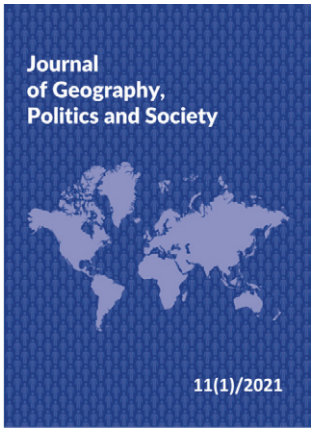

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HINTERLAND CONNECTIVITY AS A DRIVER OF THE DEVELOPMENT OF COMPETITIVENESS OF POLISH PORTS IN THE POST-EU ACCESSION PERIOD

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Abstract
Academic research has indicated that port competitiveness is multidimensional. Although a wide range of drivers of port competitiveness has already been determined, particular ports seem to use different sets of them at different development stages. This paper argues that significant growth in transhipment in Polish ports results from infrastructural development and mainly from enhanced hinterland connectivity. Before Poland had joined the EU, the hinterland connectivity was so underdeveloped that it was more convenient for many companies to use services of the German North Sea ports. However, with EU funds, road investments, travel times between the ports and hinterland have shortened by at least one-quarter. Moreover, the development of railway lines as well as the increase in the number of intermodal container terminals in the hinterland have also improved accessibility to the ports. Rail transport is especially significant for maintaining the competitiveness of ports at times of cutting-edge industry change, increasing the role of economies of scale in shipping.

Key words
port competitiveness, drivers of competitiveness, hinterland connectivity, road transport, rail transport, Poland.

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1. Introduction – systemic transformation, European integration and port competitiveness

According to Eurostat data (Gross weight of seaborne goods…, 2018), transhipment in Polish ports grew by 37.3% from 2006 to 2016. It was the second-highest growth among the coastal states of the European Economic Area. A decade earlier, T. Palmowski (1997) indicated a weakening competitive position of Polish ports when describing their operation and functioning conditions in the first years after the

systemic transformation (after 1989). The decrease in transhipment was mainly due to the peripheral geographic location, structural changes in the hinterland economy and underdeveloped hinterland connectivity. On the one hand, it was an effect of infrastructural underinvestment; on the other, it resulted from mistakes made when privatising and deregulating the transport system (Taylor, Ciechański, 2017). All the circumstances mentioned above made Hamburg the most critical seaport for Polish international trade for almost two decades. Still, in 2017 Hamburg served more than 204 thousand TEU to/from Poland. However, it was 7% less than in 2016 (Top 10…, 2019).

Thus, hinterland connectivity was a weak point of Polish seaports. Nonetheless, large infrastructural projects implemented after Poland had become the EU member state have significantly enhanced it. Therefore, this paper's main objective is to reconstruct changes in the hinterland connectivity with special attention paid to road and rail modes of transport to assess the role of hinterland connectivity in shaping the competitiveness of Polish seaports. The paper refers to the concept of competitiveness. Scientists, economists and politicians widely use this approach. The term competitiveness itself derives from works by classical economists. The numerous later interpretations significantly vary, resulting in analytical difficulties (Pilinkienė et al., 2017). For the purpose of this article, the definition by M.E. Porter (1990) was adopted, saying that competitiveness is a skill or talent resulting from acquired knowledge, able to generate and sustain superior performance as well as face competitive dynamics. This concept is used for multiscale analyses: international, national, regional, or local (business ecosystems or clusters) ones. As pointed in the literature (De Langen, 2006; Hollen et al., 2015; Lugt et al., 2015, 2017; Notteboom, Winkelmans, 2002; Parola et al., 2017), seaports can be perceived as business ecosystems and, as such, they can be analysed with the use of the concept of competitiveness (Brandenburger, Nalebuff, 1997). Their competitive position on the global transhipment market depends on the ability of the whole port community to perfect their resources, competencies and skills to cooperate between the port authority and other entities operating in the ports and their hinterland. In this case, competitiveness has an inter-port dimension and applies to ports located within the same port region and the ones located in different regions (Song et al., 2016).

Port competitiveness can be perceived and analysed as revealed (direct) and potential (indirect) competitiveness. Generally, the first category addresses the transhipment volume (Kim, 2015), the second the set of drivers affecting port performance. Thus, their revealed competitiveness has significantly increased in the case of Polish ports, as confirmed by the high transhipment dynamics (37.3%) between 2006 and 2016. The research problem addresses the role one particular driver plays in shaping transhipment volumes. In the broad sense, the revealed port competitiveness depends on the total cost of transport chains, and a particular port is its one link (Song et al., 2016). Thus, broadly speaking, the port competitiveness drivers may be categorised as follows: port location, endogenous factor, and maritime and hinterland connectivity. When analysing port competitiveness in the context of the total cost of transport chains, the traditional approach to shaping competitiveness– by port abilities and port-foreland-hinterland linkages – seems to lose its significance. At the same time, port authorities have less control over some competitiveness drivers (Meersman et al., 2016). J.M. Moya and M.F. Valero (2017) pay particular attention to seeking a real decision-maker in the choice of a container port. They state that there are two groups of decisive factors – factors under control (FC) of PAs and factors beyond control (FBC) of PAs. The FC include port performance (efficiency and effectiveness), connectivity, and port charges, while the FBC group includes transport cost, inland and maritime distance to/from the port and geographical location of the port. The authors emphasise the significance of the door-to-port/port-to-door relation as a factor in improving port competitiveness. They also point out that the absolute competitive advantage in this scope depends on port authorities, terminal operators and people managing transport systems in the hinterland.

