

Prospects for the Development of Polish Seaports

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The article is divided into two parts. Part I focuses on two chapters: SPECIFICS OF SEAPORTS AS ECONOMIC ENTITIES and THE ATTRACTIVENESS OF SEAPORTS COMPARED TO OTHER MEANS OF TRANSPORTATION.

- SPECIFICS OF SEAPORTS AS ECONOMIC ENTITIES: This chapter explores the unique characteristics of seaports as vital economic entities, tracing their evolution from communication nodes to modern logistics centres. It also discusses emerging trends in future port development, emphasizing autonomy and advanced technologies driven by information technologies and logistics 4.0 principles.
- THE ATTRACTIVENESS OF SEAPORTS COMPARED TO OTHER MEANS OF TRANSPORTATION: This chapter scrutinizes the allure of seaports vis-à-vis alternative transportation modes. It assesses a plethora of factors – economic, social, political, and technological – that shape the competitiveness and innovativeness of seaports. Furthermore, it delves into the pivotal role of seaports in global supply chains and their consequential impact on socio-economic landscapes.

In the latter part (Part 2) of the article, our focus will shift towards analysing two chapters: “SELECTED MEANS OF MARITIME TRANSPORT” and “PROSPECTS FOR THE DEVELOPMENT OF POLISH PORTS IN THE NEXT 30 YEARS.”

- SELECTED MEANS OF MARITIME TRANSPORT: This section focuses on crude oil and LNG (Liquefied Natural Gas), highlighting their characteristics, advantages, and challenges. It examines their transportation, storage, and usage in the global maritime economy, alongside their development prospects considering new technologies, environmental regulations, and energy sector trends.
- PROSPECTS FOR POLISH PORTS IN THE NEXT 30 YEARS: This section explores the future of Polish ports, focusing on key hubs such as Gdansk, Gdynia, Szczecin, and Świnoujście. Gdansk connects Scandinavia with South-eastern Europe, while Gdynia handles various types of cargo. Szczecin and Świnoujście serve as maritime gateways connecting Scandinavia with Central and Southern

Europe. The analysis concludes with a review of the strategic development plan for the Port of Gdynia (2014-2027), aiming to enhance its market position through infrastructural development and environmental sustainability.

PART 1

Abstract:

Polish ports in Gdansk, Gdynia, Szczecin, and Świnoujście are vital in the global market, handling large cargo volumes and serving as crucial links in international trade. This article explores their innovative capabilities and pivotal role in economic development and global competitiveness. Through analysis, we aim to uncover their untapped potential and propose strategies for fostering innovation. In summary, Polish ports facilitate global trade, drive economic growth, and can enhance their contributions through innovation, thereby maintaining competitiveness internationally.

Keywords: maritime ports, evolution, innovation, competitiveness, sustainable development, innovations

1. SPECIFICS OF SEAPORTS AS ECONOMIC ENTITIES

European seaports stand as vital components of global supply chains, pivotal in fostering international trade and economic advancement. Their progression from basic facilities to sophisticated logistics hubs mirrors the adaptive response to shifting economic and technological landscapes.

Specifics of Seaports as Economic Entities

Seaports have traversed various developmental stages, transitioning from mere communication hubs to futuristic logistics centres. In recent years, we have witnessed the emergence of next-generation ports, characterized by autonomous equipment and integration of cutting-edge technologies.

Significance of Intellectual Capital in Seaport Development: In the context of the dynamic development of seaports, understanding the role of intellectual capital and innovation in enhancing competitiveness and operational efficiency is essential.

Innovative Trends in European Seaports – European seaports, such as Rotterdam and Antwerp, are experiencing dynamic expansion (Pieter Emmer Amsterdam and Rotterdam: actors in the European dynamic, 2020) marked by the adoption of advanced information technologies, data-driven management systems, and a strong commitment to sustainability. *Nature of Innovation*: Innovation, as conceptualized. Joseph Schumpeter¹ encompasses the introduction of new products, production methods, market openings, or acquisition of raw materials. Its interpretation varies contextually, often representing beneficial change, novelty, idea, or entrepreneurial tool. The characteristics of Polish Seaports² Polish seaports, such as Gdansk, Gdynia, Szczecin, and Świnoujście, exhibit a universal character, serving diverse modes of transport and types of cargo. Internal specialization enhances efficiency and competitiveness by catering to specific cargo groups.

Factors Driving Seaport Competitiveness: (Katarzyna Anna Kuźmicz, 2020)

„The economic activities of a maritime port entail providing services tailored to the requirements of vessels and cargo, in essence, facilitating the transition of goods between land and sea transport modes, or vice versa.” (Kamil Jedynak, CEO of OT Logistics, 2023)

Port competitiveness is influenced by various factors including location, water depth, navigational conditions, transportation network, services, pricing, infrastructure, and economic stability. Success is closely tied to the advantageous positioning near major sea routes and production hubs.

Transport Connections with the Hinterland (Wiśnicki, 2003): Efficient road, rail, and inland waterway connections with the hinterland are crucial for enhancing logistics efficiency and fostering seaport development. *Hinterland and Foreland Dynamics*: Each seaport encompasses its hinterland and foreland, crucial for port turnovers and investment planning. The delineation of boundaries remains challenging, yet enduring connections persist as a result of various factors. *Supporting Facilities and Forecourts*: Seaports are accompanied by supporting facilities and forecourts, integral for cargo handling and economic activities. Despite challenges in defining boundaries, the enduring link between cargo and specific ports remains sustained.

¹ Joseph Schumpeter (1883-1950) was an Austrian economist and economic theorist, recognized as one of the key economic thinkers of the 20th century. His work primarily focused on analysing innovative processes and the impact of entrepreneurship on economic development

² <https://www.parkiet.com/transport/art38553521-porty-morskie-odgrywaja-kluczowa-role-w-gospodarce> <https://temida.io/wiedza/transport-intermodalny-polskie-porty/>; access: 20.12.2023

Tab. 1. The aspect of port services – Economic and legal perspectives

Aspect of Port Service	Description
Container deconsolidation and consolidation	Ports offer services for deconsolidation (unloading) and consolidation (loading) of containers, enabling flexible management of deliveries and cargoes.
Cargo batch assembly	Ports can provide services for assembling individual cargo batches, collecting different cargoes into a coherent batch before loading onto a ship.
Handling of oversized and hazardous cargo	Ports must be prepared to handle cargo with non-standard dimensions (oversized) and hazardous cargo, meeting appropriate safety procedures and standards.
Repair of damaged packaging or containers	Ports may offer services for repairing damaged packaging or containers to restore their functionality and transport safety.
Customs warehouse and storage	Ports can provide customs warehouses or storage facilities that allow goods to be stored under customs control, pending further customs formalities.

