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CITY LOGISTICS: INFLUENCE OF OVERSIZED ROAD TRANSPORT ON URBAN DEVELOPMENT

Summary. This paper describes the influence of road transport on urbanization and the transport of oversized loads. There is an increasing interest in oversized transport and urban development. In this developmental context, it is necessary to transport heavy construction machinery, infrastructure elements, pipes for gas pipelines and waterworks, or even rails to create roads for rail transport. For this purpose, the transport of loads exceeding standard parameters (16.50 m in length, 2.55 m in width, 4.00 m in height and 40 Mg in mass) is used. Oversized traffic has many obstacles on the roads, such as low bridges and viaducts, narrow roads, poor technical condition of roads, road works and low-permeability roundabouts.

Keywords: city logistics; oversized transport; load distribution

1. INTRODUCTION

The ubiquitous development of the economy and industry has led to a growth in car sales. Every year, the number of passenger cars and freight is growing. It has been estimated that the number could amount to three billion units by 2050 [1]. The development of road transport is associated with problems such as congestion on roads, air pollution and noise [2]. At the same time, the development of cities is observed alongside the development of transport. People are more likely to settle in developed cities where shopping centres, cultural parks, businesses,

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corporations, hospitals and schools are located. The growth of urbanization generates more interest in car and passenger transport, as new services and industries are developing. Thanks to the development of urbanization and transport, it is possible to move people and goods to more distant and previously inaccessible places. New roads, new jobs, housing estates and medical centres will be created. In order to reduce congestion in cities, new traffic bypasses, motorways and highways are being created. In this way, cities become attractive in terms of accessibility and economic growth. Unfortunately, Polish cities are facing many problems, such as an insufficient number of traffic bypasses, bridges and car parks, bad roads, and a lack of modern (smart) ITS solutions. At peak times, there is a poor flow of roundabouts, as well as traffic jams [3]. The basis of the modern city building must correspond with oversized transport. In this way, transportation of large elements is possible, such as long or heavy construction elements for high chimneys, long bridges, gas and water pipelines, buildings and house components, steel structures for the construction of halls, transport of buses and trains, locomotives and helicopters, as well as transport of production lines to industrial zones. However, the realization of oversized transport generates many problems in the city. It creates dangerous situations on the roads and traffic jams, aggravates the condition of the roads (in many cases the weight of tractor and trailer sets exceeds 40 Mg), causes greater congestion and even closes roads for passage, increases noise, and pollutes the environment. Therefore, it is necessary to prepare routes for non-normative vehicles, which do not include major city streets and night transport, in order not to interfere with traffic rhythm at peak hours. The aim of this paper is to describe and present the influence of the transport of excess loads on the development of urbanization and city logistics.

2. DEFINITIONS AND BRANCHES OF TRANSPORT

There are many transport definitions, and their diversity is due to the aspect of transport being perceived. The most common definition of transport is the process by which goods, persons or energy are moved from one place to another [4]. However, according to Wierzejski and Kędzior-Laskowska [5], transport is considered from three aspects:

- Functional aspect - transport is understood as movement
- Subjective aspect - transport is understood as an activity from other activities
- Material aspect - i.e., understanding of transport as a product or equipment serving the process of moving

Transport activities include moving and auxiliary services, with movements include loading, unloading, and short-term or long-term storage. Additional activities include customs clearance, logistic services, forwarding, brokerage, inspection and valuation services. All these activities, when taken together, create a transport process. In fact, the transport process consists of operations from the time an order is received to the transport itself. The transport process includes pretransportation activities, including the packing of goods, pelleting, storage, selection of the appropriate means of transport, and preparation of cargo for shipment. The transport process itself assumes cargo loading, transportation, and unloading at the desired location. Transport operations consist of the preparation and documentation of transport, collection of cargo by the consignee, unpacking, storage and further actions (for instance, delivery of goods to the next consignee) [5-6]. Technological advances require the development of transport, in particular, in the search for new solutions for advanced means of

transport and their optimum choice for transported cargo. Design and construction of more specialized means of transport are also needed for the transport of complicated loads with non-standard parameters. At present, it is also possible to combine several different modes of transportation to transport complicated loads (for instance, road and rail transport) [3, 6].