The analysis covers the period starting after Poland's accession to the European Union, from 2004 to 2016. In this period, some crucial organisational changes were implemented in Polish ports. As already mentioned, the period of systemic transformation – symbolically narrowed to the years of 1989–2004 – was a period of stagnation for Polish ports. During that period, some essential structural changes were implemented, including those in ownership. Local authorities became co-owners of the ports, yet most were privatised, primarily the specialised port terminals. One of the achievements of this period was strengthening the market position of some ports. Investing mainly in the superstructure, the terminal operators contributed to enhancing the port efficiency and port quality. However, all those changes were not accompanied by proper infrastructural development of the ports and hinterland, which could improve the hinterland

connectivity and attract new investors to construct new terminals and establish new connections – thus improving the maritime connectivity. Such changes took place after 2004 and were possible thanks to the EU structural funds, especially under two particular financial perspectives: 2004–2006 and 2007–2013 (with budgetary execution by 2015). Moreover, Poland's accession to the European Union confirmed its economic and political stability. This coincided with the economic recovery; thus, the hinterland of Polish ports was able to produce more significant cargo flows, which then started to be transported by sea. Although the changes implemented before 2004 were crucial for the later success, they were not sufficient. The ones which took place after 2004 have opened the door for absolute competitiveness, and therefore they will be analysed in this paper mainly in the context of the development of hinterland connectivity.

2. Methods and data

The empirical part covered the analysis of changes in the hinterland connectivity in road accessibility to ports and rail terminals located in the hinterland. Here, the GIS methods were implemented, especially the network analysis. A road model was created based on the main roads network selected using OpenStreetMap for Poland (Cich et al., 2016; Stępniak et al., 2017). Speeds for the road model used for cross-sectional time analyses (1995–2015) were derived from Poland's national traffic model created by the Institute of Geography and Spatial Organization PAS. Data on infrastructural investments made from 2004 through 2013 were derived from the Ministry of Development (Komornicki et al., 2013, 2018). The primary method used when determining the shortest possible way to the seaports in the isochrone method (an isochrone is a line connecting an area with the exact arrival time) (Ratajski, 1989). Another method used is the signature method, using lines depicting road investments in the selected periods (Fig. 1). Both the investments and isochrones were divided into particular periods during which some events affecting the road system development process took place. The two decades of the research period were also divided into two: the one before the accession and the one after it. For the investments, two periods were created: 2004–2006 (the first programme period) and 2007–2013, including the investment finished in 2015 (the second programme period). The seaport time accessibility was analysed in four periods: 1995, 2004, 2006 and 2015 (Fig. 2).

3. Improving hinterland connectivity of the leading Polish ports

The hinterland of Polish ports mainly covers the area of Poland. However, the ports' impact range extends also to the Czech Republic, Slovakia, a west part of Ukraine and a part of Belarus. Despite numerous

