ANALYSIS OF SOCIO-TECHNOLOGICAL CONDITIONS FOR THE DEVELOPMENT OF INTERMODAL TRANSPORT IN THE CROSS-BORDER AREA

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Abstract

The article attempts to identify and assess socio-technological conditions for the development of intermodal transport in the cross-border areas of the Silesia and Opole province. The research presented in the article is based on expert judgment and is a fragment of broader research aimed at developing a strategy for the development of freight transport in the field of international research project implemented in territorial cooperation of three countries: the Czech Republic, Poland and Slovakia with the participation of the European Grouping of Territorial Cooperation TRITIA, established to improve cross-border, transnational and interregional cooperation between its members.

Keywords: PEST analysis, socio-technological conditions, TRANS TRITIA

1. INTRODUCTION

One of the important activities of increasing the competitiveness of regions is undoubtedly the process of creating high-quality transport links as part of their development. However, this process can not only concern the development of the line infrastructure of various transport branches, the activities in this area should also concern the implementation of integrated solutions for intermodal transport. However, the participation of intermodal transport in Poland is too low compared to the potential it has. Research carried out by the authors, regarding the assessment of the potential of cross-border areas in the Silesia and Opole province, based on reports, CSO data, expert opinions and a developed synthetic indicator of potential assessment, based on the taxonomic extent of development, allowed to determine that the region with the greatest potential for the development of intermodal transport is the Silesia province (in the area of point and linear infrastructure of road and railway transport) and the Opole province (in the field of inland waterway transport). Therefore, the further development and development of both point and line infrastructure have the crucial meaning for the growth of intermodal transport, which should also be a priority in determining transport development documents at local, regional, national and international levels, including project implementation. The article presents a part of research concerning the determination of socio-technological conditions for the development of intermodal transport as part of the TRANS TRITIA project, carried out in three countries and four regions: The Moravian-Silesian Region, the Opole Voivodeship, the Silesian Voivodeship and the Žilina Region. The territory of TRITIA is 34069 km^2 and over 7.8 million inhabitants. The project area includes important roads and transport corridors, including road No. 58, E75 and E462 (European corridors) and the Baltic-Adriatic corridor. The aim of the project is to improve planning and coordination between regional authorities, transport managers and freight transport operators. The project focuses on cross-border, transnational and interregional cooperation to strengthen economic and social cohesion in order to achieve the goals set in the Europe 2020 Strategy or the EU White Paper on Transport.

2. THE RESEARCH CONCEPT OF INTERMODAL TRANSPORT DEVELOPMENT IN TRITIA AREA

Intermodal transport is indicated as one of the key factors in the sustainable development of both supply chains and regions. Intermodal transportation refers to multimodal chains or networks involving at least two transportation modes, freight being packed into a “container” and not being handled at intermodal-transfer terminals on its trip from its origin to its destination. This characterization makes intermodal transportation a

multi-actor complex system involving a broad range of interacting stakeholders, decision makers, operations, and planning activities [1]. The only legal instrument at EU level to directly encourage the shift from road to transport with lower emission levels, such as inland waterway, sea and rail, is Directive 92/106 / EEC 6 (Combined Transport Directive). Its aim is to increase the competitiveness of cross-border intermodal transport compared to road freight transport.

The use of other transport modes than truck for long haul freight transport can therefore contribute to more energy efficient transportation systems. As a result, the successful promotion of intermodal transport, using rail or sea on the long haul part, has been identified as the most critical action to achieve a sustainable transport sector [2].

The effects of using intermodal transport can be divided into three groups: economic, ecological and social. The economic effects consist mainly in reducing operating costs (fuel, drivers' working time), longer truck life, reducing road charges (motorways, tunnels, etc.), and less road use. Ecological effects consist in limiting environmental pollution by reducing exhaust emissions, reducing noise, in particular reducing the external costs of transport. Social effects concern the increase of road safety.

However, uneven development of intermodal transport can be noticed between countries and regions in some countries. This trend is particularly noticeable in cross-border regions. In these regions, different conditions of each country are encountered. An unevenly developed intermodal network in some regions of the country, causes bottlenecks and delays in freight transport. Such a phenomenon is observed in the region of Silesia-Žilina-Moravia (Śląskie Voivodeship, Opole Voivodeship, Moravian-Silesian Region, Local Government Žilina) at the intersection of three countries: Poland, the Czech Republic and Slovakia. The solution of the bottlenecks problem in the development of freight transport in the cross-border area is the main goal of the international TRANS TRITIA project implemented since 2017. One of the initial stages of the development of the freight transport strategy in the cross-border area is the PEST analysis. The author of the PEST analysis is F. Aguilar (1967). The PEST analysis, otherwise called the general segmentation of the environment, defines the basic spheres of the environment, i.e. areas that have a key impact on the functioning of the organization. It also sets the future strategy for the organization's operation by identifying and assessing factors: Political, Economic, Social, Technological. The PEST analysis has been aptly named a typical bird's eye view of the business, political and social landscape in which the organization operates. [3]. The article focuses on the identification and assessment of two groups of factors: social and technological.

