished [9]:

a) two sea-land transport nodes (including terminals located in sea ports),
- Gdansk/ Gdynia (Access to line C-E 65),
- Świnoujście/ Szczecin (Access toC-E 59),

b) Warsaw node, including 3 terminals; located in Warsaw and Pruszków – all with access to line C-E20,
c) Poznan node, including 3 terminals: 1 in Poznan, 1 in Gądki and 1 w Kobylnica – all with access to line C-E 20,
d) Małaszewicze border node with a terminal located in w Małaszewicze – access to line C-E 20,
e) Southern node: including 3 main terminals: Gliwice Kontenerowa, Sławków and Krakow Krzesławice – with access to do 3 lines AGTC: C-E 59; C-E 65 i C-E 30).

5. Optimization of solutions for combined train- car connections

In order to improve the transport situation in Poland it is necessary to boost competitiveness of transport means which are alternative for the rod transport. This means railway should carry as much loads as possible as this form of transport is not as harmful for the environment and people as the road transport.

The main reasons for optimization of train – car connections are as follows:

- one 40 ton truck damaged the road surface as much as 163 840 passenger cars (with the assumption that the weight of one car is one ton),
- in 2004 trucks caused 4.349 accidents that is 12 accidents every day,
- for transport of the same cargo by train, 9 times less energy is used than by car,
- relieving roads which are not adjusted to the increasing transport of loads.

In this study, optimization of the transport process was made on the example of the route Rzepin-Małaszewicze. This choice was made due to the fact that this route connects the west with the east of Poland. Whereas, the so called system of "Rolling motorways" was chosen as the optimal technology enabling to carry the whole road unit that is saddle trailer + an articulated trailer.

The course of loading according to this technology is as follows:
- train enters the terminal,
- after the rake of train is stopped a ramp is placed at the head of the last train car,
- vehicles ride through the ramp and they move along the rake (movable road),
- after reaching the desired position the truck with its trailer are blocked on the wagon,
- the whole operation finishes at the moment of the last road block entrance on the wagon, its blockage and removing the ramp,
- unloading takes place in the reverse direction after detaching the locomotive from the ramp.

Advantages of the system:
- fast loading and unloading under the traction network,
- no special requirements as for the equipment of terminals – only a drive-in ramp,
- as the truck with its trailer is carried on the wagon it is possible to continue the load transport right after unloading it.

Disadvantages of the system:
- special wagons are needed with wheel small diameters of wheels which limits the stress of the axel to 7.7tones and speed Vmax to 120km/h,
- rims of wheel with small diameters wears faster,
- limited pressure of the block on the rails involves an increasing the number of axels on the wagon,
- no possibility to unload o given unit (unload must be consistent with the load order).

The course of railway router from Rzepin to Małaszewicze has been presented in the Fig. 1:

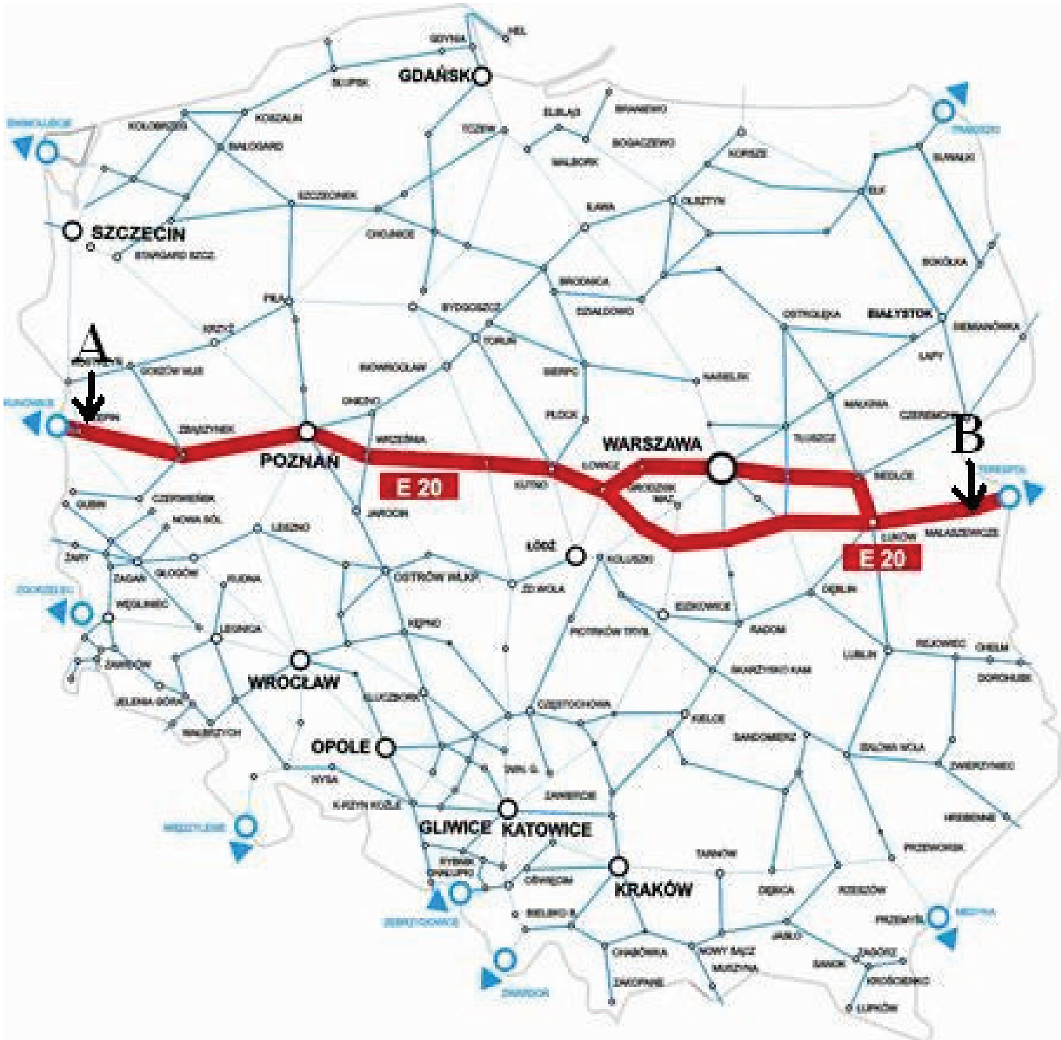

Fig. 1. The railway route from Rzepin A –Małaszewicze B

Whereas, the course of road route from Rzepin to Małaszewicze has been presented in Fig. 2.

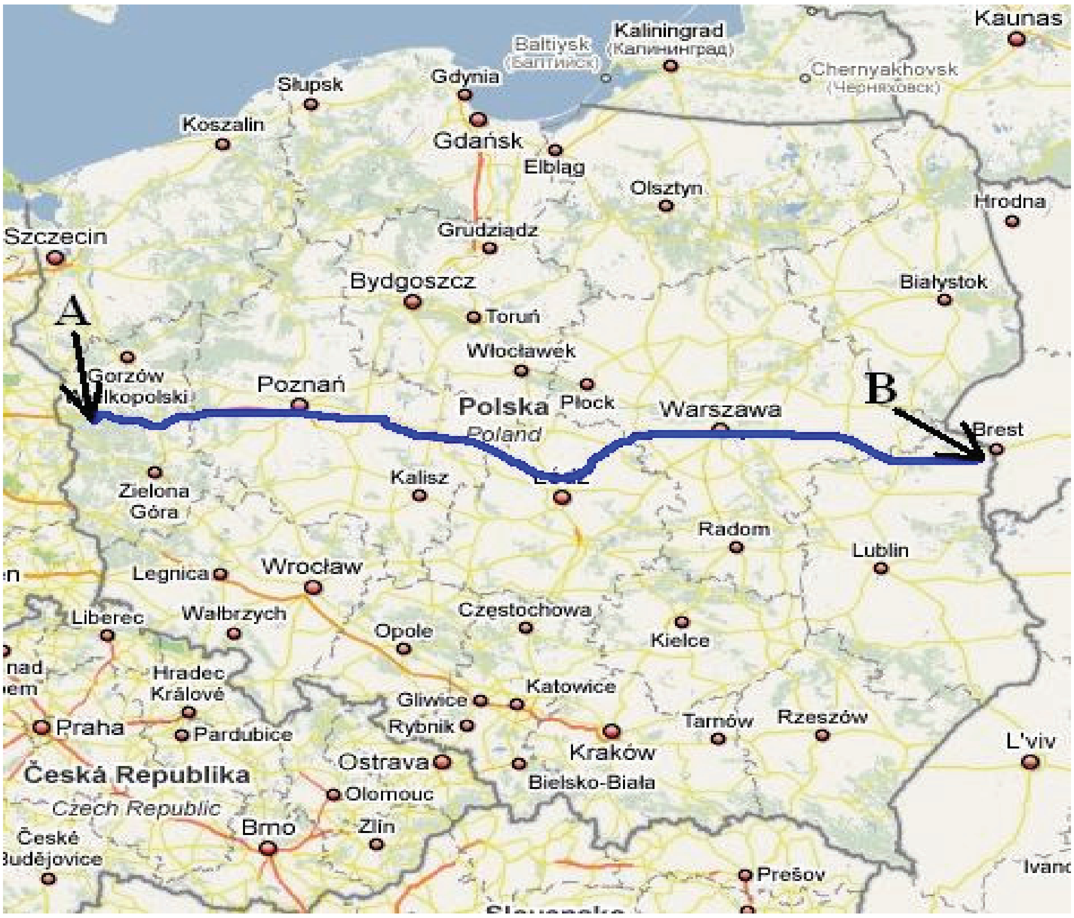

Fig. 2. Road route between Rzepin (A) – Małaszewicze(B)