Source: (Magdalena, 2021)

Tab. 2. Factors influencing port attractiveness

Factor Influencing Port Attractiveness	Description
Geographical location	Ports located near production areas or areas with high demand for goods tend to attract cargo from these areas. Geographic proximity facilitates transportation and reduces logistics costs.
Port infrastructure	The presence of appropriate port infrastructure, such as quays, cranes, container terminals, warehouses, enables efficient and effective handling of various types of cargo. Ports with specialized infrastructure attract cargoes requiring specialized handling.
Specialization and competencies	Some ports specialize in handling specific types of cargo, such as oil, LNG, automobiles, containers, or food. Ports specializing in a particular field have the relevant competencies, experience, and technical infrastructure, attracting cargoes related to that field.
Additional services	Ports offering high-quality additional services, such as container stuffing and unstuffing, warehousing, cargo repair and maintenance, access to land terminals, have a greater chance of attracting cargoes. The availability of such services influences logistic efficiency and added value for shippers.

Factor Influencing Port Attractiveness	Description
Partnership and cooperation	Ports that establish strategic partnerships and cooperation with carriers, logistics providers, and other industry entities can create comprehensive logistic solutions. This collaboration contributes to better cargo handling and building lasting relationships with customers.

Source : <https://yadda.icm.edu.pl/yadda/element/bwmeta1.element.ekon-element-issn-1640-6818-issn-1644-0501>

The presence of these factors often leads cargoes to align with a specific port, even though port infrastructure tends to vary significantly.

Tab. 3. Factors influencing port attractiveness and marketing development directions in Polish seaports.

Factor	Description
1. Transport infrastructure	The availability of an extensive network of roads, highways, railways, and inland terminals near the port enables efficient distribution of cargo to various areas. The lack of adequate transport infrastructure can limit the port's hinterland reach.
2. Communication connectivity	A well-developed telecommunications network, high-quality internet, and telephone services are essential for effective communication between the port and the economic entities operating within its hinterland. The absence of proper communication connectivity can hinder the flow of information and decision-making.
3. Regional and local policies	Regional and local policies can influence the development and functioning of the port's hinterland. Decisions regarding spatial planning, infrastructure investments, environmental protection, or taxes can significantly impact the attractiveness of the area for economic entities and, thus, the relationship between the port and its hinterland.
4. Access to resources	Ports located near areas rich in resources or other assets have the potential to attract cargo related to these resources. The availability of energy resources, natural resources, or construction materials can influence shipper preferences in choosing a port.
5. Local and regional market	A developed local and regional market, characterized by high demand for goods, can create a strong hinterland for the port. The existence of various industries and economic sectors in the vicinity of the port may promote the diversification of cargo handled by the port.

Source: (Tłoczyński, 2005)

Ports adapt to changing market, infrastructural, and political dynamics, influencing the diversification of their hinterland. Besides the direct hinterland, there exists a substitute hinterland where inter-port competition plays a pivotal role. Modern ports actively compete for cargo, expanding their substitute hinterland. Furthermore, a port's foreland, encompassing overseas regions with regular shipping links, enhances its appeal, particularly in liner shipping. Ports with consistent oceanic connections are attractive for cargo handling, and the final choices of shippers depend on various factors, including the port's specialized production capacities.



Fig. 1. General cargo transportation

Source : <https://unilog.eu/transport-drobnicowy-co-musisz-o-nim-wiedziec>

Research Projects in Smart Ports:

1. Implementation of 45 research projects in the field of smart logistics and energy, with plans for additional projects until 2023.
2. Innovative Laboratories: Establishment of RAMLAB, H2EnergyLab, Block Lab, Floating Lab for researching new technologies.
3. Port XL Accelerator and Start-ups: Port XL accelerator programme, agreements with start-ups (Tulyp Wind, EONconcrete, Cargo ledger, Whale Washing) in the field of low-emission technologies and advanced materials.
4. IoT Projects: Monitoring of equipment and devices using cloud and sensors.
5. Silver Economy Projects: "Senior Employment Program" and "Personal Choice Budget" for employing seniors.
6. Innovative Game Changer Project: Introduction of an organization problem-solving programme in the workplace.
7. Tegra Road Inlet Project: Monitoring and maintenance using Tegra inlets with sensors.

8. These projects illustrate the dynamic adaptation of the port in Rotterdam to contemporary trends and challenges.

2. THE ATTRACTIVENESS OF SEAPORTS RELATIVE TO OTHER MEANS OF TRANSPORTATION (Ricardo J. Sanchez, Adolf K. Y. Ng and Lorena Garcia-Alonso, 2011)

Introduction

Seaports are crucial for global trade and logistics. In this section, we analyse their attractiveness in relation to other modes of transport, focusing on functions, economic significance, and their role in regional and global development. Transport is vital for the economy, facilitating goods flow and linking producers and consumers. It is an ancient field, which has been evolving dynamically along with technology. Maritime transport dominates global trade owing to its unique traits and strategic geographical positioning.

- Significance of Seaports :

Seaports are strategic logistics hubs that enable the transportation of goods on a large scale. They play a crucial role in the global supply chain, facilitating the movement of goods between countries and continents. Compared to other modes of transport such as land or air transport, seaports often offer higher throughput and lower transportation costs. With the ability to handle large vessels, seaports can efficiently transport large quantities of goods at once, enhancing their attractiveness in international trade.

- Challenges for Seaports:

Despite their attractiveness, seaports face various challenges, such as the need for continuous modernization of infrastructure and compliance with changing international regulations. Increasing the competitiveness of seaports requires investment in modern technologies and streamlining administrative procedures.

