

Article

The Development of Major Seaports in the Context of National Maritime Policy. The Case Study of Poland

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Abstract: State authorities may influence the development of seaports by employing the tools of national maritime policy. On the one hand, seaports contribute to the socioeconomic development of coastal regions; on the other, they have a significant impact on foreign trade turnover. The aim of this study is to identify the major factors that have influenced the development of Poland's seaports in the context of the country's maritime policy. The paper examines and explains the development and transitions of major Polish seaports such as Gdansk, Gdynia, Szczecin, and Swinoujcie. In order to identify the state of the port economy the authors used public statistics and data analysis. Furthermore, they created a model of comanagement of major seaports and presented a qualitative and quantitative comparison of the development of major seaports from 2005 to 2019. It was discovered that port turnover increased, but in various ways in each of the analysed ports. The government of Poland, acting in a dual role as the coordinator of national maritime policy and the majority owner of seaports, was the most powerful decision-maker in the port economy. However initiatives to implement sustainable principles in seaports have gradually emerged through bottom-up activities of port authorities supported by local and regional authorities.

Keywords: Polish seaports; maritime policy; cargo traffic; sustainable development



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1. Introduction

Seaports are a key component of the country's transport infrastructure. They contribute significantly to socioeconomic development [1,2]. Studies show that there is a need for targeted investment in seaports in both developed and developing countries [3]. Handling activities, brokerage, and storage services are concentrated in seaports [4]. Development of seaports is a response to the dynamic growth of international trade. It is estimated that more than 90% of the volume of trade in the world is completed by sea transportation [5]. Seaports are important economic spaces, which provide a wide range of services and serve a wide range of customers including shippers, forwarders, transport companies, and logistics operators [6]. Results of the various reports from seaports worldwide clearly put forth the idea that they are a vital part of a country's economy [7].

There are clear links between global trade, port activity, and economic growth. Development of seaports results in increased investment and trade opportunities [8]. A primary source of environmental impact of seaports is terminal activities. It causes air emissions from ships at berth and terminal handling equipment, noise associated with cargo handling operations, and potential congestion associated with landside operations of barges, rail, and trucks [9]. Currently, undertaken investments must be based on balancing three aspects—the economic, social, and environmental dimensions. Sustainable development of seaports is indicated as one of the main elements in reducing environmental burdens in

the logistics chain [10]. The adoption of solutions based on the principles of sustainable development is given top priority [11].

Seaports are described as catalysts for the socioeconomic and spatial development of regions. They cover transport, industrial, commercial, logistics, and distribution functions, together with those related to spatial development (city-forming and region-forming) [12]. Seaports are constantly evolving. The change in the port economy takes place under the influence of economic changes and globalization trends. The phenomena occurring in the social sphere as well as the evolution of approaches to comprehensive protection and responsibility in the environmental sphere are also particularly important.

The development of seaports leads to an increase in the scale of threats to the natural environment. The sources of pollution in seaports can be divided into two main groups. The first is related to the presence of ships and cargo. Ships in the port are a source of pollutant emissions to the atmosphere in the form of harmful gases and dust. They also influence the formation of water and soil pollution. Important causes of pollution include activities during ship bunkering. The effects of collisions between vessels can also be dangerous.

In the case of cargo, a significant threat is created by reloading activities, especially dangerous goods (including chemicals) and activities related to their storage and warehousing. The second group covers production and service activities as well as investment and development works, including: deepening of fairways and water basins, and waste disposal. The connection of the port with the hinterland causes noise, vibrations, congestion, and the possibility of collisions and transport accidents [13]. A particularly important problem is the emission of carbon dioxide (CO₂), sulfur oxides (SO₂), and nitrogen oxides (NO₂), which have a major impact on climate change related to the greenhouse effect.

As seaports, transport and ecology are highly interlinked and an integrated research approach is needed [14,15]. The development of environmentally friendly transport systems is in line with the concept of the “blue economy” [16] and contributes to the achievement of the sustainable development goals (SDG) [17]. This also applies to maritime transport systems of which seaports are important elements [18].

Contemporary pro-ecological initiatives deal with three main elements, such as the environment, economy, and society. Green ports, the development of which takes into account the indicated elements, have become a response to contemporary challenges. They are the result of research initiatives undertaken by the scientific community and the industry community, specializing in the development policy of the maritime sector. The fifth generation ports create increasingly more close ties with the local community in order to solve problems and conflicts that arise from their activities. Therefore, the basis of port strategies should be the sustainable development of both its foreground and hinterland. They should increase the quality of logistics services and smooth cargo exchange. The activities undertaken by the port to create pro-ecological solutions are also important. These include reducing exhaust emissions, minimizing potential dangers arising from its activities, education, and knowledge exchange [19].

According to A. Martiz, C.J. Shieh, and S.P. Yeh (2014) [20], the development of green ports is a global trend. It is a response to the energy crisis and the deteriorating condition of the environment. The authors point out that in port management systems a balance should be kept between environmental protection and economic interests. Green ports are characterized by the rational use of resources. The authorities of such ports implement effective environmental protection policies, reduce energy consumption, and demonstrate social responsibility. Therefore, the idea of “ecoports” includes those ports that implement the concepts of internalizing external costs. It enables solving environmental problems using the diversified market of port services [21].

For many years, the development of ports was assessed primarily in the context of economic benefits for the state and regions [22,23]. Environmental issues were often overlooked [24]. Therefore, it has become increasingly more important to stimulate the development of ports taking into account environmental aspects [25]. In the scientific

literature, the number of publications on “sustainable ports” and “ecoports” has increased tremendously [26]. It is assumed that a port’s principal goal is to create such a socially acceptable and safe port that is also energy-efficient and ecologically acceptable while maximizing economic benefit [27]. Green development of seaports is usually supported by port authorities. The port authority is usually a public or semipublic body that is responsible for managing and improving the port area through infrastructure construction and maintenance, leasing or concessionary provision of infrastructure to private companies, and the port cluster’s growth and competitiveness [28]. Port authorities usually almost always work in cooperation with other stakeholders, among which state authorities play a key role as regulators of the maritime economy [3]. Such a situation also occurs in Poland. Polish authorities systematically include environmental issues in the maritime policy that shapes the port economy [29].

As seaports, transport and services are highly interlinked [30] and an integrated research approach is needed [4]. The growth of seaports is strongly influenced by their location in the Baltic Sea Region [31–38]. Major Polish ports are currently among the largest in the Baltic Sea [39]. A challenge is to continuously improve their competitiveness. In this context, the State maritime policy may play an important role [40]. This paper attempts to identify determinants of development of Polish major seaports resulting from the State maritime policy.

An aim of this paper is to answer the following research questions:

- (1) What are the most important factors driving a development of major seaports in Poland?
- (2) Does the direction of transformation of Polish seaports comply with the State maritime policy?
- (3) Does this policy include references to sustainable development with particular attention to seaports?
- (4) Is the notion of sustainable ports implemented at Polish ports, and if yes, how?

In the context of research objectives and problems, legal regulations in the field of maritime policy are identified and analyzed. A model of comanagement of major seaports is built, depicting the important stakeholders and their interconnections.

