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# ASSESSMENT OF THE COMPETITIVENESS OF THE MARITIME TRANSPORT INFRASTRUCTURE OF UKRAINE AND EUROPEAN COUNTRIES

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## ABSTRACT

The article provides an assessment of the competitiveness of the maritime transport infrastructure of Ukraine and European countries. Methods for assessing competitiveness are considered and identified as the most relevant method for assessing the competitiveness of the maritime transport infrastructure of Ukraine and European countries. The main indicators of the competitiveness of the maritime transport infrastructure have been determined for the main factors of ensuring the competitiveness of the maritime transport infrastructure. Highlighted a group of European countries, such as the Netherlands, Germany, Spain, Great Britain, France, Belgium, as they are leaders in the field of maritime transport infrastructure. Several stages were implemented to calculate the integral indicator of the maritime transport infrastructure's competitiveness. At the first stage, the indicators were standardized, at the second, the weight coefficient of the selected indicators was calculated, at the third stage, the total rank of indicators was calculated, at the fourth stage, the weighting coefficient was calculated for each group of indicators, and at the fifth stage, the integral indicator of the competitiveness of the maritime transport infrastructure was determined. It was determined that the leaders in assessing the integral indicator of the competitiveness of the maritime transport infrastructure are Great Britain (8.13), Germany (7.78), and Belgium (7.07).Ukraine has the lowest rate (4.7).Also, it was found that the most influential are external factors, such as economic, legal, political, social, technological, environmental, integration, institutional (Ukraine — 2.65; Netherlands — 2.87; Germany – 2.07; Spain – 2,19; Great Britain – 1.87; France – 2.16; Belgium – 3.22).The main directions of increasing the competitiveness of the Ukrainian maritime transport infrastructure are proposed, taking into account the experience of the leading countries.

**Keywords:** maritime transport infrastructure, European integration, competitiveness, infrastructure, competitiveness assessment

**JEL Classification:** F15, L90, N70, R41

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## INTRODUCTION

The maritime transport infrastructure is widely used for domestic and international transport. It plays an important role in forming the country's economic ties, especially with foreign countries, and is characterized by high efficiency compared to other types of transport infrastructure. Maritime transport has more advantages than disadvantages, such as lower transportation costs, high carrying capacity, virtually no restrictions on the size of cargo and the throughput of sea transport, unified transportation standards, a single legal framework, so we can talk about the importance of sea transport not only with from the point of view of cargo transportation, as well as the movement of passengers.

## LITERATURE REVIEW

At the present stage, the issues of increasing the competitiveness of the maritime transport infrastructure in the scientific and foreign literature are highlighted from different points of view by many authors. So, N. V. Dubovyk investigated approaches to




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assessing competitiveness and substantiating the possibility of their application in assessing the competitiveness of enterprises of service activities in sea transport [1], A. V. Berezhnoj formalized the organizational-economic mechanism of the competitiveness of the seaport of the region, the necessity of assessing the competitiveness of the port of the region was considered and a function of a freight transshipment complex and the supply chain was offered [2], K. Novikova proposed an economic mechanism of ensuring the competitiveness of the seaport which is a set of actions aimed at achieving the primary goals by creating favorable conditions for rational and efficient use of available resources [3]. P. Peng, Y. Yu, L. Feng, C. Shifen, M. Naixia, Y. Ren designed a comprehensive evaluation CCPE model measuring port competitiveness by 18 factors related to conditions, capacity, potential, and efficiency using big data related to the geographical environment, cargo vessels trajectories, port infrastructure, and regional socioeconomics and determined that a port's status in the global maritime transport network was the most influential of all competitiveness indices [4]. M. R. Pires da Cruz, Joao J. Ferreira, S. Azevedo researched the key factors of seaport competitiveness from the perspective of Iberian seaports stakeholders by applying the Analytic Hierarchy Process (AHP) model and found out that seaport users and seaport service providers differ in their understanding of the key factors of seaport competitiveness [5]. Gabriel Figueredo De Oliveira and Pierre Cariou investigated issues and examined how the degree of competition measured at different levels (local, regional and global level) impacts the efficiency score of a given container port by implementing a truncated regression with a parametric bootstrapping model [6]. Jesse M. Lane, Michael Pretes point out that access to maritime shipping and global participation in maritime trade is key to attracting global capital and an Index of Maritime Dependency was created and mapped to display the geographical distribution of maritime dependency [7]. Sedat Baştuğ, Hercules Haralambides, Soner Esmer, Enes Eminoğlu concluded that the factors port operators consider important for the competitiveness of their port are not necessarily of equal importance for shipping companies when selecting a port. Thus, for port operators, the most important criterion for competitiveness is port location, followed by service level, port tariffs, and port facilities and In contrast, the most important criterion for carriers is (port) operational efficiency [8].

The purpose of the article is to assess the competitiveness of the maritime transport infrastructure of Ukraine and European countries.

## RESULTS

An important stage in the development of strategic directions to improve the competitive position of the maritime transport infrastructure is the assessment of competitiveness, this assessment will maximize the improvement of activities and reveal the hidden potential of the maritime transport infrastructure for its successful functioning in the transport services market.

