Development of the Silesian Logistic Centres in Terms of Handling Improvement in Intermodal Transport on the East-West Routes

Damian Gąska and Jerzy Margielewicz

Abstract The chapter presents the characteristics of Silesian logistics centres as the most important elements of logistics point infrastructure in the south of Poland, serving connections and integrating various branches of transport in East-West relations. The analysis was carried out on the example of the centre in Gliwice—located in the inland port in the west of the Silesian Province and the centre in Sławków—the point in Europe with the easternmost broad-gauge (1520 mm) railway line. These centres support the second largest in terms of population and the first in terms of industrialization region in Poland—the province of Silesia. The authors focused on presenting the development that has taken place over the last few years in both centres. The expansion and new equipment made it possible to significantly increase the throughput and capacity of handling and storage. The parameters of handling machines for container reloading have been characterized and compared, which in recent years have been installed in two container terminals. In addition, the warehouse space and its equipment, handling capacity, advantages and disadvantages of the applied solutions and development plans were presented. A separate theme is the characterization of the location of both logistic centres and accompanying facilities in the Polish transport system and on the east-west line. As well as the characteristics of the location giving opportunities for the development and increase of intermodality of transhipments and implementation of international and intercontinental transports. As part of this, the comparison of reloading machines and trends in their application and construction are presented. The chapter is concluded with a summary and conclusions regarding the planned increase in cargo transport about the new Silk Road.

Keywords Intermodal transport · Railway transport · Logistics centres Container terminals · Cranes · East-West routes · Silesia

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1 Poland as a Key Country for Transcontinental Logistics

Optimal configuration of logistics infrastructure is the biggest challenge for both businessman's and the authorities of a country or region. It is not possible to develop without the appropriate amount and length and technical condition of road, railway and inland waterway infrastructure in each area. These conditions both the development of a given area, companies and individual territorial units. The most important element, however, is the integration of various transport systems into one reliable network that will enable efficient, economic and ecological transport of various goods necessary in the global economy. Such integration is ensured by the appropriate point infrastructure in the form of logistic centres. The developed and efficient transport system, as a unified transport potential covering all branches of transport, is an important condition conducive to the creation of logistics centres. The logistics centre is located at the crossroads of important (international) transportation arteries and is a point element in transport infrastructure with a high degree of technical and organizational complexity. It is equipped with elements such as: intermodal transport node, modern warehouse space, transhipment platforms, modern office facilities, customs post, gas station for various means of transport, technical service and repair point of transport equipment, IT infrastructure, bank, post office, insurance offices, hotel and catering facilities and others [1].

Modern transport logistics is largely based on the transport, storage and transhipment of ISO containers both in short-distance, international and intercontinental connections. A significant concentration of fixed and investment assets on a limited number of point facilities of transport infrastructure requires adequate provision of large transhipment and storage needs. This can be achieved by closing dispensed check-in desks on the rail or road network and organizing transport between individual logistics centres. Within this system, carriers from various transport sectors (rail, car, water and air) cooperate, to deliver cargo in containers in the simplest relation from the sender to the recipient (so-called "door to door"), by means of one or several transport modes.

The contemporary approach to transport requires a comprehensive look at the entire transport chain. It is necessary to depart from the branch assessment of transport, and look at it as one whole structure. Modern intermodal transport is such a contemporary expression of trends in modern transport. The advantages of intermodal transport are primarily a reduction in transport costs and ensuring a fast and timely delivery of cargo, especially in international transport and reducing the risk of damage to the goods. In addition, increasing the possibility of disposable transport of a larger amount of cargo and an increase in the number of possible modes of transport and ecological aspects resulting from the use of railways and water transport. Basic disadvantages, and at the same time development opportunities for logistic centres is the necessity of using specialized handling machines (e.g. cranes, reachstackers), which provide the possibility of transporting multi-ton cargo units outside the reach of stationary equipment and the need to equip railway terminals with appropriate handling devices.

The key element of intermodal transport is transhipment between various means of transport belonging to separate transport modes. The logistics centre as an integrator of these branches is the key to the efficient implementation of transport and logistics processes in international relations. The scope of services provided by the centres is determined by efficient and very fast transshipment between individual means or modes of transport. The use of individual means of transport in the transport of goods is determined by the distance. On the shortest sections, transport is carried out by road, on further routes by rail and as part of the global economy by means of sea transport. There are, of course, deviations from this rule, but one remains unchanged—the need for transhipment. In this regard, it becomes necessary to equip logistics centres with appropriate technologies and handling machines.

Typical reloading machines in the integration of means and modes of transport are overhead cranes, reachstackers, forklifts and bulk cargo handling machines—tipplers and conveyors. However, transshipment itself is not everything. It is unnecessary to equip the transhipment points with spaces for the storage of individual goods and passive means of transport (e.g. containers) and warehouses for protection against weather conditions. In addition, it is necessary to increase the security of the entire transhipment and storage process. Such points become complicated, both in technical, organizational and IT terms, places that meet the increasing requirements of clients and enable the implementation of most logistic services.

Poland is one of the countries whose transit location determines the flow of cargo in the global economy, especially in the era of globalization. The immediate neighbours of Poland are the countries of the former Eastern bloc like Belarus and Ukraine and in the west Germany. The latter is Poland's main trading partner, with which goods exchange accounts for 40% of the total import and export of goods from Poland and to Poland. On the eastern border there is mainly one-sided exchange—import of goods to Poland with a small share of exports. The reason for this state of affairs is a certain collapse of the Ukrainian market and a flood of cheap products from Asia and energy raw materials from Russia. The majority of rail transport is carried out using containers, whose share in the total number of loading units is estimated at 98%, with 40-foot containers dominating in rail transport with a share of 50–60%. In the last few years, an extraordinary boom in container transport by rail in Poland has been noted.

The second aspect of transport on the East-West line relates to the transit location of Poland as a link between East and West not only in Europe but also in Asia. Currently, most of the goods reach Europe from Asia by sea, but more and more often (both in political and business circles) talk about the development of the land route as a new silk route. The amount of freight carried by rail in this relation is only 2% of the total exchange between Asia and Europe. However, this is to change in the coming years in favour of land transport, especially rail transport. However, this will require appropriate line and point infrastructure in the form of onshore container terminals and logistics centres. The new Silk Road may contribute to changing the 500-year global transport structure. In the past, all the most important countries in the world have based their power on maritime trade. China intends to

add a land road to this, which will allow the development of both the Middle Kingdom, former Eastern Bloc countries and Europe, and allow the development and use of logistics centres, including in Poland.