Development of major Polish seaports in qualitative and quantitative terms is also examined. The four largest seaports in Poland—Gdańsk, Gdynia, Szczecin, and Świnoujście—are examined as areas of fundamental importance for the national economy. Authors investigated changes in the volume and structure of cargo traffic. All analyses covered the period 2005–2019. It is shown how performed investments have influenced changes in the volume and structure of cargo handling in individual ports.

2. Materials and Methods

The studies were based on desk research and public statistics, which were used to identify the state of maritime economy and to compare the situation in major Polish seaports. In addition, research methods were supplemented by a query of Polish professional press, which made it possible to identify the latest development trends of the studied ports.

The authors used official data of Statistics Poland and information from major stakeholders of national port economy.

The studies concentrated on six basic cargo groups: liquid bulk, dry bulk, large containers, ro-ro units (self-propelled and non-self-propelled), and other general cargo [41].

Research procedure included following steps:

- Developing a model of comanagement of seaports;
- Analysis of maritime policy documents at national and European level;
- Collecting basic information about the studied seaports, including their location, quays, and handling terminals; links to the inland transport network; and position among the Baltic harbors;
- Collecting of statistical data on cargo traffic, their handling as well as visualization on graphs and analysis of the collected data in terms of an importance of each of the

studied ports in handling total and individual cargo groups, along with changes in its structure;

- Collecting and analyzing information on the main investments in the studied ports and their impact on increasing cargo traffic, and on measures to minimize the impact of ports on the environment in accordance with the concept of sustainable development.

3. Results

3.1. Maritime Policy of Poland

The model of comanagement of the main seaports in Poland indicates the key stakeholders of the port economy, including port authorities, operating as joint-stock companies, as well as state, regional, and local authorities (Figure 1). The co-owners of the ports are state authorities and local self-government authorities, i.e., the cities of Gdańsk, Gdynia, Szczecin, and Świnoujście. The state, as a regulator of maritime economy, carries out its tasks through the minister responsible for maritime economy and the maritime offices in Gdynia and Szczecin. These offices, on behalf of the government, cooperate with port authorities and implement selected investments that have an impact on port operations. Seaports are located in two administrative regions, i.e., in the Pomorskie and Zachodniopomorskie voivodeships. The voivodeship authorities do not own the ports. However, they have an indirect impact on their functioning by shaping the regional policy related to the maritime policy of the state.

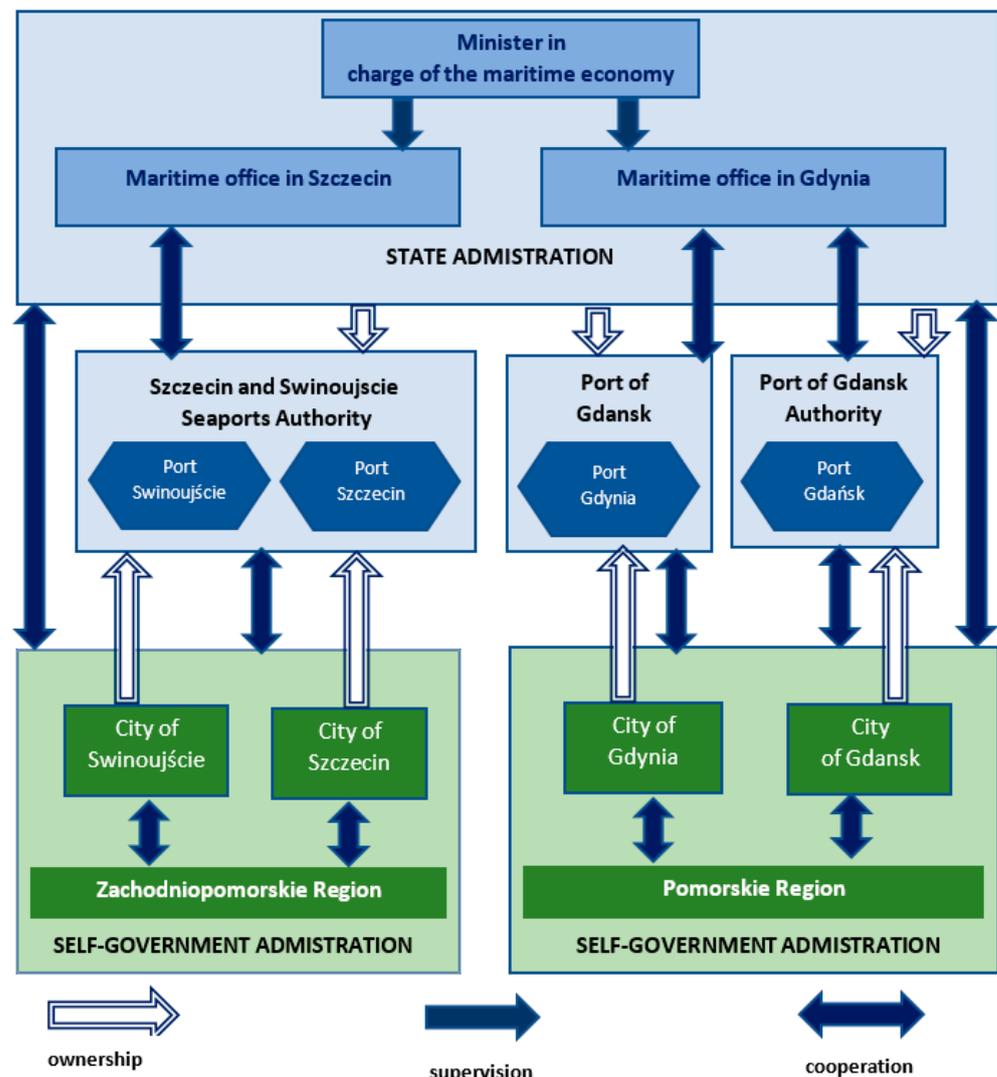


Figure 1. Model of comanagement of major seaports (own study, based on [42–44]).

The Pomorskie [45] and Zachodniopomorskie [46] voivodeships' strategies included issues connected to the growth of the port economy. There was a mention of the necessity for port authorities to have a stronger role in port management. At the same time, regional government authorities committed to improving seaport accessibility and developing multimodal nodes that connect seaports to the region's transportation infrastructure.

At the state level, crucial activities on development of maritime policy were initiated in 2008. For this purpose, an Inter-Ministerial Maritime Policy Team of the Republic of Poland was established [47]. The effect of its work was a development of the official document setting out priority and directions of State maritime policy. This document was adopted by the Polish government in 2015 [48]. Nine directions of maritime policy are listed therein, among which the following were considered the most important: strengthening the position of Polish seaports, increasing the competitiveness of maritime transport, and ensuring maritime safety and security. The others concerned a rational use of natural resources of the sea as well as energy security. Improving access to seaports from the land—road, rail, inland waterway, and pipeline connections—and from the sea—fairways, breakwaters, and port entrances—were highlighted. The need to develop seaports as logistics centers and increase their share in the global market was pointed out [48]. Further important national documents relating exclusively to seaports were:

- (1) Act on Seaports and Harbors [49];
- (2) Seaport Development Strategy until 2015 [50];
- (3) Polish Seaport Development Strategy until 2030 [51].