When assessing the competitiveness of the maritime transport infrastructure (MTI), several methods should be applied, which should ensure the maximum correspondence of the results obtained to the real state of the distribution of competitive forces and make it possible to determine the competitiveness of the industry taking into account a sufficient number of factors.

Each separate method for assessing competitiveness has advantages and disadvantages and a specific set of factors and variables. More often, scientists use such assessment methods as a matrix, the method of expert assessments, and an integrated approach. The whole set of methods for assessing the management of MTI competitiveness can be divided into qualitative, quantitative, special, and complex.

Qualitative assessment methods have a low degree of mathematical formalization, which is characterized by implementation complexity and discrete assessment. They do not allow the assessment of competitiveness in the process of analyzing and formulating priority areas to strengthen competitive positions in the market [9].

Quantitative methods allow us to assess the real capabilities of an enterprise in the competition for strategic areas of management and make balanced strategic management decisions [10, p. 18].

Special methods make it possible to assess the competitiveness of an object in certain aspects of its activity: production, innovation, marketing, financial, etc. Comprehensive methods are based on an integrated approach to assessing competitiveness [11, c. 57].

It has been established that the most relevant methods for assessing competitiveness are methods based on an integrated approach since they are aimed at analyzing the full range of functioning parameters. Also, some researchers [12, p. 65; 13, p. 227; 14, p. 602] note that comprehensive methods for assessing competitiveness are aimed at analyzing a large range of the most important parameters of an enterprise. The priority of such methods is to obtain reliable and more accurate information about the competitiveness of the subject and its advantages.

The feasibility of using an integrated method for assessing the competitiveness of maritime transport infrastructure is because maritime transport infrastructure is a complex system, the development of which depends on the nature and intensity of various economic processes, the influence of many factors. For an adequate assessment of the competitiveness of the maritime transport infrastructure, it is necessary to use a full set of indicators that can characterize the degree of competitiveness of the maritime transport infrastructure and take into account all the most important aspects of its activities. In this regard, it should be noted that to assess the competitiveness of the maritime transport infrastructure, we have formed an integral indicator, which is the result of the aggregation of the parameters of the maritime transport infrastructure.

In previous scientific articles [15; 16] it was found that the main factors for ensuring the competitiveness of the maritime transport infrastructure are: external and internal, basic and derivative, general and special. In our study, the listed factors were included in the calculation of the integrated indicator, which can be quantified. External factors are more fully characterized by the complex indicator «Global Competitiveness Index» since it includes such indices as [17]:

1. Macroeconomic stability, market size, product market, financial system, and business dynamism, characterizing economic factors.
2. Public-sector performance and future orientation of government – political factors.
3. Checks and balances (budget transparency, judicial independence, efficiency of legal framework), corporate governance, transparency, and property rights – legal factors.
4. Social capital, security, health, workforce, labor marketта utility infrastructure – social factors.
5. Innovation capability and introduction of information and communication technologies – technological and information providing (general factors).
6. Environmental determinant more fully outlines «Environmental Performance Index», which outlines the state of the environment and the viability of ecosystems.

The next group of factors is basic:

1. Natural and climatic conditions – it is necessary to use the «length of the coastline» indicator, which is an important component of the development of shipping and maritime transport infrastructure in general.
2. Socio-demographic – indicator «number of employed», demonstrating the potential for employment in the maritime transport infrastructure.

Regarding the derivative factors, we note that to assess the competitiveness of the maritime transport infrastructure, it is necessary to choose:

1. Indicator «R&D expenditures in GDP», characterizing the «research and structural achievements» in the country.
2. Indicator «number of enterprises of service activities incidental to water transportation» – competitive conditions for economic activity and the provision of maritime transport services (competitive conditions for the provision of Maritime Transport Services – MTS).

The next are internal factors since they directly characterize the maritime transport infrastructure of the state:

1. Labor factors (internal) – «internal», «average number of employees» in the field of maritime transport infrastructure.
2. Technical and technological – indicators «number of ships», «DWT» (deadweight tons in thousands), showing the full carrying capacity of the country's merchant fleet.
3. Service and production – indicators «processed cargo» and «transported passengers» maritime transport infrastructure.

To assess the competitiveness of the maritime transport infrastructure using a complex indicator, the following group of countries was selected: the Netherlands, Germany, Spain, Great Britain, France, Belgium and compare them with Ukraine, since the presented group of countries are the leaders of the maritime transport infrastructure in Europe (*Table 1*).