- Development Perspectives :

The growth of international trade and globalization underscores the significance of seaports in the global economy. The development of port infrastructure and integration with other modes of transportation will be crucial. Poland boasts approximately thirty seaports, facilitating vessel traffic, cargo handling, and passenger

transport. In 2016, cargo turnover in these ports increased by 4.9% compared to 2015 and by 33.2% compared to 2005. International maritime turnover accounted for 97.1% of the total turnover in 2016, reaching 70,776.3 thousand tons. (GUS Statistics Poland pp.23-24, 2017)

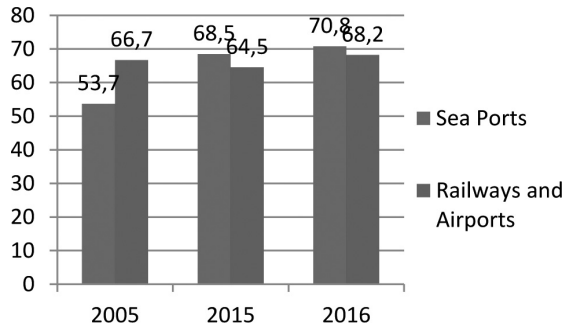


Fig. 2. International freight transport by selected modes of transport (in million tons).

Source: GUS, Maritime Economy in Poland, 2017.

Through detailed analysis and projections regarding cargo and passenger handling in Polish seaports, the development goals for the Programme until 2020 and beyond to 2030 have been formulated. Polish seaports are envisioned as pivotal nodes in the global supply chains for Central and Eastern Europe. Enhancing their competitiveness holds the potential to bolster their role in Poland's socio-economic landscape and elevate their status within the international transport network. (Assumptions for the Development Programme of Polish Seaports until 2020 (with a perspective towards 2030), 2023)

Key priorities within the development programme for Polish seaports encompass:

- Expansion of port infrastructure, as well as infrastructure providing access to ports from the sea side,
- Adaptation of port infrastructure to the changing cargo structure and expansion of other economic functions,
- Linking ports with other participants in transport chains by developing infrastructure for land access to seaports,
- Digitization of Polish seaports,
- Ensuring protection for port traffic participants,
- Incorporating environmental requirements into port activities.

- The main challenge concerning Polish seaports is the adaptation of port infrastructure and access infrastructure from the sea side to handle larger vessels.

CONCLUSION

Seaports are vital components of global transportation infrastructure, pivotal for international trade and logistics. They offer throughput, efficiency, and cost advantages compared to other transport modes. Yet, to sustain attractiveness, continual investment in infrastructure and adaptation to market and regulatory shifts are imperative. The evolution of European seaports illustrates adeptness in response to economic and technological shifts. Innovations enhance competitiveness, efficiency, and sustainability. Insights from European ports serve as a model for global ports, fostering efficient and sustainable development.

PART 2

Abstract

The second part of the article delves into the modes of maritime transportation and the future of key Polish ports such as Gdansk, Gdynia, Szczecin, and Świnoujście. Gdansk connects Scandinavia and South-eastern Europe, Gdynia handles diverse cargoes, and Szczecin and Świnoujście facilitate trade between Scandinavia and Central/Southern Europe. Additionally, the analysis includes Gdynia Port's strategic development plan (2014-2027) focusing on infra-structure, transport accessibility, and environmental sustainability.

Keywords: Seaport Economics, Maritime Transport, Polish Port Development, Gdansk, Gdynia, Strategic Development Plan

1. SELECTED MEANS OF MARITIME TRANSPORT

- SHIPPING IN GLOBAL LOGISTICS: AN INTEGRAL COMPONENT (A. Przybyłowski CEION Biblioteka Nardowa, 2009)

Shipping has traditionally been a key aspect of international logistics but has seen increased importance recently owing to the e-commerce trends and shifts in global manufacturing. Current analysis shows maritime transport dominating international trade logistics, constituting approximately 80% to 90%.

Maritime Transport: An Overview: Maritime transport, with the introduction of containers since the 1960s, has revolutionized cargo handling, ensuring efficient shipment, cost reduction, and improved goods monitoring. This innovation has positioned maritime transport as a leading force in international logistics.

Maritime transport offers a plethora of advantages, rendering it the preferred choice for global enterprises:

- Large Capacity: Cargo ships boast immense tonnage capacities, surpassing other transportation modes.
- Cost-Effectiveness: With the ability to ferry substantial cargo volumes internationally, maritime transport proves 4 to 6 times more economical compared to air freight.
- Versatility: A diverse array of vessels caters to varied cargo types, ensuring adaptability.
- Abundance of Options: Market-driven competition results in a wide selection of maritime transport alternatives.
- Safety: Stringent safety protocols govern maritime logistics, resulting in minimal cargo losses, a trend witnessing continual decline.

Types of Maritime Transport: Maritime logistics exhibits remarkable versatility, encompassing various transport categories tailored to distinct cargo types and capacities:

- Bulk Carriers: Designed for bulk cargo such as minerals and fertilizers.
- Container Ships: Predominantly utilized since the 1960s, these vessels reign as the foremost choice for sea-bound cargo, featuring modern, emission-efficient designs.
- General Cargo Ships: Equipped with on-board cranes, these vessels handle dry cargo sans containers.
- Reefer Vessels: Characterized by refrigeration capabilities, these ships excel in transporting perishable goods at heightened speeds.
- Heavy Lift Cargo Vessels: Essential for transporting hefty industrial loads pivotal for large-scale projects.
- Roll-on-Roll-off (Ro-Ro) Vessels: Tailored for wheeled cargo transportation, including automobiles, machinery, and more, boasting specialized securing mechanisms.

Maritime transport, with its myriad vessel types and unparalleled advantages, continues to navigate as a cornerstone of global logistics, underpinning seamless cargo movement across oceans.