According to information provided by railway carriers, despite the gradual development of the point infrastructure in Poland, intermodal transport is still much less competitive than in other European countries. Poland has a relatively large number of intermodal terminals, located quite symmetrically throughout the country [2]. However, these are small terminals, which do not constitute the strength of intermodal transport in Poland. Logistics centres are located only in some places, including Sławków and Gliwice in Silesia (Fig. 1). These are centres that, immediately after Polish seaports, have the highest capacity and handling possibilities in Poland.

Fig. 1 Container terminals and logistics centres in Poland. 1—Logistics centre in Gliwice (SCL Gliwice), 2—Logistics centre in Sławków (Euroterminal Sławków). *Source* Own elaboration based on [14]

Intermodal transport is indicated by the European Union as the most ecological form of transport in building supply chains. The intermodal transport market in Poland is still a relatively underdeveloped market, which over the last few years has been characterized by a constant development trend. The implementation of the European Union policy in the field of sustainable development requires a properly prepared transport network, because transport is crucial for the proper functioning of logistics processes. Properly developed transport infrastructure is the basis for organizing the flow of resources, such as raw materials, semi-finished products, finished goods or information, and the most important resources, such as employees [3].

For a long time, there have been systematically growing flows of intermodal transports across Poland, including directions:

east-west: China, Russia, Belarus:

- area of Poland (especially harbours in Gdynia and Gdansk container terminals located in Silesia and the western part of Poland),
- Germany (especially the harbours: Hamburg, Bremerhaven/Duisburg)
- The Netherlands (especially the harbour of Rotterdam), Belgium (including the harbour of Antwerp)

Logistics centres in Silesia mainly serve north-south directions in the field of transport and transhipment to Polish seaports and the east-west direction in the scope of:

- The logistics centre in Gliwice (SCL Gliwice) supports transport and reloading mainly towards the west,
- The logistics centre in Sławków (Euroterminal Sławków) supports transport and reloading mainly to the east.

2 Silesian Region and Its Location on the East-West Route

The Silesia region is in the southern part of the country near the border with the Czech Republic and Slovakia. It borders on the following provinces: Łódzkie, Świętokrzyskie, Małopolskie and Opolskie. In the radius of 600 km from Katowice (capitol of Silesia) there are six European capitals: Berlin, Bratislava, Budapest, Prague, Warsaw and Vienna. The Silesia region is located in the node area of two major European corridors that run from the West to the East and from the North to the South of Europe, these are:

- Corridor III—relation: (Madrid–Paris–Brussels) Berlin–Wrocław–Katowice–Kraków–Kiev–(Asia),
- Corridor VI—relation: (Helsinki) Stockholm–Gdańsk–Katowice–Žilina–(Budapest–Athens), with a branch VI B for the relation Częstochowa–Ostrava (Vienna–Venice).

The density of public roads in the Silesia region is by far the largest compared to other voivodships and regions in Poland and amounts to 176.6 km/100 km^2. The value of investment outlays incurred on public roads in the region is the highest among all voivodships in Poland. Through the Silesia voivodship runs: A1 (Gdańsk–Gorzyczki) and A4 (Jędrzychowice–Korczowa) highways and S1 (Pyrzowice–Cieszyn) and S69 expressways (Bielsko-Biała–Myto–Skalité). The point of view of transport is the very favourable location of road infrastructure in the region, including important international roads such as A1 and A4 highways in the north-south and east-west directions (Fig. 2). Despite the constant development

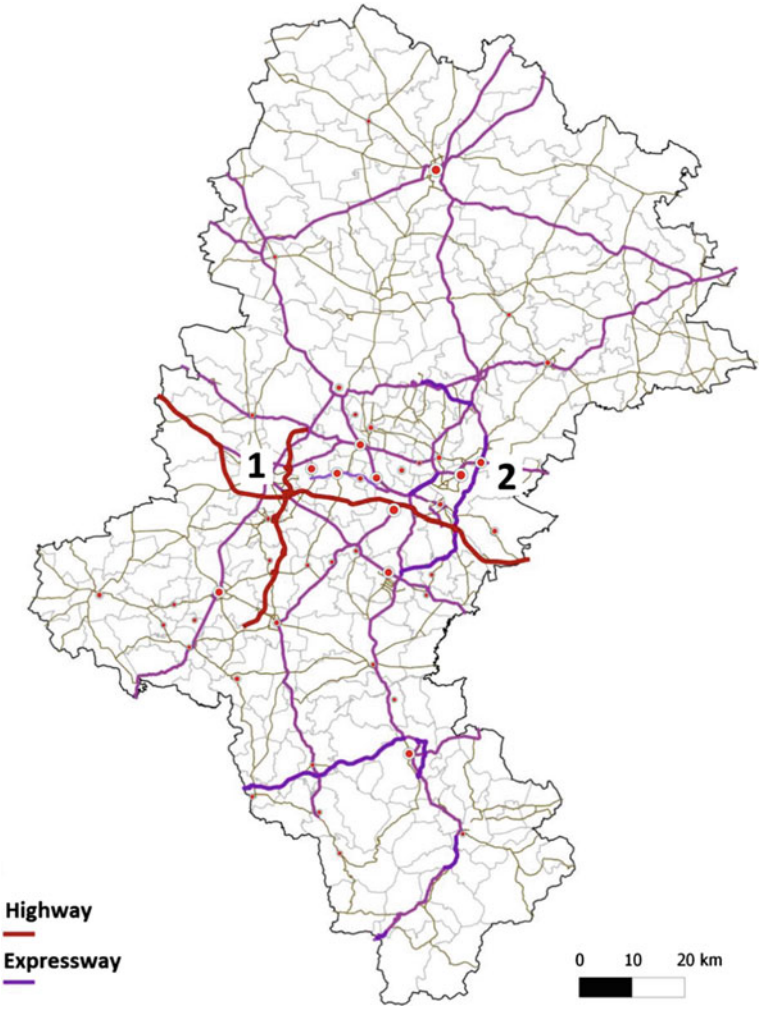

Fig. 2 A network of highways and expressways in the Silesia region. 1—Logistics centre in Gliwice (SCL Gliwice), 2—Logistics centre in Sławków (Euroterminal Sławków). *Source* Own elaboration based on [7]

of road infrastructure on the Voivodship's roads, there are still so-called Bottlenecks, above all north-south in the northern part of the region. The east-west direction is very well connected due to the A4 motorway.

