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EFFICIENCY ANALYSIS OF SEAPORTS IN RUSSIA'S BALTIC BASIN: PERFORMANCE EVALUATION

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This research presents a comprehensive analysis of the performance efficiency of Russia's Baltic seaports, taking into account various economic indicators and addressing investment planning and management issues. Special attention is given to the sustainable development goals and objectives of the seaports, considering their significance in transport and logistics systems. The primary objective of this work is to develop a system approach for conducting multi-criteria studies on seaport performance efficiency. The findings obtained through the proposed methodology consider criteria at different levels of seaport management, offering valuable practical implications. Notably, this study fills a gap in the literature as no previous work has provided a comprehensive methodology for studying and analyzing ports from the perspectives of management, logistics, and macroeconomics. The system approach can also incorporate environmental considerations and innovative solutions in port infrastructure management. By proposing a new approach to interpreting statistics on Baltic seaports' performance and presenting empirical research on sustainable development in transport and logistics systems, this study enables a multidimensional examination of seaport performance and establishes a framework for efficiency analysis and evaluation, which is crucial for effective management. The methodological scheme and algorithm for analyzing different categories of managers further facilitate the practical application of the approach. Moreover, it can serve as a strategic tool for informing regional economic policies regarding logistics and transportation.

Keywords:
seaport, Baltic region, efficiency, performance indicators, transport logistics, sustainable development, coastal zone

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Introduction

The need to apply new technologies to solve classical management tasks is driven by the accelerated pace of digitization of individual functions and processes, economic globalization, geopolitical transformation [1; 2], the emergence of new socio-political problems, the imbalance between existing and required infrastructure, the increasing share of transportation costs in the overall structure of logistics expenses, and other factors. However, focusing solely on optimizing operational activities does not seem sufficiently convincing from the long-term perspective of development. Research on companies engaged in various transport and logistics operations has revealed a lack of attention to the analysis and evaluation of performance from a strategic management standpoint. While significant research has been dedicated to other strategically important aspects such as designing logistics systems, planning performance indicators, and forecasting demand and supply, the analysis of effectiveness is often treated as a secondary element of management, which, in our opinion, is a misconception. On the contrary, regular monitoring and evaluation of transport and logistics activities are essential [3]. Experts [4; 5] suggest that a high level of analysis accuracy promotes rational resource management and enables timely corrective actions.

The study of both domestic and foreign literature, including the examples provided in these sources [3; 6], has led to the recognition of the significant scientific and practical interest in adopting a systemic approach to analyze port activities using multiple criteria. This interest stems from the recognition of the maritime coastline's substantial resource and communication potential within the complex geopolitical environment of the modern world, characterized by escalating tensions in various regions of Russia (such as Crimea, the Kuril Islands, and the Arctic). In this context, the analysis and evaluation of port activities as a vital component of the transport and logistics system hold strategic importance for regional development and the nation as a whole. Maritime ports play a pivotal role in global trade, which is an integral aspect of globalization and the establishment of regional trade agreements [7]. In addition to considering purely economic aspects in the analysis of port activities, it is important to take into account a whole range of additional factors, which are most fully examined in the context of the concept of 'territorial capacity'. Under this term, specialists [8] understand the possibility of intensifying the use of existing resources (infrastructure, nature, human resources, recreational, etc.) with or without investment planning, aimed at the comprehensive development of the territory and increasing the efficiency of port activity.

In the work [9], it is noted that since the 2000s, maritime transport has played a decisive role, accounting for up to 60% of all cargo transportation in conducting export-import operations. The significance of the effective functioning of a port as a connecting element in the organization of export-import operations, enabling the growth of various sectors of the economy, has long been recognized. As mentioned in the study [10], the "maritime factor," traditionally considered in the context of various aspects, is an important component of continuity in the development experience and comprehensive exploitation of the coastal territory. It includes characteristics such as economic and infrastructural facilities, the maturity of port structures and their significance at the national level, the rational use of maritime resources, their accessibility, and others.

Therefore, in order to enhance the competitiveness of the national trade system at the international level, special attention should be paid to the efficient operation of seaports. Furthermore, ports perform a complex of logistical operations that add value (such as packaging, consolidation, cargo storage, etc.). It should be noted that the level of development of the region's transport and logistics infrastructure directly affects the efficient operation of a seaport, which serves as a transportation hub where various modes of transportation such as road, rail, and maritime interact. The work [11] highlights that the efficient organization of a seaport as a transportation hub, connecting the inland logistics infrastructure and maritime routes, can achieve the goal of minimizing transportation costs and promoting sustainable development (including reducing carbon footprint). The high practical significance of a systematic study of a seaport demonstrates its relevance in the case of countries in the Caribbean Basin [12], China [11], ports along the transportation corridor under the Chinese government's "One Belt, One Road" initiative [6], and others. Considering various aspects when analyzing the activities of a seaport as a significant element of the transport and logistics system allows for the evaluation of its efficiency according to multiple criteria and facilitates the systematic resolution of strategic-level problems as well as the improvement of operational activities.

The aforementioned considerations have led to the formulation of the research objective, which is to develop a systemic approach for analyzing the effectiveness of seaport operations using multiple criteria. To accomplish this objective, a set of research tasks has been identified and defined: to determine a set of priority methods of scientific cognition (analysis, synthesis, generalization, and modelling); to justify the need for further developments in the research topic (by identifying research gaps in existing scientific research); to conduct a content analysis of statistical data sources; to propose a methodology that considers criteria for different levels of port management; to indicate the possibility for practical application of the developed solution.

Ports of the Baltic Basin of the Russian Federation

Maritime ports hold immense importance for the Russian Federation, as highlighted in the Strategy for the Development of the Russian Seaport Infrastructure until 2030. This strategic plan aims to enhance various aspects of the port industry, including capacity expansion, improved governance, increased competitiveness, and ensuring safe and sustainable development. The successful implementation of this strategy is anticipated to yield significant outcomes such as fostering innovation within Russian ports, mitigating adverse environmental effects, and establishing state-of-the-art port infrastructure.

Nowadays, five sea basins have been identified in the Russian Federation: the Baltic, Arctic, Far Eastern, Caspian, Azov-Black Sea, where a total of 67 ports operate. According to the Federal Agency for Maritime and River Transport (Morflot), in general, the cargo turnover showed positive dynamics in 2022, with the highest volume of transportation attributed to the ports of the Baltic and Azov-Black Sea basins (Fig. 1).