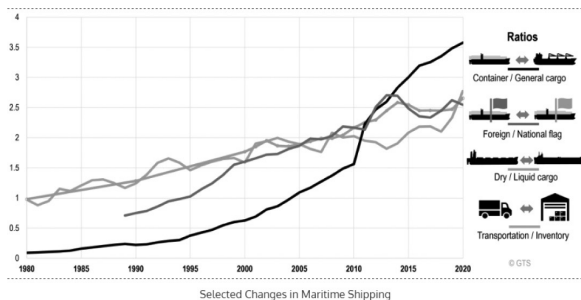


Fig. 3. Container to general cargo ratio based on registered fleet in dwt
 Source : (Hoffmann, UNCTAD, 2012)

Cargo Traffic in Seaports: 2022 Overview (GUS, Maritime economy in Poland in 2022 pp. 1-5, 2023)

In 2022, cargo traffic in seaports surged to 119.0 million tonnes, marking a remarkable 23.1% increase compared to the preceding year. Notably, significant growth was observed in several key ports:

- Gdansk: Experienced the highest surge in cargo traffic, recording a remarkable 40.3% increase.
- Świnoujście: Followed closely with a substantial 16.5% rise in cargo handling.
- Szczecin: Also witnessed notable growth, with cargo traffic surging by 13.2%.
- Gdynia: Reported a modest but noteworthy uptick of 1.5% in cargo handling.

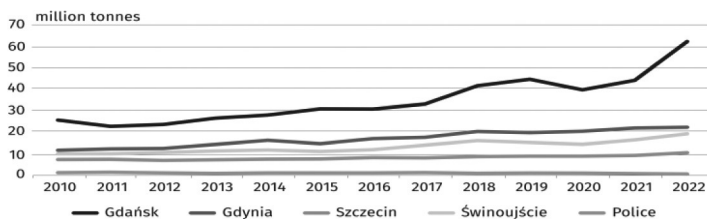


Fig. 4. Cargo traffic in seaports
 Source (GUS, 2022)

Tab. 4. Share of seaports in domestic cargo traffic (2022)

Port	Share (%)
Gdansk	53.1
Gdynia	19.4
Świnoujście	16.8
Szczecin	9.4

Port	Share (%)
Police	1.0
Other ports	0.3

Source: GUS, Maritime Economy in Poland, 2022.

Tab. 5. Structure of cargo traffic (2022)

Cargo Type	Share (%)
Dry Bulk	35.0
Liquid Bulk	32.6
Large Containers	19.1
Other General Cargo	X
Ro-Ro Units	X

Source: GUS, Maritime Economy in Poland, 2022.

Tab. 6. Cargo traffic changes (2022 vs previous year)

Cargo Type	Change (%)
Dry Bulk	+46.2
Liquid Bulk	+29.9
Other General Cargo	+17.2
Ro-Ro Units	-3.1
Large Containers	-1.6

Source: GUS, Maritime Economy in Poland, 2022

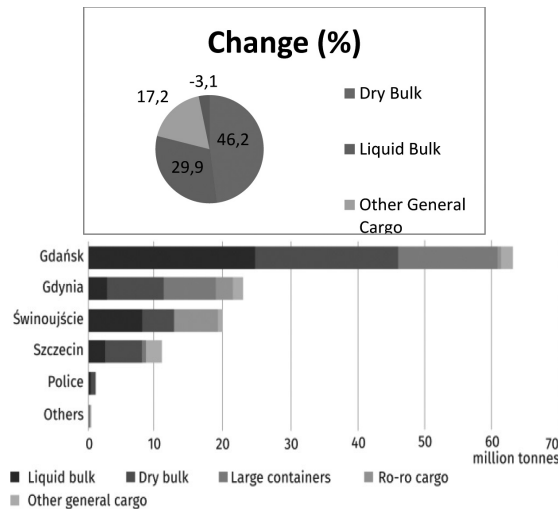


Fig. 5. Cargo traffic by seaports and cargo categories (2022).

Source : (GUS, 2022)

- MARITIME TRAFFIC STATISTICS (2022)

In 2022, the total domestic maritime traffic amounted to 5.1 million tonnes, marking a substantial increase of 23.7% compared to the previous year. This domestic traffic constituted 4.3% of the overall cargo traffic volume.

On the international front, maritime traffic surged to 113.9 million tonnes in 2022, representing a notable increase of 23.1% from the figures recorded in 2021.

International Maritime Traffic by Continent (2022)

The breakdown of international maritime traffic by continent is as follows:

- Europe: 60.5%
- Africa: 14.5%
- Asia: 10.2%
- North America: 6.7%
- Central and South America: 5.2%
- Australia and Oceania: 2.5%

These figures highlight the significant role of European ports in facilitating international maritime trade, with the majority of traffic flowing to and from Europe.

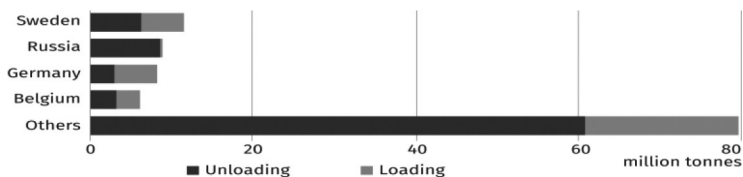


Fig. 6 International maritime traffic by country of loading/unloading cargo (2022)

Source : (GUS, 2022)

Tab. 7. Structure of transit cargo in seaports (2022)

Port	Transit Cargo Volume (million tonnes)	Increase from Previous Year (%)
Gdansk	12.8	11.3
Szczecin	1.4	11.8
Gdynia	1.0	46.4

Port	Transit Cargo Volume (million tonnes)	Increase from Previous Year (%)
Świnoujście	0.9	9.0
Elbląg	0	N/A

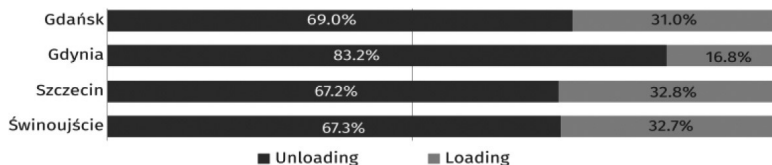


Fig. 7 Structure of transit cargo in seaports (2022).