Social factors are a set of barriers that must be overcome in order to develop intermodal transport. In general, the public is aware of the harmful impact of road transport on the environment. External transport costs, however, are often identified with passenger transport. The challenge is therefore to promote solutions for freight transport. If in the PEST analysis no groups of environmental factors have been identified, they are included in the social group. Social factors are included in the assessment of the region's attractiveness for the development of freight transport.

Technological factors set the standards for the implementation of transport tasks. Transport capacity, meeting quality standards, innovation and distribution in the transport network determine the reliability of freight flows. Technological factors determine both the intermodal maturity of the region and the attractiveness of the region for the development of freight transport.

Research on social and technological factors was carried out in accordance with the PEST methodology:

1. First stage - Collection of factors related to individual segments of the environment (social and technological)
2. Second stage - Identification of key factors in the social environment and in the technological environment
3. Third stage - Determining the impact of each factor on the development of freight transport in the cross-border area

4. Fourth stage - Determining the relationship between the development of freight transport in the cross-border area and social and technological factors

The analysis of social and technological factors has been limited to the Polish regions of the TRITIA area. The intermodal transport market in Poland is a young market that is characterized by low but constant development. Currently, in terms of the weight of cargo transported by intermodal transport, Poland ranks eleventh among the EU countries. The potential for developing this type of transport in Poland is significant; the more so because the European Union aims to gradually replace road transport - by sea and rail transport.

3. IDENTIFICATION OF PRIORITY SOCIAL AND TECHNOLOGICAL FACTORS FOR THE DEVELOPMENT OF INTERMODAL TRANSPORT IN THE TRITIA AREA

As a result of the conducted analyzes, the factors adopted as a base for further work were identified. They were identified on the basis of an in-depth analysis of the scientific literature, a series of reports and studies on the state of intermodal transport and interviews with industry representatives. The indicated factors have been subject to expert assessment in order to identify those that are priorities for the development of intermodal transport. Each factor was assessed on a scale of 1 to 10, where the higher the rating, the higher the priority of a given factor (the sum of the ratings awarded to all factors was 100 points). The list of factors together with their assessment is presented in **Tables 1 and 2**.

Table 1 Social conditions - analyzed factors [own study]

No.	Factor	Rank	No.	Factor	Rank
1	Social external costs of transport	10	9	The progress of civilization	6.5
2	Society ecological awareness	8.5	10	The level of social mobility	6.5
3	Social sensitivity and activities in the field of freight transport	8	11	Customer requirements and expectations	5
4	Differentiation of the geographical environment	8.5	12	The level of motorization of the society	4.5
5	Natural hazards (floods, mining damage, landslides)	8	13	Traditions and customs (including shopping)	5
6	Demographic indicators	7	14	Health awareness	6
7	The level of science and education	5.5	15	Lifestyle	3.5
8	The level of income of the society	4.5	16	Point of view (opinions) of the media	3

Table 2 Technological conditions - analyzed factors [own study]

No.	Factor	Rank	No.	Factor	Rank
1	Eco-innovation in freight transport	7.5	9	The innovative potential of the region	5.5
2	The development of modern interbranch reloading systems	9.5	10	The rate at which new products are introduced (shortening of product life cycles)	4
3	Development of information technology and ITS	9.5	11	Level of development of line infrastructure	5.5
4	Permissible and commercial speeds on railways	7.5	12	Level of point infrastructure development	5.5
5	Knowledge transfer (including technology)	7	13	Automation and robotization	4.5
6	The level of cooperation between enterprises and R & D units	7	14	The development of means of transport	5
7	Standardization and compliance with quality standards	7.5	15	The existing level of freight transport development	5
8	Level of expenditure on R&D	5	16	Economy servicizing	4.5

A group of factors creating social and technological conditions for the development of intermodal transport in the examined cross-border area were adopted for further analyzes, the evaluation of which was at least 7. They were considered as priority conditions (in the tables marked with shaded area).

