критичної інфраструктури. Оцінка умов впровадження системи інформаційної безпеки є одним із найважливіших принципів діяльності критичної інфраструктури, що забезпечує отримання комплексної інформації про матеріально-економічні та фінансові можливості об'єкта критичної інфраструктури.

Використано методи системного аналізу, математичного моделювання, аналізу та синтезу. Основними результатами дослідження є: сформовано модель та методику проведення дослідження умов впровадження системи захисту інформації на об'єкті критичної інфраструктури; визначено комплексний показник для оцінки умов впровадження системи захисту інформації; розраховано багатофакторну регресійну модель, яка визначає зв'язки на рівні оцінки потенціалу виробничої складової та запропоновано комплексну систему забезпечення інформаційної безпеки об'єкта критичної інфраструктури.

Ключові слова: *критична інфраструктура, інформаційна безпека, комплексний показник, математичне моделювання.*

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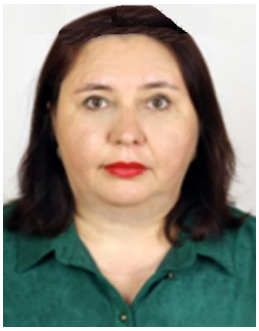

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MANAGEMENT OF AN INTEGRATED MODEL OF INNOVATION IN MARITIME TRADE

Abstract. The article presents a model that will allow substantiating the sequence of introducing a system of innovative activities with integrated management of an integrated model of innovative activity. In order to identify the sequence of innovative activities, a study was made of indicators of maritime trade in Ukraine for the period from 2016 to 2020 according to the

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State Statistics Service of Ukraine. The features of the formation of an innovative marketing plan in the integrated model of innovative activity in maritime trade are considered. Using the presented mathematical model, an analysis of a potential plan for the introduction of innovations in various fields was carried out on the example of maritime trade in Ukraine, and their sequence was determined. The proposed mathematical model can be used to identify the influence of a certain set of factors on the result. The model can be applied to various types and categories of activities, showing the degree of influence of each of the selected influencing factors on the selected resulting attribute. The ability to select an arbitrary number of influence factors makes it universal for use in different types of activities and at different stages of analytical work. The article provides an example of the application of the developed mathematical model for the maritime trade of Ukraine.

The obtained results indicate that the priority task in the field of innovation is the modernization of liquid transportation (significance coefficient for the final result -0.09), container transportation (significance coefficient -0.03), and packaged cargo (significance coefficient 0). Conducting a study in the field of maritime trade is due to the increase in the level of importance of this type of trade in modern conditions.

Keywords*: maritime trade, integration, innovation, management, innovation marketing plan, mathematical model, efficiency analysis.*

Introduction. The modern conditions of maritime trade imply the constant presence of innovative processes since international integration requires infrastructure to match the capacities aimed at fulfilling the tasks of timely delivery of raw materials and finished products. Maritime trade is characterized by features associated to a fairly large extent with both technological innovations and innovations in the management system, and in the system of information support for activities in the field of maritime trade.

Since at present the share of international trade that is carried out by sea is more than 80 %, and by 2050 the demand for maritime transport services is expected to triple with a constant lack of supply of this type of service, leading to a constant need for innovation in this area.

To introduce innovations, it is necessary to draw up a clear multi-level innovation marketing plan, which will lead to the high-quality implementation of innovative processes in the maritime trade industry. Innovative processes are especially relevant during the period of active integration within the framework of modern globalization processes since the formats of cooperation between countries constantly require innovation. The creation of innovative marketing plans is associated with the constant need to form qualitative and quantitative, analytically sound algorithms that allow you to get the maximum benefit from the implemented changes. The formation of a management system for an integrated model of innovation activity in maritime trade is reduced to the construction of a qualitatively substantiated, well-defined system of priorities for innovation processes. This system of priorities can be reduced to the construction of vertically and horizontally dependent innovation activities that form a complete set of innovation marketing plans.