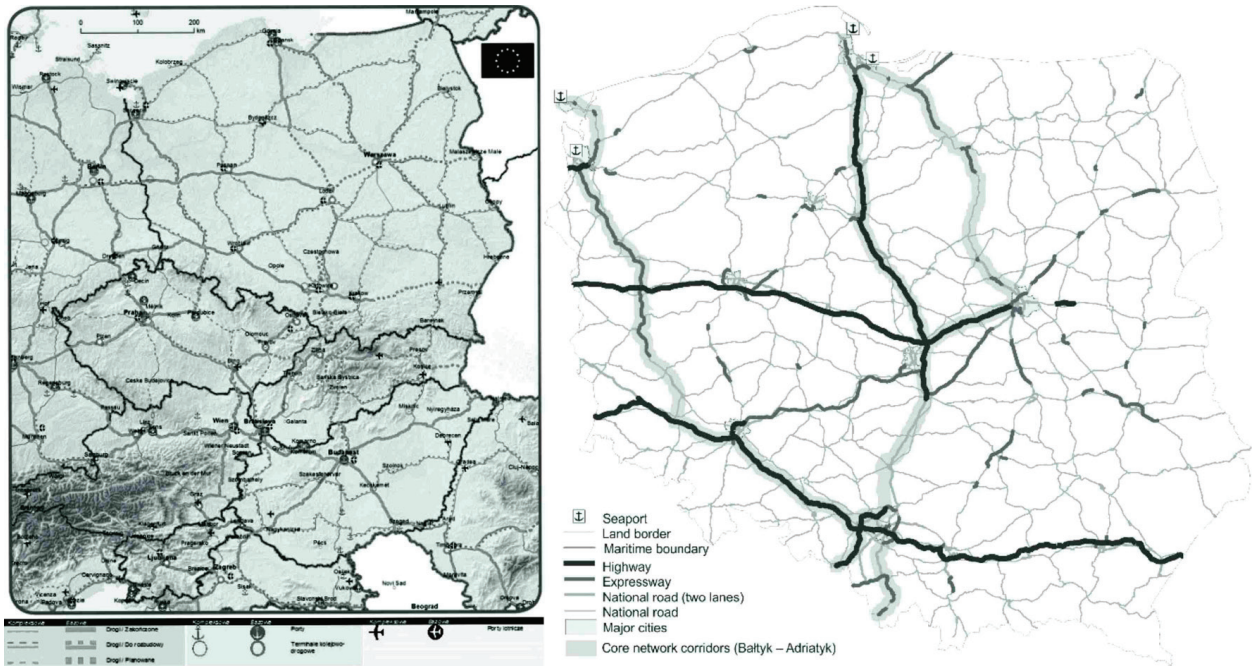

Fig. 1. Network corridors running through Poland (Baltic–Adriatic)

Source: own elaboration.

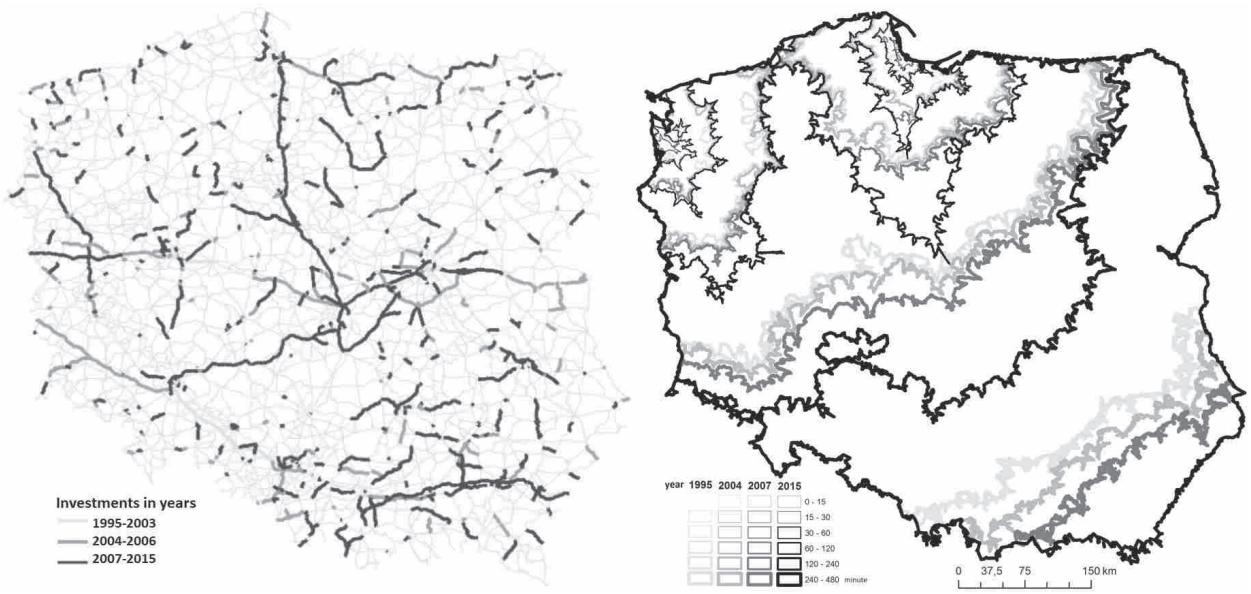

Fig. 2. Transport investments 1995–2015 (left) and changing the accessibility time (right) 1995–2015
Source: own elaboration.

social and economic problems, the systemic transformation was generally a period of economic growth. From 1989 to 2012, Polish GDP doubled (fixed prices). Simultaneously, the sold production of industry tripled; export and import values increased eightfold and tenfold, respectively (Polska 1989–2014, 2014).

Undoubtedly, the development of the infra- and superstructure enhancing nautical accessibility, port efficiency, and port quality was necessary to strengthen the Polish ports' competitive position, yet it was not enough to attract the growing volume of goods. The FBC of PA's actions were of crucial meaning – especially development and modernisation of the transport infrastructure, both road and rail, on the hinterland, resulting in a significant enhancement in port transport accessibility. This accessibility allowed attracting cargo flows from both the hinterland and foreland.

3.1. Road accessibility

The EU structural funds, especially the financial framework 2007–2013, allowed and still allow co-financing infrastructural projects which have changed the Polish road system (Komornicki et al., 2013). In the context of port accessibility, the most crucial investment was to develop and modernise roads being part of the core and comprehensive TEN-T (Trans-European Transport Networks) (Fig. 1).