Table 2 shows a comparison of selected parameters for road and railway transports.

Tab. 2. Parameters of transport connection from Rzepin to Małaszewicze

	Railway	Road
Distance	700 km	664 km
Time of travel	12 h	23 h*
Economic speed	60 km/h	60km/h

**- considering the driver's working time*

Characteristics of the transport process of big trucks on low-floor train cars between Rzepin and Małaszewicze:

a) expected effects:
- improvement in the road traffic safety; transfer of some portion of road transport onto railway transport will have measurable effects for relieving road traffic in Poland, which will have a positive impact on its safety,
- reduction of load transport time. As it is commonly known, carrying loads is connected with frequent stops caused by e.g. the driver's rest time, whereas on the train the driver takes a rest in a specially prepared wagon called "sleeping car",
- provision of the transport continuity. In railway transportation a system of direct trains can be applied which involves systematic transport of loads,

b) obligatory breaks in road transportation:

- rest time for drivers, according to AETR agreement (European agreement which regulates work time of drivers of international road connections),
- during 24 hours,
- during weekends,
- during heats,

c) basic conditions necessary to achieve a success:

- choice and development of a proper technology; the example of such a technology can be the discussed “Rolling motorways” technology,
- efficient organization of transports; undoubtedly the loading and unloading of road blocks in the “Ro-La” technology is characterized by efficiency as trucks drive onto the train cars by means of mobile ramps without using other cargo handling facilities,
- assurance of finances; countries of western Europe are a good example of how to finance this kind of transport, these include: Germany, Holland, etc.; in these countries the government supports to implement intermodal transport by subsiding investments of terminals, granting loans with no interest,

d) organization of transports:

- one pair of trains for twenty for hours,
- composition of the rake of traim: 20 low-floor wagons + 1 sleeping car (for the driver),
- loading/unloading of trucks on wagons by means of mobile ramps,

e) investments:

- 40 (+ the reserve) of low-floor wagons,
- hardening the ground,
- mobile ramps,
- administrative support.

Tab. 2. Approximate components of transport costs on the route from Rzepin to Małaszewicze [2]

Road transport (20 wozokm)	Railway transport (1 railwaykm 20 car)
Fuel	Access to infrastructure
Maintenance services	Locomotive with service staff
Wear of tires	Energy and fuel
Transport fees	Loading
Others	Rent of train cars
Sleeping car with service staff	
Total 38.00	**Total 58.00**

Estimation of external costs of 20 road units (source: elaborated according to the Institute of Politics and Economic Research):

a) transport on the road: 0.155 pln / tkm x 30 ton x 20 = 93 pln/km,
b) transport by train: 0.032 pln / tkm x 30 ton x 20 = 19.2 pln/km,

Comparison of total costs(pln/km) - external costs + transport costs = total costs:

a) road transport = 93 pln/km+ 38 pln/km = 131 pln/km,
b) railway transport = 19 pln/km+ 58 pln/km = 77 pln/km.

In order to perform efficient transports with the use of the technology it is necessary:

- build new and extend the already existing terminals for intermodal transport,
- btain new means from the EU – Marco PoloII Project,
- estimate actual costs and profits connected with the development of infrastructure in Poland.

6. Conclusion

In the work, a project of transport optimization on the route Rzepin-Małaszewice has been presented. The assumption of this project is to show reasons for development of sustainable transports of loads, choice of a proper transport technology by railroad and presentation of advantages of the combined transport.

In Poland, there are favourable conditions for intermodal transport development, both as regards domestic and international transports – and whether the development is to be well planned and organized or chaotic and spontaneous will largely depend on the state transport policy and willingness of the interested parts to cooperate.

If the transportation system in Poland is to develop according to the rules of sustainable development and migration, it is necessary to eliminate the existing barriers and introduce complex measures promoting intermodal transport in Poland.

Creation of complex and coherent packets, including organizational, legal, administrative and financial instruments, promoting development of intermodal transport in Poland is advisable and fully justified.

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