For the development of the innovative activity, the control system for this process and the degree of integration are fundamentally important, which allows for innovative transformations in various directions per unit of time. To build an innovative marketing plan that meets all these requirements, it is necessary to make a preliminary analysis, then select the necessary innovations and design changes in specific resulting features that will change under the influence of the innovations being introduced. An analysis of the effectiveness of innovation implementation can be made using a mathematical model used for preliminary analysis.

Analysis of recent research and publications. The importance of innovation marketing planning has been extensively researched in the current specialized literature. Authors such as Diaz and others view innovation modeling as a separate process that requires an integrated research approach and clear forecasting (Dias, Salmelin, Pereira, & Dias, 2018).

Shane pays special attention to the construction of the innovation implementation algorithm itself, the methods of collecting and structuring the information environment necessary for the formation of ideas about the information environment necessary for the consistent promotion of the innovation implementation process (Shane, 2008).

Adaptation of innovative processes to the conditions of real production processes is of interest to many modern authors since in real conditions there are many questions that have a qualitative dependence on how clearly the sequence of innovations is defined, that is, the plan of innovative activities. Authors such as Shane et al (Shane, 2008)., Aram et al (Aram, Baxter, & Nutkevitch, 2019)., and Fragerberg et al. (Fragerberg, Mowery, & Nelson, 2006) consider various technologies for introducing innovations, however, the general opinion for all these authors is the need for a qualitative analysis before introducing innovations and the existence of a clear plan for introducing innovations.

For the successful implementation of innovations, various methods for the formation of marketing plans are proposed, in particular, a multi-level innovation marketing plan is considered by such authors as Brem et al. (Brem, Tidd, & Daim, 2019), Stefan (Stefan, 2021), Diaz, and others (Dias, Salmelin, Pereira, & Dias, 2018). Also, special attention is paid to building a communication system when introducing innovative solutions in enterprises, Rogers and others (Rogers & Shoemaker, 1971) pay attention to intercultural interactions, since specialists from various parts of the world are often involved in high-quality innovation processes at present.

Maritime trade often involves trade between countries, that is, it is often considered the most accessible type of trade between countries located at a sufficient distance from each other, therefore, when considering maritime trade, it is necessary to take into account all the features of international business. Authors such as Hill (Hill, 2008), Honcharova and Metil (Honcharova & Metil, 2022), Kunert (Kunert, 2018), McKinnon (McKinnon, Button, & Nikamp, 2002), and others consider the features of transport logistics in the cross-border movement of goods, which gives a certain understanding of the features of the formation of innovations in transport systems serving maritime trade.

However, the introduction of innovations in the transport industries serving maritime trade should not harm nature, therefore, authors such as Koval and others (Koval, Honcharova, Metil, & Stepanova, 2023), Trachenko and others (Trachenko, и др., 2021) pay special attention to the need to take into account the environmental factor when developing plans for introducing innovations in transport, which is especially important for maritime transport, since pollution of the oceans and lack of energy resources are one of the main global problems affecting the industry under study.

The purpose of the article is management of innovative activity of maritime trade of Ukraine on the basis of an integrated model of innovation activity in maritime trade. With the help of the presented mathematical model,

an analysis of a potential plan for introducing innovations in various fields was carried out using the example of Ukraine's maritime trade and their sequence was determined.

Formulation of the main material.

Methodology. To determine the sequence of studying the internal processes of the object of innovation activity, it is necessary to build a system of indicators that directly affect some selected resulting factor.