In Poland, the main lorry transport routes run along the main transport corridors being part of the core and comprehensive TEN-T (Trans-European Transport Networks). The core TEN-T corridors have been established to implement large infrastructural projects of the highest European added value more effectively (Komornicki et al., 2013; Weenen et al., 2016). In the context of hinterland connectivity, the core corridors are the most important ones. There are two of them running through Poland. The first one goes latitudinally and connects the North Sea and the Baltic Sea. It can be considered a transport alternative for the Polish ports, especially for short sea shipping. The second corridor connects the Adriatic Sea and the Baltic Sea. This corridor is used to transport goods from the Polish ports inland and abroad (Fig. 1). Both alternatives run through port cities. Nowadays, the route called Via Carpathia is becoming more and more critical. It connects the port in Thessaloniki with areas located on the Baltic Sea's eastern shore and the ports in Gdańsk and Gdynia (Rosik et al., 2018).

The described road network has been intensively developed and modernised since 2004 (Fig. 1). It has resulted in visible improvement in the port road accessibility (Fig. 2) (Rosik et al., 2014). A reduction in long-distance travel times can measure this enhancement scale – between the ports and border crossing points in Gorzyczki (the Czech Republic) and Zwardoń (Slovakia). During the two decades (1995–2015) the travel times were reduced by 23–34%, depending on the relation (Tab. 1).

Although there had been some road infrastructure investments before 2004, their visible growth was recorded during the first EU programming period 2004–2006 (Komornicki et al., 2013; Rosik et al., 2017). However, they were primarily focused on the latitudinal road sections, and their modernisation has only decreased the competitive position of the Polish ports as it has improved conditions for lorry

Tab. 1. Changes in travel times between the Polish ports (Gdańsk, Gdynia, Szczecin, Świnoujście) and border crossings with the Czech Republic (Gorzyczki) and Slovakia (Zwardoń) in the years 1995–2015

Connection\time [min]	1995	2004	2007	2015	Reduction in time [min]	Reduction in time [%]
Świnoujście–Gorzyczki	505	480	462	389	116.2	23.0
Świnoujście–Zwardoń	597	557	522	450	146.8	24.6
Szczecin–Gorzyczki	459	433	415	339	119.4	26.0
Szczecin–Zwardoń	550	510	475	400	150.0	27.3
Gdańsk–Gorzyczki	532	522	507	353	178.4	33.5
Gdańsk–Zwardoń	544	542	528	391	153.0	28.1
Gdynia–Gorzyczki	545	535	513	362	183.5	33.7
Gdynia–Zwardoń	557	555	534	399	158.0	28.4

Source: own elaboration based on: Komornicki et al., 2013, 2018; Rosik et al., 2014; Rosik, Stępniak, 2015; Stępniak, Rosik, 2018; Rokicki, Stępniak, 2018.

transport. During the last analysed programming period of 2007–2013 (some of the investments were finished in 2015), the most significant number of roads were modernised or constructed in Poland (Fig. 2) (Komornicki et al., 2013; Stepniak, Rosik, 2013). Some of the road sections being part of the core TEN-T were constructed or modernised with private investors' financial participation or large consortia that manage them and charge fees later on (Komornicki et al., 2013; Rosik, Stępniak, 2015; Rosik et al., 2015). During the analysed period, a long section of express road S3 was constructed. This road is vital for the operation of the ports in Świnoujście and Szczecin. As for the ports in Gdańsk and Gdynia, the whole section of A1 from Grudziądz to Piotrków was constructed at that time, excluding the section connecting Stryków and Piotrków, which was finished in 2016 (Rosik et al., 2015, 2017). The constructed sections of express road S7 were also essential for the ports located in Tricity. During eight years, more than a thousand kilometres of roads: highways, express roads, national roads and others (provincial, county, local) as well as several dozen road junctions and other road facilities were constructed (Rosik, Stępniak, 2015). The most crucial road infrastructure projects, mainly the bypasses, have significantly increased safety on Polish roads, and they have lowered the congestion and channelled the traffic (Komornicki et al., 2013; Rosik et al., 2015). All those projects have improved time accessibility and internal consistency (Komornicki et al., 2013; Stępniak, Rosik, 2016). They have also improved port accessibility by significantly reducing travel times – mainly from central and western Poland (Fig. 2).

3.2. Rail accessibility

Two international rail lines, located in TEN-T corridor VI (Baltic – Adriatic), have basic meaning for rail services of Polish ports' (Transeuropejska..., n.d.). Line CE65 leads to Gdańsk and Gdynia and line CE59 runs to Szczecin and Świnoujście. Some national rail lines are also of significant importance for port services. They are: Gdynia – Bydgoszcz (an alternative route for CE65 line), Inowrocław – Poznań and Kołobrzeg – Poznań (Fig. 3).

