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Strategic Planning for the Development of Ukraine's Seaports: Definitions, Trends, Efficiency Criteria

Abstract

Purpose. This article aims to justify the necessity of strategic planning for the development of Ukraine's maritime ports in the context of global logistics challenges, geopolitical instability, and the need for integration into the European transport network. The study defines the conceptual framework of strategic port development, identifies current trends, and develops a system of efficiency criteria that can guide sustainable and competitive growth in the maritime sector. *Methodology.* The research applies a qualitative analytical approach based on a review of academic literature, policy documents, and port development strategies. A multidimensional framework of port efficiency is developed, encompassing economic, environmental, social, innovative, and operational criteria. Comparative and system analyses are used to assess their relevance for strategic port planning under the conditions of transformation and uncertainty in the global logistics environment. *Results.* The study confirms that strategic planning must integrate state policy instruments, market mechanisms, and digital technologies. Economic efficiency supports investment strategy and optimal resource use; environmental performance reflects compliance with international standards and enhances port attractiveness; social efficiency is linked to regional development and community engagement; innovation ensures modernization through digitalization and automation; and operational productivity determines the speed and quality of port services. The proposed efficiency framework offers a holistic vision for developing Ukrainian ports as sustainable and competitive logistics hubs. *Value / Originality.* This research contributes to the theoretical and practical discourse on port development by proposing a comprehensive set of efficiency criteria applicable in strategic planning. It emphasizes the importance of coordinated interaction between government, business, academia, and international partners in the modernization of Ukraine's maritime infrastructure and its integration into global logistics chains.

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strategic planning,
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1 Introduction

In the context of globalization, transport integration, and rising competition among logistics hubs, seaports are essential to sustainable national economic growth. They function not only as transport

nodes but also as key logistical and industrial centers contributing to the gross domestic product of maritime countries. Meanwhile, military threats, global trade shifts, climate change, and technological advances compel the sector to adopt new planning approaches. Strategic planning is gaining importance

as a tool for enhancing competitiveness, resilience, and long-term development by setting priorities for infrastructural, organizational, and digital transformation in line with business, state, and local needs.

In international academic discourse, the strategic development of seaports is viewed as a complex, multi-level system that encompasses infrastructural, managerial, technological, and environmental components.

The works of (Notteboom & Rodrigue, 2022; Baird, 2020) examine the transformation of ports into logistics hubs, particularly in terms of digital integration, sustainable development, and privatization approaches to port infrastructure management. These studies emphasize the need for new models of strategic governance and highlight the role of the private sector in advancing the industry.

Other researchers, such as (Van den Berg & De Langen, 2019), focus on the geoeconomic aspects of port operations, stressing the importance of hinterland integration, the development of intermodal connections, and the use of dry ports as a strategic resource for reducing logistics costs and improving transport efficiency.

Studies such as (Jović et al., 2021; Acciaro et al., 2022) explore the impact of digital technologies on port management processes. The authors justify the importance of implementing smart systems, automation, and data analytics as factors that enhance port efficiency and competitiveness in the context of globalization.

Environmental dimensions of strategic port planning are addressed in the work of (Darbra et al., 2009), which proposes a system of environmental indicators for assessing the sustainable development of ports. The researchers underscore the need to incorporate environmental standards into port management strategies, particularly in response to growing requirements for CO₂ emissions reduction and protection of marine ecosystems.

Overall, international literature highlights the necessity of strategic adaptation of ports to the challenges of digital transformation, climate change, intensified competition, and increasingly complex global logistics chains.

In the Ukrainian scholarly context, the strategic planning of seaport development is examined through the lens of infrastructure modernization, digitalization, institutional transformation, and the influence of external threats (Anisimova, 2020; Boiko, 2020; Danyliuk, 2023; Diez, 2021; Umanskyi, 2022).

At the same time, Ukrainian academic discourse is still dominated by studies describing the current state of ports or localized technical solutions, whereas issues related to comprehensive strategic planning, effectiveness assessment, and scenario-based forecasting of port system development remain insufficiently explored.