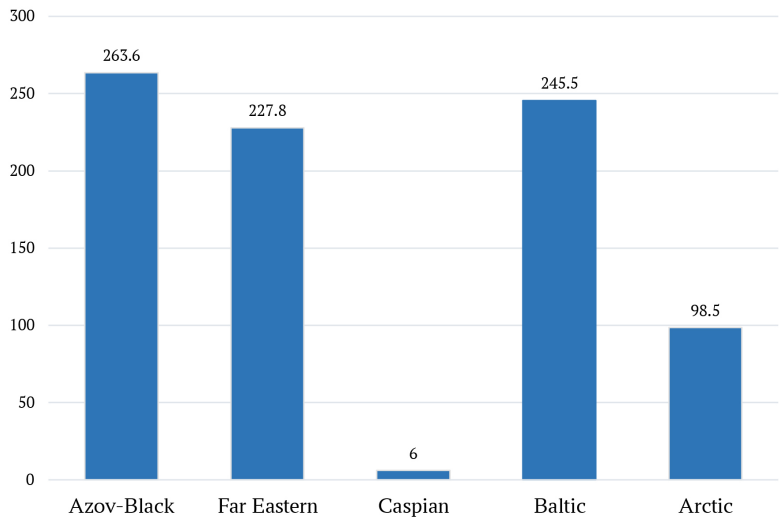

Fig. 1. Cargo turnover of Russian ports by sea basins, 2022, million tons

Source: compiled by the authors according to Portnews.[1]

Within the framework of this research, the ports of the Baltic Basin of Russia will be considered due to their special importance for foreign trade transportation: for example, the majority of cargo transportation from Europe is handled by the ports of the Baltic region. It is worth noting that the Baltic Basin includes ports of the Russian Federation and other countries, while more than half of the cargo flow in the region falls on Russian ports [13] (Fig. 2).

[1] Cargo turnover of Russian seaports in 2022 increased by 0.7 % to 841.5 million tons, 2023, Portnews, URL: https://portnews.ru/news/341316/ (accessed 13.01.2023).

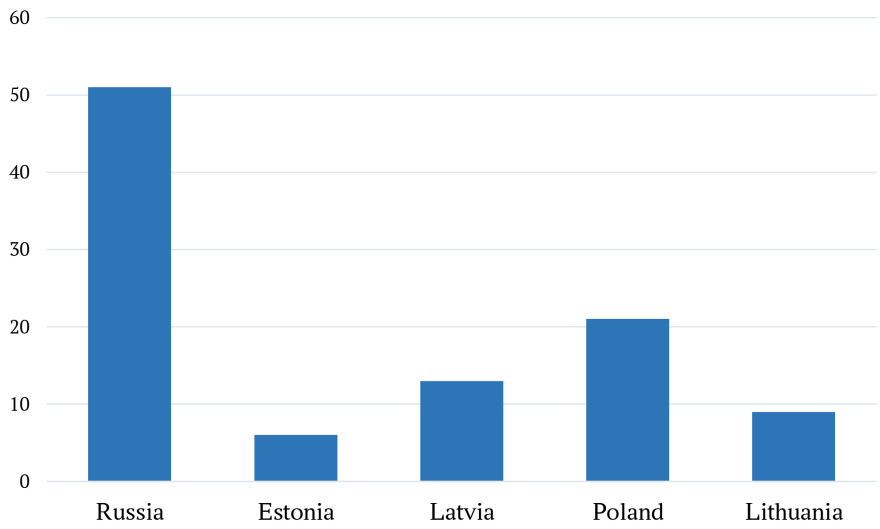

Fig. 2. Distribution of cargo flows in the Baltic seaports of Central and Eastern Europe by country, 2019, %

Source: compiled by the authors based on data [13, p. 6].

The Baltic Basin of Russia includes the following ports: the Big Port of Saint Petersburg, Vyborg, Vysotsk, Kaliningrad, Primorsk and Ust-Luga. All these ports are located on the territory of the North-Western region of Russia, which has significant transport potential. The region is crossed by two international transport corridors: Corridor №2 ("East-West") and Corridor №9 ("North-South"), they are important for the country's economic development [14; 15]. The main idea of the North–South MTK is to create favourable conditions for the delivery of goods from the Middle East to the Baltic states. Goods from the Persian Gulf, India, and Pakistan are transported to the ports of the Northwestern region of Russia and further to their destinations. MTK "East-West" allows cargo to be delivered via the Trans-Siberian railway to the northern ports of Russia, in particular to Murmansk, Arkhangelsk, as well as to the Baltic States and other ports. It is evident that the quality of performing multimodal international transportation through the MTK largely depends on the level of logistic service provided by various components of the logistics system, including the seaport, which serves as a transportation hub that concentrates elements of the logistics infrastructure for efficient and high-quality cargo handling. For example, the Big Port of Saint Petersburg is served by several railway stations, such as Novy Port and Avtovo. On the other hand, ports are of key importance both for regional economic growth and for employment indicators of the region's population. For instance, it is planned that by 2030, the Ust-Luga seaport will create 17,200 jobs, indicating a range of socially significant initiatives beyond solving economic and logistics tasks.

The concept of sustainable development of the port in the context of the implementation of transport and logistics activities

It is important to note that studying the problems of the port is impossible without a systematic approach, which includes taking into account a wide variety of factors that have both direct and indirect impacts on its activities. In this regard, the concept of integrated coastal zone management (ICZM) represents a special scientific and practical interest. As mentioned in [8, p. 145], "effective management of the coastal area requires integrating the natural environment and human activities into a single system." The authors [8; 10; 16] emphasize that the comprehensive approach to coastal zone management involves considering various aspects: ecosystem development, use of natural resources to achieve socio-economic development goals and objectives, the existence of conflicts between nature use and other maritime activities, the possibility of human economic activity in the coastal zone, etc. According to foreign experts [17], a comprehensive approach to coastal zone management (and, correspondingly, the elements of the transport and logistics system located within it) should involve close collaboration with government authorities in implementing any initiatives. Referring to the research findings [18], it is worth noting that key environmental issues related to the activities of seaports include water and air quality, noise, and waste disposal. This problem has long been under the close attention of the world community. In particular, the Baltic region is included in the SECA (sulfur compound emission control area), which imposes a ban on the use of marine fuel with a sulfur content of more than 0.1%. This means that using fuel oil, which is the most cost-effective fuel option, is not allowed. As the analysis of sources [19] has shown, today there is an active search for opportunities to manage indicators of sustainable development of the port's activities, taking into account these limitations and the environmental aspect in general. Foreign specialists [20] propose the following metrics for assessing environmental efficiency, which are part of the concept of a "green port": carbon footprint, waste management, and water consumption volumes. The listed indicators are operational; on the other hand, there are also managerial indicators such as an environmental monitoring program, environmental management, environmental training for personnel, and preparation of environmental reports [21]. Managerial indicators pertain to the strategic level of management. Ports that develop strategies to reduce negative environmental impacts and adhere to them can be considered sustainable since their activities enhance the sustainability of transportation and supply chains as a whole [22]. The concept of a sustainable port is relatively new, and various interpretations may be found in the literature. For instance, the American Association of Port Authorities introduced the term "sustainable port" in 2007, which encompasses a set of strategies and actions by the port that meet the current needs of stakeholders, ensure the protection of natural resources, and consider social aspects of personnel management. At the same time, interested parties