The Śląskie Voivodeship has the densest network of railway lines in Poland (16 km/100 km^2) [4]. It is twice as large as the average value in Poland. Many railways in the region are included in international and national rail transport systems. The Main Central Railway, which is a part of the international transport corridor C-E 65, deserves special attention. In Tarnowskie Góry, one of the largest marshalling yards in Europe is located, which is also the largest freight railway junction in the country. The final point of the non-electrified LHS broad-gauge railway line (1520 mm) is located in logistics centre in Sławków in Silesian region. This line through the Ukrainian railway system has direct access to the Trans-Siberian Railway. It gives the opportunity to connect with the rail system of Ukraine and Russia and create a pan-European Europe-Asia land transport corridor. Due to poor technical condition of the tracks and many years of lack of investment in the linear infrastructure, intensified works aimed at increasing the average speed of trains have been carried out for several years.

There are currently only a few short sections of waterways in the Śląskie Voivodeship. They are part of the Oder Waterway. The following parts belong to this waterway:

- Canal Gliwice (IIIrd class waterway, which enables connection of the Śląskie Voivodeship with Western Europe via Wrocław, Szczecin and inland canals of Germany). This canal has a beginning in the Gliwice inland port which is at the same time the headquarters of the logistics centre,
  - Oder River (km 51.2–98.6, fragment of the river located in the Silesian Voivodeship is a class Ia waterway),
  - Gliwice inland port (it is the beginning of the Oder Waterway and the Gliwice Canal). It is also the place where the Logistics Centre in Gliwice (SCL Gliwice) is located. The port in Gliwice is characterized by high communication accessibility. The A1 and A4 highways are located near the port.

The existence of various modes of transport in the Silesia voivodeship and the even distribution of transport networks have a positive impact on the development possibilities of logistics centres. However, it should be borne in mind that in the light of standards adopted in better developed countries, Poland is still at the stage of creating and developing a network of large and modern logistics centres. In the area of the Silesia region, apart from logistics centres in Sławków (Euroterminal Sławków) and Gliwice (SCL Gliwice), there are about several dozen logistic parks and storage centres, the largest of which have a storage area of up to 250,000 m^2. However, these centres are equipped only with storage infrastructure and they do not have the possibility of integrating transport modes due to the integration with only car roads.

3 Characteristics and Parameters of Silesian Logistics Centres

3.1 Transhipment Possibilities and Development of the Logistics Centre in Sławków (Euroterminal Sławków)

In the seventies of the twentieth century, when Huta Katowice (Katowice Steelworks) was founded in Upper Silesia, the only 394 km section of the broad-gauge railway was built on the territory of Poland, directly connecting the railway network of the then USSR with the Polish steelworks. This solution served an easier (without the need to reload goods or replace trolleys) exchange of materials between the Polish metallurgical plant and the Soviet Union. The broad-gauge route operated for many years under the name Linia Hutnicza-Siarkowa, because one of the transported components was sulphur. In addition, there is a broad-gauge railway siding to transport iron ore, which extends from Sławków to Huta Katowice located in Dąbrowa Górnicza. The total length of the line is approximately 394.65 km, of which about 2.2 km in the Śląskie Voivodeship. As part of the construction there was also a bulk material handling terminal which, after expansion, became a logistics centre under the name Euroterminal Sławków. Due to the location and convenient transport location with the international rail and road network—it is a very attractive place for organizing intermodal reloading.

Euroterminal Sławków benefited from several large EU subsidies for the construction of the International Logistics Centre (modern warehouses and a container slab were build). Thanks to the investments, Euroterminal Sławków diversified the handling capacity and was transformed from a typical bulk cargo terminal, mainly ore, coal and coke, into an intermodal terminal with the simultaneous option of handling and storing standardized goods—on pallets, in big bags and steel constructions and above all reloading and container storage.

Euroterminal Sławków has an excellent location and thanks to investments also a connection in domestic and international traffic. The most important railway routes that allow to connect the logistics centre in Sławków are:

1. Direct connection with the LHS broad-gauge railway line about 400 km long, via the border crossing Izow/Hrubieszów through Ukraine with the Far East (Fig. 3),
2. Access to the lines specified in the AGTC Agreement (agreement on main lines of combined transport), as a result of connections with lines:
   - CE30: Zgorzelec-Wrocław-Katowice-Kraków-Przemyśl-Medyka,
   - CE65: Gdynia-Gdańsk-Warszawa-Katowice-Zebrzydowice,

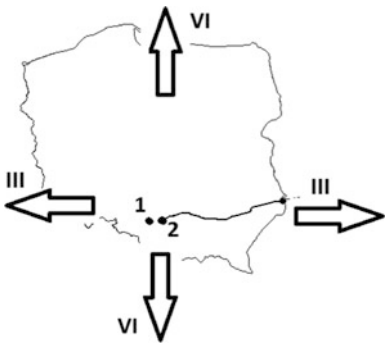

Fig. 3 Container terminals and logistics centres in Silesia as well as transport corridors and broad-gauge railway line to the border with Ukraine. 1—Logistics centre in Gliwice (SCL Gliwice), 2—Logistics centre in Sławków (Euroterminal Sławków)

3. Access to the Europe–Asia transport corridors. The location of Euroterminal allows convenient connection both to the Pan-European Corridor VI and III (Fig. 3).

The most important road connections, thanks to the proximity of the main transport routes of Poland are:

1. A1 Highway (Warszawa–Bielsko Biała), distance 8 km from Euroterminal,
2. A4 Highway (Katowice–Kraków), distance 10 km from Euroterminal,
3. E40 Route (Katowice–Kraków), distance 5 km from Euroterminal.

Near Euroterminal there are also two international airports:

1. Kraków Balice, distance 57 km from Euroterminal,
2. Katowice Pyrzowice, distance 44 km from Euroterminal.

The Euroterminal Sławków logistic centre is the furthest west to which trains with broad-gauge railway can reach (1520 mm). Such railway lines are widely used in former USSR countries in opposite to Poland and other European countries with standard-gauge (1435 mm) railway lines. Sławków is therefore designed to handle rail transport to and from Ukraine, Russia and Kazakhstan as well as China and South Korea (Fig. 4). The terminal has permanent intermodal connections with the Polish Baltic ports and the Italian terminal at Maddaloni and the Schwarzheide terminal (Germany) $2\times$ per week. In diffused mode, containers are sent daily eastward, among others to Ukraine, to Russia or Kazakhstan [5].