3. OVERSIZED TRANSPORT

Under Polish legislation, oversized (over-normative, non-normative) transport refers to a vehicle or combination of vehicles whose axle load, with or without cargo, is greater than the permissible road or road weight limit, or with or without loads that are higher than the allowable ones, as provided for in the Traffic Act. Extraordinary transport is when the parameters of the car (with laden or unladen) exceed the following dimensions: 16.50 m long, 2.55 m wide and 4.00 m high [7-8]. From the above definition, it follows that a non-normative vehicle is one whose parameter exceeds the stated norm. Axial thrust is also important and should not exceed 11.50 t per drive axle. Non-standard transport may include different modes of transport (road, rail, water, sea, river, inland waterway and air) [6-9]. Road transport is one of the most developed transport sectors, with the largest amount of transported oversized loads transported by car. Despite the high number of traffic accidents, this transport is characterized by availability, frequency, short delivery time and door-to-door delivery [10]. In order to integrate the transport interests of European countries, the Interreg South Baltic Programme for cross-border cooperation was established, with members including Poland (northern regions), Sweden (southern regions: Kalmar, Blekinge, Skane), Denmark (Southern part of Bornholm island), Lithuania (Klaipeda region) and Germany (northern regions). The programme is concerned with transport development of new routes, improvement in the quality of journeys, and openness to common interests. As part of the programme, the Oversize Baltic initiative was established, which aims to develop the transport of oversized loads in South Baltic countries. In the process, the quality of transport has improved, the volume of transported goods has increased, the cooperation between the countries of the region has improved, and a database and trade information flows have been established between these countries [11-13].

4. OVER-NORMATIVE CARGO

Over-normative cargo is a load whose parameters together with the vehicle set exceed at least one of the standard dimensions: 16.50 m long, 2.55 m wide, 4.00 m high and 40 Mg total mass. Any load measuring more than the standard parameters is called a non-normalized load. Loads of unnormal loads, due to their parameters, are a special issue in oversized transport. Most of these loads have a significant monetary value. Therefore, their transport must take place with extreme caution. The choice of transport and security measures should take into account the load, its features and its parameters, such as dimension, shape, shock and impact, and scratch resistance [9,12]. Specialized semi-trailers offer the opportunity to carry a variety of loads, which could not have been transported a dozen or so decades ago. This opens up new opportunities for the creation of modern buildings and elements of road infrastructure, as well as the development of industrial areas, the design of new installations (such as for petrochemicals) and the formation of wind turbines. The development of oversized transport can be considered as coupled with the development of industry and vice versa, as the

development of some industries generates an interest in transporting non-normative loads [9,11,18]. In over-normative transport, there is an indivisible charge, which means that the load cannot be divided into several smaller loads because of the risk of injury or disproportionate costs [7]. It is also important that the whole set, together with the excess load, should not exceed 40 Mg. If a tractor with a trailer and load weighs more, it is necessary to divide the main load into two or several smaller loads.