Directions of activities related to ports and maritime transport were also included in other strategic documents. The *Strategy of Transport Development until 2020* assumed: development of infrastructure in seaports and their hinterland, strengthening the economic function of seaports, and increasing the importance of maritime shipping in the supply chain of goods and passenger transport [52], whereas the *Strategy for Sustainable Transport Development until 2030*, which replaced a/m document, underline the need for new construction and modernization of existing infrastructure, including expansion of outer ports. The key undertakings foreseen by 2030, i.e., the Central Port in Gdańsk, the Outer Port in Gdynia, and the Container Terminal in Świnoujście, are also listed there. These activities are expected to make ports in Gdynia and Świnoujście so-called "hubs" and will strengthen Gdańsk, which already plays such a role [53].

Since Poland belongs to the European Union, the EU rules should also be enforced in addition to national maritime policy. There are more than 1200 seaports in the EU, through which more than 33% of intra-EU goods and about 75% of goods traded with non-EU countries pass annually. The volume of cargo handled in EU ports is forecasted to increase 50% by 2030 [54]. Directions of the European maritime policy can be found in EU regulations:

- (1) Assumed the development of an EU port system (2007) [55];
- (2) Included guidelines for developing national maritime policies (2008) [56];
- (3) Suggested transformation of seaports into intermodal hubs of the Trans-European Transport Network (TEN-T) (2013).

EU funding has been secured for seaport development [57]. The "EU Strategy for the Baltic Sea Region" was adopted in 2009. It covered eight Member States with access to the Baltic Sea: Estonia, Denmark, Finland, Germany (federal states: Berlin, Brandenburg, Hamburg, Mecklenburg–Vorpommern, and Schleswig–Holstein), Latvia, Lithuania, Poland, and Sweden [58].

The Action Plan for the implementation of this Strategy was updated in 2021. It establishes three main objectives and nine specific objectives. Two relate to the operation of seaports: "clean and safe shipping" and "good transport conditions". One of the three assumed activities within the clean shipping thematic area is to support the development of quayside facilities for clean maritime transport, including alternative fuel infrastructure [59].

3.2. Characteristics of the Studied Ports

There are 33 seaports on the Polish coast [48] including four ports of primary importance for the Polish maritime economy located in Gdańsk, Gdynia, Szczecin, and Świnoujście [49]. They are ranked among the top ten largest ports on the Baltic Sea (Figure 2). The ports of Szczecin and Świnoujście form a pair under joint management.

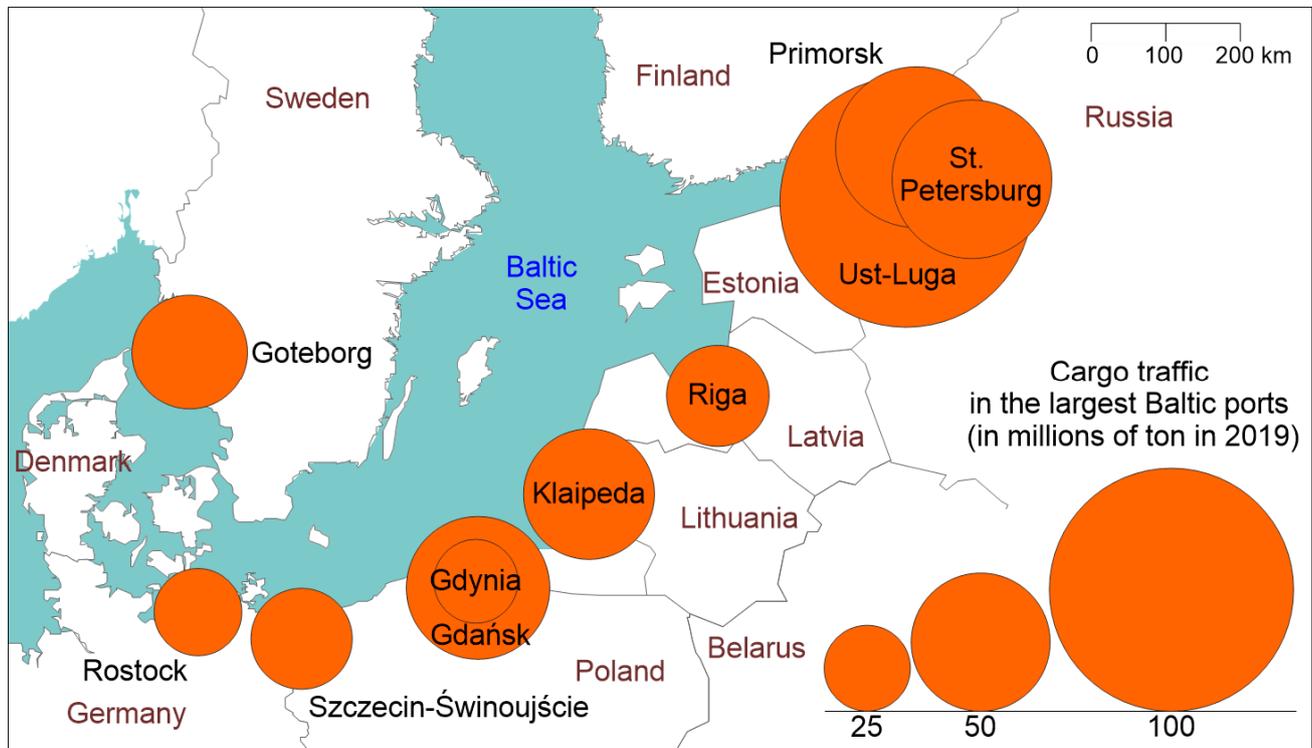


Figure 2. The largest seaports on the Baltic Sea (own study, based on [60]).

The studied seaports are located in two metropolitan areas—Gdańsk (Tricity) and Szczecin. As ports of fundamental importance, they are managed by state-owned enterprises. These ports are connected to the Trans-European Transport Network (TEN-T)—corridors VI and XII (Figure 3) and the rail freight corridor no. 5. Ports of Gdańsk and Gdynia are located in the central part of the southern Baltic coast on the Gulf of Gdańsk. Port of Gdańsk is the largest container hub in the Baltic Sea and the largest Polish logistical node. Szczecin and Świnoujście form Poland's westernmost port complex. Location of this complex places it on the shortest sea route connecting Scandinavia, Baltic countries, and Russia with Southern and Western Europe. The Szczecin–Świnoujście port facilities cover western Poland, Berlin, and Brandenburg, and the Czech Republic, while Gdańsk and Gdynia seaports cover the whole of Poland, eastern Czech Republic, Slovakia, and western Ukraine.

All studied ports, apart from Szczecin, are available for ships with a draught of more than 10 m, including the largest vessels entering the Baltic Sea with a draught of up to 15 m. All four ports have intermodal terminals, including container terminals, whose importance in global transport chains is constantly growing. The ports of Gdańsk and Gdynia have large container terminals and extensive logistical facilities, which are lacking in Szczecin and Świnoujście (Table 1).



Figure 3. Commercial seaports in Poland against the background of major transport corridors (own study).

Table 1. Characteristics of major seaports in Poland in 2019 (own study, based on [41,51,61,62]).