Modernisation and reconstruction of rail infrastructure in Poland started at the end of the 1990s using the EU funds. The first projects, co-financed under the PHARE and ISPA pre-accession funds, concerned line E20 (east–west). During the 2004–2006 financing perspective, mainly preparatory projects were implemented. The 2007–2013 financing perspective brought intensification of the construction works to develop the whole rail network in the country. Those projects were funded under the EU programmes, the National Fund, the public budget, and the national railway infrastructure operator. At the very beginning, the projects aimed at the development of passenger transport.

Modernisation of the latitudinal rail routes, especially lines CE65 and CE59 (Palmowski, 1997), and adjustment of railways technical parameters to the international standards were the most critical actions for the development of the Polish ports. An increase in the maximum axle load to 221kN and modernisation of the traffic control system were the most significant enhancements for cargo traffic as they allowed to introduction of heavier trains into traffic and increased the railway lines capacity.

Modernisation of line 226 and construction of a new bridge on the Martwa Wisła River was a critical

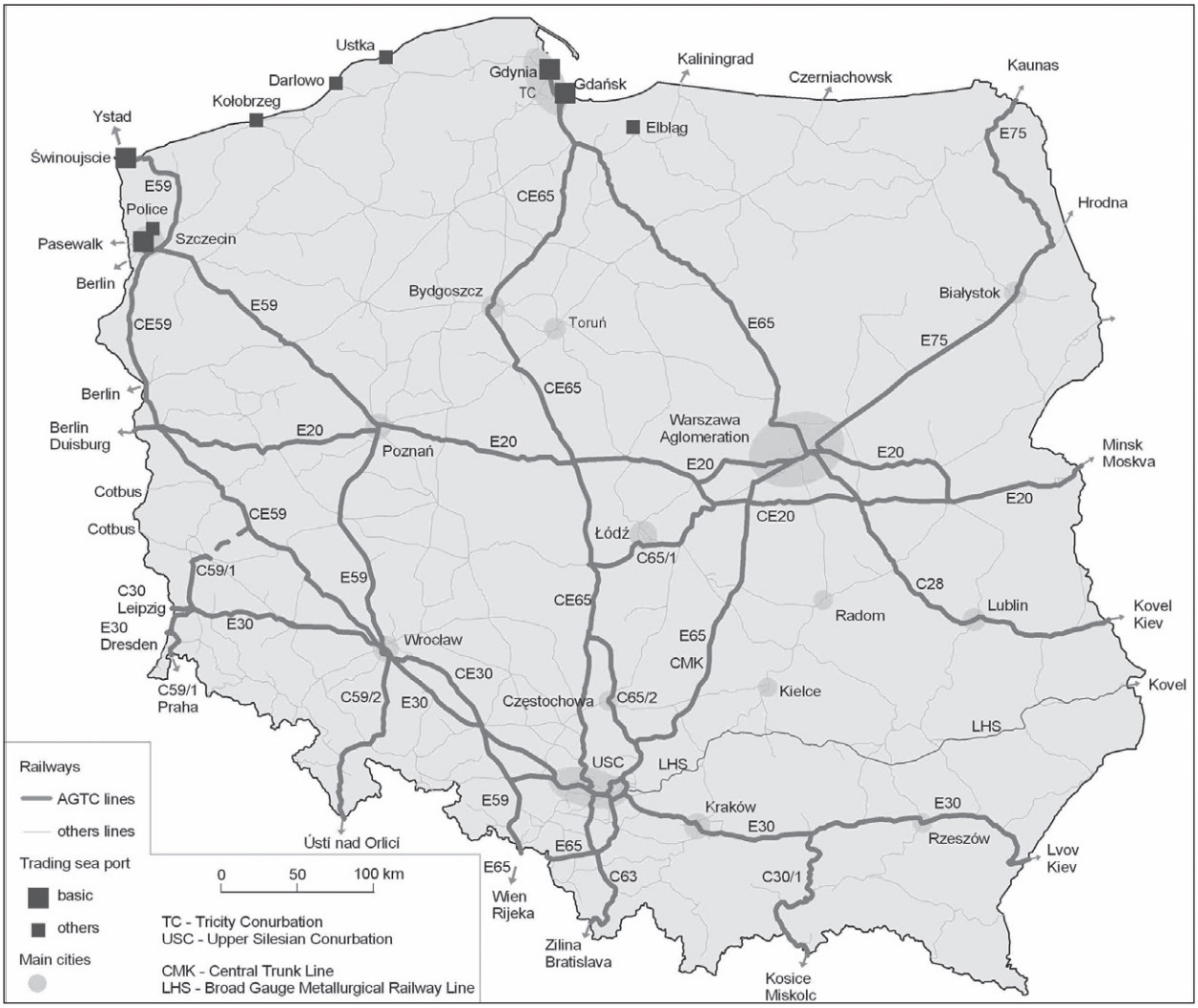

Fig. 3. Railways and trading sea ports in Poland

Source: own elaboration based on: Transeuropejska..., n.d.; Bocheński, Palmowski, 2015.

infrastructure project for the port in Gdansk. The construction works started in 2014 and finished in 2016 (Tab. 2). This line serves the eastern part of the port, including the external port and DCT terminal, the Baltic leading container hub.