The purpose of this article is to develop a theoretical and applied approach to strategic planning for the development of Ukrainian seaports, taking into account current challenges, international experience, and the priorities of digital and

2 Strategic Planning: General and Sectoral Interpretations

The concept of strategic planning originated in corporate management in the 1950s-1960s and has since evolved into an interdisciplinary framework, now adapted to public administration, transport, and infrastructure sectors. In general terms, strategic planning is the process of defining long-term goals for an organization and determining the means of achieving them in the context of external instability (Mintzberg, 1994).

In the modern context of seaports, strategic planning ensures the justification of investment decisions, the prioritization of infrastructure development, the implementation of digital technologies, ecological modernization, and integration into global logistics chains (Anisimova, 2020).

According to Notteboom & Rodrigue (2022), port strategic planning is based on the synergy between the public and private sectors, the balance of interests among regions, the state, and port operators, and is also influenced by the type of port governance model (landlord, service port, tool port).

Ukrainian scholars also propose context-specific approaches. For instance, I.M. Boiko defines strategic planning in a seaport as "a tool for shaping a competitive logistics environment by identifying priority directions for investment, technological renewal, and integration into the national transport system" (Boiko, 2020).

A crucial role in strategic port planning is played by the logistics concept of "Port 4.0," which promotes the use of digital technologies such as the Internet of Things (IoT), artificial intelligence, blockchain, and automated control systems to increase port operational efficiency (Diez, 2021).

International organizations regulating port policy provide strategic guidelines and conceptual frameworks for port planning:

- UNCTAD (United Nations Conference on Trade and Development) develops policy guidance for effective port governance in developing countries, with a focus on integration into logistics chains and institutional capacity building (UNCTAD, 2023).
- IMO (International Maritime Organization) promotes principles of safety, environmental responsibility, and energy efficiency in ports through strategies aligned with the implementation of MARPOL, SOLAS, and GHG regulations (IMO, 2023).

- IAPH (International Association of Ports and Harbors) issues comparative reports, performance evaluation guidelines, and facilitates international exchange of best practices (e.g., through the World Port Sustainability Program).

For example, in the IAPH Port Planning Manual, strategic planning is defined as "the development of a long-term vision that incorporates global trends, scenario analysis, multi-level stakeholder coordination, and environmental responsibility" (IAPH, 2022).

Thus, strategic planning in the port sector relies on an interdisciplinary approach that combines principles of management, logistics, digitalization, and sustainable development.

3 Current State and Trends in Strategic Development of Seaports

Seaports remain critical nodes in the global logistics network, handling over 80 % of world trade by volume and over 70 % by value (UNCTAD, 2023). However, their current state varies significantly depending on regional characteristics, the level of integration into international transport corridors, infrastructure availability, and management effectiveness.

At the global level, there is a marked trend toward the automation of port operations, an increase in container traffic, and heightened requirements for environmental sustainability. Leading ports such as Rotterdam, Singapore, Los Angeles, and Shanghai are actively implementing digital solutions – Port Community Systems, smart cranes, and digital cargo tracking systems – that increase cargo handling efficiency and reduce vessel idle times (World Bank, 2022).

As of 2025, Ukraine's port system continues to operate under severe external pressures, including war, disrupted logistics chains, and limited access to the Black Sea. Nevertheless, the implementation of the "grain initiative," development of the Danube cluster, and partial redirection of cargo flows to Romanian and Polish ports have helped preserve basic logistics activity. One of the critical bottlenecks remains the limited integration with the railway infrastructure and the lack of specialized transshipment capacities, particularly in border regions (Danyliuk, 2023).

According to the Port Performance Index developed by the World Bank, no Ukrainian ports were ranked among the top 100 in 2023 (World Bank, 2023). This highlights the urgent need for systemic reforms, infrastructure investment, and modernization of port governance models. Nevertheless, comparative analysis suggests that Ukrainian ports, if guided by strategic planning, hold significant potential for rapid transformation,

positioning themselves as key transit hubs in Central and Eastern Europe.