Characteristic	Gdańsk	Gdynia	Szczecin	Świnoujście
Geographic location	Gdańsk Bay (Gulf of Gdańsk) * estuary of the Dead Vistula **	Gulf of Gdańsk and harbor channel	Oder River and its branches, 68 km inland	Pomeranian Bay * estuary of the Świna River **
Length of handling quays suitable for use (in meters)	10,790	11,287	11,340	6768
Maximum vessel dimensions (in meters)	draught	15.0 *	9.1	12.5 *
	LOA	400	366	320
Transport connections ^a	Road ^b	E75 (A1), E77 (S6)	E28	E28 (S6, A11), E65 (S3)
	Railway ^c	CE65	CE65	CE59
	Waterway ^d	E40 ^f	-	E30

Table 1. Cont.

Characteristic	Gdańsk	Gdynia	Szczecin	Świnoujście
Port and harbor industries except shipyards ^e	refinery, chemical industry	-	chemical industry	-
Logistics facilities	Pomeranian Logistics Center	Logistic Valley ^g	-	-
Ferry connections to Sweden	Nynäshamn	Karlskrona	-	Ystad, Trelleborg
Number of specialized terminals	4 * 11 **	10	11	1 * 5 **
Container terminal capacities (millions TEU per year)	3.25	1.83	0.12	0.07
Population of the port city (in thousands)	470.9	246.3	401.9	40.9

^a Trans-European Transport Network (TEN-T); ^b AGR; ^c AGCT; ^d AGN; ^e industries generating cargo streams in the port; ^f the Vistula waterway is navigable only in a short section; ^g the distributed logistics center formula; * external port; ** internal port.

The state owns the vast majority of shares in the joint stock companies that manage the analyzed ports. The remaining shares belong to the port cities and other investors (Figure 4).

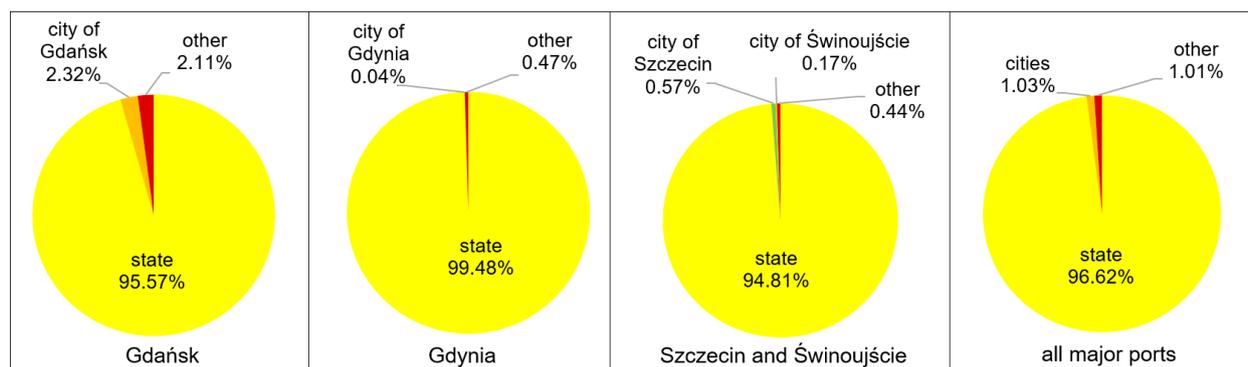


Figure 4. Ownership structure of major seaports in Poland in 2020 (own study, based on [63–65]).

3.3. Cargo Traffic in Seaports in Poland

Cargo traffic in major ports shows an upward trend. Between 2005 and 2007, only Gdynia recorded an increase, while in 2009 the turnover of the nearby Gdańsk started to grow. After a decrease in 2011 in Gdańsk and Świnoujście, since 2012, a continuous increase in turnover has been recorded in all four ports. The largest increases were in 2010 (32%) and in 2018 (18%) (Figure 5).

Apart from 2007–2008, in the entire period under study, the port of Gdańsk was responsible for more than 40% of cargo traffic and its share among Polish seaports in 2019 reached 48.5%. The port of Gdynia was responsible for more than 20%, with a peak in 2007 when it reached 28.3%. The share of port of Świnoujście in terms of cargo traffic was between 17%–19%, with periodic drops below 16% in 2006–2007 and 2009, along with a peak in 2012, when it reached 19.2%. In contrast, the share of port of Szczecin decreased to 10%, with the highest in 2008—15.9%. Other Polish ports were of minor importance and accounted for 2–5% of the cargo traffic during the studied period (Figure 5).

In terms of cargo type, dry bulk cargo accounted for the largest share, between 31% and 43%, with a slow decline in their share since 2014. Liquid bulk cargo was second—from 22% to 31% of cargo traffic. Handling of cargo was characterized by some fluctuations with a maximum in 2010 and an upward trend since 2017. The third group was containers,

with their share steadily increasing, apart from slight decreases in 2009 and 2015. In 2019, they accounted for almost 25% of cargo traffic. The share of rolling cargo was relatively stable—between 9.5% and 11.5%. Rolling self-propelled cargo accounted for an average of 8.9%, with a maximum in 2016–2017 when its share exceeded 10%. The share of non-containerized general cargo varied between 5.1% and 7.1% between 2009 and 2019, with a minimum in 2014 and maximums in 2009 and 2018 (Figure 6). Overall, bulk cargo accounted for about 60% of cargo traffic and prevailed in the three ports. Only Gdynia showed a slight predominance of general (break bulk) cargo.

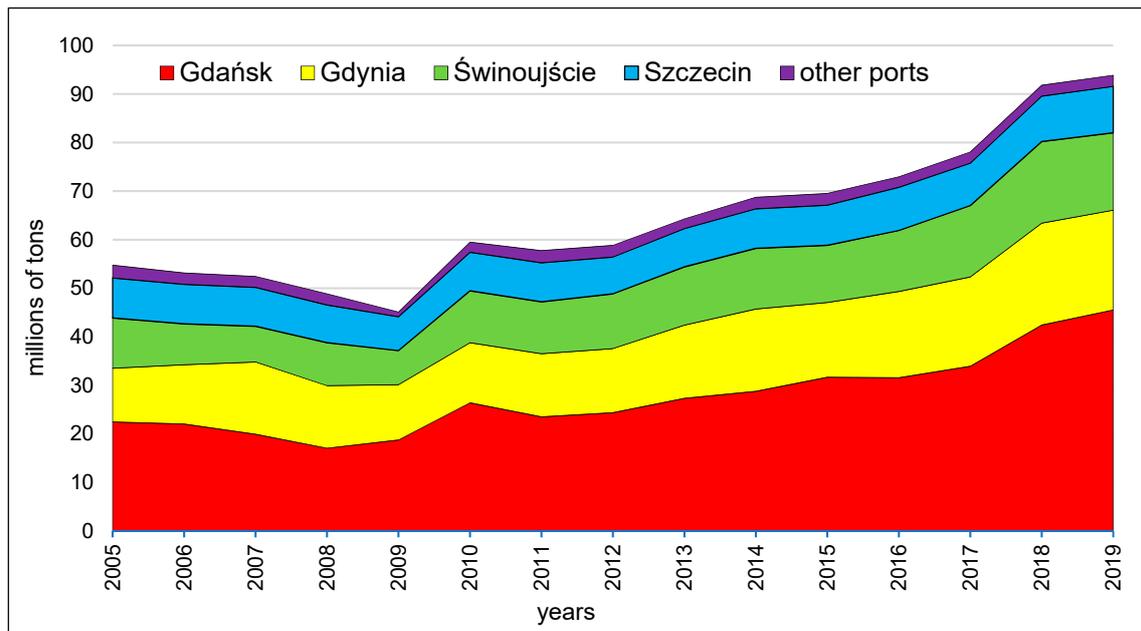


Figure 5. Cargo traffic in seaports in Poland in the years 2005–2019 (own study, based on [41,66]).