may be investors, cargo owners, ship owners, shipping companies, stevedores, the state, ministries, port administration, etc. [23]. On the other hand, European specialists often use the terms 'sustainable' and 'green' port interchangeably, emphasizing that the activities of such a seaport are focused on developing, implementing, and monitoring programmes to reduce environmental impacts [24]. Some differences in understanding these terms can be noted: the concept of a green port focuses on addressing environmental issues, while sustainability concerns problems of an economic, social and environmental nature, which, in our opinion, are most succinctly reflected in the ESG (Environmental, Social, and Governance). There is no exact translation of this foreign term in the domestic literature, but the concept is commonly understood as a combination of "environment," "social sphere," and "management." In some works, in particular, in [25], a quantitative method for evaluating indicators included in the main categories of ESG is proposed. Further development of the issue of assessing the effectiveness of the port's activities, in our opinion, should be developed within the framework of the ESG concept as a tool for a multidimensional vision of the problems of the port's functioning through the prism of a systematic approach to the ICZM.

Methodology for conducting a comprehensive analysis of the efficiency of ports

The question of analyzing the efficiency of logistical activities in seaports is particularly relevant in light of the modern challenges faced by the Russian economy. Accurate results from performance evaluations of logistics activities in seaports will enable the timely identification of "bottlenecks" and the implementation of appropriate measures to eliminate them. Let us consider in more detail the methodological basis for conducting a comprehensive multidimensional analysis of the activities of the seaport as the most important border transport hub between internal and external trade flows. ISO 9000 states that efficiency is understood as the ratio between the obtained result and the resources used to achieve it. The efficiency of a company's work can be indicated by certain indicators, which can be classified into two types: generalized indicators or particular metrics. The first type includes key performance indicators that allow taking into account total costs, execution time, investment volume, service, and performance indicators [26]. The second group consists of specific indicators related to the performance of operational tasks: port capacity, productivity, customer satisfaction with the provided service (which is reflected in global ratings, for example, in the LPI — Logistics Performance Index calculated by the World Bank), port cargo turnover, and others. As already noted, today the efficiency of port operations is also associated with reducing the carbon footprint. Obviously, from the perspective of applying a comprehensive approach, various port performance indicators should be evaluated according to the level of responsibility of the decisions taken (strategic, tactical, operational) and the time horizon

(short-term, medium-term, long-term). The conceptual approach proposed by the authors of this study implies, at the first stage, identifying all the parties involved in the interaction structure of the seaport and the external environment. This group may include cargo owners, consignees, logistics companies, transportation companies, shipping companies, port administration, investors, government agencies, municipalities, ministries, and others. The efficiency of the port depends on different indicators for each group, so the next step is to determine a set of characteristics suitable for everyone. For example, investors, the government, and port administration assess the efficiency of port activities from the perspective of cargo turnover. Additionally, for the government, the efficiency of the port depends on the use of modern environmentally friendly equipment. From the point of view of cargo owners, the efficiency of the port will be higher if a "smart port" system is implemented in the port. For operators, a high level of efficiency involves following the trend of implementing remote equipment control systems, while employees performing current tasks may face difficulties in mastering new technologies.

On the other hand, the seaport interacts with the participants of the external environment who are not interested in the results of its activities directly, but indirectly influence it. For example, to carry out loading and unloading operations in the port, lifting and transporting equipment is necessary, therefore, the port's activity depends on equipment suppliers, the main criteria for the effectiveness of which are the quality of the equipment supplied, the delivery time and the probability of accurate fulfillment of contractual conditions. In addition, the quality of the provided utility services is crucial for the uninterrupted operation of the seaport.

Another significant aspect concerns the issues of investment planning in determining the amount of funds allocated for the development of digital technologies, modernization of access roads, reconstruction of quay walls, construction of approach channels, or equipment procurement.

Taking into account the above-mentioned aspects, the methodological approach to the analysis of the port's activities, which allows for the consideration of temporal and managerial factors, aspects of investment planning and sustainable development, can be presented in the form of a matrix (Fig. 3).

As seen in Figure 3, efficiency analysis for different management levels is based on different information sources and categories. That is why the suggested approach requires the relevant database about the seaport's performance: financial reports, port schemes, its terminals, etc. Moreover, for the efficient application of the proposed approach, there should be data available about the partners of the seaport in order to define the stakeholders [23]. The complex analysis and further assessment of performance efficiency, in correlation with the conceptual ideas proposed by the authors, can be achieved through several steps (Fig. 4).

<table>
<tr><td colspan="3">Decision-making level</td></tr>
<tr><td>Strategic</td><td>Tactical</td><td>Operational</td></tr>
<tr><td colspan="3">Time, t →</td></tr>
<tr><td colspan="3">Control</td></tr>
<tr><td>Definition of the stakeholders</td><td>Resources: seaport infrastructure</td><td>Instructions and technological maps</td></tr>
<tr><td>Strategic goals statement
Trans-border cooperation between the companies</td><td>Regulations and rules of the seaport activities</td><td>Process standardization</td></tr>
<tr><td></td><td>Choice of the development strategy:
Cooperation
High service level
Costs reduction</td><td>Current tasks
Cooperation with the service providers</td></tr>
<tr><td></td><td>Process definition
Task statement:
Short-term
Sustainable development
Increasing customer loyalty
Process support (informational, financial, service)
Defining the opportunities: resources</td><td>Completing logistics operations:
Cargo handling operations
Cargo consolidation
Storage
Customs clearance
Road maps on applying the new technologies
Technology usage</td></tr>
<tr><td colspan="3">Stakeholders</td></tr>
<tr><td>Seaport authorities
Stakeholders
Government
Public authorities
Ministry</td><td>Cargo owner
Consignee</td><td>Logistics company
Transportation company
Shipping company</td></tr>
</table>

Fig. 3. Matrix of multi-level efficiency performance analysis of the seaport: characteristics of the steps and levels of realization for different groups of stakeholders