To build a mathematical model, it is necessary to choose an indicator that will inform about the result of the activity, for example, for a certain company engaged in servicing maritime trade, this can be the number of ships carrying dry cargo, the number of container ships and several types of special ships. Let us assume that the resulting factor is the net profit from the provision of services for servicing maritime trade and denote it Y. Each of the types of ships, with the help of which the indicated net profit is obtained, is denoted by A_i, and the degree of influence of the i-th type of ship on the overall result is denoted by α_i, then:

$$Y = \prod_{i=1}^{n} {A_i}^{\alpha_i} \quad (1)$$

In order to evaluate the influence of each of the selected factors, it is necessary to take the logarithm of both parts of formula (1) with the subsequent application of the property of the logarithm of the power expression (formulas 2 and 3), which will allow us to evaluate the influence of each of the selected influence factors on the result.

$$\ln Y = ln\, {A_1}^{\alpha_1} + ln\, {A_2}^{\alpha_2} + \cdots + ln\, {A_{n-1}}^{\alpha_{n-1}} + ln\, {A_n}^{\alpha_n} \quad (2)$$

$$\ln Y = \alpha_1\, ln\, A_1 + \alpha_2 ln\, A_2 + \cdots + \alpha_{n-1} ln\, A_{n-1} + \alpha_n ln\, A_n \quad (3)$$

Fig. 1 gives an idea of the degree of influence of the selected factors on the resulting one through the values of the coefficients.

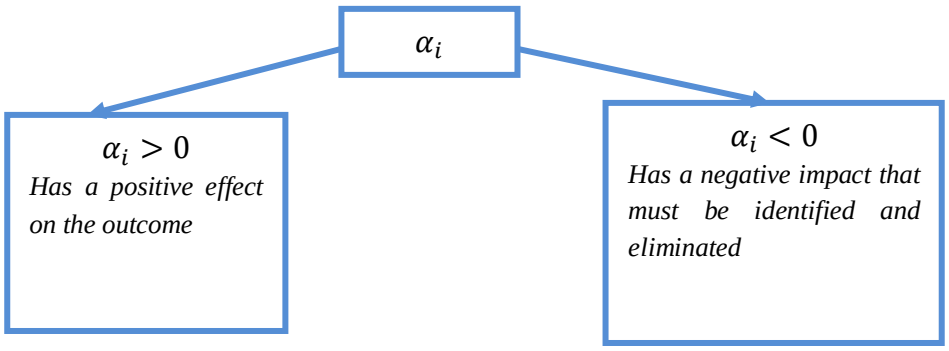

Fig. 1 – Assessing the impact on the result
Source: compiled by the authors

Thus, the factors influencing the resultant sign from the point of view of the quality of influence are considered. The obtained coefficients indicate that for factors with negative coefficients, it is necessary to continue research in order to determine the directions of necessary innovations since a clear idea of quantitative characteristics is required to form an innovative marketing plan, which should be changed as a result of ongoing innovative activities.

After working through the characteristics of the first level, it is necessary to carry out actions similar to those of the first level for the attributes of the second level. Formulas (4)-(6) show the model, in which the resultant attribute is A, and the factor attributes are attributes of group B. For example, such factor attributes as the quality of the rolling stock, the quality of port services during loading and unloading, and the quality of the provided logistic support influence the work of the container transportation sector in maritime trade.

$$A_i = \prod_{j=1}^{k} B_j^{\beta_j} \quad (4)$$

$$\ln A_i = ln\, B_1^{\beta_1} + ln\, B_2^{\beta_2} + \cdots + ln\, B_{n-1}^{\beta_{n-1}} + ln\, B_n^{\beta_n} \quad (5)$$

$$\ln A_i = \beta_1\, ln\, B_1 + \beta_2 ln\, B_2 + \cdots + \beta_{n-1} ln\, B_{n-1} + \beta_n ln\, B_n \quad (6)$$

The values of the coefficients β_j obtained as a result of calculations can be classified similarly to the previously obtained coefficients α_i . Based on the values obtained, subsequent decisions are made on the advisability of further vertical analysis, that is, when each factor with a negative characteristic has a number of subfactors studied in the same order. When performing similar reasoning, a relationship of dependencies is built, a simplified model of which is provided in Fig. 2.