Source : (GUS, 2022)

Tab. 8. Maritime and coastal shipping

Metric	2022	2021
Number of Ships	88	88
Deadweight (DWT)	2728.0 thousand	2593.7 thousand
Gross Tonnage (GT)	1960.1 thousand	1876.0 thousand

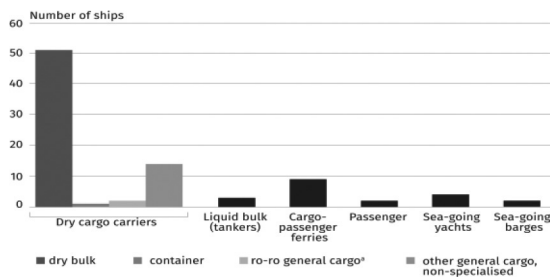


Fig. 8. Maritime cargo-carrying fleet in 2022 As of 31 December

Source : (GUS, 2022)

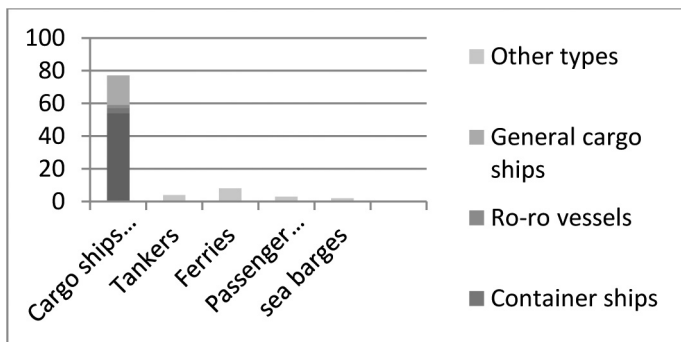


Fig.9. Maritime transport fleet overview.

Source: Self-prepared based on Maritime Economy in Poland 2016 – CSO, Warsaw 2017.

Tab. 9. In the Port of Gdansk, the statistics for total cargo handling and container handling are as follows

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
19826	17781	18863	27128	25305	26898	30259	32278	35914	37289
2017	2018								
40614	49032								

Source: (Port Szczecin, 2019)

Characteristic of crude oil transportation: Crude oil transportation utilizes various methods: maritime tankers, pipelines, railway tank cars, and trucks. Tankers handle international transport, pipelines are effective for mid-range distances, and railway/truck tankers are flexible for short hauls. Port infrastructure must meet stringent safety standards due to the risk of accidents and environmental disasters, leading to strict global regulations. Compliance with environmental and safety standards is crucial for the global economy’s reliance on crude oil transportation.



Fig. 10. Tanker

Source <https://pl.wikipedia.org/wiki/Zbiornikowiec>

Maritime fuel transportation is crucial for global logistics, moving large quantities of fuel between nations. Tankers, following strict regulations, transport various fuels and adhere to safety protocols, including cargo classification and environmental protection. International maritime organizations prioritize safety and environmental regulations in this sector.

The largest vessels for liquid cargo transportation are classified using abbreviations that typically refer to different types of tankers.³ Here are some of the key abbreviations used in this context:

- VLCC - Very Large Crude Carrier⁴: Very Large Crude Carrier: A very large tanker for transporting crude oil.
- ULCC - Ultra Large Crude Carrier⁵: An ultra-large tanker for transporting crude oil, larger than VLCC.
- SUEZMAX⁶ - A tanker with maximum dimensions to pass through the Suez Canal.
- AFRAMAX⁷ - Average Freight Rate Assessment (Aframax): A medium-sized tanker, with a capacity of approximately 80,000-120,000 tons, suitable for most refineries worldwide
- PANAMAX⁸ - A tanker with maximum dimensions to pass through the Panama Canal.
- MR - Medium Range: A tanker with medium range, often used for transporting refined products such as gasoline
- LR1 - Long Range One: A tanker with long range, also used for transporting refined products.
- LR2 - Long Range Two: A larger tanker with long range, often used for transporting chemicals and oils.

These abbreviations help classify tankers according to their size, carrying capacity, and manoeuvrability in various straits and channels...

³ <https://www.money.pl/gielda/orlen-czeka-na-wazna-dostawe-dotrze-do-polski-na-dniach-6936519359842912a.html> ; access: 17.12.2023 Ważny statek płynie do Polski. Zabezpieczenie na rok,

⁴ Very Large Crude Carriers (VLCCs) <https://scmwiki2012.wordpress.com/u/very-large-crude-carriers-vlccs/>; access: 17.12.2023

⁵ *WÄRTSILÄ Encyclopaedia of Marine and Energy Technology* <https://www.wartsila.com/encyclopedia/term/ultra-large-crude-carrier-hellespont-alhambra>

⁶ <https://pl.wikipedia.org/wiki/Suezmax>; [https://en.wikipedia.org/wiki/Suezmax#/media/File:The_Seavigour_oil_tanker_\(2017\).jpg](https://en.wikipedia.org/wiki/Suezmax#/media/File:The_Seavigour_oil_tanker_(2017).jpg); access: 17.12.2023

⁷ <https://www.vesselfinder.com/pl/vessels/details/9282912>; access: 17.12.2023

⁸ <https://en.wikipedia.org/wiki/Panamax>; access: 17.12.2023

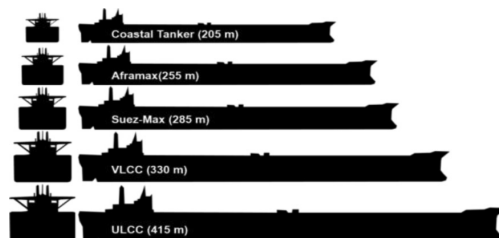


Fig. 11. Tanker sizes and classes

Source : <https://porteconomicsmanagement.org/pemp/contents/part8/ports-and-energy/tanker-size/> and <https://www.eia.gov/todayinenergy/detail.php?id=17991>;

The Demand for Oil is Highest in the Transport Sector (Oil industry and trade' POPiHN, 2023)

The demand for oil is highest in the transport sector, followed by industry, construction, and electricity and heat generation (below 1%). Poland has well-developed oil infrastructure, including a maritime terminal in Gdansk, two large refineries, significant storage capacity, and an extensive pipeline network.