5. CITY LOGISTICS

The problem of urbanization is part of city logistics, which aims to "plan, implement, coordinate and control processes related to the movement of people, goods and information related to urban areas in order to reduce costs and improve quality of life" [1]. This poses a serious challenge for the European authorities as it involves long-term planning, while the effects of the implemented solutions can only be seen after a long time. In addition, the effects of the introduced changes should be harmless, and safe for the environment and inhabitants, while reducing noise and air pollution in the city. So far, in many Polish cities, there is no plan for freight transport, nor adequate transhipment facilities or parking lots. Freight solutions have not been implemented yet. These are issues for local government, but there are no specific and appropriate roles dedicated solely to solving these problems. Freight and delivery cannot pollute the environment and affect the city's spatial economy, enabling all residents to be accommodated, especially people with disabilities. The implementation of transport should also not interfere with accessibility to the city areas in terms of the movement of people between work and home. In today's reality, the introduction of any pro-ecological change creates awe and fear about the effects of these changes. The best solution would be the functioning of an advisory body or financial support for entrepreneurs. The best examples of urban development are coastal towns, ports, such as Gdynia or Gdańsk. In these cities, in addition to the development of local industry, the development and introduction of new ferry services are important. These are the conditions for cooperation between foreign cities. With the development of new ferry connections, contacts with new ferry operators are being established. The development of ferry connections is linked to the development of industry (new trade routes, business-to-business agreements), the development of culture and regions, and the growth of tourism. The reasons for moving people are different: they involve business trips, travel for business purposes, and for cognitive and recreational purposes. With the expansion and development of the ferry port, the city is expanding [1-3].

6. OVERSIZED INFLUENCE OF OVER-NORMATIVE TRANSPORT ON THE DEVELOPMENT OF URBANIZATION

Road transport is currently the most widely used transportation sector, due to its wide availability, speed, flexibility and low cost of service. It is also the most frequently problematic area of transport due to many legal regulations and inadequately prepared roads for carrying heavy loads. Oversized transport is a type of transport that affects the development of industry and the economy. Long, wide, high and heavy loads are being transported to new facilities, wind farms, production halls, buildings and roads [13-15] (Figs. 1-2). In Poland, the continuous development of cities and infrastructure is observed. The largest Polish industrial district is located in Upper Silesia, where several economic zones are

located outside the city. These areas include automotive, chemical, manufacturing, energy and construction companies. Besides, there are mines, steel mills and food processing plants in the Upper Silesia Industrial District (GOP). Oversized truck transport includes such loads as [12-15]:

- Construction machinery - Cranes, excavators, crushers, loaders, i.e., machines that make it possible to demolish or build new buildings or production halls. Their operating costs are so high that they exceed the cost of transporting these machines, so it is necessary to transport them from the owner to the site.
- Urban infrastructure elements - Bridges, spans, railings, beams, columns, parts of viaducts, rail and power trains, houses and their components, containers, tanks, reactors and parts of water supply systems for the construction of sewage treatment plants. In other words, all elements and building materials used to build buildings and roads in the city (Figs. 1-2).

Fig. 1. Transport of long bridge elements [13]

Fig. 2. Transport of heavy Equipment [14]

- Elements of the power industry - Turbines, generators, converters, shovels and wings of windmills, chimneys, which, most often, involve very long loads (sometimes exceeding 40 m), very wide loads (exceeding 7 m) and very heavy loads (even weighing 50Mg).
- Chemical industry - Reactors, generators, tanks and production lines. The chemical industry is also highly exposed to danger during the production process. Therefore, specialized equipment in this case is made of specific materials, which often involves heavy weights.
- Mining and metallurgical industries - Conveyors, production lines, mining machinery, construction and metalworking machines. Heavy and long loads are transported to specific plants to support their development.
- Military industry - Tanks, cannons, ammunition, tracked vehicles and transport vehicles, and even helicopters, stormtroopers and bombers. The development of the military industry is observed throughout Europe. In Poland, large-scale military vehicles are also produced in the Silesian Voivodeship.
- Electronic industry - Wires, ropes, railway and electric trains, electrical poles, signalling generators, and generators for power stations and urban networks.
- Woodworking and furniture - The carriage of woodworking machinery (grinders, saws, milling machines), wood panels, furniture and furniture boards is carried out by over-normal transport.

In recent years, there has been the greatest development in roads, traffic bypasses and motorways that Poland has seen in connection with various major events. Existing redevelopments are under way, along with changes in the organization of movement. In the next few years, plans for the construction of hydroelectric power plants, wind power plants, biogas plant waste incinerators and nuclear power plants in Żarnowiec and Lubiatowo-Kopalin [10] are expected. The Silesia region plans to build factories, production facilities and big sports halls. Extra-standard transportation will also be used to transport school, swimming and school playground elements. An interesting aspect of urban development has been the transport of ropes in drums to Silesian Park. Oversized transport has also been involved in the renovation of Wroclaw Zoo, in which wild big animals were transported to special destinations. Oversized transport is also used as a chain link in multimodal transport, where several transport links are combined.