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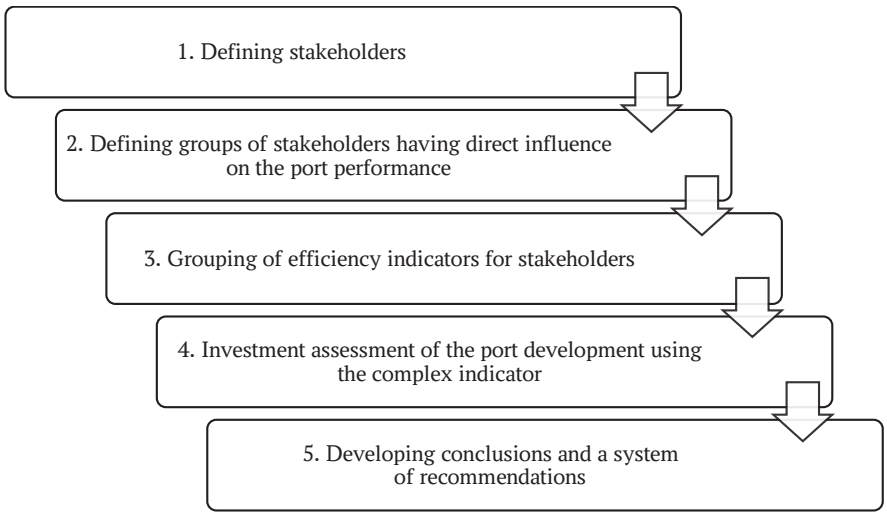

Fig. 4. Algorithm of the efficiency analysis of the seaport

Sequential actions presented in Figure 4 allow concluding that the well-known rules of the systemic approach, such as integration, integrity, decomposition, and hierarchy [27], can contribute to achieving the tasks of complex investigation of the seaports activities, and increase the decision-making quality at all management levels with certain time perspectives. As mentioned earlier, the system approach to the process management investigation has been studied within the ideas of ICZM, where sustainable development is considered from the long-term perceptive of commonwealth governance of economic, political and social factors.[1] In the short term, the perspectives of sustainable development may not be attractive, whereas in the long term, the situation is quite the opposite. This emphasizes the need of concentrating the attempts on considering different aspects of the ICZM with sustainable development goals on the strategic management level according to the proposed matrix (Fig. 3). There is an objective need to design a model of efficiency assessment of management decisions on operational and strategic management levels, their correlation and influence on the goal function relevant in the following aspects of ICZM:

1) ecological balance;
2) economic indicators;
3) ethical aspects;
4) institutional aspects;
5) social aspects;
6) technological development.

[1] Towards a European Integrated Coastal Zone Management (ICZM) Strategy: the General Principles and Policy Options, a reflection paper, 1999, *Directorates-General Environment, Nuclear Safety and Civil Protextion Fisheries Regional Policies and Cohesion*, URL: https://ec.europa.eu/environment/iczm/pdf/vol1.pdf (accessed 02.02.2023).

Thus, the research question of the present study aims to design performance indicators that align with the complex functioning of the seaport. These indicators should encompass various aspects of port activity and deviate from traditional approaches, such as comparing current values with those from the previous period, among others.

Analysis of the performance efficiency indicators of the Baltic seaports

Further, we consider diversified technical metrics relevant to the port performance analysis in order to verify the proposed methodology for tactical and strategic management levels [28; 29]. It includes the tasks of facility allocation, process intensity, number of technical vehicle service zones and so on [30—32]. The generalized results of the analysis of technical-related features are presented in Table 1.

Table 1

The basic technical characteristics of the Baltic seaports, 2022 year

Port	Throughput capacity, thousand tons per year	Navigation period	Port area, hectares	Water area, km^2	Berths number
Saint Petersburg	118 246.01	All year round	745.9	616.93	149
Vyborg	1970	All year round	16.658	2.87	9
Vysotsk	21 200	All year round	143.6	1.26	8
Kaliningrad	45 023.2	All year round	376.91	21.33	106
Primorsk	86.5	From May till November	247.448	31.77	12
Ust-Luga	156 000.25	All year round	1 188.1997	67.56	41

Source: complied according to the Rosmorport.[1]

The next step of the Baltic Seaports analysis includes an investigation of the investment activities. Consider the investment projects realized up to the current period and their results (Table 2).

Table 2

Investment projects implemented by the Baltic Seaports, 2022 year

Port	Investment project	Period	Results
Saint Petersburg	Icebreaking fleet facilities have been launched (two berths and navigation signs)	2018	The necessary safety facilities for the icebreaking fleet have been established, resulting in decreased costs for renting berths

[1] North-western basin branch, 2022, *Rosmorport*, URL: https://www.rosmorport.ru/filials/spb_seaports/ (accessed 28.12.2022).

The end of Table 1

Port	Investment project	Period	Results
Vyborg	Large-scale modernization associated with a reduction in coal shipments and a focus on liquid cargo	2024—2025	Port dependence on the coal supply has been decreased
Vysotsk	A grain terminal is planned to be launched with an estimated contract sum of 5.5 billion rubles	2022	Plans include the creation of 50 jobs, along with the construction of a warehouse complex with a capacity of 240,000 metric tons
Kaliningrad	The reconstructed base of navigation equipment was put into operation	2019	Nine buildings have been built. The berth has been reconstructed. Increased safety of ships navigation
Primorsk	Realization of the project 'Primorsky universal loading complex'	Up to 2024	The cargo turnover of the port increased up to 65 million tons per year. A logistics centre and new terminals were built
Ust-Luga	The new water area in the southern part of the port was started for use	2022	There are created conditions for the ships «Astrakhan», «SL-7», «SO-14»

Source: complied according to the Rosmorport.[1]

Despite the complicated economic and political situation in the country and worldwide, planned investment projects aimed at modernizing and enhancing the performance of Baltic seaports are not being squeezed or postponed. On the contrary, new investment projects are being developed.

The next step of the proposed conceptual approach is focused on environmental concerns. As mentioned earlier, the objectives of sustainable development garner significant attention from local authorities and international communities. This is reflected in the activities of the seaport through information integration and the utilization of advanced technologies [33]. For example, the 'Ecological justification of economic activities to maintain the design depths in the water areas, channels and fairways of the seaport Big Port Saint Petersburg in 2016—2026' is the document that was developed to regulate the annual performance of repair dredging. As part of the implementation of this project, a total of 53.9 million rubles were allocated to the port for fish farming based on the results from 2012 to 2021. This allocation allows for a comparison between the goals of sustainable development and the budget planning of the port.

[1] North-western basin branch, 2022, *Rosmorport*, URL: https://www.rosmorport.ru/filials/spb_seaports/ (accessed 28.12.2022).

Let us consider other examples of the ecological activities of the Baltic Seaports. In particular, the port authorities of Saint Petersburg have developed an ecological programme, receiving annual funding (in 2019 — 66 million rubles). The main ecological services provided by that port are the following: collecting, transporting and disposal of the ship wastes. The same eco-services are provided in the port of Ust-Luga with the use of a vessel collector, a waste processing station and specialized transport for waste transportation.

