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КОМПЛЕКСНА МОДЕЛЬ ОЦІНКИ РОЗВИТКУ СУДНОПЛАВНИХ КОМПАНІЙ З ФРАХТУВАННЯ І ПОПОВНЕННЯ ФЛОТУ: МІЖНАРОДНІ ТА НАЦІОНАЛЬНІ АСПЕКТИ

Актуальність. *Сьогодні, транспортна система, особливо водний транспорт України, перебуває у стані турбулентності бізнес-середовища, тому розвиток ринку транспорту та динаміка воєнного впливу морських перевезень схильні до суттєвих коливань. В сучасних умовах при аналізі роботи судноплавних компаній разом із прагненням максимізації поточних фінансових показників функціонування важливими також є питання, пов'язані з довгостроковим плануванням фрахтування флоту судноплавних компаній із урахуванням тенденцій зміни стану фрахтового ринку та динаміки воєнного впливу на економіку України.*

Мета та завдання. *Метою даної роботи є розробка комплексної моделі оцінки розвитку судноплавних компаній, ефективності експлуатації суден судноплавних компаній, що використовуються у морських трампових перевезеннях, із урахуванням тенденцій зміни кон'юнктури фрахтового ринку у міжнародних та національних аспектах. Задачі. В досліджені обґрунтувати модель оцінки ефективності використання морських суден, яка дозволяє робити оптимальний вибір судна для фрахтування флоту судноплавної компанії з урахуванням динаміки воєнного впливу та змін фрахтових ставок.*

Матеріали та методи. *Це дослідження ґрунтується на аналізі розподілу фрахтового ринку щодо формування вантажопотоків для глобальної системи безпеки судноплавства. Застосовано методи: графічний метод, статистичного аналізу, економічного аналізу, системного аналізу на прикладі фрахтування флоту судноплавних компаній.*

Результати. *Авторами дослідження був проведений аналіз розподілу міжнародного ринку фрахтових ставок із врахуванням різних складових параметрів. Значення фрахтових ставок і цін на пальне для суден, обладнання та інше, схильні до випадкових коливань. Практичний інтерес представляє розвиток запропонованої авторами моделі розвитку проєктів з фрахтування і експлуатації суден до можливих випадкових коливань бізнес-середовища. Тому, постає необхідність у перегляді підходів, якими регулюються транспортні перевезення та необхідність у розробці комплексної моделі оцінки показників ефективності фрахтування морських суден судноплавними компаніями у розрізі стратегічних цілей транспортної безпеки. Запропонована послідовність обґрунтування критичних значень фрахтових ставок є універсальною при оцінці розвитку судноплавних компаній шляхом фрахтування, поповнення складу суден судновласників.*

Висновки. *Отже, для судноплавної компанії дохід формується на базі фрахтових ставок, тому надходження грошових коштів із поповнення флоту засновані на критичних фрахтових ставках (рейсового чартеру). Відзначимо, що фрахтування флоту, найчастіше, орієнтоване на власну комерційну експлуатацію (з можливою участю компаній, які займаються комерційним менеджментом суден). Таким чином, комплексна модель фрахтування флоту є з одного боку, одним із варіантів реалізації стратегій розвитку судноплавної компанії, з іншого – заміною старих суден для забезпечення утримання наявних ринкових позицій.*

Ключові слова: *судноплавна компанія, модель, фрахтування суден, фрахтовий ринок, вантажні перевезення, морський транспорт, глобальна безпека судноплавства.*

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A COMPREHENSIVE MODEL FOR EVALUATING THE DEVELOPMENT OF FREIGHTING AND ADJUNCTION FLEET SHIPPING COMPANIES: INTERNATIONAL AND NATIONAL ASPECTS

Topicality. *Today, the transport system, especially the water transport of Ukraine, is in a state of turbulence in the business environment, therefore the development of the transport market and the dynamics of the military influence of maritime transport are subject to significant fluctuations. In modern conditions, when analyzing the work of shipping companies along with the desire to maximize current financial indicators of operation, issues related to the long-term planning of the fleet of shipping companies, taking into account the trends of changes in the state of the freight market and the dynamics of the military influence on the economy of Ukraine, are also important.*

Aim and tasks. *The purpose of this work is to develop a system model of the efficiency indicators of the shipping company's vessels used in sea tramp transportation, taking into account the changing trends of the freight market in international and national aspects. Tasks, the work, to substantiate the model for evaluating the efficiency of the use of sea vessels, which allows making the optimal choice of a vessel for chartering the fleet of a shipping company, taking into account the dynamics of military influence and changes in freight rates.*