Strategic planning for the development of seaports must account for a wide range of challenges and opportunities arising from the dynamic geopolitical, economic, and technological environment.

One of the main challenges is geopolitical instability and the disruption of global supply chains. Armed conflicts, sanctions, and the blocking of transport corridors undermine cargo flow stability and reduce investment attractiveness for ports located in high-risk areas (Notteboom & Rodrigue, 2022).

Outdated infrastructure represents another systemic barrier. In many countries, including Ukraine, parts of the port infrastructure are morally and physically obsolete, which limits the ability to accommodate large vessels, efficiently process containers, and integrate with multimodal networks (Umanskyi, 2022).

A significant issue also lies in the shortage of qualified personnel in port management, digital technologies, and automation. Amidst the digital transformation of port operations, the lack of appropriate human capital hampers the implementation of innovations (UNCTAD, 2023).

Despite numerous challenges, the strategic development of seaports offers several significant opportunities. Foremost among these is the advancement of digital infrastructure. The implementation of systems such as Port Community Systems, blockchain, automated cranes, digital customs procedures, and smart logistics enables cost reduction, increased transparency, and faster cargo processing (Jović et al., 2021).

Another promising direction is the expansion of integration with rail and inland waterway transport – particularly in the context of developing multimodal terminals and dry ports, which extend a port's hinterland reach deeper into the continent. This integration helps reduce logistics costs, shorten delivery times, and enhance competitiveness (Van den Berg & De Langen, 2019).

In addition, the environmental transformation of ports is becoming a major competitive advantage. Investments in green technologies – such as shore power systems, hybrid tugboats, energy-efficient lighting, and crane electrification – not only reduce environmental impact, but also increase the appeal of ports to international cargo owners and partners guided by ESG criteria. Climate change adaptation is also becoming increasingly relevant. Ports are highly vulnerable to climate-related risks, including sea level rise, intensifying storms, and extreme heat. Strategic planning must therefore include resilience-building measures such as infrastructure upgrades, protective barriers, and operational flexibility (EU Green Deal, 2020).

Thus, strategic port development planning must be grounded in global trends that are reshaping

the maritime industry. In the 21st century, the key trends include digitalization, environmental sustainability, multimodal integration, and climate change adaptation (given in Table 1).

4 Recommendations and Efficiency Criteria for Strategic Planning of Port Development in Ukraine

Ukraine possesses significant port potential, but its realization requires a systematic approach to strategic planning based on the integration of infrastructure, digital, environmental, and managerial components.

Priority should be given to investments in the reconstruction and modernization of port infrastructure, including deep-water terminals, container facilities, and access roads. This will improve the capacity to handle large vessels and reduce logistics costs. According to UNCTAD (2023), infrastructure modernization requires annual investments equivalent to 3-5 % of the national maritime logistics volume.

It is also essential to attract private investment through public-private partnership (PPP) mechanisms. Between 2020 and 2023, only a few concession projects were implemented (Olvia and Kherson ports), but their effectiveness still needs to be evaluated (IFC, 2022).

Ukrainian ports should more actively implement the Port Community System (PCS), electronic document flow, and integration with customs and logistics platforms. Digital interaction among all participants of the port ecosystem significantly reduces cargo handling time and corruption risks (KPMG Ukraine,

2023). As the example of the Port of Valencia shows, automation can reduce operational costs by up to 25 %.

To enhance the competitiveness of Ukraine's seaports, it is necessary to ensure their integration with rail, road, and inland waterway networks. The concept of "port hinterland connectivity" involves the strategic linkage of ports with inland logistics centers, terminals, and dry ports. Special attention should be paid to the development of intermodal hubs, particularly in the directions of Lviv, Uzhhorod, Kyiv, and the EU border (Chubuk, 2023).

Successful strategic planning requires the formation of a modern workforce – specialists in digital logistics, infrastructure project management, and data analysis. It is recommended to expand educational programs in cooperation with international partners and implement dual education models.

It is also important to strengthen the capacity of institutions responsible for port planning (Ukrainian Sea Ports Authority, local administrations) through digitalization, anti-corruption oversight, and public monitoring of KPIs.