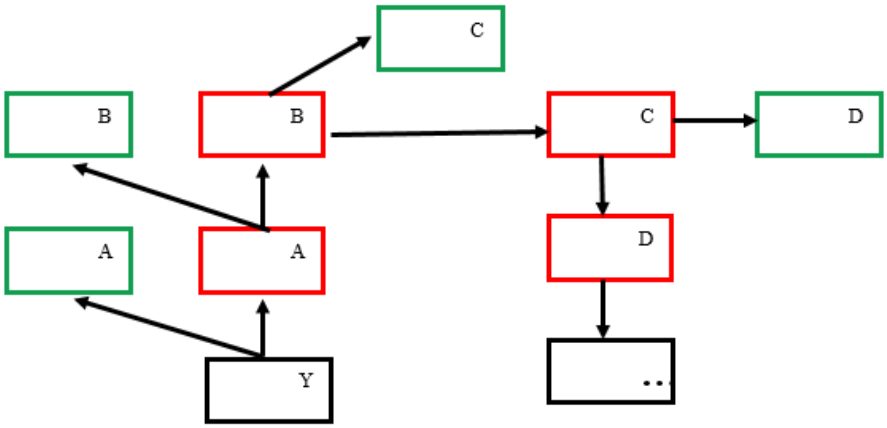

Fig. 2 – Model for building vertical links
Source: compiled by the authors

However, in most real processes there are not only vertical, but also horizontal and intermediate links, which are characterized by varying degrees of mutual influence, that is, they can be determined by determining the magnitude of the correlation dependence.

To study the mutual influence between some horizontally connected links of the planned innovation marketing plan, selected in pairs, you can apply the study of the correlation between indicators. If the resulting correlation coefficient is from 0 to 0.3, then the relationship is very weak, if from 0.3 to 0.5. then the connection is weak, if from 0.5 to 0.7, then the connection is average, however, all these connections have no influence and are not taken into account due to the small degree of mutual influence. If the obtained correlation coefficient is from 0.7 to 0.9, then the degree of relationship is high. and with a

correlation coefficient of 0.9-1, it is very high. Hence. horizontal relationships should be taken into account in the innovation marketing plan when obtaining a correlation coefficient between these factors of at least 0.7.

After performing a preliminary analysis, during which vertical and horizontal relationships are identified, a draft innovation marketing plan is formulated. The essence of managing an integrated model of innovation activity is to form a marketing mix in such a way that the innovation policy is based on specific data obtained in the course of the study, and the behavioral concept of the object of innovation activity reflects not only the possibilities of supply but is clearly based on demand data for goods or services placed on the market.

Results. Maritime trade in the field of foreign trade of Ukraine occupied and occupies one of the main positions since Ukraine's trading partners are located in various parts of the world. Consider the structure of transportation of various types of goods by sea for 2016-2020 (Table 1).

Table 1

Transportation of goods by sea, thousand tons

Type of goods	*2016*	*2017*	*2018*	*2019*	*2020*
Dry bulk	52.7	32.5	30.0	30.0	7.5
Liquid bulk	996.9	638.5	672.4	819.6	418.5
Tare-piece	1666.2	1408.4	1175.5	1270.6	920.0
In containers	37.5	8.0	0.4	0.001	0.001
Other	279.2	165.7	13.7	0.001	0.001
Total	3032.5	2253.1	1892.0	2120.2	1346.0

Source: compiled by the author based on the materials of the State Statistics Service of Ukraine (2022)

See Table 1 for cargo. the tonnage of which is not significant, we show 1 t in the corresponding cells, since the transportation of these goods was carried out for small private entrepreneurs and does not exceed the specified amount. To perform calculations, you must first enter the designation system (Table 2) and write down the mathematical model (7&8).