Among the social conditions, the social external costs of transport were singled out first. They represent effects felt by a third party that is not a direct participant in the transaction. The effects of transport activities can have both positive and negative effects. However, much attention has recently been focused on the latter category. It includes: costs due to congestion, accidents, air pollution, water, soil, climate change, noise, land occupancy. The external costs of transport activity are strongly dependent on parameters such as location, time of day or branch of transport [4]. Hence, such a high significance of this parameter seems to be fully justified among the social conditions under consideration. Another parameter - environmental awareness of the society includes knowledge of the pro-ecological approach to the carried out activities. It manifests itself mainly in the level of ecological education and the perception of the connection between one's own everyday behavior and the quality of the environment. The level of public awareness about freight transport and its impact on generating negative effects on the environment and society is particularly stressed in this parameter. This factor is strongly related to the sensitivity and social activity in the field of freight transport and its external transport costs (another factor under investigation). The assessment of this factor takes into account public participation in campaigns devoted to the issue of the impact of transport on the environment or the change in social behavior as a result of pro-ecological initiatives. The next two factors representing social conditions concern the same group of factors of a geographical nature. The first of them (diversification of the geographical environment) concerns the geographical landscape of the region, land relief, forms of land use, defragmentation of space and the level of urbanization. It also includes the occurrence of naturally protected areas, which have a decisive influence on the created linear transport infrastructure. The second factor addresses the problem of various natural hazards. In the region under consideration, particular attention was paid to anthropogenic surface degradation as a result of mining activities, eg mining damages on roads, depressions and deformations of the area (Śląskie Voivodship) and potential floods (mainly Opole voivodships). The factor also includes potential threats related to the climate, however, no significant problems have been identified in this respect. The last factor from the group of social determinants are demographic factors. In their area, the development of transport is primarily influenced by the recorded decline in population, the aging population and related staff shortages, the level of migration and the growing concentration of population in agglomerations.

Among the technological conditions, the greatest importance was attributed to two factors. The first is the development of modern inter-branch reloading systems. It is told here about various forms of transhipments carried out between individual transport branches with the use of all intermodal loading units (containers, swap bodies, car semi-trailers): ro-ro (horizontal trans-shipment), lo-lo (vertical trans-shipment), Ro-La (reloading of entire road vehicles). A lot of attention has recently been focused on very modern horizontal technologies (eg CargoBeamer, Modalohr, Mega Swing), which are perceived as a significant driving force for the development of intermodal road-rail transport in Europe [5]. The second factor with the same weight is the development of IT technologies and solutions within intelligent transport systems (ITS). It should be emphasized that this factor applies to the aforementioned solutions implemented in all modes of transport; this is particularly important due to the fact that currently the highest level is recorded in road transport. The third factor of technological conditions is the development of eco-innovation. The definition of eco-innovation in literature is recognized in a variety of ways, including: "eco-innovation", "sustainable innovation", "eco-friendly innovations". They are designed to reduce the use of non-renewable resources, reduce the emission of harmful substances into the environment [6]. Eco-innovations are also strongly connected with transport, where much attention is paid to the possibilities of developing alternative sources of propulsion, implementation of engines with lower emission of pollutants or the use of modern means of transport with reduced fuel consumption and ecological driving mode. Another factor is the permissible and commercial speeds on the railway roads, which form the basis for the development of rail transport. This factor is in line with the adopted guidelines related to the development of rail freight transport and the need to increase the speed of freight trains on AGC / AGCT lines. An important

aspect is also commercial speed, which is the result of both the speed allowed on a given line and train stops during a transport task. Due to the development of intermodal transport, an important factor is also standardization and compliance with accepted standards. Standardization primarily concerns cargo units used in transport and significantly improves the implementation of transport processes. In addition, it can be reflected in road classes of various modes of transport. The last factors are the transfer of knowledge, including technology and the level of cooperation between enterprises and R & D units. They are relatively important mainly due to their impact on generating and adapting innovations that give great opportunities for the development of intermodal freight transport.

The priority social and technological conditions identified and explained above were evaluated in terms of strength and direction of their impact on the development of intermodal transport in the analyzed cross-border area. For the strength of influence, three gradual scores were adopted: 1 - low impact force, 2 - medium impact force, 3 - high impact force; for the direction of impact, the scale was two-tier - negative impact, positive impact. In the last stage, a weighted evaluation of the mentioned parameters was made - the results are shown in **Figure 1**.