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**Table 1.** Indicators of competitiveness of maritime transport infrastructure for 2015–2019

| Factors | | Country | Indicator | Ukraine | | | | | The Netherlands | | | | | Germany | | | | | Spain | | | | | The United Kingdom | | | | | France | | | | | Belgium | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 |
| 1 | | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| External | Economic, legal, political, social, technological | | GCI | 4,14 | 4,03 | 4 | 4,11 | 3,99 | 5,45 | 5,5 | 5,57 | 5,66 | 5,77 | 5,49 | 5,53 | 5,57 | 5,65 | 5,8 | 4,55 | 4,59 | 4,68 | 4,7 | 5,19 | 5,41 | 5,43 | 5,49 | 5,51 | 5,74 | 5,08 | 5,13 | 5,2 | 5,18 | 5,46 | 5,18 | 5,2 | 5,25 | 5,23 | 5,36 |
| | Ecological | | EPI | 49,01 | 49,01 | 79,69 | 79,69 | 52,87 | 77,75 | 77,75 | 82,03 | 82,03 | 75,46 | 80,47 | 80,47 | 84,26 | 84,26 | 78,37 | 79,79 | 79,79 | 88,91 | 88,91 | 78,39 | 77,35 | 77,35 | 87,38 | 87,38 | 79,89 | 71,05 | 71,05 | 88,2 | 88,2 | 83,95 | 66,61 | 66,61 | 80,15 | 80,15 | 77,38 |
| Basic | Socio-demographic | | $N_{emp.}$ | 18 073,3 | 16 443,2 | 16 276,9 | 16 156,4 | 16 360,9 | 8028 | 8115 | 8223 | 8376 | 8543 | 38908 | 39176 | 40165 | 40482 | 40636 | 17211 | 17717 | 18183 | 18649 | 19136 | 29559 | 30020 | 30444 | 30786 | 31112 | 26109 | 26136 | 26255 | 26464 | 26686 | 4497 | 4499 | 4541 | 4587 | 4699 |
| | Natural and climatic conditions | | $L_{coastl.len.}$ | 2 782 | 2 782 | 2 782 | 2 782 | 2 782 | 451 | 451 | 451 | 451 | 451 | 2389 | 2389 | 2389 | 2389 | 2389 | 4964 | 4964 | 4964 | 4964 | 4964 | 3400 | 3400 | 3400 | 3400 | 3400 | 3 427 | 3 427 | 3 427 | 3 427 | 3 427 | 66,5 | 66,5 | 66,5 | 66,5 | 66,5 |
| Derivative | Research and structural approaches in the country | | $S_{GERD/GDP}$ | 3 | 2,4 | 2,1 | 1,7 | 1,6 | 16 | 16,4 | 16,9 | 17,5 | 18,6 | 102,9 | 109,6 | 114,1 | 119,9 | 131,3 | 19,3 | 19,4 | 19,8 | 20,2 | 21,9 | 41,5 | 43,8 | 45,7 | 47,4 | 49,3 | 58,4 | 60,6 | 61,6 | 63 | 64,7 | 11,4 | 11,9 | 12,7 | 13,6 | 14,6 |

*continued on next page)*



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**Table 1.** *(continued)*

| 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Derivative | Competitive conditions for the provision of MTS | $N_{NESAIWT}$ | 33 | 32 | 32 | 29 | 27 | 1699 | 1613 | 1548 | 1431 | 1285 | 703 | 691 | 688 | 668 | 641 | 435 | 421 | 405 | 413 | 344 | 953 | 939 | 923 | 909 | 924 | 397 | 389 | 346 | 405 | 505 | 135 | 139 | 146 | 146 | 150 |
| Internal | Technical | $N_{ship.}$ | 436 | 425 | 417 | 410 | 417 | 1247 | 1233 | 1209 | 1212 | 1233 | 670 | 639 | 628 | 622 | 629 | 473 | 470 | 459 | 460 | 466 | 1593 | 1564 | 1535 | 1547 | 1570 | 540 | 538 | 539 | 544 | 552 | 190 | 188 | 184 | 184 | 192 |
| | | DWT | 501 | 430 | 415 | 377 | 375 | 8574 | 8462 | 7838 | 7388 | 7327 | 14055 | 12538 | 11275 | 10523 | 9937 | 2184 | 1836 | 1822 | 1908 | 1923 | 41832 | 38864 | 37313 | 40835 | 44040 | 7395 | 6468 | 6918 | 7349 | 7109 | 6923 | 8658 | 8311 | 8030 | 8498 |
| | Labor | $W_{turn.empl.}$ | 79,4 | 78 | 78,2 | 68,3 | 78,9 | 419,2 | 411,1 | 408,4 | 378,1 | 393,8 | 1231 | 1200,4 | 1230,7 | 934,9 | 1202 | 264,9 | 263,7 | 261,6 | 266,5 | 251 | 1076,2 | 588,4 | 623,7 | 635,3 | 704,4 | 1088,9 | 927,7 | 1001,8 | 818,6 | 740 | 1322,3 | 1372,1 | 1467 | 1430,6 | 1387,9 |
| | | $\mu_{avg.n.empl.}$ | 188,35 | 193,59 | 245,39 | 226,57 | 330,72 | 4250 | 4283 | 4291 | 4333 | 4400 | 3670 | 3767 | 3862 | 3815 | 3905 | 2624 | 2466 | 2487 | 2474 | 2494 | 2837,76 | 3073,6 | 2645,37 | 2579,79 | 2608,5 | 2175 | 2210 | 2199 | 2218 | 2258 | 3 550 | 3 685 | 3 745 | 3 790 | 3 923 |
| | Production | $C_{proces.cargo.}$ | 142,8 | 144,6 | 131,7 | 132,6 | 135,2 | 571,6 | 594,3 | 588,8 | 595,8 | 604,5 | 303,7 | 295,9 | 297,1 | 299,2 | 296,2 | 427,7 | 447 | 451,3 | 485,8 | 519,1 | 503,2 | 496,7 | 484 | 481,8 | 483,3 | 298,2 | 297,9 | 292,2 | 302,8 | 308,6 | 237,9 | 241,5 | 253,5 | 257,8 | 270,3 |
| | | $P_{transp.pas.}$ | 29,4 | 25,5 | 30,3 | 28,6 | 71,9 | 1819 | 1910 | 1906 | 1928 | 1980 | 30780 | 30087 | 30849 | 30774 | 30687 | 23486 | 24522 | 26323 | 27899 | 32558 | 28135 | 27805 | 26887 | 26336 | 26676 | 26638 | 26133 | 24514 | 25093 | 25732 | 821 | 844 | 1118 | 1270 | 1127 |