7. OVER-NORMATIVE TRANSPORT RESTRICTIONS

Oversized transport includes the transportation of non-standard loads, which exceed the standard dimensions (16.5 m in length, 2.55 m in width, 4.00 m in height and 40 Mg in mass). Not all roads are adapted to the transport of such loads, on account of the maximum axle load. The biggest limitation is obtaining permission from the General Directorate for National Roads and Motorways (in Polish, GDDKiA). Compliance with all the requirements for contractors of oversized transport, as well as repairing and constructing new roads and reconstructing existing roads, is difficult in organizational terms [12-16]. Conducting any arrangements with the construction or road maintenance managers involves the designation of alternative routes, which are often more costly and time-consuming. In addition, the organization of non-normative transport often involves stopping traffic and closing two lanes for the transit time. Long loads require pilot presence, which helps to organize an alternative

route, informs other traffic participants about the upcoming transport, or closes the lane for transit. Waiting time for authorization is not always 14 days. In the case of a designated route that runs through numerous road reconstruction and repairs, the time of issue may be extended by up to one month. From the moment you submit your application to the GDDKiA, you should expect an answer and approval from the officials as to whether the designated route and the completed application are correct [12-15]. Road infrastructure is another important undertaking for the performance of oversized transport. Low bridges do not allow for high loads, which also hinders transport and requires a different route. Narrow city roads, near traffic lights and road signs, are further elements of the road infrastructure, increasing the cost of oversized transport. Dismantling road signs and traffic lights for the duration of the transport and re-assembling after transport increase the cost of the order. Sharp curves and arches on the roundabouts, in the same way, change the route and increase the cost of transport. For high loads, light signals are placed over the road and rail and electric train tracks, as well as electric poles and street lighting lanterns. Often, cutting back organisms, such as trees, and railings placed close to the road need cutting is impossible (it requires the consent of the relevant authorities and departments, and this generates a longer transit time). In such cases, it is also necessary to establish another route [10,11,17]. Cargo handling of oversized loads is usually done in the evening or at night. This is to reduce the risk of crashes on roads with other road users. At night, there is a limited congestion, which is why the organization of oversized transport usually occurs at this time [6,15]. Transport costs are also limited. Upon receipt of a request for the execution of a particular shipment, the customer declares the amount that s/he will pay for the execution of the order. After analysing all the costs for the freight, calculating the route and miles, selecting the appropriate trailer for the load, and adding the costs for the permit and piloting, it is possible to determine whether the transport can be carried out. The initial determination and cost analysis are also limitations of the performance of oversized transport [16,17,19].

8. SUMMARY

Oversized road transport has a huge impact on the development of cities and is adding to the problems of city logistics. Year after year, the interest in extraordinary transport increases at a fast pace. In recent years, the urbanization of rural areas has been observed, where and transportation is not available, as well as the development of cities. Roads, highways and traffic bypasses are being built in existing cities to enable local populations to reach their homes, workplaces, schools or medical centres. In spite of many technological advances, excess transport encounters obstacles on the roads (narrow roads, impassable low-rise roundabouts or low turning angles, reconstruction and numerous repairs, low viaducts and bridges). Oversized transport has a huge impact on the development of city logistics. Heavy transport of bridges, heavy construction machines, chimneys, parts of buildings, pipes for water and gas pipelines, concrete elements of infrastructure, production lines, rails for railways, crane elements and electrical switchgears can be transported through the transport of oversized and diverse truck trailers. Looking ahead, we can anticipate the further development of cities with the use of oversized road transport and the development of facilities for oversized loads. Relatively low transport costs, reliability, availability, time-saving and a variety of transport semi-trailers are just some of the features of road transport.

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