In 2010, the rail network had more than a 55% share in servicing the Szczecin-Świnoujście port team and more than a 20% share in servicing the ports in Gdynia and Gdańsk (Pluciński, 2013). Such a percentage is a result of the shipment volume and structure. Bulk goods, like coal and, more often, containers, were delivered by trains. At the turn of the 20th and 21st centuries, the role of rail transport was not that significant. However, in the second decade of the 21st century, this tendency reversed in Gdynia and Gdańsk. It was a result of growing transhipment and an effect of intermodality development and an increase in the number of containers delivered by rail (Bocheński, Palmowski, 2015). In 2015, the rail network had more than a 28% share in servicing the port in Gdańsk (Dolecki, 2016). In 2012, the share exceeded 35% for the DCT terminal and 40% for the BCT terminal in Gdynia. As for Szczecin and Świnoujście, the role of rail transport has remained relatively negligible (Bocheński, Palmowski, 2015).

The network of regular container train connections between the sea and land terminals is fundamental for rail services provided to the ports. Those regular connections are especially significant for the DCT terminal in Gdańsk and two other terminals in Gdynia. When analysing the regular connections, a significant disparity between Gdańsk–Gdynia and Szczecin–Świnoujście was observed. There were, on average, 3–4 container trains a day running south from Tricity and only one train in 3–4 days from Szczecin. It is worth mentioning that regularity and frequency are the two most important advantages of intermodal transport. As for delivery speed,

Tab. 2. Rail infrastructure projects of particular significance for the Polish seaports operation were implemented in 1995–2015

Line number	Section	Source of founding	Type of works	Completion period
E65	Gdynia – Warszawa	IEP*	modernisation	2009 – 2015
CE65	Tczew – Bydgoszcz	GB	revitalisation	2010 – 2015
CE65	NowaWieśWielka – Trzciniec	RF	partial modernisation	2009
CE65	Inowrocław – Bydgoszcz	GB, RF	revitalisation	2012 – 2015
CE65	Inowroclaw – Chorzow Batory	GB, RF	revitalisation	2012 – 2015
CE59	Świnoujście – Szczecin	GB	partial modernisation	2010 – 2013
CE59	Szczecin – Dolna Odra	GB, RF	modernisation	2010
CE65	Pruszcz Gdański – Gdańsk Port Północny	IEP	modernisation	2014 – 2016

IEP – Infrastructure and Environment Programme, ROP – Regional Operational Programme, GB – Government budget, RF – Railway Fund, * – the investment was co-founded under several different projects.

Source: own elaboration based on information by Mapa inwestycji…, 2019.

container trains do not compete since all container trains in Poland run at 29 km/h. It means that it takes 17–20 hours for a container train to cover the distance between Tricity (located in the north) and significant economic centres located in the south. Reaching destinations located in central Poland takes 11–12 hours (Poliński, 2015).

The development of intermodal rail transport in Poland results in the construction of new container terminals. Before the systemic transformation (1989), only four container terminals were constructed. At the beginning of the 1990s, there were only a few terminals in operation in Poland. The process of terminal infrastructure development intensified after Poland had become a member state of the EU. In 2017 there were almost 40 terminals in operation (Tab. 3, Fig. 4). Some new sites have been built in recent years, and the existing ones have been modernised and developed, while others were closed. Modernisation of the road network facilitating distribution of goods in the rail container terminals' hinterland was a factor fostering the development of intermodal connections between the ports and the hinterland. Implementing projects aimed at constructing new roads and modernising the existing ones has significantly increased transport accessibility of the ports (Fig. 5) and strengthened their competitive position on the freight market.

4. Discussion and conclusions

The 37% increase in shipment in Polish ports recorded between 2006 and 2016 was the second-highest one among the European Economic Area's seaports. This article is perceived as a manifestation

Tab. 3. The number of publicly accessible container terminals in Poland in the selected years

Specification			Years						
			1990	1995	2000	2005	2010	2015	2017
Number of terminals	Total		4	9	12	21	30	38	38
	sea		1	2	3	5	5	6	6
	land	total	3	7	9	16	25	32	32
		with broad-gauge railway	1	2	2	4	6	7	8
Density of terminals	per 1,000 km of railway lines		0.17	0.40	0.56	1.06	1.49	1.98	1.98
	on an area of 10,000 square kilometres		0.13	0.29	0.38	0.67	0.96	1.22	1.22

Source: own elaboration based on: Bocheński, 2016; Number and characteristics…, 2017; Transport. Wyniki działalności 1995–2015, 1995–2015.