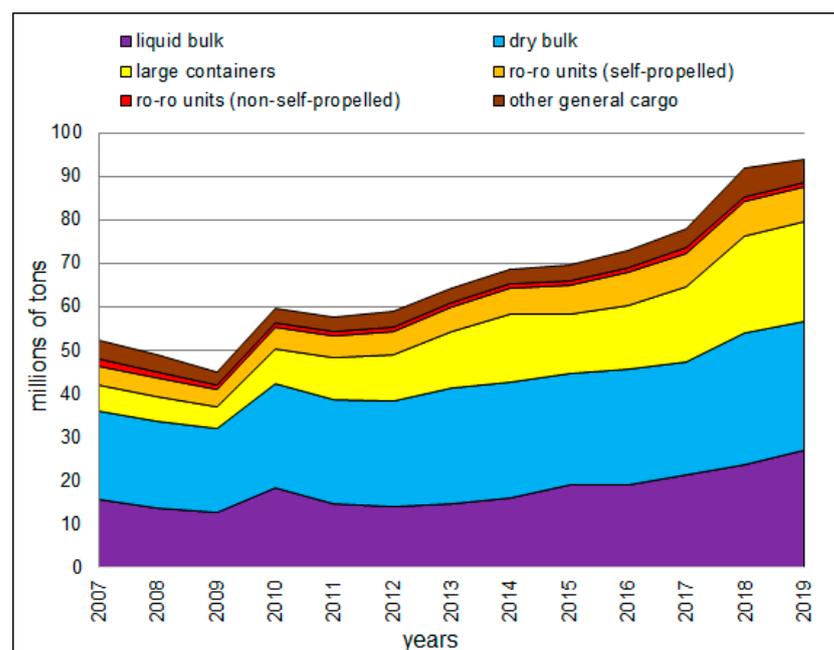


Figure 6. Structure of cargo traffic in seaports in Poland in the years 2007–2019 (own study, based on [41,66]).

An increasing share of intermodal transport, among which containers are the vast majority, can be observed in port cargo traffic. Bulk commodities are traditionally dominated by energy-producing raw materials: crude oil and coal, while the importance of liquefied natural gas (LNG) is also increasing.

In the port of Gdańsk, liquid bulk cargo accounted for more than half of the cargo traffic until 2010, but in 2017 its share fell below 40%. The main commodity in this group was crude oil and its products. This is due to the functioning of a deep-water oil terminal and a large refinery in Gdańsk. Since 2010, a dynamic increase in container handling has been visible. As of 2017, they constituted the second largest cargo group handled by this port. Dry bulk cargo also played an important role. Its share ranged from 23.6% in 2008 to over 30% in 2009 and 2013. Other cargo groups were of minor importance. The share of rolling cargo was the highest in 2008—3.5%. Gdańsk handled more than 60% of liquid bulk cargo and containers and more than one-third of dry bulk cargo transhipped in Polish ports (Table 1). It owes its position mainly due to the possession of the deep-water port and a developed industry [60]. Over 90% of crude oil and over 50% of coal and coke handled by Polish ports were concentrated in the port of Gdańsk. The share in handling of refined oil products was also high but declining in recent years, mainly to the benefit of the port of Gdynia.

In the port of Gdynia, dry bulk cargo was on the first place in a structure of cargo traffic, followed by containers. Dry bulk cargo accounted for 32.0% in 2007 and 33.8% in 2018 up to 47.5% in 2009. The share of containers was maintained at a level of more than 30%, except in 2009 and 2010, when it fell to 24.0 and 27.8% respectively. In contrast, it reached a maximum in 2014—42.1%. Liquid bulk cargo accounted for more than 10% except for the years 2011–2015 when its share fell below 9%. Between 2007 and 2014, the share of self-propelled rolling cargo was between 7.6% and 9.0%. The maximum was recorded in 2015—10.4%, followed by a decline. The share of non-self-propelled rolling cargo fell from 6.7% in 2007, to 2.7%, and then increased to exceed 3.5% in 2019. It should be noted that the port of Gdynia accounts for almost 70% of the turnover of this cargo group handled by Polish ports. Non-containerized general cargo accounted for a few percent—the minimum was recorded in 2014—3.2%, and the maximum in 2018, when its share rose quite sharply to 10.3%. Gdynia is the most universal Polish port, having a share of 20% and more in handling five of the six analyzed groups transhipped in all ports in Poland. Intermodal is extremely important. Gdynia is also a major port for grain; in 2019 its share in handling agricultural products among Polish ports was 63.3%.

In the port of Świnoujście, as recently as 2007, dry bulk cargo accounted for more than half, but its importance subsequently declined. At the turn of 2014 and 2015, its share fell sharply by as much as 9.6%. Since then, it has fluctuated between 26.9% and 33.0%. Handling of ore and scrap metal was of significant importance, from around 50% to over 70% of this cargo group in Polish ports. At the same time, the importance of handling of liquid bulk cargo was increasing, with a share exceeding 20% in 2016 and 30% three years later. This is undoubtedly due to the launch of the gas terminal. This terminal handles more than 80% of the liquid gas transhipped in Polish ports. Świnoujście is also Poland's largest ferry port, so rolling cargo accounted for more than 30% of its cargo traffic and reached more than 47% in 2015–2016. Świnoujście handled more than 70% of self-propelled rolling cargo transhipped in Polish ports and ranked among the top ten largest ferry ports on the Baltic Sea [67]. Non-containerized general cargo accounted for a few percent, only in 2009 and 2015 it exceeded 6.0% and 5.4%, respectively.

In Szczecin, an increase in the share of liquid bulk cargo and a decrease in dry bulk cargo were observed until 2017. For almost the entire period under study, dry bulk cargo accounted for more than half, reaching a share of 64.2% in 2009. From 2015 onwards, its share declined reaching less than 50% between 2017 and 2018, followed by a rebound. A relatively large share in the structure was occupied by non-containerized general cargo, with a share outside 2009 exceeding 20%, reaching a maximum in 2018—29.5%. Containers accounted for an average of 6%, with only 7% in 2009, the best year in this respect.

Szczecin is the largest Polish general cargo port; it handled almost half of this cargo group transhipped in Polish ports. This group included, among others, metallurgical products, in which Szczecin recorded a share of over 50% among Polish ports. The port specializes also in oversized cargo: granite blocks, paper, and cellulose.

In 2018, the cargo traffic in all Polish ports exceeded 90 million tons. As late as 2015, only Gdańsk was in the top ten Baltic ports in terms of cargo handling [67]. A few years later, Gdynia also joined this list, while Gdańsk in 2019 was ranked fourth. The top ten largest ports in the Baltic Sea also include the port complex Szczecin–Świnoujście, which is counted together [68].

3.4. Traffic of Containers in Seaports in Poland

Intermodal transport is the most dynamically developing transport segment. Container terminals in seaports are key elements of the intermodal transport infrastructure. In Poland, as in other countries, container handling is playing an increasingly important role.