Table 2

Designation system

Type of goods	Designation
Dry bulk	D
Liquid bulk	L
Tare-piece	T
In containers	C
Other	O
Total	Y

Source: compiled by the authors

$$\ln Y = lnD^{\alpha_1} + lnL^{\alpha_2} + lnT^{\alpha_3} + lnC^{\alpha_4} + lnO^{\alpha_5} \qquad (7)$$

or

$$\ln Y = \alpha_1 lnD + \alpha_2 lnL + \alpha_3 lnT + \alpha_4 lnC + \alpha_5 lnO \quad (8)$$

After taking the logarithm of the initial values and building a linear dependence model, the following values of the model coefficients (8) will be obtained:

$$\alpha_1 = -0{,}09, \alpha_2 = 0{,}12, \alpha_3 = 0, \alpha_4 = -0{,}03, \alpha_5 = 0{,}34.$$

The obtained values of the coefficients indicate that it is necessary to make innovations, first of all, in the liquid cargo trade industry, and then in the field of cargo transportation in containers, then innovations are needed in the field of packaged cargo. Further studies are needed after the economic measures have been taken.

Conclusions. Since maritime trade is currently attracting special attention due to its importance, innovations in this area can increase its effectiveness. In order to determine the sequence of innovations, it is necessary to assess the degree of influence on the resulting feature of each of the components that affect the final result. The article presents a mathematical model and a fundamental algorithm for conducting such a study.

A delivery analysis element is also presented, which demonstrates how the sequence of actions can be structured in determining in which order innovations should be made. Determining the degree of influence on the final result of each of the factors of influence makes it possible to build an innovative marketing plan in such a way that such results are achieved in the shortest possible time, increasing rather than reducing the final result.

The resulting mathematical model was applied to identify the sectors of maritime trade in Ukraine that are most in need of innovation. According to the results of the research, three sectors of the industry showed negative results: bulk cargo, container transportation, and packaged cargo, the coefficients of influence of which on the overall result of maritime trade are -0.09, -0.03, and 0, respectively. Thus, it is possible to determine the necessary sequence of innovations in the selected trade sector.

Conflict of Interest and other Ethics Statements
The authors declare no conflict of interest.

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УПРАВЛІННЯ ІНТЕГРОВАНОЮ МОДЕЛЮ ІННОВАЦІЙ У МОРСЬКІЙ ТОРГІВЛІ

Анотація. У статті представлено модель, яка дозволить обґрунтувати послідовність впровадження системи інноваційної діяльності з інтегрованим управлінням інтегрованою моделлю інноваційної діяльності. З метою визначення послідовності інноваційної діяльності проведено дослідження показників морської торгівлі України за період з 2016 по 2020 роки за даними Державної служби статистики України. Розглянуто особливості формування інноваційного маркетингового плану в інтегрованій моделі інноваційної діяльності в морській торгівлі. За допомогою представленої математичної моделі на прикладі морської торгівлі України проведено аналіз потенційного плану впровадження інновацій у різних сферах та визначено їх послідовність.

Запропонована математична модель може бути використана для виявлення впливу певної сукупності факторів на результат. Модель може бути застосована до різних типів і категорій діяльності, показуючи ступінь впливу кожного з обраних факторів впливу на обрану результуючу ознаку. Можливість вибору довільної кількості факторів впливу робить його універсальним для використання в різних видах діяльності та на різних етапах аналітичної роботи. У статті наведено приклад застосування розробленої математичної моделі для морської торгівлі України. Отримані результати свідчать про те, що пріоритетним завданням у сфері інновацій є модернізація наливних перевезень (коефіцієнт значущості для кінцевого результату -0,09), контейнерних перевезень (коефіцієнт значущості -0,03), тарних вантажів (коефіцієнт значущості 0). Проведення дослідження в галузі морської торгівлі зумовлено підвищенням рівня значущості цього виду торгівлі в сучасних умовах.

***Ключові слова**: морська торгівля, інтеграція, інновації, менеджмент, маркетинговий план інновацій, математична модель, аналіз ефективності.*

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