Materials and methods. *This study is based on the analysis of the distribution of the freight market in relation to the formation of cargo flows for the global shipping security system. Methods are applied: graphic method, statistical analysis, economic analysis, system analysis on the example of chartering the fleet of shipping companies.*

Research results. *The authors of the study conducted an analysis of the distribution of the international market of freight rates, taking into account various constituent parameters. Values of freight rates and fuel prices for vessels, equipment and others are subject to random fluctuations. Of practical interest is the development of the model proposed by the authors for the development of projects for the chartering and operation of vessels to possible random fluctuations in the business environment. Therefore, there is a need to review the approaches used to regulate transport and the need to develop a comprehensive model for evaluating the performance indicators of the chartering of sea vessels by shipping companies in terms of strategic goals of transport safety. The proposed sequence of substantiation of critical values of freight rates is universal when evaluating the development of shipping companies through chartering, replenishment of shipowners' vessel.*

Conclusions. *So, for a shipping company, the income is formed on the basis of freight rates, therefore, cash receipts from replenishment of the fleet are based on critical freight rates (flight charter). It should be noted that fleet chartering is most often focused on its own commercial operation (with the possible participation of companies engaged in the commercial management of ships). Thus, the system model of fleet chartering is, on the one hand, one of the options for implementing the shipping company's development strategies, and on the other hand, it is a replacement of old vessels to ensure the maintenance of existing market positions.*

Keywords: *shipping company, model, ship chartering, freight market, cargo transportation, maritime transport, global shipping safety.*

Problem statement and its connection with important scientific and practical tasks. Currently, the transport system of Ukraine, especially water transport, is in a permanent turbulence of the business environment, therefore the transport market and the dynamics of the

military influence of sea transportation are prone to significant fluctuations. At the present turbulent time, i.e. the era of ongoing wars, crises, theories of change only have conceptual problematic foundations of sustainable economic development, which are based on the constant renewal of the technological base of production activity, changes in ship technologies, technological systems of the freight market. Thus, despite the constant development of the theory of enterprise management on the example of shipping companies, it should be stated that there is a practical lack of research devoted to the problems of the development and strategy of shipping companies regarding the chartering of water transport in international and national aspects of their activities. Therefore, the sole purpose of maritime business entities is to obtain profits and sustainable development, as well as to improve the management efficiency of shipping companies (B.V. Burkynskyi, S.V. Ilchenko, V.F. Hryshchenko, 2022).

Analysis of recent publications on the problem. The theoretical aspects of the study of issues related to the study of the formation and modern state of cargo transportation by sea vessels and vessel chartering were elaborated in the scientific works of Ukrainian authors: S.V. Rudenko, I.O. Lapkina, S.P. Onishchenko, A.V. Bondar ., Y.O. Koskina, T.I. Bernevek, who in their research conducted a thorough analysis of development strategies of shipping companies and issues related to ship billing. International aspects of ship chartering by shipowners were highlighted in the works of: B.V. Burkynskyi, S.V. Ilchenko, V.F. Grishchenko, V.M. Lysyuk, S.B. Kolodynskyi, O.V. Zakharchenko, and other authors.

Allocation of previously unsolved parts of the general problem. In the case of the current maritime transport of Ukraine, the following contradictions appear: a) inconsistency of the parameters determined by the logistics of ships, modern requirements taking into account the development strategies of river ports, sea ports and the transport system of Ukraine; b) the inconsistency of the state of the ports with the current military conditions for ensuring the safety of navigation (mining of the russian federation's water areas of ports and waterways, terrorizing infrastructure and logistics facilities by enemy missiles, naval drones, unmanned aerial vehicles, etc.); c) inconsistencies in the quality of ship service in the sea and river ports of Ukraine during the martial law. In particular, during martial law, this may apply to transshipment, navigation and hydrographic equipment of ports, signaling systems during air alarms, etc. (S.O. Kramskyi, I.Yu. Labunets, 2023). Ship replacement involves changing the modifications of ships that have served their useful life or were damaged due to natural disasters, accidents, etc., by chartering a fleet of ships and related systems and equipment from a shipping company with similar parameters and characteristics.

Formulation of research objectives (problem statement). The purpose of the study is to develop a comprehensive model for evaluating the efficiency of the shipping company's vessels used in sea tramp transportation, taking into account the trends of changes in the freight market in international and national aspects. The task of the work is to substantiate the model of evaluating the efficiency of the use of sea vessels, which allows making the optimal choice of a vessel for chartering the fleet of a shipping company, taking into account the dynamics of military influence and changes in freight rates.

Materials and methods. This study is based on the analysis of the distribution of the freight market in relation to the formation of cargo flows for the global shipping security system. Methods are applied: graphic method, statistical analysis, system analysis, economic analysis on the example of chartering the fleet of shipping companies.