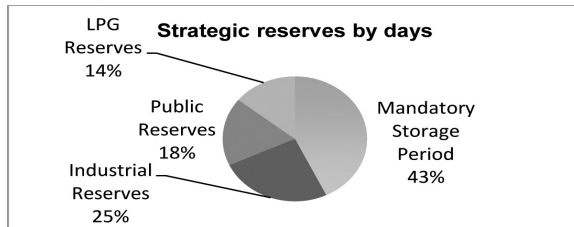


Fig. 12. Strategic reserves

Source : <https://www.iea.org/articles/poland-oil-security-policy>

Maritime Port Operations: The rise in maritime oil transportation has led to specialized terminals and transshipment bases, leveraging large ships and seaports. Loading points are typically in oil-exporting nations, while unloading terminals are situated in importing countries or those facilitating imports. Refineries in port areas, such as Western Europe, receive oil for processing. Similarly to containerized cargo, ports handling crude oil exhibit polarization, with base ports near major economic centres serving as redistribution hubs. Terminals, located away from residential areas for safety, integrate with pipelines and feature ship berths, storage tanks, and control rooms.

Sea-Landing transportation: The technological progress in liquefied natural gas (LNG) transport compensates for pipeline limitations. Maritime LNG shipping is becoming competitive for long-distance routes, surpassing pipeline efficiency. The rising global significance of natural gas demands advanced infrastructure, notably LNG carrier fleets, crucial for secure and efficient energy supply chains.

Faces influencing maritime LNG transport development: Natural gas, with lower emissions than other fossil fuels, aids emission reduction goals such as the 2009 Copenhagen Accord. Delivering it economically, especially via long pipelines, faces challenges, increasing the importance of LNG. The costs of LNG depend on factors such as reservoir size and terminal distance. While pipeline transport costs are currently lower, they are expected to rise due to depleting nearby reserves, making maritime LNG transport more competitive (S. Filin, 2006), ensuring low emissions and secure energy delivery (Voytyuk, 2012). However, liquefaction and maritime transport costs constitute a significant portion of the overall expenses. Despite its advantages, there is a need for monitoring and research regarding potential threats, such as Rapid Phase Transition (RPT),⁹ during extreme LNG spills into water.

LNG is transported over long distances by specialized vessels known as LNG carriers, crucial for the gas supply chain. This operation relies on a complex network of infrastructure and technological procedures.

The LNG supply chain infrastructure from gas extraction to delivery includes:

1. Gas extraction,
2. Purification, liquefaction, transport to the terminal, and loading onto the ship,
3. Maritime transport,
4. Regasification and delivery to the receiving country's transmission system.

The production of LNG starts with gas extraction, followed by purification, liquefaction, and loading onto carriers at the terminal. Ships transport LNG to receiving terminals for regasification. Membrane tankers ensure safe transport. There is a trend toward larger ships and smaller vessels for shorter routes.

Selected Characteristics of LNG Carriers: In this subsection, an analysis was conducted on the project and operational characteristics of a potential LNG tanker

⁹ Rapid Phase Transition (RPT) is a process in which a liquid gas, such as LNG, uncontrollably transforms into high-pressure gas during extreme leaks into water. This phenomenon can generate significant forces and pose a potential threat if LNG release is not properly controlled, necessitating constant attention and research to minimize risk.

from the Persian Gulf. The optimal dimensions of the tanker, hull resistance and propulsion examination, as well as construction and operating costs, were discussed.

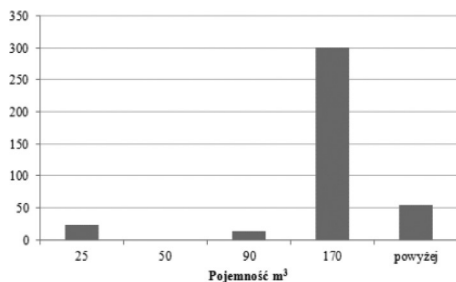


Fig. 13. Ships by cargo capacity (units).

Source: International Group of Liquefied Natural Gas Importers, 2013

New LNG tankers, introduced in 2013 with an average capacity of 135,000 m,³ are replacing older units. Approximately 65% of the current LNG fleet is less than 10 years old, with 10% of ships operated for over 30 years. Despite the gradual phasing out of older units, LNG carriers can operate for 40-50 years, more than twice as long as oil tankers, owing to the lesser impact of liquefied methane on steel structures. Emissions Management and Environmental Protection:

- Emission Monitoring to track greenhouse gas emissions.
- Implementation of Eco-friendly Technologies in terminal processes.
- Integration with the Energy System:
- Adaptation to the National Energy System for effective integration.

Technological solutions in Logistics 4.0

Logistics 4.0 in maritime transport involves leveraging advanced technologies such as IoT, AI, and blockchain to streamline logistical operations. It encompasses the integration of innovative solutions in fleet management, cargo tracking, and route planning. The aim is to enhance efficiency, safety, and sustainable development in maritime transport through data analysis and operational optimization.

Summary and Conclusion:

The article discusses recent innovations in European seaports, highlighting their evolution into advanced logistical hubs driven by technology and logistics 4.0. Key trends include advanced IT technologies and sustainable development initiatives shaping the landscape of these ports. Maritime fuel transportation, facilitated by tankers adhering to strict norms and protocols, is essential for global logistics.

European seaports play a vital role in global trade and economic development, evolving and embracing innovative trends. The adoption of advanced technologies and sustainable practices is crucial for enhancing competitiveness and efficiency in the global economy. As innovation drives changes in the maritime industry, seaports must adapt to remain at the forefront of global trade networks.

2. PROSPECTS FOR THE DEVELOPMENT OF POLISH PORTS IN THE NEXT 30 YEARS

The Port of Gdansk, a crucial Baltic hub, links Scandinavia with South-eastern Europe, experiencing rapid growth. Gdynia specializes in cargo, vital for Trans-European Transport Corridor VI owing to favourable conditions. Szczecin and Świnoujście serve as complementary gateways, with Świnoujście facilitating larger vessels and Szczecin offering inland access. Both ports are well-connected, crucial for serving the German market directly.¹⁰

Development Strategy: The Port of Gdynia's Strategic Plan (2014-2027) (Development Strategy - The Port of Gdynia, 2023)

The Port of Gdynia's Strategic Development Plan for 2014-2027, approved in August 2014, aims to strengthen its market position in the South Baltic Sea Region.