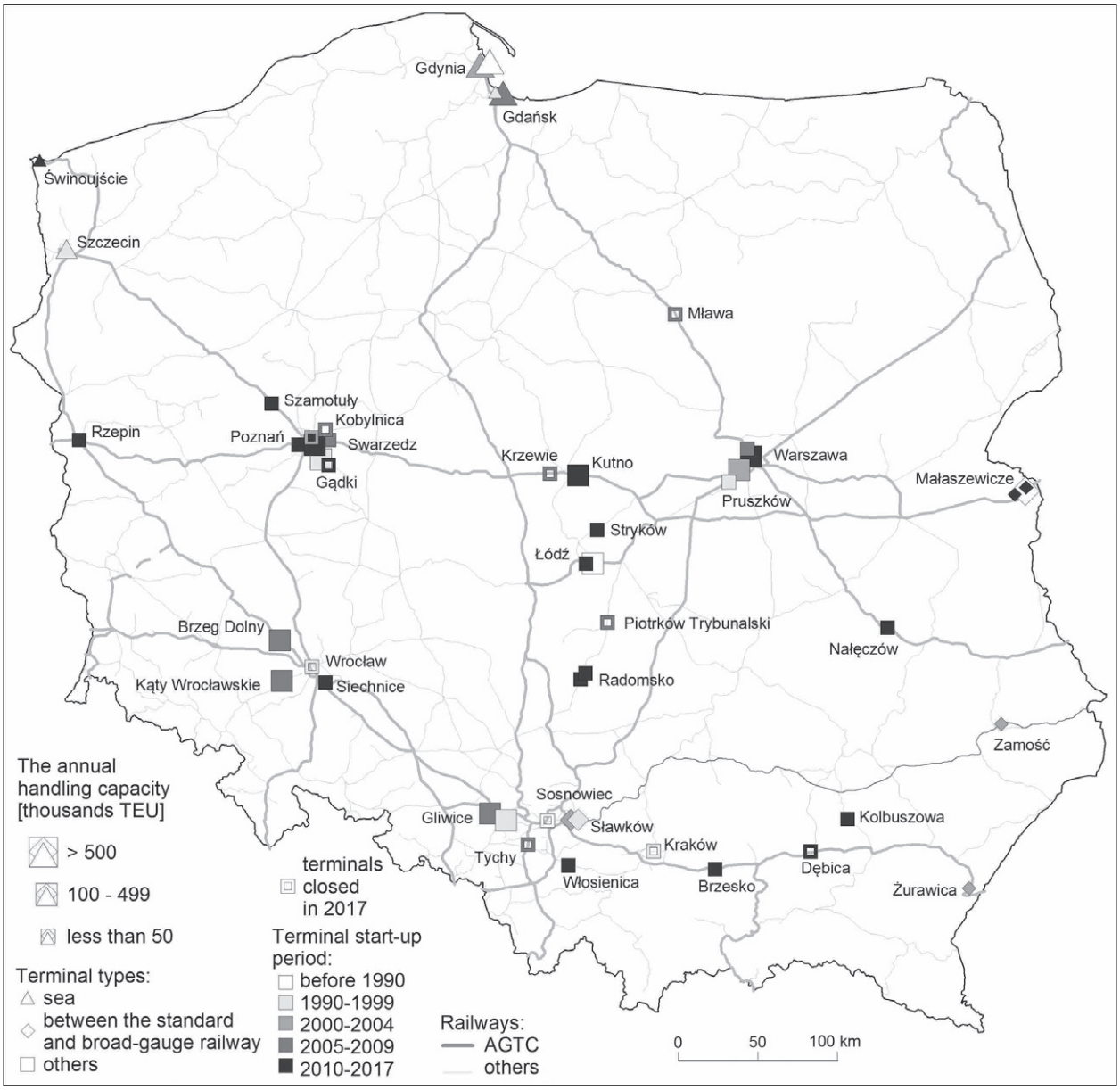

Fig. 4. Development of container terminals in Poland until 2017

Source: own elaboration based on: Bocheński, 2016; Number and characteristics…, 2017.

of the revealed (direct) competitiveness (Kim, 2015). This growth affected a set of different factors, and research results on competitiveness drivers (Parola et al., 2017) revealed. In this context, two groups of drivers have been developed the most: port infra- and superstructure and hinterland connectivity. This article focuses on the second one as, thanks to the EU funds, most of the pre-accession hinterland connectivity development barriers have been removed (Palmowski, 1997). Moreover, the enhancement of hinterland connectivity was a key development driver for the Polish ports. It has made it possible to redirect some goods that used to be delivered from the Polish hinterland to German ports of the North Sea. The scale of road infrastructural investments, focused mainly on the development of express roads and highways, has reduced travel times from the south of Poland to the ports located in the north by 23–34%. In the case of rail development projects, the enhancement resulted from the rail infrastructural projects and expansion of the network of intermodal containers terminals in whole Poland. While in 1995 there were only 9 of them, in 2015 their number reached 38, which has significantly enhanced accessibility to intermodal transport services. Most of them have regular connections to the leading Polish ports in their offer.