Polish seaports currently have a total of four container terminals, Gdynia has two (BCT and GCT) and the remaining ports have one each [69]. Until 2009, Gdynia was the largest Polish container port, but in 2010 Gdańsk became the leader in this respect. Since 2012, the port of Gdańsk has been ranked second among the Baltic ports as per containers handling, and if we consider transshipments in Gdańsk and Gdynia together, a complex of these ports is the busiest on the Baltic Sea. On the other hand, container handling in Szczecin was at the level of several tens of thousands of TEUs and in Świnoujście only a few thousand TEUs per year (Figure 7).

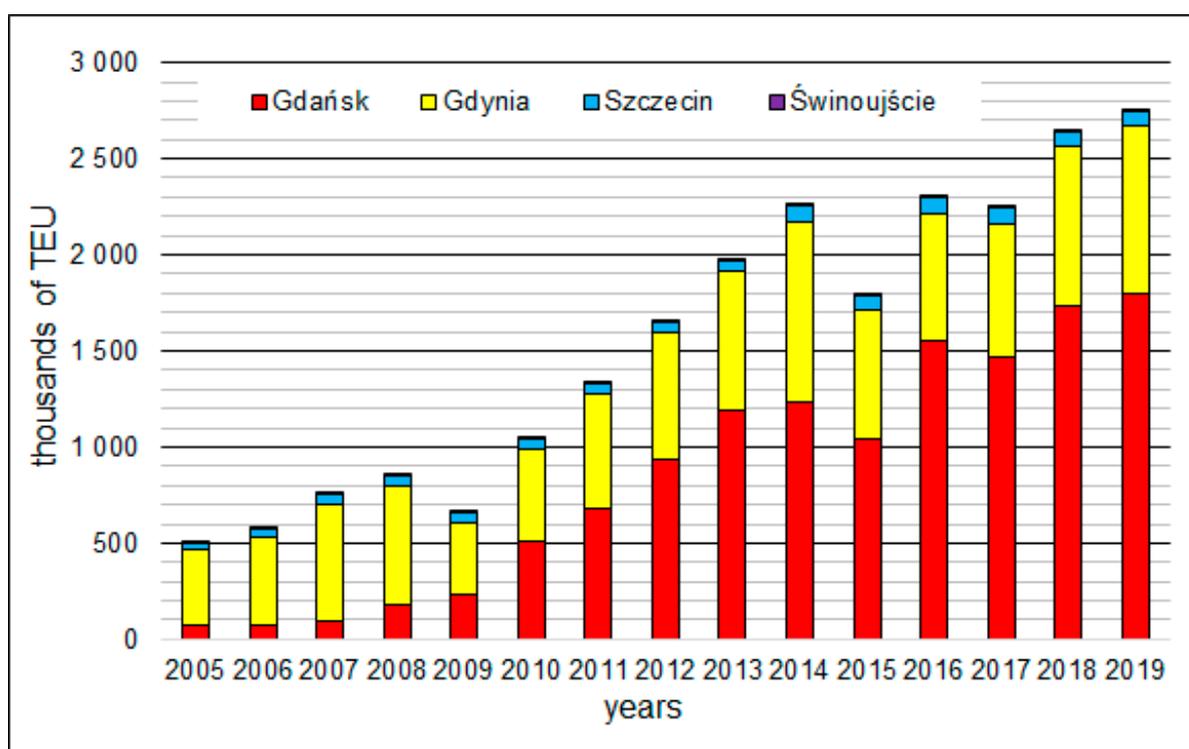


Figure 7. International maritime traffic of containers in seaports in Poland in the years 2005–2019 (own study, based on [41,66].)

An important factor affecting a development of terminal infrastructure is the use of an existing handling capacity. In Gdańsk, a share in the handling of containers exceeded the share in the handling capacity, whereas in remaining ports it was lower. The existing Polish container terminals still had capacity reserves (Table 2). The terminal in Świnoujście was the least used, where only in 2017 the level of 10% had been exceeded. On the other hand, the terminal in Szczecin in the best year 2014 had occupancy of 72%. It should be

noted that the DCT terminals in Gdańsk and GCT in Gdynia were enlarged during the analyzed period—in case of DCT, its handling capacity has been doubled.

Table 2. Capacity utilization of container terminals in Polish seaports in 2018 (own study based on [69,70]).

Port	Handling		Annual Handling Capacity		Utilization Rate (%)
	TEU	%	TEU	%	
Gdańsk	1,948,974	68.8%	3,250,000	61.7	60.0
Gdynia	803,871	28.4%	1,830,000	34.7	43.9
Szczecin–Świnoujście	81,451	2.9%	190,000	3.6	42.9
Total	2,834,296	100.0	5,270,000	100.0	53.8

It is forecasted that in 15–20 years, container handling in Polish ports may reach 8 million TEUs [71], while some indicate even 9.5 million TEUs [72].

3.5. Economic Aspects of the Development of Seaports in Poland

The Polish state earned double in ports—as the main shareholder of port companies and through tax revenues. It is estimated that in the second decade of the 21st century, seaports handled about 40% of Poland’s foreign trade and generated significant revenues to the state budget due to customs and tax duties [73]. In 2018, revenues to the state treasury amounted to PLN 40.6 billion, which accounted for 11% of state revenues, of which 8.5% was attributable to the ports of Gdańsk and Gdynia [73]. The largest revenues to the state budget were generated by the DCT Gdansk container terminal—PLN 10 billion [74]. It was related to the fact that this terminal performs the function of a hub terminal in the Baltic Sea.

In the years 2013–2020, all major ports reported a net profit, which in total amounted to an average of almost PLN 168 million per year. The highest profit was recorded in 2017, after which it began to decline systematically (Figure 8). These profits were largely spent on investments. The most profitable ports were in Gdańsk and Gdynia, which can be associated with high cargo turnover and a significant share of containerized cargo.

In the analyzed period, many investments were carried out in the main ports, a large part of which was cofinanced by the European Union. In the years 2007–2020, a total of 55 projects were implemented that were closely related to the development of the main seaports. Additionally, one project cofinanced by Norway Grants. These projects focused on infrastructure and superstructure in the ports themselves and their immediate hinterland, as well as links to the land transport network. Cofinancing of the investment came from four programs (Table 3), the most important of which was the EU Operational Program Infrastructure and Environment (OPIE). In Poland, among the maritime transport projects cofinanced by the OPIE, as many as 75% related to the analyzed ports. The Connecting Europe Facility (CEF) instrument, based on competitions at the EU level, was of significant importance. CEF was aimed at supporting infrastructure investments in key elements of the trans-European transport network. The implementation of seven CEF-financed projects by Polish ports proves their effective management.