Modern challenges require the integration of environmental dimensions into the strategic development documents of ports. Within the framework of the European Green Deal, ports must adapt to environmental standards: reducing emissions, developing an ecological fleet, and using alternative energy sources. This will facilitate the attraction of international cargo owners focused on ESG approaches (IMO, 2023).

Modern strategic planning for seaport development requires a multidimensional approach to evaluating their efficiency. Traditional economic indicators are complemented by environmental, social, innovative, and operational criteria, which together form a

TABLE 1 Strategic Development Trends of Seaports

Trend	Key Elements	Impact on Strategic Planning	Example
Port Digitalization ("Smart Ports")	Automated logistics management systems, digital platforms, Internet of Things (IoT), blockchain, cloud computing	Planning for IT infrastructure and cybersecurity to ensure transparency and faster data processing	The Port of Rotterdam uses the PortXchange digital platform, allowing shipowners, agents, and terminals to jointly manage expected time of arrival, reducing fuel costs and improving logistics efficiency
Greening and Sustainable Development ("Green Port Policy")	CO ₂ emission reduction, shore power, use of alternative fuels (LNG, biofuels)	Integration of environmental standards into development projects	The Port of Hamburg implemented an onshore power supply system, reducing emissions by 30 % during vessel berthing
Development of Multimodal Systems (Ports as Logistics Platforms)	Integration with rail, road, and inland waterway transport	Designing multimodal delivery schemes and creating logistics hubs based at ports	The Port of Gdańsk is developing a multimodal hub around its new deepwater terminal (DCT), integrating rail links to Central Europe
Climate Change Adaptation (Sea Level Rise, Storms, Extreme Heat)	Enhancing infrastructure resilience, constructing new protective engineering structures, increasing operational flexibility	Inclusion of climate risks in investment planning and infrastructure design	The Port of New York is raising pier levels and constructing flood protection barriers as part of its Climate Resilience Plan

comprehensive model for the sustainable functioning of a port (given in Table 2).

Traditionally, port performance is assessed using financial and economic indicators that demonstrate cost and revenue metrics, as well as the effective use of capacities. In European ports, such as Antwerp or Hamburg, financial KPIs play a key role in strategic budgeting and investment decision-making. Studies of Northern European ports show that when terminal utilization is below 65 %, financial stability declines (Notteboom & Rodrigue, 2022).

In Ukraine, similar approaches are used for assessing the effectiveness of state stevedores (e.g., in the reports of the Ukrainian Sea Ports Authority and the Accounting Chamber). This analysis has been conducted for the ports of Greater Odesa and the Danube region (Hryhoriev, 2022).

Global warming challenges and IMO requirements for emission reductions stimulate the assessment of environmental efficiency in ports. Ports such as Rotterdam and Los Angeles implement green port policies and evaluate "environmental efficiency" under certification programs like ISO 14001 or EcoPorts (Darbra et al., 2009). The ports of Barcelona and Gothenburg are examples of active implementation of energy efficiency programs and ISO 14001 certification, as well as being participants in EcoPorts.

Social aspects of strategic development include: According to an IAPH (2022) study, social efficiency is considered a part of the sustainable development

model of the port, ensuring harmonious relationships with the community and regional economy (IAPH, 2022). Educational programs for port workers and the creation of a favorable social environment are strategically important, as demonstrated in the ports of Hamburg and Rotterdam.

Innovation is the foundation of modern strategic port management. Innovation efficiency is assessed through the Port Digital Maturity Index, developed by the European Commission and IAPH (Acciaro et al., 2022). The implementation of IT solutions and digital technologies enhances the functional efficiency and competitiveness of ports. For example, the Port of Hamburg has implemented the smartPORT logistics system, which combines IoT, cloud technologies, and GPS for real-time transportation management.