*Footnote. GCI – Global Competitiveness Index, EPI – Environmental Performance Index, $N_{emp.}$ – a number of employees (thousand people), $L_{coastl.len.}$ – coastline length (km), $S_{R\&D/GDP}$ – R&D expenditures in GDP (million dollars USA), $N_{ESAIWT}$ – Number of Enterprises of Service Activities Incidental to Water Transportation (things), $N_{ship.}$ – a number of ships (units), DWT – Deadweight (tons in thousands), $\mu_{avg.n.empl.}$ – an average number of employees (persons), $W_{turn.empl.}$ – turnover per employee of water transport (thousand euros), $C_{proces.cargo.}$ – processed cargo (million tons), $P_{transp.pas.}$ – transported passengers (thousand people).*

*Source: compiled by the author on the basis [17; 19; 20–25].*



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Since the proposed indicators are presented in absolute terms and have different units of measurement, the next step in the assessment is the standardization procedure. This is necessary for the adequate application of mathematical methods and to establish a correspondence between quantitative values.

Based on the initial data in Table 1, the indicators were normalized by year and the standardized coefficients were calculated. So, the index of criteria is defined as standardized by the maximum value of the index of the indicator calculated by the formula [18, c. 146]:

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$$I_i^j = \frac{p_i}{p_i^{\max}}, \quad (1)$$

where $I_i^j$ - index of the *j*-th indicator of the *i*-th year; $p_i$ – index of the indicator of the *j*-th indicator *i*-th year; $p_i^{\max}$ – the maximum value of the index of the indicator of the *j*-th indicator *i*-th year.

The next stage of the assessment is the calculation of the coefficients of the significance of the selected indicators. For this, the total rank of the *j*-th indicator of the *i*-th years was calculated using the formula:

$$S = \sum_{i=1}^{m} I_i^J, \quad (2)$$

where $j_i$ – separate indicator for each factor; $m$ – year.

After calculating the total rank, the total rank of the *j*-th indicators was calculated to determine the coefficient of the significance of the factors according to formula 3 and the calculation results are presented in *Table 2*.

$$k = \frac{S_i}{\sum_{i=1}^{n} S_i}, \quad (3)$$

where $k$ – factor weight of indicators, $S_i$ – total rank of the *i*-th indicator, $n$ – number of indicators.

The weighting factor for each group of indicators has been determined, which affects the competitiveness of the maritime transport infrastructure (formula 4), and the calculation results are presented in *Table 3*.

$$K = S_i \cdot k_i \quad (4)$$

where $K$ – weight coefficient; $S_i$ – total rank of the *i*-th indicator; $k_i$ – factor weight.

At the last stage, based on preliminary calculations, an integral indicator of the competitiveness of the maritime transport infrastructure was introduced, which is the sum of the weight coefficients for each group of indicators:

$$\Delta I_{CT} = \sum_{i=1}^{n} (S_i \cdot k_i), \quad (5)$$

where $\Delta I_{CT}$ – integral indicator of competitiveness MTI, $S_i$ – total rank of the *i*-th indicator, $k_i$ – factor weight, $n$ – number of indicators.

**Table 2.** Standardized indicators of the competitiveness of the maritime transport infrastructure of Ukraine and European countries for 2015–2019