Euroterminal estimates its transhipment capacity at almost 285,000. containers per year; it can also reload about 2 million ton of coal, 380 thousand tonne of steel products and approx. 365 thousand ton of other mass goods, such as salt, biomass or grain, and 200,000 tonne of goods on pallets. Part of the terminal area was included in the Katowice Special Economic Zone. Table 1 presents the handling capacity and basic information about the logistics centre Euroterminal Sławków.

In addition to terminal services in intermodal transport, reloading, security and shipment of palletized, bulk, metallurgical products as well as non-standard and oversized goods are also carried out in direct and indirect relations (via storage

Fig. 4 Railway connections from Sławków are possible thanks to the broad-gauge railway line. *Source* Own elaboration based on [5]

Table 1 Basic characteristics of the logistics centre Euroterminal Sławków

Characteristics of the container plate	Unit	
Area of logistic centre	ha	91
Area of container terminal	ha	4
Loading capacity	TEU/year	284,810
Number of storage layers	–	5
Steel products	t/year	380,000
Goods on pallets	t/year	200,000
Commodities	t/year	2,000,000
Bridge cranes (load capacity 40/50 t)	–	2
Reachstackers	–	3
Storage capacity	TEU	3500
Connections to isotherms	–	90
Warehouse area	m^2	10,000
Distance to the national road	km	4 to DK1/S1 10 to DK4/A4 4 to S96
Distance to the railway line	km	5.7 to RL 665 2.2 to RL 674
Number and length of railway tracks for loading and unloading on terminal	-/m	7/700
Total length of railway tracks (1435 mm)	m	24,256
Total length of railway tracks (1520 mm)	m	17,521
Number of parking spaces for trucks	–	90

yards, warehouses) from broad-gauge railway wagons/standard-gauge railway wagons/road trucks. Transhipments are carried out in three main directions:

1. from broad-gauge railway lines (1520 mm) to standard-gauge railway lines (1435 mm) and in reverse direction,
2. from broad-gauge railway lines (1520 mm) to trucks and in reverse direction,
3. from standard-gauge railway lines (1435 mm) to trucks and in reverse direction.

Trans-shipments are carried out using cranes, jib-cranes, excavators, loaders. The logistics centre is also equipped with two reloading points for unloading loose goods (pellets, salt, grain) from Hopper type lower wagons in relation to trucks.

In recent years, many investments have been carried out at Euroterminal Sławków, the effect of which is the launch of the Universal Warehouse No. 2 (2013) and the expansion of the container deck with a container bridge crane (2013). The landfill of steel products as well as loose commodities were also put into use, as well as technical infrastructure accompanying railway tracks (broad and standard gauge), roads and parking lots as well as water supply, gas network and storm water drainage system. Thanks to these investments, Euroterminal currently has a technical infrastructure that provides comprehensive forwarding and transport services in Poland and abroad using rail and road transport. The container terminal after expansion in the logistics centre in Sławków has a total storage area of 40,000 m^2.

Figures 5 and 6, according to [6], show the quantities of container units reloaded in 2012–2016 and the forecasted value in 2017. Despite the infrastructure conducive to the disruption of transport in corridor III—on the east-west axis—in 2014 there was a breakdown and a definite decrease in the transported containers (Fig. 5). The reason for this is the outbreak of armed conflict in Ukraine. In the years 2012–2013, there was a dynamic increase in the number of transhipments and if this trend was maintained, we could be dealing with amounts comparable to the north-south direction. Currently, the terminal reloads mainly containers within the VI corridor in relation to Polish seaports and terminals in southern Europe (Fig. 6). The total planned quantity of reloaded containers in 2017 is 150,000 TEU, of which only 20% is in the east-west direction. However, this does not change the fact that the

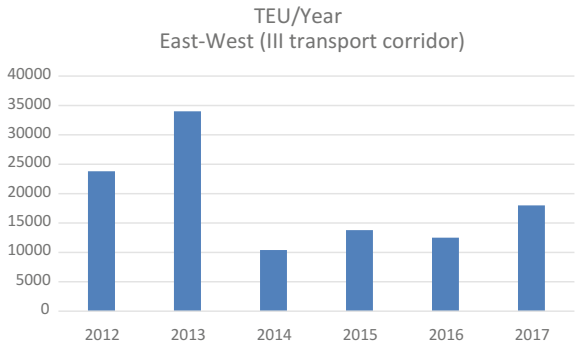

Fig. 5 Total transferred container units in Euroterminal Sławków as part of the III transport corridor in East-West direction

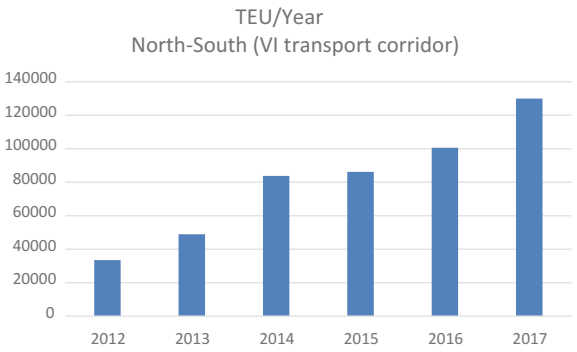

Fig. 6 Total transferred container units in Euroterminal Sławków as part of the VI transport corridor in South-West direction

handling capacity is high, and the use of broad-gauge railway is only a matter of time.

In addition to the infrastructure related to container reloading, Euroterminal Sławków also has extensive warehouse infrastructure, also in the field of bimodal warehouses combining the road and railway infrastructure at the same time. There are 4 warehouses in the logistics centre:

1. Warehouse with an area of 2660 m^2, standard and broad-gauge railway ramps and truck docks. Capacity of 1780 europallets—the possibility of accepting 12 wagons with pallets and a minimum of 576 pallets for trucks daily
2. Warehouse with an area of 4860 m^2, standard and broad-gauge railway ramps and truck docks
3. 380 m^2 warehouse with a capacity of 200 europallets
4. 600 m^2 warehouse with a capacity of 350 europallets

Permanent railway connections carried out by the Euroterminal Sławków logistics centre are connections three times a week to the Deepwater Container Terminal in Gdańsk and in the reverse direction. In addition, twice a week to the logistics centre in Maddaloni and in the return direction, as well as connections in the dispersed traffic with the countries of the former Eastern bloc are served (Fig. 7).

