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TRANSPORT INFRASTRUCTURE AS A DETERMINANT OF OVERSIZED CARGO TRANSPORTATION

A b s t r a c t: Nowadays, the demand for transport of this type of cargo is very often reported on the transport services market. When executing such orders, in addition to experience and professionalism, infrastructure is also an important aspect in the use of high-class specialized equipment dedicated to the transport of unusual cargoes. The aim of the article is to present limitations resulting from the existing infrastructure, which are encountered by carriers of oversized cargo in road and rail transport. The research method used by the author in the work is based on the analysis of the existing literature.

K e y w o r d s: transport, transport infrastructure, oversized cargo transportation

J E L C o d e s: L91; R41

INTRODUCTION

Transport plays a fundamental role in economic life. The development of transportation affectsbringing markets together and activates economic infrastructure. The main task of transport is to deliver cargo at the right time, at an acceptable cost and in good condition. In addition to the transport of daily consumer goods, one can distinguish oversized loads that require special fleet or special conditions when being transported.However, any transport of oversize cargo is a major challenge for transport companies, which must have the appropriate knowledge and means to carry it out.

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1. GENERAL CHARACTERISTICS OF OVERSIZED CARGO

Non-normative cargo is a cargo which, due to its properties: weight, external dimensions and a form of delivery is unsuitable for transport by standard means of transport. Oversized loads are also called dimensions or non-normative [Chrostowa-Dobrowolska, 2011, p. 468]. Pursuant to the Act of 20 June 1997 on Road Traffic, a non-normative vehicle is a vehicle or combination of vehicles whose axle loads together with or without cargo exceeds permissible limits provided for a given road in public road regulations, or whose dimensions or the actual total weight, with or without the load, are greater than the permissible, provided for in the provisions of the Act [The Act on Road Traffic of 20 June 1997].

Special transportation means have the load-bearing capacity, dimensions, marking and construction (or one of these elements) different from standard means, and the handling equipment must have a capacity corresponding to the mass of the oversized load [Neider, 2015, p. 161].

In road transport, vehicles or road sets are used for transporting loads. It can be a vehicle with a trailer or a tractor with a trailer. As far as the vehicle's dimensions are concerned, there are numerous restrictions that cause that when we cross them, we deal with other conditions. The permissible weight of a loaded road set is regulated by law provisions of individual countries. According to Polish regulations, the total weight of lorries should not be more than 42 tons, assuming the pressure on individual axles does not exceed 10 tons. Exceeding the permitted mass of the transported road set or permissible external dimensions by up to 1 cm results in the fact that the transport is considered as oversized [Szymonik, 2014, p. 110].

A vehicle is defined as oversized when the transported load exceeds the following values:

a) the vehicle height is over 4 meters,

b) the vehicle width is more than 2.6 meters,

c) thetotal weight, i.e. the vehicle with the load, is more than 42 t,

d) the overall length of the set together with the trailer is over 18.5 m [Grzybowska, 2009, p. 226].

Considering the weight, shape and dimensions, the following cargoes can be distinguished:

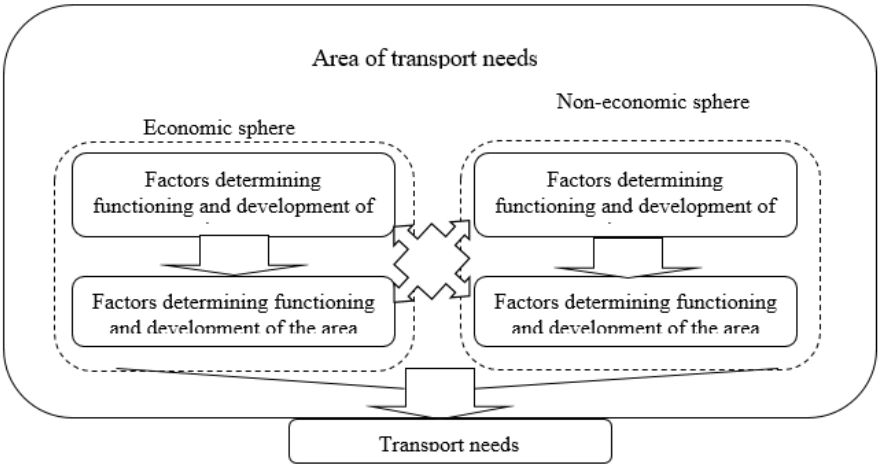
– *oversizedordinary*, i.e. various types of steel structures, small machines and industrial equipment including working machines, small tanks, and many more. Theirweight is up to 25 tons, while the dimensions slightly exceed the permissible parameters for rail and road transport, i.e. 15-16 m, the width of 3.5-4 m and the height of 3.0-3.5 m. These types of loads can be transported by standard road sets (a tractor with a semi-trailer without tarpaulin) and wagons with appropriate safeguards and marking;