| Country / Factors | Indicator | Ukraine | | | | | | The Netherlands | | | | | | Germany | | | | | | Spain | | | | | | The United Kingdom | | | | | | France | | | | | | Belgium | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2015 | 2016 | 2017 | 2018 | 2019 | S | 2015 | 2016 | 2017 | 2018 | 2019 | S | 2015 | 2016 | 2017 | 2018 | 2019 | S | 2015 | 2016 | 2017 | 2018 | 2019 | S | 2015 | 2016 | 2017 | 2018 | 2019 | S | 2015 | 2016 | 2017 | 2018 | 2019 | S | 2015 | 2016 | 2017 | 2018 | 2019 | S |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 |
| External | GCI | 0,71 | 0,69 | 0,69 | 0,71 | 0,69 | 3,49 | 0,94 | 0,95 | 0,96 | 0,98 | 0,99 | 4,82 | 0,95 | 0,95 | 0,96 | 0,97 | 1 | 4,83 | 0,78 | 0,79 | 0,81 | 0,81 | 0,89 | 4,08 | 0,93 | 0,94 | 0,95 | 0,95 | 0,99 | 4,76 | 0,88 | 0,88 | 0,9 | 0,89 | 0,94 | 4,49 | 0,89 | 0,9 | 0,91 | 0,9 | 0,92 | 4,52 |
| | EPI | 0,55 | 0,55 | 0,9 | 0,9 | 0,59 | 3,49 | 0,87 | 0,87 | 0,92 | 0,92 | 0,85 | 4,43 | 0,91 | 0,91 | 0,95 | 0,95 | 0,88 | 4,6 | 0,9 | 0,9 | 1 | 1 | 0,88 | 4,68 | 0,87 | 0,87 | 0,98 | 0,98 | 0,9 | 4,6 | 0,8 | 0,8 | 0,99 | 0,99 | 0,94 | 4,52 | 0,75 | 0,75 | 0,9 | 0,9 | 0,87 | 4,17 |
| Total ($S_1$) | | | | | | | 6,98 | | | | | | 9,25 | | | | | | 9,43 | | | | | | 8,76 | | | | | | 9,36 | | | | | | 9,01 | | | | | | 8,69 |
| *Factor weight ($k_1$)* | | | | | | | *0,38* | | | | | | *0,31* | | | | | | *0,22* | | | | | | *0,25* | | | | | | *0,20* | | | | | | *0,24* | | | | | | *0,37* |
| Basic | $N_{emp.}$ | 0,44 | 0,40 | 0,40 | 0,39 | 0,40 | 2,03 | 0,2 | 0,2 | 0,2 | 0,21 | 0,21 | 1,02 | 0,96 | 0,96 | 0,99 | 0,99 | 1 | 4,9 | 0,42 | 0,44 | 0,45 | 0,46 | 0,47 | 2,24 | 0,73 | 0,74 | 0,75 | 0,76 | 0,77 | 3,75 | 0,64 | 0,64 | 0,65 | 0,65 | 0,66 | 3,24 | 0,11 | 0,11 | 0,11 | 0,11 | 0,12 | 0,56 |
| | $L_{coast.len.}$ | 0,56 | 0,56 | 0,56 | 0,56 | 0,56 | 3 | 0,09 | 0,09 | 0,09 | 0,09 | 0,09 | 0,45 | 0,48 | 0,48 | 0,48 | 0,48 | 0,48 | 2,4 | 1 | 1 | 1 | 1 | 1 | 5 | 0,68 | 0,68 | 0,68 | 0,68 | 0,68 | 3,4 | 0,69 | 0,69 | 0,69 | 0,69 | 0,69 | 3 | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,05 |
| Total ($S_2$) | | | | | | | 4,83 | | | | | | 1,47 | | | | | | 7,3 | | | | | | 7,24 | | | | | | 7,14 | | | | | | 6,69 | | | | | | 0,61 |
| *Factor weight ($k_2$)* | | | | | | | *0,27* | | | | | | *0,05* | | | | | | *0,17* | | | | | | *0,21* | | | | | | *0,15* | | | | | | *0,18* | | | | | | *0,03* |
| Derivative | $S_{SR\&D/GDP}$ | 0,02 | 0,02 | 0,02 | 0,01 | 0,01 | 0,08 | 0,12 | 0,12 | 0,13 | 0,13 | 0,14 | 0,64 | 0,78 | 0,83 | 0,87 | 0,91 | 1 | 4,39 | 0,15 | 0,15 | 0,15 | 0,15 | 0,17 | 0,77 | 0,32 | 0,33 | 0,35 | 0,36 | 0,38 | 1,74 | 0,44 | 0,46 | 0,47 | 0,48 | 0,49 | 2,34 | 0,09 | 0,09 | 0,1 | 0,1 | 0,11 11 | 0,49 |
| | $N_{NESAIWT}$ | 0,75 | 0,63 | 0,59 | 0,51 | 0,55 | 3,03 | 0,18 | 0,19 | 0,17 | 0,18 | 0,20 | 0,92 | 0,65 | 0,67 | 0,69 | 0,7 | 0,72 | 3,43 | 0,51 | 0,56 | 0,55 | 0,55 | 0,56 | 2,73 | 0,99 | 1 | 0,98 | 0,93 | 0,95 | 4,85 | 0,88 | 0,92 | 0,94 | 0,95 | 0,98 | 4,67 | 0,14 | 0,14 | 0,14 | 0,15 | 0,15 | 0,72 |
| Total ($S_3$) | | | | | | | 3,11 | | | | | | 1,56 | | | | | | 7,82 | | | | | | 3,5 | | | | | | 6,59 | | | | | | 7,01 | | | | | | 1,21 |
| *Factor weight ($k_3$)* | | | | | | | *0,17* | | | | | | *0,05* | | | | | | *0,18* | | | | | | *0,10* | | | | | | *0,14* | | | | | | *0,19* | | | | | | *0,05* |