Other services provided at the Euroterminal Sławków logistics centre are as follows:

- container hoist (filling and emptying containers),
- technical assessment and suitability for food products,
- container repairs,
- basic washing of containers and vehicles,
- possibility of crushing, sorting, mixing bulk goods,
- weighing wide-gauge, standard-gauge wagons, trucks,
- receiving and sending goods for transport,
- organization of combined transport,
- full terminal service,

Fig. 7 Bimodal warehouse —rail-road. *Source* [5]

- customs service of goods in import and export,
- freight forwarding services in Poland and abroad,
- installation of flexi-tanks.

3.2 Reloading Possibilities and Development of the Silesian Logistics Centre in Gliwice (SCL Gliwice)

Silesian Logistics Centre S.A. commenced operations in 1989, as the Silesian Free Customs Area, a company established to establish and organize the Free Customs Area, as well as manage and administer inland ports in Gliwice and Kędzierzyn-Koźle. In 2002, the company's name was changed to the Śląskie Centrum Logistyki Spółka Akcyjna (SCL Gliwice). The city of Gliwice, by contribution of the land and property of the Gliwice port, has become the majority shareholder [7]. The logistics centre in Gliwice is located on the territory of the inland port—at the end of the Gliwice Canal (Fig. 8). For this reason, it is a place that connects and integrates three modes of transport—road, rail and water-inland.

Fig. 8 A view of the Port and logistics centre SCL in Gliwice. *Source* [8]

Port in Gliwice due to the layout and shape of port basins, constructions and length of wharfs (over 2.5 km), reloading facilities, storage yards and handling capacity (about 1.6 million ton per year) is the most modern and universal inland port in Poland. The Gliwice port has a direct connection with the Szczecin–Świnoujście seaports complex and with the entire waterway network in Western Europe (Fig. 9) [8].

Port in Gliwice is the largest and most modern facility of this type in Poland. The reloading of goods takes place here using jib cranes with a lifting capacity of up to 20 t (Fig. 10) or by using the unloading system of bucket wagons type FAS. All cargo can be weighed on site using electronic railway and car weights.

The Gliwice Canal and the port in Gliwice provide national and international transport of goods, especially mass and large-size goods. Due to obsolete devices and hydraulic engineering structures, transport capacity (6 million ton per year) is used only in 50%. Only barges with a maximum tonnage of 500 tonne can flow through the canal. The Gliwice Canal with a total length of 41 km (in the Silesia Voivodship is 22 km at the canal width of 37 m), connects the river port in Gliwice with the Oder River and further with the Szczecin-Świnoujście seaport providing access to the Baltic Sea, and through linking via inland canals waterway transport in Germany—the Elbe and Rhine—gives access to many ports of Western Europe [9].

For several years, the port was not used for water transport and reloading in this area. This condition resulted from the maladjustment of the Gliwice Canal and the waterway as well as watergates to operate the barges. In 2017, after the water watergates were renovated on the Gliwice Canal, the first transports of coal from

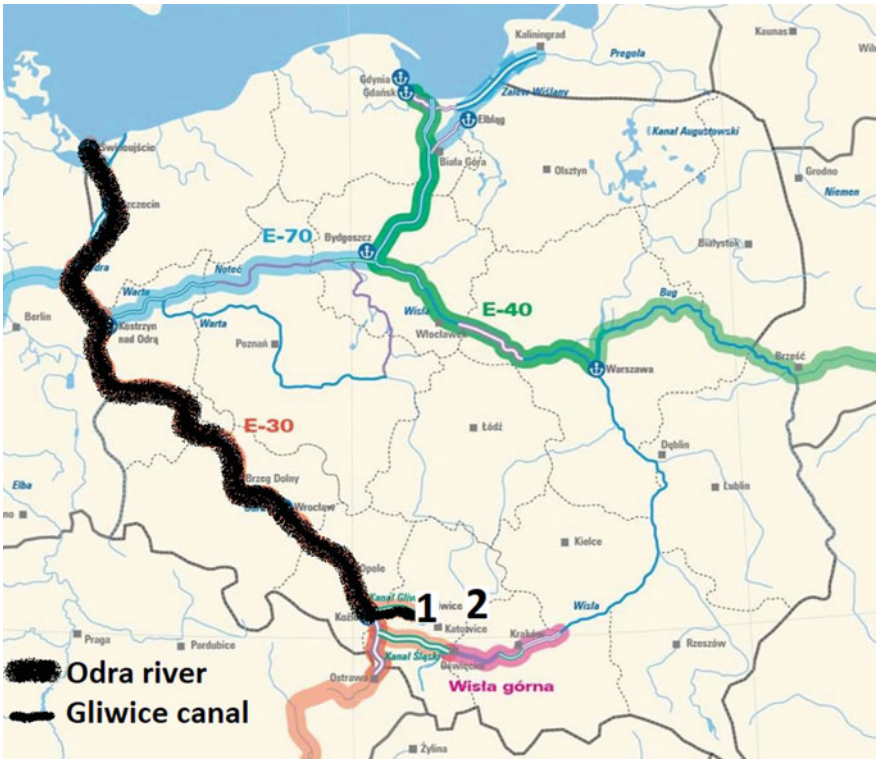

Fig. 9 The waterway of the Oder River and the Gliwice Canal against the background of waterways in Poland. 1—Logistics centre in Gliwice (SCL Gliwice), 2—Logistics centre in Sławków (Euroterminal Sławków). *Source* Own elaboration based on [15]

Fig. 10 Jib crane for bulk material handling in the Gliwice logistic centre

SCL in Gliwice to Wrocław were carried out. The purpose of the completed renovation in 2017 was to reduce the failure of water watergates, shorten the working time and reduce the amount of water consumed. The transport season starts in spring and ends in late autumn, especially for coal-filled barges. The carriage of goods is organized in such a way that first the individual barges, after the passage of the Gliwice Canal, are joined in the two sailing boats with the pusher on the Oder River. Occasionally, there are large-scale transports, e.g. steel constructions that can reach Germany or seaports in Poland, Szczecin and Świnoujście through inland waterways. Initially, the depth of the channel was 3.50 m, however, for many years the canal was operated without due care for the technical condition, that is why today only barges about 1.50 m dipping, or whose load capacity does not exceed 500 ton can use the canal. They are mostly outdated units, no longer used on other waterways. In addition, they can be sets composed only of one barge and pusher, because the longer, two-bar, do not fit in the canal watergates [10].

Silesian Logistics Centre (SCL Gliwice) provides services in the field:

- import and export of containers from around the world (FCL),
- import and export of groupage shipments (LCL),
- transports in relation door to door,
- transport of dangerous goods,
- securing (stowage) containers,
- depot for empty containers,
- specialized storage services of ADR goods,
- specialized steel storage services,
- Specialized paper and electronics storage services,
- specialized services for e-commerce,
- other services, including terminal services: reloading, sweeping, cleaning, minor repairs, power connections for refrigerated containers, assembly of flexi tanks.