Key operational indicators used in strategic planning include: high operational productivity allows a port to reduce downtime, increase throughput, and attract new clients. According to the World Bank (2023), leading ports around the world demonstrate high productivity due to deep automation and integration with rail and inland logistics systems. Ports in Southeast Asia (Singapore, Shanghai), for example, show significantly higher productivity due to automation and multi-level planning.

5 Conclusions

The article substantiates the necessity of strategic planning for the development of Ukrainian seaports

TABLE 2 Efficiency Criteria for Ports in Strategic Planning

Efficiency Criteria	Key Indicators and Directions	Impact on Strategic Planning
Economic Efficiency	• Return on Assets (ROA); • Operational profit per unit of cargo; • Capacity utilization rate; • Unit handling cost; • Revenue from port charges and services.	Evaluation of financial stability, effective resource use, investment strategies.
Environmental Efficiency	• Greenhouse gas emissions (CO₂, NO_x, SO_x); • Share of electrified or alternative energy sources for vessel servicing; • Water quality in the port area; • Waste management.	Integration of environmental standards into port planning, environmental projects.
Social Efficiency	• Employment rate, creation of new jobs; • Investment in staff training and qualification; • Occupational safety (digital risk monitoring); • Impact on local community quality of life. • Interaction with municipal and environmental initiatives; • Social responsibility.	Development of social initiatives, ensuring safety, cooperation with local communities.
Innovative Efficiency	• Digital management (implementation of PCS – Port Community Systems); • Crane automation and use of autonomous equipment (AGV, ARMG); • Blockchain for logistics process transparency; • Big Data and predictive analytics for optimizing cargo flows.	Selection of innovative technologies to improve processes, optimization, robotics, automation of workflows.
Operational Productivity	• Average container dwell time; • Productivity, i.e., the number of cargo operations per hour (moves per crane per hour); • Storage and area occupancy rates; • Dock usage rate; • Average ship processing time (berth time).	Evaluation of cargo processing speed, infrastructure improvements to enhance transshipment efficiency and service quality.

in the context of contemporary global logistics challenges, geopolitical instability, and the need for integration into the European transport space. Strategic planning should be based on a combination of state policy, market mechanisms, and digital technologies aimed at enhancing the competitiveness and sustainability of the port sector.

The application of a multidimensional approach to assessing port efficiency, which includes economic, ecological, social, innovative, and operational criteria, allows for the creation of a comprehensive model for the sustainable operation of port complexes.

1. Economic efficiency is the foundation for developing investment strategies, fostering profitability, and enhancing the effective use of port capacities. An important aspect is optimizing cargo handling costs and increasing revenues from port fees.

2. Ecological efficiency has gained particular importance in the context of international demands for emissions reduction and sustainable development. The implementation of "green" technologies and the management of ecological aspects in strategic planning will increase the attractiveness of Ukrainian ports for international cargo owners who are focused on ESG approaches.

3. Social efficiency includes the interaction of ports with local communities and the development of social initiatives that improve labor conditions and the quality of life of the population, as well as ensuring sustainable development of regions.

4. Innovation is the driving force behind the modernization of port infrastructure.

The implementation of modern automation technologies, digitalization, and the use of big data significantly enhances the operational efficiency and competitiveness of ports.

5. Operational productivity is determined by the effectiveness of cargo handling and the speed of port operations, which directly impacts the economic results of the ports. High cargo handling productivity contributes to reducing costs and attracting new clients.

Future research should address several priority areas. First, integrating digital platforms such as blockchain, IoT, and automation into Port Community Systems can enhance cargo processing and transparency. Second, developing multimodal hubs will improve connectivity between maritime, rail, road, and inland waterways. Third, research on climate change impacts and green technologies is needed to enhance infrastructure resilience and reduce emissions. Fourth, the socioeconomic effects of port development on local communities require deeper analysis. Lastly, strengthening human capital through training programs is vital for managing innovative and digital port operations effectively.

A comprehensive approach to strategic planning will ensure the sustainable development of Ukrainian seaports, their integration into global logistics chains, and contribute to the country's economic growth. The successful implementation of the outlined recommendations requires coordinated interaction between the government, business, international donors, and educational and scientific institutions.

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