The ecological policy of the Kaliningrad port includes various environmental protection measures, such as enhancing personnel qualifications in this field and implementing measures to prevent air and water pollution. The Kaliningrad port administration has implemented the following actions: equipping tankers with floating roofs to reduce air emissions, waterproofing the surfaces of tankers to eliminate the possibility of soil pollution, and constructing treatment facilities to prevent water resource pollution.

Vyborg Port demonstrates a proactive approach in adhering to sustainable development principles. For example, in 2018, they developed an ecological strategy that spans until 2025. This strategy facilitated the implementation of dust-reducing equipment to mitigate coal dust in and around the port premises. Furthermore, the port authorities allocated funds to provide citizens with double-glazed windows to reduce noise levels in their homes.

In contrast, the port of Vysotsk has not implemented similar measures, resulting in citizens filing lawsuits highlighting negative impacts associated with the port's activities. The only environmental initiative undertaken by the port was the launch of a complex of treatment facilities in 2011.

Of particular interest are the characteristics of port activities during the last year. Analysis of statistical data and reports from 2022 reveals that these changes are a result of sanctions and limitations imposed on companies engaged in various activities within the seaport territories. Despite significant investments in infrastructure and the implementation of informational transformations in the Baltic Seaports (totaling 117.1 million), the development dynamic is currently negative. Specifically, the Saint Petersburg port's performance has been affected adversely. In 2022, the share of incoming ships decreased by 30 %, with only 294 sea vessels recorded compared to 418 in 2021. The decline in the number of foreign vessels arriving at the Baltic Seaports appears to be the primary factor contributing to this trend. However, it is worth noting that in March 2022, the number of vessels arriving at the port of Ust-Luga remained stable compared to the same period in 2021, while the port of Primorsk witnessed an increase in vessel arrivals. This observed imbalance emphasizes the need for seaports to have a sensitive logistics system in conditions of external instability, necessitating careful monitoring and evaluation of their activities.

Performance analysis requires the use of a system of indicators. The most relevant is the accounting of five groups of key indicators: indicators of operational activity, the level of technical (including innovative) development, environmen-

tal factors [34], socially significant indicators (for example, the level of migration [35]), and economic indicators [26]. At the same time, there is no single integrated approach to the number and composition of performance indicators today [21; 36]. In [21], it is emphasized that studies on the evaluation of port performance and the development of a system of performance analysis indicators can be divided into three groups in accordance with the focus of publications:

— the impact of emissions (including greenhouse gases) on the ecosystem of coastal zones, including those associated with intensive port activity;

— introduction of advanced sustainable development practices into the work of the port;

— efficient use of the economic and ecological potential of coastal zones in the context of achieving target values.

However, it is important to note that none of the mentioned directions can be considered the sole correct approach. Only a systemic approach can provide answers to the challenging questions of port logistics management. Therefore, the use of comprehensive performance indicators becomes particularly intriguing, as they enable the tracking of the interplay between environmental protection initiatives, social aspects, and the economic outcomes of seaport activities. In our view, the approach presented in the work of Italian experts [21] is highly valuable, as it facilitates the consideration of these parameters through two essential indicators of port efficiency:

— EQI — Environmental Quality Index, it is used to access the pollution level of the coastal zone related to the port activities; EQI can be defined with CO_2 volume. The lower EQI, the worse environmental conditions of the coastal zone of a certain port. In the article [21] the authors suggest defining EQI through the relation of cargo turnover to the emissions volume CO_2.

— The GPE (Green Port Efforts) index reflects the environmental obligations of port authorities and encompasses several blocks: the strategy of eco-management, eco-design, and ecological certification. The first block includes activities aimed at reducing emissions, optimizing energy usage, and the mandatory inclusion of eco-related aspects in concession contracts. The second block involves projects for environmental protection of the coastal zone, financed by the government and/or port authorities. The third block considers the application of ecological certification (ISO-14001) in port activities, the implementation of environment-protection projects in the coastal zone, and the monitoring of water and air quality. This block is particularly significant as eco-certification is a voluntary option that highlights the port's initiatives for environmental protection. In our research, we define GPE based on the relationship between investment volume and innovations in the port area. This allows us to focus on the effectiveness of investments in specific coastal zones. Additionally, we consider a decreasing coefficient if there is no regular monitoring of air and water pollution, or an increasing coefficient if ecological monitoring is conducted on a regular basis. A higher GPE value indicates higher port performance.

In the context of ICZM both indicators look relevant as their application allows taking the port performance with economic, ecological, social aspects, and consider the positions of stakeholders (including investors) on multidimensional seaports analysis (Fig. 3)

After considering the number and sequence of the indicators, the next step in the assessment analysis involves selecting an appropriate methodology. In the article [37], the Data Envelopment Analysis (DEA) is proposed as a decision support process for assessment. The authors conducted the DEA using MATLAB and DEA solver in MsExcel. However, despite its advantages, this approach has certain limitations when aiming for unambiguous efficiency assessment. For instance, in the context of the considered data volume, the number of research objects is significantly lower than the input and output parameters. Additionally, there may be a high level of errors in accordance with the input and output parameters, among other challenges. That is why we suggest using the methodology of benchmarking (or best practice) and method of the proportional effect distribution [38; 39] to create combined metrics.[1] To track the correlation between the innovative activity of a specific port, which focuses on environmental protection and operational excellence, and its economic results, the performance assessment can be conducted using two comprehensive indicators, EQI and GPE. Table 3 provides the descriptive statistics and performance indicators of the Baltic Seaports.

Table 3

Descriptive statistics and performance indicators of the Baltic Seaports of Russia

Parameter, data on 2022 year	Saint Petersburg port	Vyborg port	Vysotsk port	Kaliningrad port	Primorsk port	Ust-Luga port
*Descriptive statistics for 2022 year**						
Monitoring of the air and water quality on the coastal zone**	1.1	1.1	0.1	1.1	1.1	1.1
Port area, hectares	745.9	16.658	143.6	376.91	247.448	1 188.2
Number of employees, people	1100	477	509	1055	892	520
Volume of investments to innovations, million rubles	1500	2400	5500	2000	1090	30 000
EQI: CO_2 emissions, million tones	0.101	0.002	0.042	0.023	0.148	0.323
Cargo turnover, million tones	38.8	0.6	16	8.9	57.1	124.1
Estimated performance indicators						
EQI	384.16	300	380.95	389.96	385.81	384.21

[1] Fact-finding studies in support of the development of an EU strategy for freight transport logistics Lot 1: Analysis of the EU logistics sector, 2015, *Publication office of the European Union,* URL: https://op.europa.eu/en/publication-detail/-/publication/4c60a2c5-969e-11e7-b92d-01aa75ed71a1 (accessed 05.12.2022).