Vision and Mission: The Port of Gdynia envisions becoming a multimodal and universal port, serving as a logistics node in the North-South Transport Corridor. Its mission is to ensure sustainable service sector development through port infrastructure enhancement, transport access improvement, market practices, corporate social responsibility, safety, and environmental protection.

Alignment with Strategic Documents: The plan aligns with international, national, regional, and municipal strategic documents, ensuring consistency with EU policies, national strategies, regional development plans, and municipal goals. It outlines investment projects to improve infrastructure, environmental sustainability, and foster long-term development, enhancing the port's pivotal role in regional and international trade.

¹⁰ Ibidem



Fig. 14. General cargo transportation

Source: <https://unilog.eu/transport-drobnicowy-co-musisz-o-nim-wiedziec/>;

Results of Activity of Polish Seaports in 2022 (Port Monitor Polish seaports in 2022: Summary and Future Perspectives, 2023)¹¹

In 2022, Polish seaports saw a 17.77% increase, handling 133.2 million tons. The Port of Gdansk led with growth in coal and liquid fuels, while Szczecin-Świnoujście and Gdynia also rose, mainly thanks to coal and LNG shipments. Despite navigation disruptions, ports managed record bulk cargo, including timber, ore, and cereals. This growing tendency continued in the first half of 2023, especially in liquid fuels, coal, and grains, while container transshipments fell by 3.89% due to the situation in Ukraine.

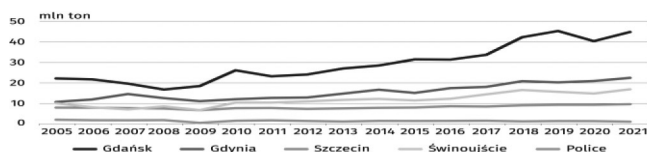


Fig. 15. Cargo Turnover in Seaports¹²

¹¹ Report on Polish Seaports in 2022: Summary and Future Outlook <https://rigp.pl/images/Polskie%20porty%20w%202022%20roku.pdf> and <https://logistyka.rp.pl/morski/art37827851-w-2022-roku-porty-zanotowaly-rekordowe-wyniki-a-w-tym-poprawia-je>; access: 22.12.2023

¹² Cargo turnover in seaports amounted to 119 million tons in 2022, representing a year-on-year increase of 23.1%. The Port of Gdansk accounted for 53.1% of the total national turnover in 2022, followed by Gdynia with 19.4%, Świnoujście with 16.8%, Szczecin with 9.4%, Police with 1%, and other ports with 0.3%, as reported by the Central Statistical Office (GUS) on April 27, 2023. Source: Google.com

Tab. 10. Cargo Handling in the Largest Polish Seaports in the Years 2017-2022 [thousand tons]

	2017	2018	2019	2020	2021	2022	Change 22/21
Seaport Gdansk	40 614	49 032	52 154	48 038	53 213	68 220	28,20%
Seaport Gdynia	21 225	23 492	23 957	24 662	26 692	28 197	5,64%
Seaport Szczecin-Swinoujście	25 424	28 314	32 175	31 178	33 220	36 810	10,81%
TOTAL	87 263	100 838	108 286	103 878	113 125	133 227	17,77%

Source: Polish Ports Rise to the Top of Europe, Author: Kamil Zajac

Tab. 11. Aspects of development in Polish ports

Aspect	Description
Service Speed	Efficiency and promptness in delivering services.
Safety	Ensuring the protection of transportation vehicles and cargo, thereby guaranteeing reliability.
Reliability	Technological effectiveness and assurance of timely and accurate delivery.
Availability	Probability of accessing services at a given time, considering financial capability.
Massiveness	Ensuring service availability in specified quantities and locations, meeting customer demands.
Eco-friendliness	Reducing adverse impacts on the natural environment.
Service Potential	Determined by the condition of port infrastructure.
Quay Equipment	Infrastructure available at port quays.
Work Organization, Employee Qualifications, Management Methods	Effective management of work processes, employing highly skilled personnel.
Port Regulations and Customs	Adherence to industry regulations and standards.
Size and Structure of Investments	Extent and types of investments made for port development.
Frequency of Shipping Connections	Number and speed of ship and cargo handling, connections with other ports.

Source: (Jagiellonian Club, 2020)

Government Plans to Modernize Polish Ports and Enhance Competitiveness

The government aims to modernize Polish ports by 2030 with a budget of PLN 40.6 billion. Polish ports achieved record-breaking results in 2019. Major ports such as Gdansk, Gdynia, and Szczecin-Świnoujście are vital for maritime transport. Investments focus on infrastructure, digitalization, ecology, and capacity enhancement. They face competition with leaders in Western Europe, and the emphasis of the port development programme until 2030 on their role in supply chains for Central and Eastern Europe, infrastructure expansion, digitization, sustainable development, and handling larger vessels, can be summarized as follows:

- 1) The government has laid out plans to modernize Polish ports by 2030, allocating a substantial budget of PLN 40.6 billion for this purpose.
- 2) The remarkable performance of Polish ports in 2019 is contingent upon the state of the economy and global trends.
- 3) Major ports such as Gdansk, Gdynia, and Szczecin-Świnoujście play a pivotal role in maritime transport.
- 4) The investments are directed towards enhancing infrastructure, embracing digitalization, promoting ecological sustainability, and augmenting capacity.
- 5) Polish ports face stiff competition from their counterparts in Western Europe, necessitating solutions to infrastructural, legal, and strategic challenges.

The port development programme until 2030 underscores the significance of Polish ports in the supply chains for Central and Eastern Europe, with a focus on infrastructure expansion, digitization, sustainable development, and the ability to accommodate larger vessels.¹³

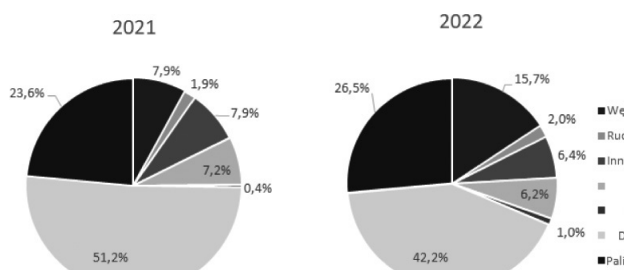


Fig. 16. Cargo handling structure in major Polish ports (2021-2022).