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**Table 2.** *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Technical** | $N_{ship.}$ | 0,27 | 0,27 | 0,26 | 0,26 | 0,26 | 1,32 | 0,78 | 0,77 | 0,76 | 0,76 | 0,77 | 3,84 | 0,42 | 0,4 | 0,39 | 0,39 | 0,39 | 1,99 | 0,3 | 0,3 | 0,29 | 0,29 | 0,29 | 1,47 | 1 | 0,98 | 0,96 | 0,97 | 0,99 | 4,9 | 0,34 | 0,34 | 0,34 | 0,34 | 0,35 | 1,71 | 0,12 | 0,12 | 0,12 | 0,12 | 0,12 | 0,6 |
| | **DWT** | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 | 0,05 | 0,19 | 0,19 | 0,18 | 0,17 | 0,17 | 0,9 | 0,32 | 0,28 | 0,26 | 0,24 | 0,23 | 1,33 | 0,05 | 0,04 | 0,04 | 0,04 | 0,04 | 0,21 | 0,95 | 0,88 | 0,85 | 0,93 | 1 | 4,61 | 0,17 | 0,15 | 0,16 | 0,17 | 0,16 | 0,81 | 0,16 | 0,2 | 0,19 | 0,18 | 0,19 | 0,92 |
| Total ($S_4$) | | | | | | | 1,37 | | | | | | 4,74 | | | | | | 3,32 | | | | | | 1,68 | | | | | | 9,51 | | | | | | 2,52 | | | | | | 1,52 |
| *Factor weight ($k_4$)* | | | | | | | *0,08* | | | | | | *0,16* | | | | | | *0,08* | | | | | | *0,05* | | | | | | *0,20* | | | | | | *0,07* | | | | | | *0,07* |
| **Labor** | $W_{turn.empl.}$ | 0,11 | 0,12 | 0,11 | 0,07 | 0,08 | 0,49 | 0,65 | 0,65 | 0,65 | 0,62 | 0,62 | 3,19 | 0,9 | 0,87 | 0,84 | 0,84 | 0,78 | 4,23 | 0,57 | 0,53 | 0,7 | 0,62 | 0,69 | 3,11 | 0,75 | 0,71 | 0,81 | 0,78 | 0,81 | 3,86 | 0,7 | 0,69 | 0,71 | 0,74 | 0,75 | 3,59 | 0,86 | 0,89 | 0,91 | 0,99 | 1 | 4,65 |
| | $\mu_{avg.n.empl.}$ | 0,04 | 0,04 | 0,06 | 0,05 | 0,08 | 0,27 | 0,97 | 0,97 | 0,98 | 0,98 | 1 | 4,9 | 0,83 | 0,86 | 0,88 | 0,87 | 0,89 | 4,33 | 0,6 | 0,56 | 0,57 | 0,56 | 0,57 | 2,86 | 0,64 | 0,7 | 0,6 | 0,59 | 0,59 | 3,12 | 0,49 | 0,5 | 0,5 | 0,5 | 0,51 | 2,5 | 0,81 | 0,84 | 0,85 | 0,86 | 0,89 | 4,25 |
| Total ($S_5$) | | | | | | | 0,76 | | | | | | 8,09 | | | | | | 8,56 | | | | | | 5,97 | | | | | | 6,98 | | | | | | 6,09 | | | | | | 8,9 |
| *Factor weight ($k_5$)* | | | | | | | *0,04* | | | | | | *0,27* | | | | | | *0,20* | | | | | | *0,17* | | | | | | *0,15* | | | | | | *0,16* | | | | | | *0,38* |
| **Production** | $C_{proces.cargo.}$ | 0,24 | 0,24 | 0,22 | 0,22 | 0,22 | 1,14 | 0,95 | 0,98 | 0,97 | 0,99 | 1 | 4,89 | 0,5 | 0,49 | 0,49 | 0,49 | 0,49 | 2,46 | 0,71 | 0,74 | 0,75 | 0,8 | 0,86 | 3,86 | 0,83 | 0,82 | 0,8 | 0,8 | 0,8 | 4,05 | 0,49 | 0,49 | 0,48 | 0,5 | 0,51 | 2,47 | 0,39 | 0,4 | 0,42 | 0,43 | 0,45 | 2,09 |
| | $P_{transp.pas.}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,3 | 0,95 | 0,91 | 0,95 | 0,95 | 0,94 | 4,7 | 0,72 | 0,75 | 0,81 | 0,86 | 1 | 4,14 | 0,86 | 0,85 | 0,83 | 0,81 | 0,82 | 4,17 | 0,82 | 0,8 | 0,75 | 0,77 | 0,79 | 3,93 | 0,03 | 0,03 | 0,03 | 0,04 | 0,03 | 0,16 |
| Total ($S_6$) | | | | | | | 1,14 | | | | | | 5,19 | | | | | | 7,16 | | | | | | 8 | | | | | | 8,22 | | | | | | 6,4 | | | | | | 2,25 |
| *Factor weight ($k_6$)* | | | | | | | *0,06* | | | | | | *0,17* | | | | | | *0,16* | | | | | | *0,23* | | | | | | *0,17* | | | | | | *0,17* | | | | | | *0,10* |
| Total S | | | | | | | 18,19 | | | | | | 30,3 | | | | | | 43,59 | | | | | | 35,15 | | | | | | 47,81 | | | | | | 37,72 | | | | | | 23,18 |


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The calculation of the integral indicator provides information on the level of competitiveness of the maritime transport infrastructure of Ukraine and European countries, taking into account all influencing indicators. The main advantages of the integral indicator are that it synthesizes the influence of the indicators included in the analysis; reduces the problem of assessing the competitiveness of maritime transport infrastructure to a single quantitative value, which greatly simplifies the economic interpretation of the results.