An outline of the main results and their justification. In order to choose the best option for diversification of shipping companies, ensure a favorable overall strategic position of the organization and increase its efficiency and competitiveness, it is necessary to consider a range of alternative divisions for the project of creating a new strategic business. There is a dynamic interplay between strategy, structure and the business environment in which shipping companies operate. One of the major mistakes of the management of a shipping company is that it simply imposes a new strategy on top of the existing organizational structure of the shipping company. The calculated values obtained are the basis for making informed decisions about increasing the efficiency of vehicles to ensure the profitability of investment projects for the development of transport companies (V.M. Lysyuk, 2023). After choosing a strategy and forming further strategic plans, the management of a shipping company should conduct a comprehensive analysis of the organizational structure to understand whether it contributes to the achievement of the company's strategic goals. The strategy of goals determines the structure, from a comprehensive point of view, the structure

should always reflect the strategy. This approach often has negative consequences, since the discrepancy between the organizational structure and strategic goals is a serious obstacle to achieving long-term strategic goals (S. Kramskyi, S. Kolodinskyi, O. Zakharchenko, 2023). National aspects of chartering the national fleet in wartime can satisfy a very limited circle of charterers, both in Ukraine and in the world. The national market of the fleet is quite limited due to its age and the types and classes of vessels. Because of the demand for the bareboat charter of vessels, for example: Fishing trawlers, fishing seiners, fishing vessels, river barges, pushers and tugs, river-sea bulkers, boats, vessels of Ukrainian port services.

The best organizational structure will be one that matches the size, dynamism and complexity of the organization. As the organization and its goals evolve, its strategies and plans change. Therefore, in the conditions of changing directions of strategic development during and after the war, the creation of an appropriate organizational structure should become one of the main tasks of the management of Ukrainian shipping companies.

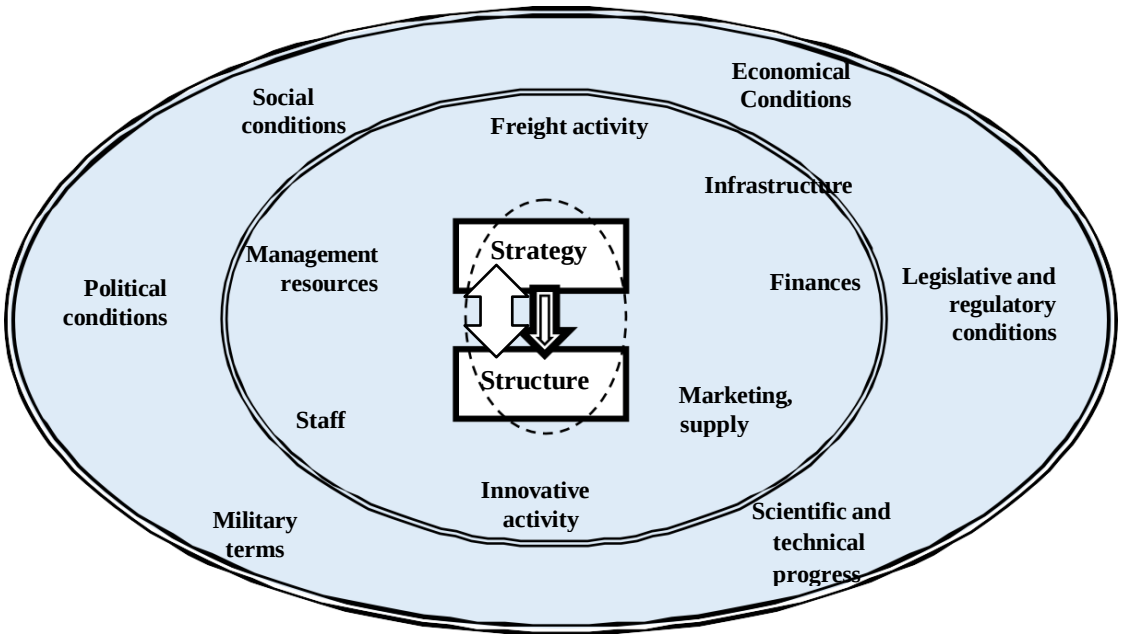

Fig. 1. A comprehensive model of the influence of environmental factors on the shipping company's strategy, outer circle – external factors, inner circle – internal factors

**Source: developed by the authors based on data (Rudenko S.V., Lapkina I.O., Kovtun T.A., Bondar A.V., 2018).*

For shipping companies, the attractiveness of fleet replenishment (updating) projects is closely related to changes in market conditions, namely the cost of new and already operated ships, fluctuations in freight rates, stability of cargo flow, etc. The effectiveness of any project is usually determined from the point of view of comparing one-time investments and future costs with future revenues received at a certain stage of the ship's charter life cycle. At certain periods of the ship's charter life cycle, there is an imbalance in the inflow and outflow of funds, which affects the cash flow *(CF)* imbalance. The investment period is characterized by large outflows of capital - in the form of spending money, for example, when buying ships (A.V. Bondar, 2016).