Referring to the classification dividing the competitiveness drivers into controlled and uncontrolled by the port authorities (Moya, Valero, 2017), it may be stated that the enhancement of hinterland connectivity in Poland is in the second group although

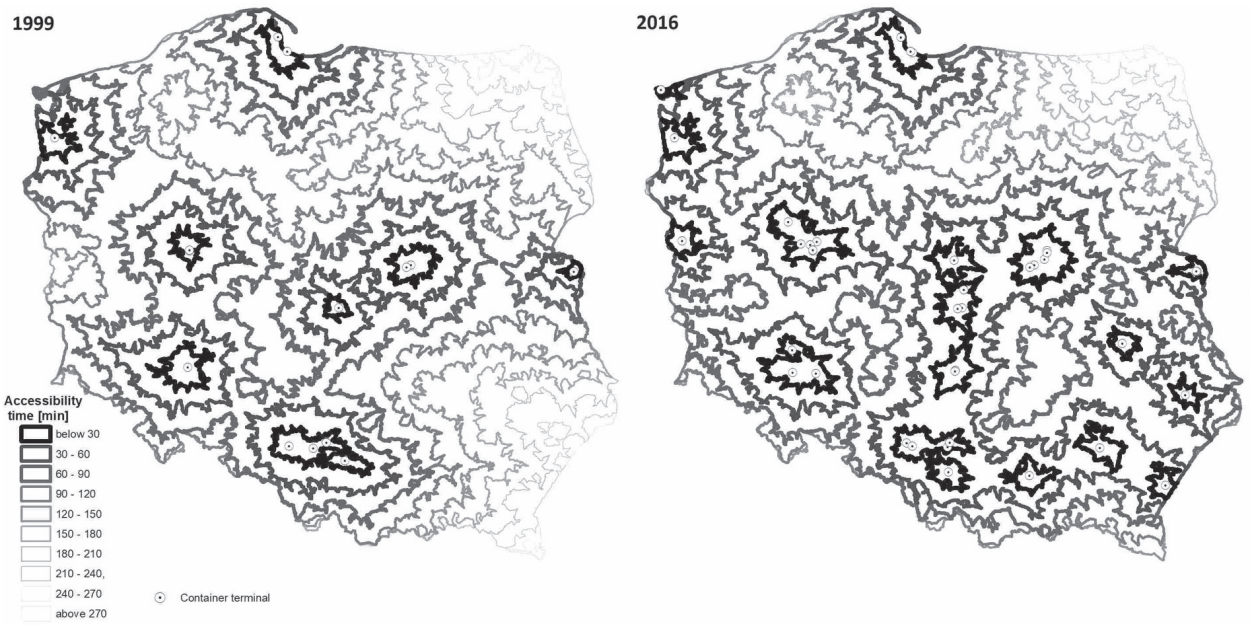

Fig. 5. Changes in time accessibility to the container terminals in 1999 (left map) and 2016 (right map)
Source: own elaboration.

the representatives of maritime affairs were lobbing for it. However, enhancement of the nautical accessibility and development of the supra- and infrastructure was under the port authorities' influence and the port community. Nevertheless, all the decisions were made with a high degree of certainty that the hinterland connectivity would be enhanced, and that the bottlenecks in servicing land-sea logistic chains would be removed.

All the transformations of the competitiveness drivers may be analysed in the context of five cutting-edge maritime logistics industry changes influencing port competitiveness (Parola et al., 2017): economies of scale in shipping, port governance changes, coopetition among ports in proximity, inter-firm networks, as well as green and sustainability challenges. The first trend seems to be the most visible in the context of hinterland connectivity. Most of the critical transformations, such as improvement in nautical accessibility, development and modernisation of port infra- and superstructure, and significant enhancement in the hinterland connectivity, were aimed at creating proper conditions for servicing larger vessels – mainly mega container ships. The success of the DCT terminal in Gdansk and its role in the development of the whole port, and its capabilities of servicing large transhipment volumes have indicated how critical it is to meet the challenges set out by economies of scale in shipping.

The analyses of changes in the hinterland connectivity focused on the spatial structure of freight systems and on one of the accessibility measures – time accessibility. Changes in cost accessibility were not subject of the analyses due to lack of data, being a commercial secret. However, such analyses should be conducted as they shed light on other important port competitiveness drivers, such as port costs and port efficiency.

To sum up, by analogy to the research on competition between ports in Hongkong and Shenzen (Tian et al. 2015), it can stated that such dynamic development of the Polish ports recorded in the analysed period was possible thanks to exploiting simple reserves, mainly in the scope of port infra- and superstructure as well as hinterland connectivity. Simultaneously, the nearest competing ports – German ports of the North Sea – focused on more sophisticated business drivers: port service quality and port site. Although costly, they used the primary reserves to increase transhipment in a relatively simple way. However, it seems to be impossible to achieve such success again. In the future, the Polish ports' operation, already having high hinterland connectivity and operational efficiency, will depend on the already-mentioned more sophisticated business drivers.

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