Based on the results of the calculations, it can be concluded that when assessing the integral indicator of the competitiveness of the maritime transport infrastructure for Ukraine, the Netherlands, Germany, Spain, Great Britain, and Belgium, external factors are the most influential. Labor factors have a greater impact in countries such as the Netherlands, Germany, and Belgium. In Italy, the next most influential factors are production factors (K=1.84), in the United Kingdom – technical (K = 1.9), in France – derivatives (K = 1.33), in Belgium – labor (K = 3.38) (*Table 3*).

**Table 3.** Assessment of the integral indicator of the competitiveness of the maritime transport infrastructure for the period 2015–2019

| Factors | External | | Basic | | Derivative | | Technical | | Labor | | Production | | Assessment of the integral indicator $\Delta I_{CT}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Indicator / Country | GCI | EPI | $N_{emp.}$ | $L_{coastl.len.}$ | $S_{SR\&D/GDP}$ | $N_{NESAIWT}$ | $N_{ship.}$ | DWT | $W_{turn.empl.}$ | $\mu_{avg.n.empl.}$ | $C_{proces.cargo.}$ | $P_{transp.pas.}$ | |
| Ukraine | 2.65 | | 1.3 | | 0.53 | | 0.11 | | 0.03 | | 0.07 | | 4.7 |
| *Weight coeffcient* | | | | | | | | | | | | | |
| Netherlands | 2.87 | | 0.07 | | 0.08 | | 0.76 | | 2.18 | | 0.88 | | 6.77 |
| *Weight coefficient* | | | | | | | | | | | | | |
| Germany | 2.07 | | 1.24 | | 1.41 | | 0.27 | | 1.71 | | 1.15 | | 7.78 |
| *Weight coefficient* | | | | | | | | | | | | | |
| Spain | 2.19 | | 1.52 | | 0.35 | | 0.08 | | 1.01 | | 1.84 | | 6.94 |
| *Weight coefficient* | | | | | | | | | | | | | |
| United Kingdom | 1.87 | | 1.07 | | 0.92 | | 1.9 | | 1.05 | | 1.4 | | 8.13 |
| *Weight coefficient* | | | | | | | | | | | | | |
| France | 2.16 | | 1.2 | | 1.33 | | 0.18 | | 0.97 | | 1.09 | | 6.88 |
| *Weight coefficient* | | | | | | | | | | | | | |
| Belgium | 3.22 | | 0.02 | | 0.06 | | 0.11 | | 3.38 | | 0.23 | | 7.07 |
| *Weight coefficient* | | | | | | | | | | | | | |

The leaders in assessing the integral indicator of the influence of factors on the competitiveness of the maritime transport infrastructure are Great Britain (8.13), Germany (7.78), and Belgium (7.07) (*Figure 1*).

As for Ukraine, the external factors influencing the competitiveness of the maritime transport infrastructure are the basic factors ($K$ = 1.3). Since Ukraine possesses relatively large socio-demographic and natural-climatic resources, our state, to develop competitively, needs to focus on improving internal factors, because they are of low importance for ensuring the competitiveness of the maritime transport infrastructure, so the weight coefficient of technical factors is 0.11. labor – 0.03 and production – 0.07.

Considering the integral indicator of the Ukrainian competitiveness of MIT about European countries, it should be noted that Ukraine needs to implement the experience of the leading countries to increase the competitiveness of the maritime transport infrastructure.

One of the key elements of ensuring the competitiveness of MIT is the formation of clusters. Thus, the European experience in the formation of clusters demonstrates that the implementation of their development takes various forms and provides several measures of state support. To implement the cluster strategy in the Ukrainian economy, one should use the experience of Germany, since the peculiarities of the formation of clusters in these countries are flexible and equal cooperation of small, medium, and large enterprises, while state support should be a key factor.


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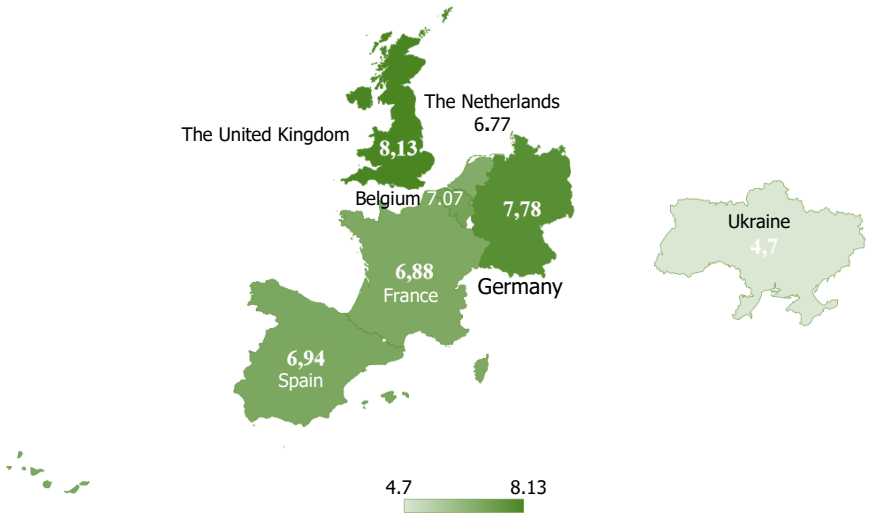