- *oversized special* - characterized by relatively large dimensions and at the same time a relatively small mass, due to which there is no negative impact on the rail or road infrastructure, howeverthere may be substantial restrictions on their parameters. The dimensions of those cargoes can reach up to 5 m in length, 6-7 m in height, 7 m in width;
- *heavy* - transported by road and rail, i.e. ones the weight of which is between 70 and 100 t. Devices and machines used in road building and construction, casing, boilers, tanks, parts of ships (e.g. superstructures) as well as railway and tramway cars including technological lines, dedicated to the energy, metallurgy, automotive and chemical industries, can be distinguished among this type of cargo;
- *heavy with concentrated mass,* these cargoes have a considerable weight in relation to their volume, their weight can range from 200 up to as much as 300 tons. Examples of elements referred to in this group may include, inter alia, power devices, i.e. generators, transformers, turbines and industrial presses as well as marine engines crankshafts. Railway wagons or multi-axle trailers are necessary to transport them;
- *heavy spatial* - their weight can be as high as 900 t, while the height of 40 m. They are transported only by sea and river.These can include industrial constructions, such as cranes, pipelines, port cranes, as well as offshore loads (e.g. a space shuttle tank);
- *long*- their length reaches up to 60 m, with other dimensions they usually do not deviate from the norm. The demand for transport of this kind of cargo is reported especially by the construction and road building. Columns and petrochemical reactors are included in this group [Sarnacka, Solecka, 2014, p. 180-181].

2. THE ESSENCE AND SOURCE OF TRANSPORTATION NEEDS

Transport needs result from the implementation of specific tasks and goals arising from the production and social activity of man, as well as the organization of social life and the functioning of national economy. A. Piskozub [1977, p. 135] points out that transport needs reported at the interface between production and settlement systems result from the incompatibility of the spatial distribution of these systems and relate to the displacement of the labor force determining the implementation of production processes. In broad terms, the primary and most important source of transport needs is spatial inconsistency between elements necessary for the activity of society (Figure 1).

Fig.1. General view of transport sources areas



Source**:** I. Dembińska, *Potrzeby i preferencje w wyznaczaniu popytu na usługi transportowe – rozważania teoretyczne* [in:] *Problemy transport I logistyki,*ed. by. E. Załoga, Publishing House of University of Szczecin, Szczecin 2011, p.12.

The detailed description of the source of transport needs refers to the indication of the location of resources. It should be emphasized that technological and technical progress in transport affects changes in the location of production and settlement, which results in the need to correct spatial transport relations and the sources of their creation. On the other hand, higher transport efficiency and effectiveness have a long-term effect on the reduction of unit tcosts. As a result, it becomes a factor generating transport needs [Rucińska, 2016, p. 53]. According to Z. Krasucki, the need to move people and things stems from the fact that man functions in space. WhileD. Rucińska states that the most important and primary source of transport needs is the spatial inconsistency that takes place between elements necessary for human activity. She emphasizes that the spatial aspect, mainly determining the location of productive forces and raw materials, is the most stable source of arranging transport needs [Dembińska, 2011, p. 11].