Table 2 presents the handling capacity and basic information about the logistics centre SCL Gliwice in the Silesian Voivodeship.

In June 2016, the container terminal at the logistics centre SCL Gliwice was opened after modernization. The terminal is operated by PCC Intermodal dealing with intermodal transport, which has several railway and road container terminals in Poland and Germany. The entire investment–reconstruction of the container slab, purchase of 2 gantry cranes, construction of railway tracks and adaptation of the terminal to higher capacity and efficiency costed over 12 million EUR. The operational area of the terminal is 50,000 m^2, with a storage capacity of 2.9 thousand TEU. Annual terminal handling capacity is 150,000 TEU. The terminal has 4 railway lines with a length of 650 m each, 2 gantry cranes, 3 reachstackers, 50 parking spaces for trucks and 60 power connections. The terminal is connected by regular railway connections with the ports in Gdańsk and Gdynia, Central Poland—the terminal in Kutno, Lower Silesia—with the terminal in Brzeg Dolny, Frankfurt/Oder, Hamburg, Rotterdam, Antwerp and Brześć on the Polish border with Belarus (Fig. 11). Every day the terminal organizes hundreds of road transfers to: Katowice,

Table 2 Basic characteristics of the logistics centre SCL in Gliwice

Characteristics of the container plate	Unit	
Area of logistic centre	ha	47
Area of container terminal	ha	5
Loading capacity	TEU/year	150,000
Number of storage layers	–	4
Commodities	t/year	1,600,000
Bridge cranes (load capacity 41 t)	–	2
Reachstackers	–	3
Jib crane for bulk materials (20 t)	–	1
Storage capacity	TEU	2900
Connections to isotherms	–	60
Warehouse area	m^2	28,000
Distance to the national road	km	10 to A1 10 to DK4/A4 4 to S96
Distance to the railway line	km	0 to E30/C-E30 15 to E65/C-E65
Number and length of railway tracks for loading and unloading on terminal	-/m	4/650
Total length of railway tracks (1435 mm)	m	11,000
Total length of railway tracks (1520 mm)	m	0
Number of parking spaces for trucks	–	50

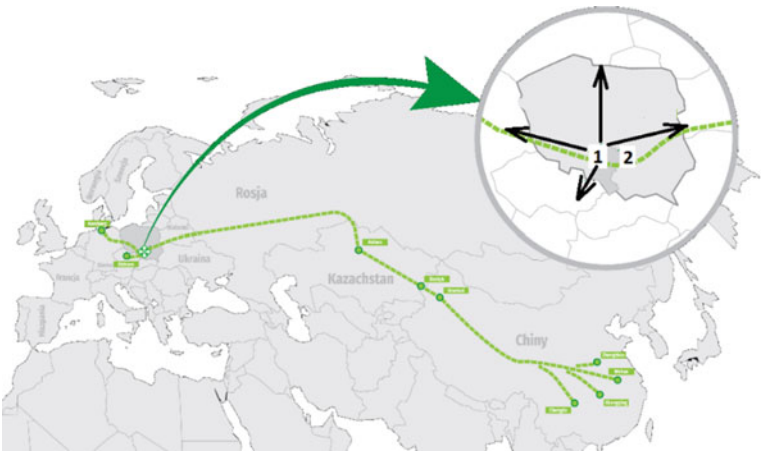

Fig. 11 Railway connections from Gliwice in the east and west direction. 1—Logistics centre in Gliwice (SCL Gliwice), 2—Logistics centre in Sławków (Euroterminal Sławków). *Source* Own elaboration based on [8]

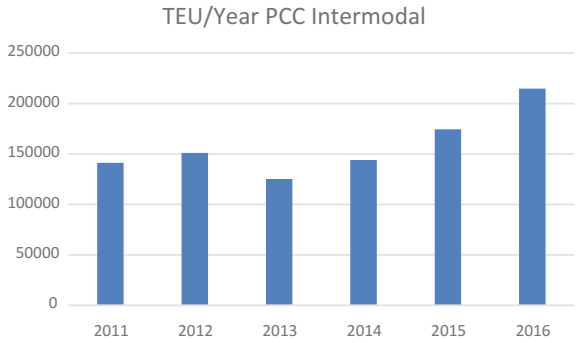

Fig. 12 Number of containers transported by the terminal (SCL Gliwice) operator—PCC Intermodal

Dąbrowa Górnicza, Opole, Kędzierzyn Koźle, Tychy, Oświęcim, Bielsko Biała, Częstochowa, Kraków and Kielce. Figure 12, according to [11], shows the number of containers transported by the terminal operator—PCC Intermodal—during the last 6 years. It should be assumed that about 1/3 of these transports has been transhipped at the terminal in Gliwice, which gives around 70,000 TEU in 2016. The upward trend for 2017 is maintained. However, also in this case, a decrease in the number of transports in 2014 and 2013 is noticeable due to the partial collapse of the eastern market.

The logistics centre in Gliwice has many specialized warehouses for storing various goods for many industry sectors. In 2016, the construction and commissioning of a new bimodal storage facility was completed. It is adapted for both road and rail transport. The warehouse has a storage area of 10,000 m^2. It is dedicated to handling industrial products in such industries as: paper, chemical, furniture and household appliances (Fig. 13). In addition, the logistics centre in Gliwice is particularly well-stocked in the storage of demanding goods. A special warehouse for the storage of steel products and dangerous goods in accordance with ADR should be mentioned here. The warehouse for steel products with an area of 6600 m^2 is equipped with:

- 3 overhead cranes controlled by means of a radio from "0" level with load capacity 32 and 25 t,
- rack system type "roll-stop" for storing coils,
- 3 gates enabling access for trucks to the hall interior (5.0 m × 4.5 m),
- 2 railway and vehicle gates,
- floor strength is 41 t/m^2.

The second specialist warehouse is also a class A warehouse, adapted to store dangerous goods in accordance with ADR with a storage area of 5800 pallet spaces on high storage racks. The warehouse is equipped with:

Fig. 13 The interior of the bimodal warehouse in the logistics centre in Gliwice

- monitored and regulated temperature area and humidity system,
- docks for front unloading and a gate for side unloading,
- railway ramp,
- non-dusty and tight floor topping,
- floor covered with anti-electrostatic layer,
- tank for possible leakages or water from sprinkler installation,
- ventilation enabling the exchange of the entire air from the warehouse within one hour,
- smoke flaps.