**Figure 1.** Representation of the integral indicator of MTI competitiveness for 2015–2019

The next key element of ensuring the competitiveness of the maritime transport infrastructure is the use of logistics technology «dry port». In European countries, this logistics technology is quite common, in particular, in Belgium, France, the Netherlands, Spain, etc. There are now about 250 «dry ports» in Europe [26, p. 51].

To ensure the competitiveness of the maritime transport infrastructure, it is necessary to implement a modern model of managing the seaports of Ukraine, taking into account the European experience. The experience of reforming the maritime transport infrastructure and state regulation of creating favorable conditions for the development of port infrastructure in the ports of Hamburg (Germany), Rotterdam (Netherlands), Antwerp (Belgium), Le Havre (France) deserves to be borrowed, in particular, to create favorable conditions for the development of port infrastructure, the respective states use such a tool as the «port-landlord» model of land concessions when the port administration acts as a landlord, who has at his disposal land within the water areas of the ports [27].

The next element of ensuring the competitiveness of the maritime transport infrastructure is the introduction of innovative logistics systems and an increase in the general level of informatization of port activities. So, in the countries of Europe, the «Single Window» form is being implemented, functioning in the seaports of Hamburg (Germany), Rotterdam (Netherlands), Felixstowe (Great Britain), Le Havre and Marseille (France), Antwerp (Belgium), Barcelona and Bilbao (Spain) and the like. On their basis, the International Port Community Systems Association (IPCSA) was created, the purpose of which is to simplify and harmonize administrative procedures applicable to maritime transport, through the electronic transmission of information and streamlining reporting procedures [28].

## CONCLUSION

Thus, the results of assessing the competitiveness of the maritime transport infrastructure of Ukraine and European countries made it possible to determine that Ukraine is in a low position. Therefore, Ukraine needs to focus on labor, technical, and production factors to ensure the competitiveness of the maritime transport infrastructure, since they are of the least importance. However, the maritime transport infrastructure of Ukraine has a fairly large indicator of the weight of basic and external factors about European countries. In this regard, the maritime transport infrastructure of Ukraine has great potential, which should be used in full. Assessment of the competitiveness of the maritime transport infrastructure of Ukraine will allow determining not only the directions for the development of maritime infrastructure but also to develop specific strategic measures to increase the competitiveness of the maritime infrastructure of Ukraine in the context of European integration.

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## ОЦІНКА КОНКУРЕНТОСПРОМОЖНОСТІ МОРСЬКОЇ ТРАНСПОРТНОЇ ІНФРАСТРУКТУРИ УКРАЇНИ І КРАЇН ЄВРОПИ

Здійснено оцінку конкурентоспроможності морської транспортної інфраструктури України та європейських країн. Розглянуто методи оцінювання конкурентоспроможності та визначено найбільш релевантний метод оцінювання конкурентоспроможності морської транспортної інфраструктури України і країн Європи. Визначено основні показники конкурентоспроможності морської транспортної інфраструктури за основними факторами забезпечення конкурентоспроможності морської транспортної інфраструктури. Виділено групу європейських країн, таких як Нідерланди, Німеччина, Іспанія, Великобританія, Франція, Бельгія, оскільки вони є лідерами у сфері морської транспортної інфраструктури. Для обчислення інтегрального показника конкурентоспроможності морської транспортної інфраструктури було реалізовано кілька етапів. На першому етапі здійснено стандартизацію показників, на другому – розраховано коефіцієнт вагомості обраних показників, на третьому – розраховано сумарний ранг показників, на четвертому етапі розраховано ваговий коефіцієнт за кожною групою показників і на п'ятому – визначено інтегральний показник конкурентоспроможності морської транспортної інфраструктури. Визначено, що лідерами з оцінки інтегрального показника конкурентоспроможності морської транспортної інфраструктури є Великобританія (8,13), Німеччина (7,78) і Бельгія (7,07). Україна має найнижчий показник (4,7). Також установлено, що найбільш впливовими є зовнішні фактори, такі як економічні, правові, політичні, соціальні, технологічні, екологічні, інтеграційні, інституційні (Україна – 2,65; Нідерланди – 2,87; Німеччина – 2,07; Іспанія – 2 19; Великобританія – 1,87; Франція – 2,16; Бельгія – 3, 22). Запропоновано основні напрями підвищення конкурентоспроможності морської транспортної інфраструктури України з огляду на досвід країн-лідерів.

**Ключові слова:** морська транспортна інфраструктура, євроінтеграція, конкурентоспроможність, інфраструктура, оцінка конкурентоспроможності

**JEL Класифікація:** F15, L90, N70, R41