Emphasizing the importance and the essence of transport needs, one should also refer to the data provided by the Central Statistical Office. According to the Central Statistical Office, in 2016, 1836.7 million tons of cargo were transported by every means of transport, i.e. by 1.8% more than in the previous year. The increase in cargo transport was mainly recorded in road, sea and air transport [www.stat.gov.pl/obszary-tematyczne/transport-i-lacznosc/transport/przewozy-ladunkow-i-pasazerow-w-2016-roku,11,5.html].

Table 1. Shaping the dynamics and structure of cargo transport in 2010-2016

MODE OF TRANSPORT	2010	2014	2015	2016	2010	2014	2015	2016
	the previous year =100				share in % of total			
TONS								
TOTAL	**104,8**	**99,5**	**98,0**	**101,8**	**100,0**	**100,0**	**100,0**	**100,0**
Rail transport	105,4	98,0	98,5	99,2	13,1	12,4	12,4	12,1
Road transport	104,7	99,7	97,3	102,1	83,1	84,1	83,5	84,2
Air transport	111,1	102,4	100,2	110,0	0,0	0,0	0,0	0,0
Pipeline transport	111,9	98,3	110,1	98,6	3,1	2,7	3,0	3,0
Inland waterway transport	90,9	151,2	156,4	52,1	0,3	0,4	0,7	0,3
Maritime transport	89,2	97,3	102,7	104,1	0,4	0,4	0,4	0,4

Source:www.stat.gov.pl

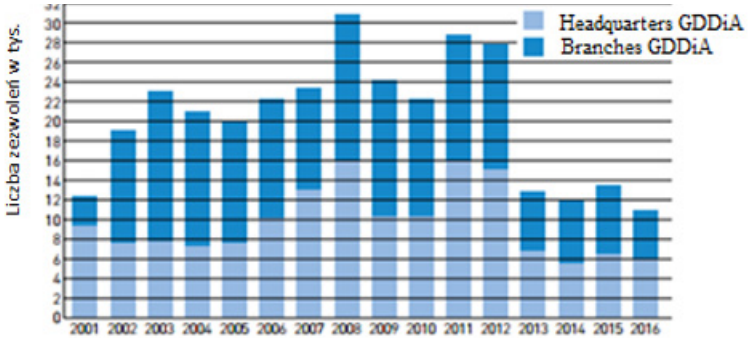
The literature identifies different sets of sources of transport needs, among which the following factors are most frequently distinguished:

- spatial - geographical differences of the distribution of productive forces, riches, as well as structures of natural settlements,
- economic,
- political and military goals,
- technological,
- economies of scale (development of technology, science, marketing),
- production,
- cooperative,
- social relations, population distribution [Dembińska, 2011, p. 12].

It can therefore be concluded that the sources of all transport needs result from the essence of socio-economic phenomena. They are not only related to their organization and functioning but also they evolve interdependently. They have a dispersed and heterogeneous nature. They refer to different branches and transport systems.

The national non-normative transport sector is illustrated by the number of permits issued for over-standard transport by GDDKiA(General Directorate for National Roads and Motorways) together with subordinate branches in 2001-2016. In 2001, 12468 permits were issued, in 2002 - 18977 items, while in 2003 - 22952 items. The acceleration of economic investments before Poland's accession to the EU generated an increase in demand over the three years by as much as 83.9% [Dembińska, 2011, p. 12].

Fig.2. Number of permits issued for oversized transport by GDDKiA in the years 2001-2016



Source: Developed based on GDDKiA

Over-standard cargoes, in contrast to standard loads transported by road, are characterized by a special organization of transport and the use of specialized equipment [Rudziński, http://www.tstefaniuk.uph.edu.pl/zeszyty/archiwalne/95-2012_22.pdf], which undoubtedly affects the formation of the dynamics and structure of cargo transport.