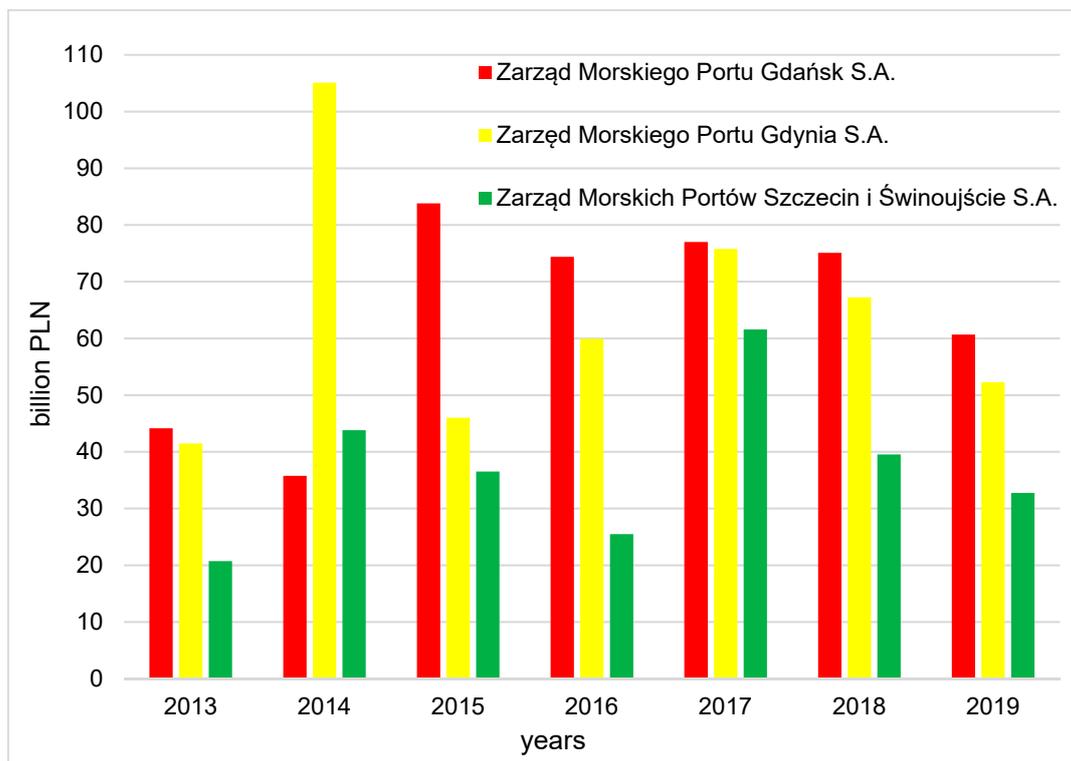


Figure 8. Net profit of major seaports in Poland in the years 2013–2019 (own study, based on [75–77]).

Table 3. Number of projects cofinanced by the European Union implemented in major ports in Poland in 2007–2020 (own study, based on [78–81]).

Source of Financing	Major Seaports					
	total	Gdańsk	Gdynia	Szczecin–Świnoujście Port Complex **	Szczecin	Świnoujście
OPIE	47 *	14	12	10	7	3
TEN-T and CEF	8	5	-	-	1	2
EEA Norway Grants	1	-	1	-	-	-
Total	56	19	13	10	8	5

OPIE—Operational Programme Infrastructure and Environment, TEN-T—Trans-European Transport Network programme, CEF—Connecting Europe Facility, EEA—European Economic Area; * one project concerned all ports with container terminals; ** projects involving investments in both ports and connections between these ports, including the modernization of the waterway.

The number of investments and their scope resulted from the potential of individual ports. The leader was the port in Gdańsk. In the case of the ports of Szczecin and Świnoujście, the modernization of the waterway connecting both ports was of significant importance. The Maritime Office in Szczecin was responsible for this investment.

3.6. Environmental Activities of the Major Seaports

All ports pursued a policy of protecting the Baltic Sea area against pollution from ships and from land-based sources, in line with the Helsinki Convention, recommendations of the Helsinki Commission, and the International MARPOL Convention. The activities of these ports were carried out in accordance with the environmental protection regulations of national and EU law and in accordance with the environmental protection permits held. Pro-ecological activities of the ports are confirmed by many obtained ISO certificates in the field of implementing the environmental management system. The ports carried out

environmental monitoring including: air pollution measurements, tests of the cleanliness and quality of port waters, and measurements of noise emissions. The ship waste collection system was also improved [82–84].

In line with the concept of green ports, actions were taken in Poland towards energy transformation, including the development of offshore wind energy. Structural elements of offshore wind farms were created in the ports of Gdańsk, Gdynia, and Szczecin. The port of Gdynia, which is to act as the main operator in the case of reloading, completing and transporting structural elements of wind farms built in Polish sea areas, was highly involved in the development of the offshore sector. This port is in line with the idea of green ports and runs an active pro-ecological policy. Port authorities take an active part in partnership European initiatives aimed at reducing pollution entering the water [85]. Electricity infrastructure was developed to supply ships during berthing at the quay, which reduced the emission of air pollutants and noise in the port [86]. Moreover, in the main ports, port quays adapted to the bunkering of LNG ships have been designated.

4. Discussion

In line with the assumptions and directions of the State maritime policy, the development of Poland's largest seaports was clearly visible during the period under study, although its scale varied from port to port.

According to the study findings, the primary variables driving the growth of Poland's major ports are:

- (1) Geographical location;
- (2) Quality and capacity of transport connections with the hinterland;
- (3) Presence of deep-water terminals, accessible to the largest vessels entering the Baltic Sea (Gdańsk);
- (4) Presence of large intermodal terminals (container terminals—Gdańsk and Gdynia, ferry terminal—Świnoujście);
- (5) Economic potential, logistical facilities (logistics and warehousing centers).

A position of the port of Gdańsk was systematically growing. Increased cargo traffic in this largest Polish port was connected with investments in, inter alia, expansion of intermodal terminals and improved access from the landside. Creating in Gdańsk a container hub on the Baltic Sea with direct shipping connections to Southeast Asian ports and a network of feeder connections was possible owing to establishing the Deepwater Container Terminal (DCT) and attracting the Maersk company, one of the leading container vessel operators in the world. Overall, since the establishment of DCT in Gdańsk, the share of containers in the port's cargo traffic has increased by 30%. Gdańsk has been ranked second in terms of container handling on the Baltic for several years. However, it should be noted that St. Petersburg, which was ranked first, served only CIS countries, whereas the port of Gdańsk, as a result of feeder connections, served the entire Baltic Sea region. Launching from DCT in 2010, the first direct connection to China by Maersk caused its very dynamic development. After a few years, the terminal's handling capacity was exhausted, and it was expanded by adding another quay and storage yards. As a result, DCT's cargo traffic was doubled in 2016. The Pomeranian Logistics Center (PLC), established at the direct back of DCT, performs not only the basic functions of storage and handling services, but also serves re-exports. Investments also included expansion and modernization of road and rail infrastructure leading to the port, owing to which it meets current European standards. Further investment plans call for a substantial expansion of the outer port.

The port of Gdynia has become specialized in handling general cargo, mainly transported using containers and ro-ro system. It was the first container port in Poland and the largest until 2010 (Figure 7). The development strategy of the port of Gdynia assumes a gradual deepening of the waterway and inner basins to a depth of 16 m; this should ultimately enable servicing the largest vessels entering the Baltic Sea. All quays have been modernized and the road and railway systems at the back of the port have been rebuilt. A new public ferry terminal located at the entrance to the port is also under construction.

It will enable easier maneuvering of ferries and shorten the time of their stay in the port, as well as significantly facilitate access to the center of Gdynia for arriving passengers. Existing ro-ro terminal will be also modernized and extended, so it will become the so-called Green Terminal [87]. Perspective plans assume further development of the port connected with the exit of its new part to the Gulf of Gdańsk [43]. Connection of Gdynia port to the highway and railway infrastructure is of vital importance.