The end of Table 2

Parameter, data on 2022 year	Saint Petersburg port	Vyborg port	Vysotsk port	Kaliningrad port	Primorsk port	Ust-Luga port
EQI, %	17.26	13.48	17.12	17.53	17.34	17.27
Deviation from the leading port, %	– 0.26	– 4.04	– 0.40	0	– 0.19	– 0.26
GPE	1.57	5.53	1.08	2.08	1.34	63.46
GPE, %	2.091	7.37	1.43	2.77	1.79	84.53
Deviation from the leading port, %	– 82.43	– 77.16	– 83.09	– 81.75	– 82.74	0

Source: complied from the data.[1]

** Value 1,1 corresponds to monitoring procedures conducted, 0,1 corresponds to none of monitoring procedures conducted.

[1] North-western basin branch, 2023, *Rosmorport,* URL: https://www.rosmorport.ru/filials/spb_seaports/ (accessed 30.12.2022) ; Sustainable development, 2023, *Seaport Saint Petersburg,* URL: https://seaport.spb.ru/sustainable-development/ (accessed 04.01.2023) ; About us, 2022, *Seaport Saint Petersburg,* URL: https://seaport.spb.ru/about/ (accessed 29.12.2022) ; Disclosure of information on the possibilities of water supply and sanitation, 2023, *Seaport Saint Petersburg,* URL: https://seaport.spb.ru/documents/information-disclosure/organization-of-water-supply-and-sewerage/ (accessed 11.01.2023) ; Environment, 2023, *Seaport Saint Petersburg,* URL: https://seaport.spb.ru/sustainable-development/environment/ (accessed 01.02.2023) ; The cargo turnover of Russian ports has increased on 0,7 % (detalization), 2023, *Portnews*, URL: https://portnews.ru/news/341725/ (accessed 11.02.2023) ; Ecology, 2023, *Port logistic,* URL: http://www.portlog.ru/jekologija/ (accessed 11.02.2023) ; «Northseaproject» will finish the reconstruction of three berths and Gutuev island the Seaport of Saint Petersburg, 2023, *Portnews*, URL: https://portnews.ru/news/341600/ (accessed 19.01.2023) ; A dry-cargo port will be built in the Vyborgsky District for more than 24 billion rubles, 2019, *Rianews*, URL: https://ria.ru/20190606/1555336031.html (accessed 19.01.2023) ; Terminals competition: on the Baltic it is announced another new project, 2022, *RBC*, URL: https://www.rbc.ru/spb_sz/01/09/2022/63105abb9a794721b4460a75: (accessed 10.01.2023) ; News of the North-Western Basin Branch, 2022, *Rosmorport*, URL: https://www.rosmorport.ru/filials/spb_news_main/44713/ (accessed 11.12.2022) ; Investors will invest 1 billion in the project of a new port in Primorsk, 2019, *Moika 78*, URL: https://moika78.ru/news/2019-05-23/234061-investory-vlozhat-1-mlrd-v-proekt-novogo-porta-v-primorske/ (accessed 12.12.2022) ; The Leningrad region has approved a marine project worth 30 billion rubles and 600 workplaces, 2022, *RBC*, URL: https://www.rbc.ru/spb_sz/17/06/2022/62ac1da59a794789f2a507d1 (accessed 24.12.2022) ; The main indicators of environmental protection, 2021, *Rosstat*, URL: https://rosstat.gov.ru/storage/mediabank/oxr_bul_2021.pdf (accessed 24.12.2022) ; Russian Seaport turnover during the first 12 months of the 2022 year, 2023, *Association of the sea trading ports*, URL: https://www.morport.com/rus/news/gruzooborot-morskih-portov-rossii-za-12-mesyacev-2022-g (accessed 20.01.2023).

The analysis of the results obtained indicates that the seaport of Kaliningrad demonstrates the highest effectiveness in terms of reducing the anthropogenic impact on the environment, with an EQI value of 17.53 %. Herewith, the deviation of the majority of other ports do not exceed 0,4 %, except Vyborg (4 %). According to the GPE indicator, which reflects the effectiveness of the use of investments in innovations in the territory of the seaport, the Ust-Luga port obtained the higher GPE value (GPE = 84 %). The proposed approach for calculating two performance indicators of the port takes into account multiple aspects of its activity, including economic, investment, social, environmental, and technological factors. This approach offers a new perspective on the traditional problem of analysis and efficiency evaluation in ports.

Table 4 presents a matrix that outlines the statistical indicators of port activity, which are considered in determining the comprehensive indicators of Environmental Quality Index (EQI) and Green Port Efforts (GPE). The table provides a schematic representation of the various factors and indicators that contribute to the overall assessment of the port's performance in terms of environmental sustainability and operational efficiency.

Table 4

Matrix of Parameter Correlations: Four Performance Aspects in Relation to Management Levels

Decision-making level	Strategic	Tactical	Operational
Aspects of port performance			
Economic	Port area		Cargo turnover
Investing	Investments		
Technological		Investments	
Ecological		Eco-projects	Emissions

Note: the green color reflects the parameters used in EQI estimation, the orange color reflects the parameters used in GPE estimation.

The proposed approach enables the evaluation of port activities using multiple criteria through the utilization of two comprehensive performance indicators — EQI and GPE — across various management levels. The resulting quantitative index provides a relative assessment of efficiency and can be utilized for monitoring the port's performance over time.

Based on the analysis of the results obtained, the authors developed a system of recommendations to improve the efficiency of the ports of the Baltic Basin of Russia by improving the values of the parameters included in the calculation of EQI and GPE indicators:

1. It is necessary to increase the volume of investments in the ports of Primorsk and Kaliningrad, as the number of inward vessel flows to these ports is growing despite the sanctions.

2. As part of the activities of each analyzed port, it is important to focus on the development of technological capabilities, including the automation and digitalization of cargo handling processes, to reduce CO_2 emissions.

3. It is require to introduce modern environmentally friendly technologies into the activities of ports.

4. A strategic plan needs to be developed, which includes identifying target markets and products, as well as assessing opportunities to increase the volume of processed cargo flows. This measure is particularly relevant for ports experiencing a downward trend in cargo turnover, such as Vyborg, Vysotsk, and Saint Petersburg.

5. Business processes in the analyzed ports should be optimized to reduce time losses, which will improve efficiency in terms of economic indicators.

Improving and modernizing the infrastructure of Vyborg and Vysotsk ports can significantly increase their cargo turnover. Measures for achieving this include the construction of new berths and the enhancement of loading and unloading equipment.

6. In ports such as Ust-Luga, Saint Petersburg, and Primorsk, tax incentives could be introduced for ships that use environmentally friendly fuels. This initiative aims to stimulate the use of environmentally friendly vessels, which will help reduce the carbon footprint.

7. The installation of energy-saving technologies can be implemented as a measure to reduce emissions from port activities.