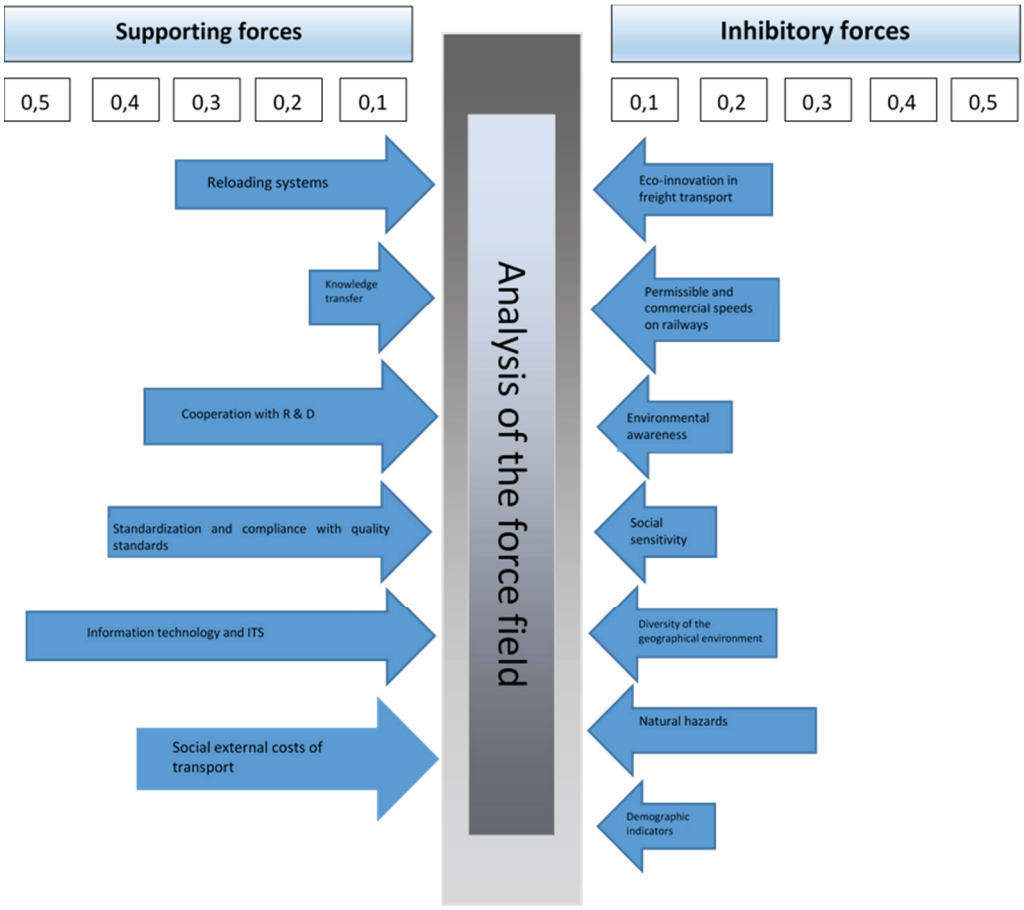

Figure 1 Analysis of the force field [own preparation]

Among the factors that can be described as strong determinants of the development of intermodal freight transport, we can distinguish primarily factors related to the development of ICT and solutions within intelligent transport systems (ITS), as well as factors related to the standardization and normalization of both cargo units and selected elements point and line infrastructure. This group also includes factors related to the social external costs of transport, which constitute approximately 29 % of the costs of the negative impact of transport on the environment, and the remaining 71 % of external costs are human and material effects of transport

accidents [7]. It should be emphasized that in Poland the biggest environmental problems are created by the large scale of the activity of broadly understood road transport [7]. Therefore, this factor can be considered as a stimulant for the development and wider use of intermodal transport. In turn, the factors that suppress the development of intermodal transport are the factors related to natural hazards related to land surface degradation as a result of mining activities (Śląskie Voivodeship) and potential floods (mainly Opole voivodeships). Also the admissible and commercial speeds on railway roads, which significantly hinder the decision to use rail transport, are also a big problem.

A change in this state of affairs requires intensification of activities on the part of various stakeholder groups, including a special role in the actions of the authorities that are responsible for the creation of transport policy [8].

4. CONCLUSION

The research carried out by the Authors in the first place concerned the distinction of factors concerning social and technological segments of the environment. Next, the authors identified these factors, which are characterized by the greatest impact on the development of intermodal freight transport in the cross-border areas of the Silesia and Opole province. These studies have identified the factors that have the lowest and highest impact on the development of intermodal freight transport.

To sum up, analyzing socio-technological factors for the development of intermodal transport in the cross-border areas of the Silesia and Opole province confirms the necessity to undertake broader research, including those that will allow for the identification the technological and social benefits of intermodal transport.

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