3. INFRASTRUCTURECONSTRAINTS IN ROAD AND RAIL TRANSPORT

The concept of infrastructure belongs to a group of terms and is used in various disciplines of science. This term, however, has not beenuncontroversially and unambiguously defined yet. Usually, the Latin origin of this term is given as a combination of the words *infra - "under, below"* and*structura - "structure, construction"*, which literally means *understructure, foundation*. While K. Wojewódzka-Król indicates that the term was taken from English and means foundation of the base, i.e. the necessary basis of the economy [Kozubek, 2012, p. 138].

In accordance with Commission Regulation (EC) No. 851/2006 of 9 June 2006, "transport infrastructure" means all roads and fixed installations for three modes of transport (rail, road, and inland), which are necessary to ensure the flow and traffic safety. The road infrastructure includes the following elements: ground, road works before laying the pavement, building structures (e.g. bridges, culverts, viaducts, tunnels), railroad crossings, road signs and signaling and communication devices, etc.

The development and functioning of transport infrastructure has a significant impact on spatial systems of economic systems. It is a significant element influencing the spatial reorientation of cities and large economic systems. Hence,

innovative technical solutions that enable faster cargo transport and lower its costsare significant here [Majewski, 212, p. 147].

The absence of efficient transport infrastructure of a country hinders its economic or social development. It is therefore essential that transport does not encounter barriers that hamper its development and proper functioning, and that it becomes an element that stimulates the country's economic development.

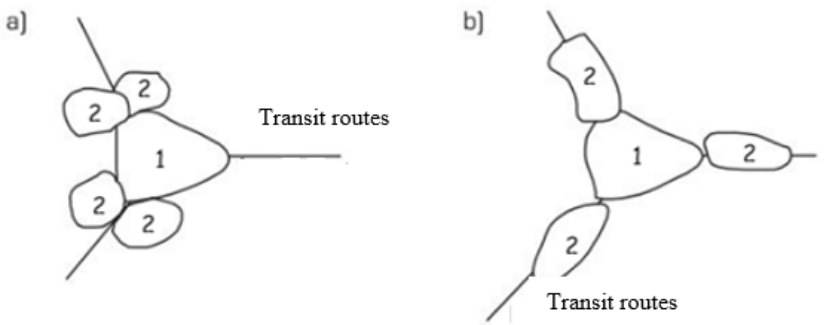
The transport infrastructure should be characterized and considered through the prism of three aspects: technical, economic and organizational. The following standard technical features of the transport infrastructurecanbedistinguished: along-life span, technical integrity, limited import possibilitiesand a long period of formation [Karbowiak, 2011, p. 11].

Transport constitutes a complex conglomerate of various issues. The transport issues and transport technology are related to various aspects of transport functioning. First, transport services are carried out in various environments (land, air, water), which forces the use of distinct technologies. Secondly, various goods with completely different characteristics, including transportability, may be objects of carriage. Technologies of transporting for example bridge spans or aggregates will be different. Thirdly, the issue of transport is not limited to the mode of transport, but also aspects such as infrastructure, the number and type of necessary machines, manpower and conditions for performing individual activities should be considered. With the road infrastructure poorly developed in relation to trade in goods, there is increased traffic intensity on specific sections of the infrastructure, where means of transport contribute to congestion, accidents or road damage. The proper technical condition of roads also influences the proper use of the transport potential and the reduction of carrier's own costs incurred. It frequently happens that a carrier is obliged to adapt the transport process to a given section of the road with the lowest parameters. The use of heavy trailers and vehicles as the main means of transporting loads in road transport is possible only with the appropriate load capacity as well as the quality of the road network [Długosz, 2009, p. 164-165].

Road transport enjoys the highest level of popularity among oversized cargo transport, whereas this type of transport is struggling with the greatest number of problems mainly related to numerous technical obstacles, among which infrastructure plays the primary role. The following elements should be considered in the route setting process: turn radii, road widths, appearing signs and columns, acceptable levels of easing the load on overpasses and bridges, roundabouts, islands, pedestrian zones, widths and heights of passings under viaducts and bridges, existing railway and electric tractions, permissible pressure on the surface, road repairs carried out on the planned route, etc. It is often necessary to remove road obstacles for the time of transport, such as road signs, lifting traction, dismantling roundabouts. Sometimes the distance between the