As part of services for the e-commerce sector, the logistics centre SCL Gliwice offers [8]:

- connection to e-commerce platforms,
- 14,000 pallet places,
- delivery service and storage of products,
- receiving and completing orders,
- labelling and marking,
- control of product features and parameters,
- fiscalization of sales on behalf of the store,
- distribution of parcels,
- returns handling,
- inventory of resources.

The area of SCL Gliwice is almost entirely developed and it is no longer possible to expand further within this logistic centre in the port of Gliwice. Further development would have to involve the acquisition of land in a different location.

3.3 Comparison of Handling Machines in Silesian Logistics Centres

Both terminals in Silesian logistics centres in Gliwice and Sławków have been thoroughly modernized in recent years. In Sławków a containerboard was enlarged, and one gantry crane was installed, while in Gliwice a new containerboard was built, and two gantry cranes were installed Figs. 14 and 15.

Fig. 14 Main bridge crane for reloading of containers in Euroterminal Sławków logistic centre

Fig. 15 Main bridge cranes for reloading of containers in Gliwice logistic centre

Fig. 16 Construction and basic elements of container gantry crane (RMG) in logistics centre in Sławków

Although both types of gantries perform very similar tasks, i.e., managing the input and output of containers to/from a block or stack of containers, they must meet very different functional and technical requirements for this type of machinery [12, 13].

Euroterminal Sławków is equipped with two container gantry cranes moving along the track (RMG—rail mounted gantry, Fig. 16). These are typical gantry cranes equipped with 2 booms to increase the spans and allow handling also outside the main field—usually loading or unloading means of rail and road transport. The crane travels along a track on steel wheels (12 on each side) and is supplied with electrical energy by a cable drum. Manipulation of the container is possible by mounting the lifting mechanism on the winch, and the rotation of the container is caused by the rotation of the entire winch (including the operator's cab). Cranes are equipped with a spreader to handle all containers and a piggy back handle for lifting removable bodies and semi-trailers.

The PCC terminal in the Silesian Logistics Centre in Gliwice is equipped with two RTG (rubber tired gantry, Fig. 17) container cranes. RTG crane are equipped with diesel engines (600 HP), which provide the power needed for driving and lifting. All mechanisms are electric, and the internal combustion engine is only a generator. The electricity and data transfer to the RTG trolley is carried out via a system of conductive conductors. Because the gantry is located in the port its main dimensions have forced the dimensions of the quay. However, its construction, no booms, prevents reloading in the terminal-water relation, which is surprising at first glance. The explanation of such a construction used by the terminal is economics—the port cannot be used to transport containers by waterway. The operating

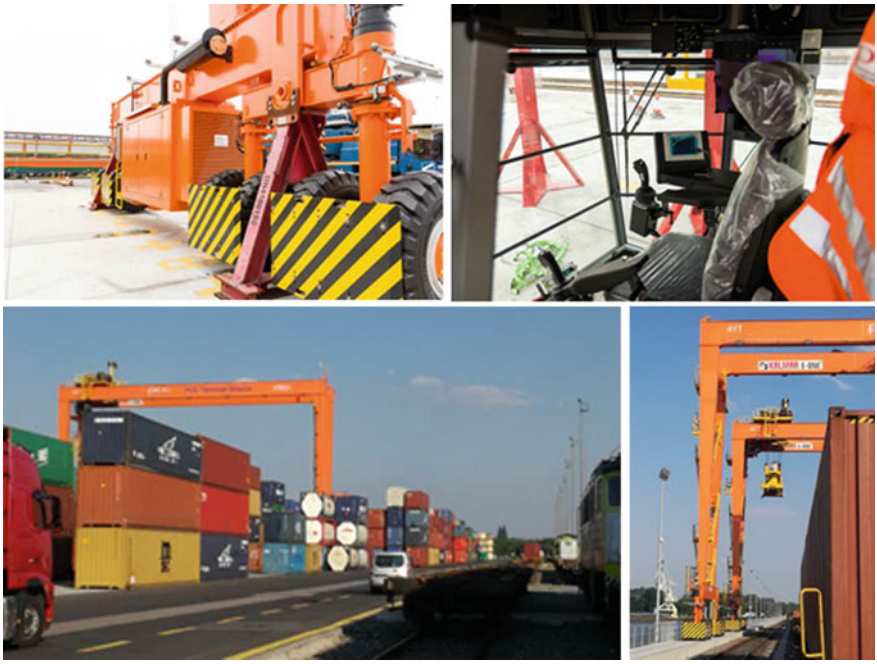

Fig. 17 Construction and basic elements of container gantry crane (RTG) in logistics centre in Gliwice

Table 3 Comparison of technical parameters of container cranes

Characteristics	Unit	Sławków	Gliwice
Structure type	–	Container, gantry, on railway track, with booms	Container, gantry, with rubber wheels, without booms
Span	m	14.5+51.7+22.5	35
Hoisting speed	m/min	30	26/52
Bridge speed	m/min	100	130
Winch speed	m/min	80	70
Load capacity	t	40/50	41

principle and operations on the container are the same as the RMG crane. Basic parameters are shown in Table 3.

Handling machines used in logistics centres are machines designed for specific tasks, and basic construction and operation trends (on the basis of Silesian logistics centres) can be divided into:

1. Specialization—adaptation to specific tasks and resulting design features such as span, operating speeds, gripping bodies. The emphasis is primarily on

performance, although specialization does not mean a degree of universality—in terms of the crane being analysed, it is primarily a spreader.
2. Reduction of the weight of the structure using modern working mechanisms to reduce the negative impact of dynamics (advanced control automation)—cranes are working intermittently. In the literal sense, the use of modern materials and computational methods to optimize the weight.
3. Modular construction—the use of the same structural components for both the load-carrying structure and the mechanisms, and depending on the intended use of the specific crane, only minor modifications are made. Typisation and unification affect cost reduction both during construction and operation, reducing the cost and time of possible repairs.
4. The use of modern drive control that assists the operator in reducing the load swing, which significantly shortens the loading cycle time. In many cases, the use of semiautomatic or automatic bridge cranes on large container terminals.
5. Cab operator equipment with many necessary sensors to support the loading process. Today's cranes are operating in 24-h mode, so the equipment needed for lighting and cameras has become the norm. However, there are also laser sensors supporting the distance measurement process, sensors to keep up to date information on the state of the individual components of the structure, the position of the gripper body, atmospheric conditions. A very important element is the ergonomics of the operator, position, cabin visibility, control access.
6. Modern gantry cranes are equipped with many diagnostics to monitor the operation of engines and components.
7. Ecology is becoming increasingly important both in the construction phase and primarily in the crane operation. Gantry cranes are manufactured to work continuously for a period of 20 or more years, but after this period they should be fully recycled. In the case of RTG crane, it is important to optimize the fuel consumption, and what is associated with the emission to the atmosphere of combustible substances. The use of other structural components—including tire. RMG crane does not emit harmful substances to the atmosphere at the workplace, but only the naive believe that electricity is coming from the socket. Therefore, energy efficiency is also very important in this case. These features are related not only to ecology, but also to the economics of use.