Discussion and conclusions

In this article, we consider a seaport as a critical element of the country's transport and logistics system. We propose an investigation of its activities using a developed algorithm for analyzing port performance, along with the application of a conceptual scheme that includes a list of tasks implemented within the operational, tactical, and strategic levels of management. The proposed methodological approach enables the analysis and evaluation of a port's efficiency, considering both traditionally used indicators of a technical nature and economic efficiency indicators, as well as investment planning and sustainable development goals. To accomplish this, we suggest, at the first stage, identifying stakeholders and then grouping them by management levels. Based on the tasks of each level, specific parameters are utilized in the estimation of performance indicators.

The study utilized data on cargo turnover, investment in innovation, carbon emissions, port area, and the number of environmental project initiatives aimed at achieving sustainable development goals and objectives as the basis for calculating two comprehensive performance indicators (EQI and GPE). To validate the proposed approach, the article presents the results of cargo turnover in Russian ports, determines the market share of ports in the Baltic basin, examines investment projects, port throughput, innovations in reducing the anthropogenic impact

of port infrastructure on the environment, and more. Consequently, performance indicator values were obtained for each port in the Baltic basin for the year 2022, and a system of recommendations has been developed. As a result, all research tasks have been fully completed, and the study goal has been achieved.

We also highlight that the proposed approach is applicable to the analysis and evaluation of port activities in other regions of Russia, as it serves as a universal tool for strategic management. The comprehensive examination of various aspects of seaport functioning through a three-level management system underscores the practical significance of this work for top and middle-management personnel. Consequently, the integrated approach presented in the article encompasses a multidimensional analysis of port efficiency, incorporating both traditional economically significant indicators and new facets of activity. Considering these aspects becomes particularly relevant in the face of global changes and challenges.

Considering the current international situation, it can be concluded that political and economic factors exert a significant influence on the port business. This situation presents both challenges and opportunities for seaport management. On one hand, it presents a challenging situation; on the other hand, it encourages the exploration of new solutions to adapt to prevailing market conditions. Therefore, the scientific discourse on analyzing seaport activities can be further expanded to explore the incorporation of risk management methods. This includes examining various strategies for managing shocks and post-shock conditions in seaport operations as integral components of the logistics system during crisis situations.

References

1. Fedorov, G. M. (eds.), 2021, *Vyzovy i perspektivy razvitiya kaliningradskoj oblasti: geopolitika i geoekonomika, Konsorcium "rubezhi Rossii"; Baltijsky Federalnyj Universitet im. Immanuila Kanta [Challenges and perspectives of development of the Kaliningrad region: geopolitics and geoeconomics, Consortium "the frontiers of Russia"; Immanuel Kant Baltic Federal University]*, Kaliningrad, BFU named after I. Kant Publisher (in Russ.).

2. Druzhinin, A. G. 2020, The strongholds of Russian coastal borderlands: economic dynamics amid geopolitical turbulence, *Baltic region*, vol. 12, № 3, p. 89—104, https://doi.org/10.5922/2079-8555-2020-3-6 (in Russ.).

3. Kammoun, R., Abdennadher, C. 2022, Seaport efficiency and competitiveness in European seaports, *Transport Policy*, vol. 121, p. 113—124, https://doi.org/10.1016/j.tranpol.2022.04.003.

4. Grabowska, S., Saniuk, S. 2022, Assessment of the Competitiveness and Effectiveness of an Open Business Model in the Industry 4.0 Environment, *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 8, № 1, 57, https://doi.org/10.3390/joitmc8010057.

5. Barykin, S. E., Strimovskaya, A. V., Sergeev, S. M., Borisoglebskaya, L. N., Dedyukhina, N., Srklyarov, I., Sklyarova, J., Saychenko, L. 2023, Smart City Logistics on the Basis of Digital Tools for ESG Goals Achievement, *Sustainability*, vol. 15, 5507, https://doi.org/10.3390/su15065507.

6. Li, L., Wang, J., Wang, H., Jin, X., Du, L. 2023, Intermodal transportation hub location optimization with governments subsidies under the Belt and Road Initiative, *Ocean & Coastal Management*, vol. 231, 106414, https://doi.org/10.1016/j.ocecoaman.2022.106414.

7. Zuev, V. N., Ostrovskaya, E. Y., Skryabina, V. Y. 2023, Trade damper effect of regional trade agreements, *Voprosy Ekonomiki*, № 2, p. 83—99, https://doi.org/10.32609/0042-8736-2023-2-83-99 (in Russ.).

8. Kropinova, E. G., Afanasyeva, E. P. 2014, Sustainable development of coastal territories as a basis for integrated management of coastal zones, *Vestnik of Immanuel Kant Baltic Federal University*, № 1, p. 140—147 (in Russ.).

9. Kuznetsov, A., Dinwoodie, J., Gibbs, D., Sansom, M., Knowles, H. 2015, Towards a sustainability management system for smaller ports, *Marine Policy*, vol. 54, p. 59—68, https://doi.org/10.1016/j.marpol.2014.12.016.

10. Druzhinin, A. G., Kuznetsova, O. V. 2023, The sea factor in the federal regulation of Russia's spatial development: Post-Soviet experience and current priorities, *Baltic region,* vol. 14, № 4, p. 4—19, https://doi.org/10.5922/2079-8555-2022-4-1 (in Russ.).

11. Yin, C., Ke, Y., Chen, J., Liu, M. 2021, Interrelations between sea hub ports and inland hinterlands: Perspectives of multimodal freight transport organization and low carbon emissions, *Ocean & Coastal Management*, vol. 214, 105919, https://doi.org/10.1016/j.ocecoaman.2021.105919.

12. Corey, J., Wang, Q., Zheng, J., Sun, Y., Du, H., Zhu, Z. 2022, Container transshipment via a regional hub port: A case of the Caribbean Sea region, *Ocean & Coastal Management*, vol. 217, 105999, https://doi.org/10.1016/j.ocecoaman.2021.105999.

13. Bocheński, T., Palmowski, T., Studzieniecki, T. 2021, The Development of Major Seaports in the Context of National Maritime Policy. The Case Study of Poland, Sustainability, vol. 13, № 22, 12883. https://doi.org/10.3390/su132212883.

14. Tagiltseva, J., Vasilenko, M., Kuzina, E., Drozdov, N., Parkhomenko, R., Prokopchuk, V., Skichko, E., Bagiryan, V. 2022, The economic efficiency justification of multimodal container transportation, *Transportation Research Procedia*, vol. 63, p. 264—270, https://doi.org/10.1016/j.trpro.2022.06.012.

15. Stephenson, Sh. 2015, Global Value Chains: The New Reality of International Trade, *The E15 Initiative. Strengthening the Global Trade System*, URL: https://e15initiative.org/wp-content/uploads/2015/09/E15-GVCs-Stephenson-Final.pdf (accessed 05.12.2022).