departure and destination points is 100 km, but the distance of, for example, 300 km must be covered to transport a given object, since it is necessary to travel around a circular route. There is also a lack of quick information about the parameters of bridges and viaducts, heights of flyovers orlimitations on individual roads. Due to the difficulties encountered, a final recipient pays more for transport and the time of transport operations is extended [http://www.logistyka.net.pl]. Furthermore, the visibility of a road is also an essential element, so that the assessment of parameters and traffic situation is as objective as possible, which is decisive for the safety of transport. The location of a variety of facilities (including buildings, street lamps or advertisements) along the road should be considered when mapping a route. Suitably qualified and experienced carriers who can "estimate" the dimensions of a set of vehicles are indinspensable, which will prevent from blocking a vehicleonrailroad crossings or under tunnels, stopping the traffic, and sometimes even a threat posed to goods being carried. In recent years, the interaction between the expansion of spatial development and the broadly understood transport activity has intensified.Consequently, this leads to the excessive concentration of spatial development, which sometimes results inunadaptation of transport routes for transporting casrgores, especially oversized ones. Figure 3 presents existing roads that are not adapted to cargo transportation (2a) and existing roads that have been specially built or extended with a view totransporting oversized cargo (2b).

Fig. 3. The addition of new (2) housing estates and industrial plants to the existing infrastructure (1): a) directly - concentration, b) along new transport routes - deconcentration.



Source: H. Karbowiak, *Podstawy infrastruktury transportu,* Publishing House of University of Humanities and Economics, Łódź 2011, p.10.

The unsatisfactory condition of the existing infrastructure should also be considered as a barrier, which results in deterioration of the capacity of main transport networks in the form of roads. Low road throughput and availability consequently contribute to the decrease in efficiency and essentially has an

impact on the increase of freight transport costs [Okniańska, 2012, p. 190]. It should also be stressed that the limitations concerning the mass of vehicles traveling on roads are crucial. Due to restrictions, the marked routes are sometimes considerably longer. Moreover, a heavy and large vehicle is not able to develop a significant speed. Not only do globalization and contemporary conditions generate numerous opportunities, but also certain limitations and problems. Only meeting the right standards in this area may result in the growth of competitive capabilities of Polish enterprises [Wincewicz-Bosy, 2013, p. 191].

The technical condition of the road should meet the following requirements when the route of an oversized vehicle is being planned:

- there should be no landslides or breakthroughs on the road,
- the height of the road engineering construction or road gauge is at least 0.1 m higher in relation to the vehicle height, including the cargo,
- the width of the road engineering construction or road gauge is at least 1.0 m higher in relation to the vehicle width, including the cargo,
- evaluation of the technical condition of the technical construction platform or girders is performed in accordance with the provisions on the numbering and recordingof public roads and bridge objects is equal to or greater than 3 (on a scale from 0 to 5) [Szymonik, 2014, p. 115].

The issue of road infrastructure in Poland is critical, since "Polish roads" are sometimes considered a symbol of our country's backwardness. Every type of limitation resulting from the parameters of linear and point road infrastructure in practice hinders and extends the process of transport preparation, and in extreme cases it results in the lack of the possibility for its execution.

The condition and forecasts of the road transport development in Poland has been the subject of numerous scientific studies. Transport policy, initiated by the political transformation in 1989 and implemented by successive governments in the last dozen or so years, was characterized by high instability and low efficiency. The assumptions of the state policy, strategies and development programs for individual elements of the national transport system developed in that period were either not implemented at all or were implemented very slowly and ineptly. The implications of these activities include the remaining poor condition of land transport infrastructure in Poland[1]. In many cases the existing infrastructure elements do not consider the necessary room for maneuver of vehicles with an oversized load. The absence of this type of structure necessitates adaptation works at roundabouts and intersections, and then restoration of their original state. These are activities that extend the transport time and generate costs because of the labor costs incurred.An opportunity for efficient implementation of the passage is the visible change in the construction of, for example, new intersections with circular

[1] J. Łacny, *Funkcjonowanie międzynarodowego transport drogowego* ładunków w gospodarce *globalnej,* Publishing House of University of Economy in Bydgoszcz, Bydgoszcz 2009, p. 41.

movement to enable the efficient passage of oversized vehicles (no concrete structures, earth embankments, high curbs, easy disassembly and assembly of road signs at intersections, roads through centers of roundabouts) [Łacny, 2009, p. 41].