Source: (Montwiłł, 2011).

¹³ *Development Programme for Polish Seaports until 2020 (with a perspective until 2030)*, Ministry of Maritime Economy and Inland Navigation, Warsaw 2018. This document operationalizes objectives from the "Strategy for Responsible Development until 2020 with a perspective until 2030" and the "Transport Development Strategy until 2020 with a perspective until 2030" for seaport development, in accordance with the Act of December 6, 2006, on development policy principles.

In Polish seaports, investments are primarily focused on modernization, dredging of channels, constructing breakwaters, quays with infrastructure, and navigational marking. Key projects include the Central Port in Gdansk, a container terminal in Świnoujście, a ferry terminal in the Port of Gdynia, quay upgrades, and an LNG export facility in Świnoujście. Forecasts also involve developing unused port basins and expanding new port areas, including the construction of reflux fields.

- Gdansk Port Ranked Second in the Baltic in Terms of Cargo Handling

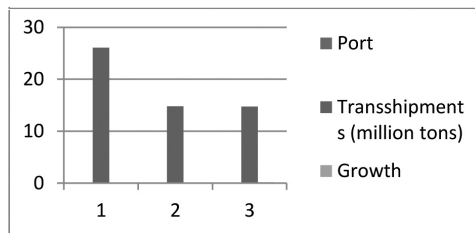


Fig. 17. Grain transshipments (million tons) at the Port of Gdansk.

Source: <https://www.gdansk.pl>

Tab. 12. Grain transshipments (million tons) at the Port of Gdansk.

Place	Port	Transshipments (million tons)	Growth
1	Ust-Luga	26,10	2,30%
2	Gdansk	14,80	11,30%
3	Primorsk	14,766	17%

Source: <https://www.gdansk.pl>

Record-breaking Year for Polish Seaports (Trade.gov.pl, 2024)

Last year marked yet another record-breaking period for Polish seaports, including Gdansk, Gdynia, Szczecin, and Świnoujście, which are integral to the national economy.

- 1) Transshipment Growth: Polish ports collectively handled 145.7 million tonnes of cargo, indicating nearly a 10% increase from the previous year's 133 million tonnes.
- 2) Gdansk Port: Notably, the Port of Gdansk saw a significant surge, handling a record-breaking 81 million tonnes of goods, marking a 19% increase from 2022. This remarkable performance was primarily driven by a substantial rise in the transshipment of liquid fuels.

- 3) Fastest-growing European Port: the Port of Gdansk achieved the status of the fastest-growing European port over the last decade, with a growth rate of 167%. Moreover, it currently holds the top position in the Baltic Sea for container handling.
- 4) Gdynia Port: The Port of Gdynia experienced a 5% increase in transshipment, reaching 29.4 million tonnes in 2023. Notably, the handling of grain saw the highest dynamics, recording a 42.7% surge.
- 5) Szczecin and Świnoujście Ports: Conversely, the Ports of Szczecin and Świnoujście witnessed a slight decrease of approximately 4% in transshipment, totalling 35.3 million tonnes compared to 36.8 million tonnes in the previous year.

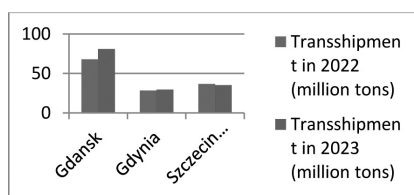


Fig. 18. Seaport of Gdynia

Source: <https://www.trade.gov.pl/en/news/a-record-breaking-year-for-polish-seaports/>

- Investments in Gdynia and Świnoujście



Fig. 19. Seaport of Świnoujście

Source: <https://www.trade.gov.pl/en/news/a-record-breaking-year-for-polish-seaports/>

The Port of Gdynia is expanding through the Outer Port project, slated to commence operations by 2028-2029. Covering approximately 151 hectares, it includes a container terminal capable of handling 2.5 million TEU. Deep-water quays spanning

2.5 kilometres will accommodate large vessels accessing the Baltic Sea. The Outer Port’s versatility extends to wind farm components, project cargo, general cargo, and ro-ro operations. Additionally, it will serve military purposes, supporting the Polish Army and allied forces, thus enhancing the Port of Gdynia’s strategic significance as a NATO base on the Baltic Sea.

Tab. 13. Investments in Gdynia and Świnoujście

Data	Value
Commencement of Transshipment	Between 2028 and 2029
Outer Port Area	Approximately 151 ha
Container Terminal Capacity	2.5 million TEU
Length of Quays	Approximately 2.5 km
Nature of Outer Port	Universal
Utilization of Outer Port	Containers, wind farm elements, project cargo, general and ro-ro cargo, defines purposes

Source: <https://www.trade.gov.pl/en/news/a-record-breaking-year-for-polish-seaports/>



Figure 19. Seaport of Świnoujście

Source: <https://www.trade.gov.pl/en/news/a-record-breaking-year-for-polish-seaports/>

The Szczecin and Świnoujście Seaports Authority plans to construct a Deepwater Container Terminal in Świnoujście, aligning with the Sustainable Transport Development Strategy until 2030. Aimed at bolstering Polish ports’ position in the Baltic Sea basin and establishing them as key hubs in Central and Eastern Europe’s supply chains, the terminal will accommodate large container ships, enhancing military readiness and troop deployment efficiency according to analyses by the Polish Armed Forces.

CONCLUSION

The second part of the article examines selected maritime transportation means and the future of Polish port development over the next 30 years, focusing on key ports such as Gdansk, Gdynia, Szczecin, and Świnoujście, which serve as vital connections for Europe's regions. The Port of Gdynia's strategic plan emphasizes infrastructure, transport, and environmental considerations. Polish ports play a crucial role in global trade, and their development is essential for maintaining competitiveness. Investment in infrastructure and technology, along with a focus on environmental sustainability, are key factors for ensuring future growth and success in the maritime industry.

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