For the efficient operation of logistics centres, it is necessary to use appropriate handling machines. In Silesian logistic centres, these machines are definitely different, and their characteristic features are:

- Construction and structural features of container cranes in Silesian logistics centres vary widely and depends on the specificity of the container terminal.
- Trends in the design and use of container cranes are related to many factors. First, with efficiency, ergonomics and control, with an ecological approach to construction and operation.
- Analysed gantries differ significantly by the span and source of the drive used—in one case electric, in the second diesel.

- RMG cranes are larger and are designed to work on larger container slabs, while RTG cranes have the ability to travel also to other terminal locations and to other container slabs.

4 Summary and Conclusions

The quality of point and linear infrastructure in European countries has a significant impact on increasing the competitiveness of rail transport in relation to other modes of transport. In Poland, the technical condition of the terminals, the lack of appropriate reloading equipment and the insufficient length of loading and unloading tracks make it difficult for the railway to start regular connections. Silesian logistics centres and transhipment terminals in them located are in a much better condition, and the development and modernization carried out in recent years gives hope for rapid development.

The average speed, for intermodal transport in domestic transport in Poland, was at 28 km/h in 2016. From the point of view of customer needs, for which the delivery time is a key issue, the low transport speed in intermodal transport limits the competitiveness of rail transport towards the road [2]. A stable policy of supporting intermodal transport in the long-term will help to reduce the disproportion between Poland and the European Union. Poland should actively participate in activities for the development of intermodal transport.

The geographical location of the Silesian region with the correct political situation in the world creates the chance that the logistic centres located here can become a significant partner in trade and transit transport. The Government Strategy for Responsible Development predicts a three-year increase in intermodal transhipments of at least 30%, which exceeds current logistics capabilities in Poland.

The advantage of the Logistics centre in Sławków is the huge potential for further investments in infrastructure in the field of international and regional transport, as well as in the field of intermodal transport in intercontinental relations. Due to its unique location, on the broad-gauge (1520 mm) railway track with European standards (1435 mm), Euroterminal Sławków can participate in the transport of cargo by rail between Europe and Asia–primarily China. As part of the so-called The New Silk Road, terminal could be a transhipment point even for several hundred trains per year. PKP Linia Hutnicza Szerokotorowa became the first Polish company co-creating the International Trans-Caspian International Transport Route (TMTM), which connects China with Europe. The weight of goods transported by sea from the Asia and Oceania region to the European Union in 2015 reached almost half a billion ton. Reloading in Polish ports amounted to 70 million ton, of which approx. 10% were from Asia. Taking over a fraction of this stream of goods through the Polish rail and logistic centre in Sławków would be a great opportunity for development.

The concept of the New Silk Road, presented in autumn 2013 by the representatives of the People's Democratic Republic of China, will be the largest infrastructure investment in history. From China to Poland, trains must overcome 11,000 km. They ride from 11 to 14 days, while transport by sea takes around 40 days. The new Silk Road leads through Central Asian countries to Western Europe through Poland, and thus through Silesian logistics centres. The concept of the New Silk Road must use the potential of transit, a very favourable location of Poland through the use of the broad-gauge railway track, ultimately reaching the Logistics Centre in the south of Poland, where all major transport routes intersect, was developed as part of the infrastructure program POLAND 3.0. The most important infrastructural projects include the restoration of the navigability of Polish rivers, starting from the Oder River, construction of the Danube-Oder-Łaba and Vistula-Oder connections, joining the Central European Transport Corridor and building a broad-gauge (1520 mm) railway track from Logistics centre in Sławków to the Logistics Centre Gorzyczki-Věřňovice. This new Silk Road running through Silesia and Czech Moravia will be both a transport and commercial route.

Due to the ongoing conflict between Russia and Ukraine and the resulting problems with rail transit through Ukraine, container traffic in this direction is currently minimal. The development of the connection network of the terminal in Sławków with the countries of Western Europe is a necessity, associated with little use of connections to the east. At the end of 2017, Euroterminal Sławków is planning to start servicing two successive new intermodal connections a week.

In Gliwice, the possibilities of expanding the infrastructure in the current location (inland port) have already virtually exhausted. At the moment, the capacity of the logistics centre is used in about 50%. However, there is a very good chance to develop transport by waterway. For this purpose, it is necessary to introduce further investments, and those made until 2017 are only the first phase. By the end of 2017, a transport to Wrocław of 20,000 tonne of coal per month is planned. Barges between Gliwice and Wrocław have about 200 km to cross. The cruise requires passage through 27 watergates.

As part of the Oder Waterway in 2021–2030, it is planned to build the Koźle-Ostrawa canal, which would be the Polish part of the waterway to the Danube. However, in 2017, an initiative to extend the broad-gauge railway line from Sławków to river ports in Gliwice and Kędzierzyn-Koźle appeared. Implementation of a new track section of about 80 kilometres would enable the dispatch of goods delivered from Asia through the intermodal rail by standard gauge, land and water roads—through Oder, Gliwice Canal and the Baltic Sea. The advantageous location of Silesian logistics centres allows for shipping goods to the Szczecin-Świnoujście seaport and Germany, and further to Scandinavia and Western Europe. The investment is justified due to the fact that Silesia is the most industrialized part of Poland and at the same time it is best equipped with transport infrastructure. Considering all other places in Europe indicated as potential ends of the New Silk Road, only the port and logistics centre in Gliwice can provide such wide access to all types of transport (railway, inland, road) and in all possible directions while maintaining the lowest possible costs. The connection of the inland

waterway with a broad-gauge (1520 mm) railway track from the Far East is a project of European interest, because all European and non-European countries will benefit from this connection—from Japan, through North and South Korea, China, Mongolia, Russia and Ukraine.

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