CONCLUSION

Road transport of oversized cargo consists of many stages and activities. Organizational skills, specialist knowledge and experience are indispensable. Organization of transport is an individual matter for each cargo due to their diversity and unusual physical properties. The entire process is time-consuming and it is necessary to overcome legal and administrative barriers as well as technical ones. However, the biggest hindrance to this type of transport by means of road transport is the condition of road infrastructure, which is not adapted to transporting loads exceeding the permissible parameters. Due to the unsatisfactory condition of the existing infrastructure, it is necessary to control its state. The elimination of emerging barriers and obstacles is of fundamental importance to increase the competitiveness of Polish transport on the international arena. The limitations of transport possibilities in the scope of transport infrastructure frequently stem from the fact that the most important part - roads or railways relate to the area, usually constitute a heritage of the past and they should be modernized or must be created at the place of transport needs. Complementing the backlog in this field is a long-term process, which results, among others, from the difficulties encountered in expropriating land for the planned motorways.Therefore, employees of transport companies must take account several factors that are necessary in the implementation of transport. The most important of them include: cargo, means of transport and infrastructure. Any inappropriate decision of the organizers affects consequently the increase in the level of costs, the extension of the single transport execution time or the safety of cargo and other road users. When choosing the right transport solution, it may be helpful to conduct multi-criteria analysis of variants. In further work, the author will analyze the choice of an optimal route option with reference to various criteria having a fundamental impact on the implementation and functioning of a given solution.

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Ustawia z dnia 20 czerwca 1997 r. Prawo o Ruchu Drogowym
Rozporządzenie Komisji (WE) NR 851/2006 z dnia 9 czerwca 2006 r. określające pozycje, które należy uwzględnić pod poszczególnymi nazwami w planachkont, stanowiące załącznik I do rozporządzenia Rady (EWG) nr 1108/70.

INFRASTRUKTURA TRANSPORTU JAKO DETERMINANTA PRZEWOZU ŁADUNKÓW PONADGABARYTOWYCH

Zarys tresci: Transport pełni zasadnicza rolę w życiu gospodarczym. Rozwój transportu wpływa na zbliżenie do siebie rynków, uaktywnia tereny infrastruktury gospodarczej. Głównym zadaniem transportu jest wykonanie dostawy ładunku we właściwym czasie, przy akceptowalnym koszcie, a także w dobrym stanie. Oprócz transportu towarów użytku codziennego możemy wyróżnić ładunki ponadgabarytowe przy transporcie którym niezbędny jest wyspecjalizowany tabor lub specjalne warunki do ich przewiezienia. Współcześnie na rynku usług transportowych bardzo często zgłaszane jest zapotrzebowanie na realizację przewozu tego typu ładunków. Jednakże każdy przewóz ładunku ponadnormatywnego stanowi duże wyzwanie dla firm przewozowych, które muszą posiadać odpowiednią wiedzę oraz środki do jego realizacji. Podczas wykonywania tego typu zlecenia, oprócz doświadczenia oraz profesjonalizmu w posługiwaniu się sprzętem specjalistycznym wysokiej klasy dedykowanym do transportu nietypowych ładunków, ważny

aspekt stanowi także infrastruktura. Celem artykułu jest przedstawienie ograniczeń wynikających z istniejącej infrastruktury, z którymi borykają się przewoźnicy ładunków ponadgabarytowych w transporcie drogowym oraz kolejowym. Metoda badawcza wykorzystana przez autora w pracy bazuje na analizie literatury.

Słowa kluczowe: transport, infrastruktura transportu, przewóz ładnków ponadgabarytowych