16. Druzhinin, A. G. 2016, Russia's coastal zone as a social and geographic phenomenon: conceptualisation and delimitation, *Baltic region*, vol. 8, № 2, p. 57—67, https://doi.org/10.5922/2079-8555-2016-2-5 (in Russ.).

17. Caviedes, V., Arenas-Granados, P., Barragán-Muñoz, J. M. 2020, Regional public policy for Integrated Coastal Zone Management in Central America, *Ocean & Coastal Management*, vol. 186, 105114, https://doi.org/10.1016/j.ocecoaman.2020.105114.

18. Anas, A., Liu, Y. 2007, A regional economy, land use, and transportation model: formulation, algorithm design, and testing, *Journal of regional science*, vol. 47, № 3, p. 415—455, https://doi.org/10.1111/j.1467-9787.2007.00515.x.

19. Puig, M., Azarkamand, S., Wooldridge, C., Selén, V., Darbra, R. M. 2022, Insights on the environmental management system of the European port sector, *Science of The Total Environment*, vol. 806, part 2, 150550, https://doi.org/10.1016/j.scitotenv.2021.150550.

20. Rodrigues, V., Russo, M., Sorte, S., Reis, J., Oliveira, K., Dionísio, A., Monteiro, A., Lopes, M. 2021, Harmonizing sustainability assessment in seaports: A common framework for reporting environmental performance indicators, *Ocean & Coastal Management*, vol. 202, 105514, https://doi.org/10.1016/j.ocecoaman.2020.105514.

21. Castellano, R., Ferretti, M., Musella, G., Risitano, M. 2020, Evaluating the economic and environmental efficiency of ports: Evidence from Italy, *Journal of Cleaner Production*, vol. 271, 122560, https://doi.org/10.1016/j.jclepro.2020.122560.

22. Hossain, T., Adams, M., Walker, T. R. 2021, Role of sustainability in global seaports, *Ocean & Coastal Management*, vol. 202, 105435, https://doi.org/10.1016/j.ocecoaman.2020.105435.

23. Duru, O., Galvao, C. B., Mileski, J., Robles, L. T., & Gharehgozli, A. 2020, Developing a comprehensive approach to port performance assessment, *The Asian Journal of Shipping and Logistics*, vol. 36, № 4, p. 169—180, https://doi.org/10.1016/j.ajsl.2020.03.001.

24. Karpova, N. P., Pavlov, M. S. 2020, Problems and prospects of green logistics implementation in Russia, J*ournal of economics, entrepreneurship and law*, vol. 10, № 4. p. 1063—1070, https://doi.org/10.18334/epp.10.4.100806 (in Russ.).

25. Santos, M., Pereira, F. 2022, ESG performance scoring method to support responsible investments in port operations, *Case Studies on Transport Policy,* vol. 10, № 1, p. 664—673, https://doi.org/10.1016/j.cstp.2022.01.027.

26. Strimovskaya, A. V., Bazhina, D. B. 2018, Design of Efficiency Index Complex for Transportation in Supply Chains, *Logistics and supply chain management*, № 3, p. 55—65 (in Russ.).

27. Tow, P., Cooper, I., Partridge, I., Birch, C., Harrington, L. 2011, Principles of a Systems Approach to Agriculture. In: Tow, P., Cooper, I., Partridge, I., Birch, C. (eds.), *Rainfed Farming Systems*. Springer, Dordrecht, https://doi.org/10.1007/978-1-4020-9132-2_1.

28. Gogas, M., Papoutsis, K., Nathanail, E. 2014, Optimization of Decision-Making in Port Logistics Terminals: Using Analytic Hierarchy Process for the Case of Port of Thessaloniki, *Transport and Telecommunication Journal*, vol. 15, № 4, p. 255—268, https://doi.org/10.2478/ttj-2014-0022.

29. Sarkar, B. D., Shankar, R. 2021, Understanding the barriers of port logistics for effective operation in the Industry 4.0 era: Data-driven decision making, *International Journal of Information Management Data Insights*, vol. 1, № 2, 100031, https://doi.org/10.1016/j.jjimei.2021.100031.

30. Panova, Y., Hilmola, O-P. 2015, Justification and evaluation of dry port investments in Russia, *Research in Transportation Economics*, vol. 51, p. 61—70, https://doi.org/10.1016/j.retrec.2015.07.008.

31. Lachininskii, S. S., Semenova, I. 2015, Saint Petersburg as a global coastal city: positioning in the Baltic region, *Baltic region*, № 3, p. 47—57, https://doi.org/10.5922/2079-8555-2015-3-4.

32. Startceva, N. V. 2020, Analysis of the activity and competitiveness of Baltic Sea ports, *System analysis and logistics,* № 1 (23), p. 9—19 (in Russ.).

33. Zub, I. V., Ezhov, Y. E., Angolenko, T. S. 2022, Information systems as a tool for improving the seaports productivity, *Vestnik Gosudarstvennogo universiteta morskogo i rechnogo flota imeni admirala S. O. Makarova*, vol. 14, № 2, p. 218—229, https://doi.org/10.21821/2309-5180-2022-14-2-218-229 (in Russ.).

34. Khan, S. A. R., Sharif, A., Golpîra, H., Kumar, A. 2019, A green ideology in Asian emerging economies: From environmental policy and sustainable development, *Sustainable Development*, vol. 27, № 6, p. 1063—1075, https://doi.org/10.1002/sd.1958.

35. Druzhinin, A., Mikhaylov, A., Lialina, A. 2021, Coastal regions of Russia: migration attractiveness and innovation performance, *Quaestiones Geographicae,* vol. 40, № 2, p. 5—18, https://doi.org/10.2478/quageo-2021-0019.

36. Strimovskaya, A., Sinko, G., Tsyplakova, E. 2023, Efficiency Assessment System Based on Analytical Approach for Sustainable Development of Transport Logistics. In: *Reliability and Statistics in Transportation and Communication — RelStat 2022. Lecture Notes in Networks and Systems*, vol. 640, p. 162—173, https://doi.org/10.1007/978-3-031-26655-3_15.

37. Zelenskaya, E. M. 2018, Measuring performance of cultural organizations on the data of the envelopment analysis, *Vestnik of Immanuel Kant Baltic Federal University. Series: Humanities and Social Sciences*, № 2, p. 39—51 (in Russ.).

38. Cruijssen, F., Dullaert, W., Fleuren, H. 2007, Horizontal Cooperation in Transport and Logistics: A Literature Review, *Transportation Journal*, vol. 46, № 3, p. 22—39, https://doi.org/10.2307/20713677.

39. Vinogradov, A. B, Tyurkina, M. N. 2017, Methods of Gain Sharing in Horizontal Cooperation Projects, *Logistics and supply chain management*, № 4 (81), p. 41—51 (in Russ.).

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