Ports of Gdańsk and Gdynia have become important links in Corridor VI of the Trans-European Transport Network (TEN-T) Baltic–Adriatic. They have a well-developed network of shipping and railway connections with the hinterland. Both are making preparations for development of their outer parts with container terminals and handling of transcontinental shipping connections. These ports, which are located very close to each other and have a similar range of back-up facilities, are clearly in competition. Increasing flows of cargo directed by rail require modernization of the 201-railway line connecting Gdynia with Bydgoszcz and redirecting part of the trains going to the port of Gdynia to this line. This will make it possible to bypass the overloaded route through Tricity and Tczew (E65) and ensure fast and efficient transport of goods to and from Gdynia. There is a need to create an intermodal center for consolidation and redistribution of cargo, the so-called dry inland port. It is planned to be built in Bydgoszcz and the authorities of the port of Gdynia, among others, are involved in its construction [88].

Conditions for development of the Szczecin–Świnoujście port complex were different. Świnoujście is an important ferry seaport serving connections to Sweden. Ferry terminal has been modernized and extended. New quays to enable handling of larger ferries have been built, and since 2019, work is underway to adapt the terminal to handle intermodal trains. In December 2015, an open-sea LNG terminal designed to handle and regasify 5 billion m³ of liquefied natural gas per year became operational. The Bunge terminal, which specializes on agricultural and food commodities, was constructed in Świnoujście in 2011.

The development of the port in Szczecin is limited by a shallow waterway. It is planned to deepen it from Świnoujście to 12.5 m over a distance of about 62 km, while simultaneously widening it to 100 m [89]. Key port investments concern modernization of quays and dredging of further port basins, both in bulk and general cargo areas [90]. These works are expected to be completed by the end of 2024. [19,91]. The railway infrastructure in both seaports is undergoing modernization. There are also plans to bring the S3 expressway to Świnoujście as part of the reconstruction of the E65 road. This road connects the ports of Szczecin–Świnoujście with the Czech Republic; in 2021, more than 75% of its Polish section was already in expressway standard, with the remainder under construction.

Industrial plants located in the neighborhood of ports stimulated the volume of cargo traffic. In Gdansk, there is a refinery. In Szczecin and Gdańsk, plants producing mineral fertilizers that use phosphate rock imported by sea had a positive impact on the development of the ports. Furthermore, shipyards are located in proximity to all major seaports. The largest operate in Gdańsk and Gdynia. These shipyards not only built ships, but also produced the necessary elements for the offshore industry [61].

5. Conclusions

In the Baltic Sea Region, the development of seaports took place in a very competitive environment. The service potential of ports and the volume of transshipments were influenced by the location in relation to the hinterland and the connection with important inland transport corridors. The infrastructure of these corridors has been significantly expanded over the past decade. Bathymetric conditions were also of great importance in the development of the ports. In the context of the analyses carried out, it can be concluded that the construction of a deep-water container terminal in Gdańsk and then the launch of direct connections with Asia were important factors that dynamized the increase in port turnover. Operational programs financed from European Union funds were an important instrument enabling the transformation of Polish ports. They allowed for the implemen-

tation of 56 projects in the analyzed ports. The main beneficiary was the port of Gdańsk, which had the highest increase in cargo turnover.

The harmonious cooperation of stakeholders, including national and local government entities, has a substantial impact on port economy. However, in Poland the most important role was played by the state, which had the majority of shares in joint stock companies managing the ports. At the same time, the state had the largest funds at its disposal, which means that in practice it is not the cities and regions, but the state that took responsibility for the entire development of the port economy.

Maritime policy, as a component of economic policy, enabled state authorities to identify development goals and establish the tools needed to carry them out. The issues of development of seaports, together with maritime safety and security, were highlighted as major goals in the Republic of Poland's Maritime Policy.

One of the goals was to boost the competitiveness of Polish seaports, along with their contribution to the country's socioeconomic growth and place in the worldwide transportation network. To a considerable extent, this goal has been realized.

The steps performed enabled port expansion to be adapted to contemporary maritime transport and environmental protection conditions. Investments made at Poland's major seaports helped to enhance access to ports from the sea and land. The security of port traffic has increased, and environmental requirements have been included into port operations.

Port of Gdańsk is one of the few deep-water ports on the Baltic Sea. For several years it has been playing a role of the most important hub on the Baltic Sea. Its expansion plans aim to strengthen this position. Ports in Gdynia and Świnoujście plan to join the group of deep-water ports serving the largest vessels entering the Baltic Sea. Thus, it can be seen that Polish ports are competing increasingly more strongly with each other. This is in line with the State maritime policy, which assumes equal development of the ports of primary importance as well as financing competitive investments in them.

So far, port investments have been carried out in accordance with the principles of sustainable development. Implemented measures limit emissions of pollutants into the atmosphere from port and transport activities. Opportunities for the use of alternative fuels by ships, electricity supply from shore to vessels at berth, and reduction of emissions from storage yards have been created. These investments reduce the amount of pollution from port activities into water, both surface and subsurface. Port of Gdynia is particularly pro-ecological and conducts a policy of sustainable development. Among its four priorities, the port's development strategy until 2027 includes a provision to make Gdynia as environmentally friendly as possible. New facilities and equipment in this seaport meet the most up-to-date environmental standards. In the long term, green terminals, environmentally neutral, will be developed. In this respect, expansion and modernization of major Polish ports using technical and organizational innovations and considering environmental protection requirements will become economically and socially viable, which is in line with the State maritime policy and EU documents.

The intensive cooperation with the international port network "ecoports" is critical for the long-term sustainable growth of the major seaports. This network includes two main seaports: Gdansk and Szczecin-Swinoujscie. The overarching principle of "ecoports" is to raise awareness on environmental protection through cooperation and sharing of knowledge between ports and improve environmental management [92]. PERS (Port Environmental Review System) certificates became important instruments of the network stimulating the sustainable development of ports. This certificate incorporates the key requirements of recognized environmental management standards (e.g., ISO 14001) but also takes into account the specificities of ports. Its implementation is independently reviewed by Lloyd's Register. So far, Polish ports do not yet have PERS certificates. However, they make efforts to obtain other important documents. A good example is the port of Gdańsk, which has been ISO-certified for many years. In addition, this port is the only one in Poland that obtained the PRS (Protection-Reliability-Safety) certificate in 2021. The document

proves that effective measures have been taken to minimize the risk of infection, and also has confirmed the company's readiness to respond in the event of an epidemic [93].

Due to the ownership structure, state authorities, responsible for both planning and implementation of maritime policy, have a decisive influence on the sustainable development of ports. In the regulations defining the maritime policy, the development of the port economy was considered mainly in economic terms. Over time, largely under the influence of the EU, environmental issues began to gain more importance in the country's maritime policy. Port development, taking into account the principles of sustainable development, was often of a bottom-up nature. The initiators of the pro-ecological activities undertaken were, first of all, the port authorities supported by the authorities of cities and regions. The analysis of the activities carried out so far confirms the need to take into account the environmental aspects to a greater extent in the maritime policy of the state acting as both the regulator and the co-owner of the ports.

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