During the vessel's operation, the ratio of inflows to outflows shows a characteristic of gradually decreasing outflows when market conditions are stable. This is due to the fact that the loan obligations must be repaid. This repayment can take the form of annual payments, usually starting from the first year of the vessel's operation, or include the option of deferring repayment of the loan for several years (such deferral is known as a grace period). In this representation, the total net present value is equal to:

$$NPV = NPV' + NPV''. \quad (1)$$

Where, NPV are the components of the net present value of the project in the investment and post-investment periods, respectively. Let's consider the organization of the vessel's operation on the basis of the bareboat charter voyage contract during the investment period. By defining investment as $(f * Q)$, and the outflows as $R_{oper}+(d(t)$, it is possible to express that:

$$NPV' = (f * Q - R_{oper} - d(t)) * C_{pv} - I_0^{owner} \quad (2)$$

As conventional designations, we use the annual volume of transported cargo *(Q)*, the freight rate for 1 ton of cargo *(f)*, the annual amount of operating costs (R_{oper}), as well as the annual costs of securing a loan *(d(t))*, one-time investments (I_0^{owner}), interest bank rate *(C_{pv})* for providing a loan to a shipping company. As you can see, the rate takes into account operating costs, initial investment, annual costs and interest rates on the loan, as well as the volume of goods shipped annually. Thus, the market of freight rates for the transportation of goods can be represented according to the following parameters: resource, geographical, economic, transport. Among these parameters, a special place is occupied by freight rates under various sea transportation contracts, knowledge of these critical values ensures efficient operation of ships, given in fig. 2.

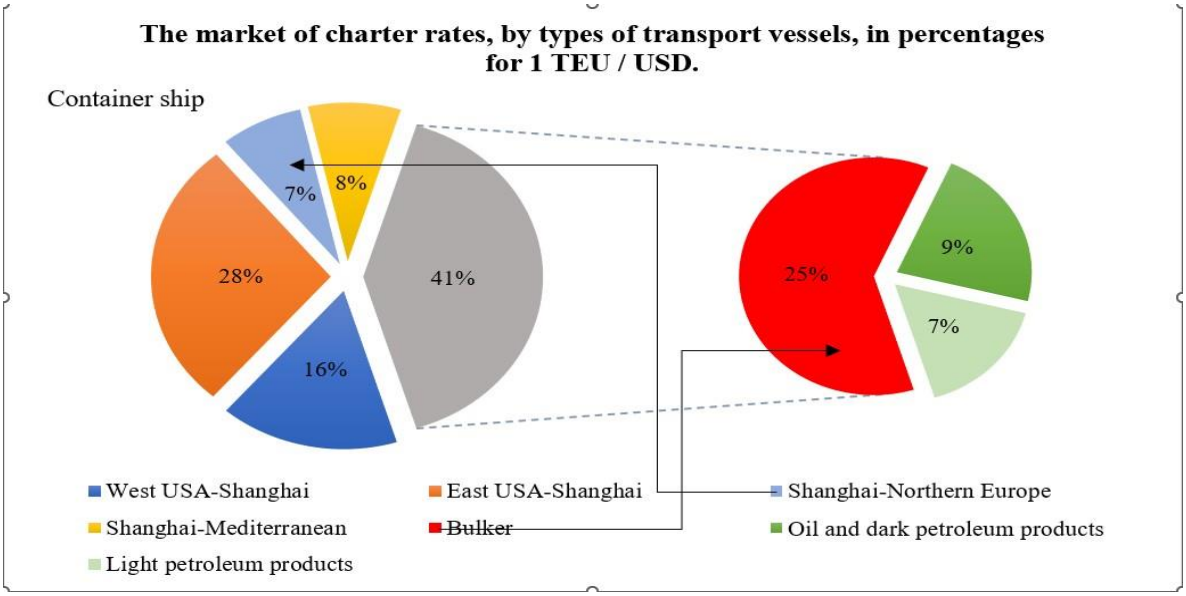

Fig. 2. Distribution of the world market of charter rates, in USD by 1TEU

** Source: compiled by the authors based on open data of the State Customs Service, 2023.*

Development projects of shipping companies for the establishment and development of representative offices or agency network in other geographical regions represent the geographical expansion of shipping companies. Key rates are long-term rate values associated with price fluctuations in the freight market. The results of the calculation of different values of credit interest (p = 15% and 8%) for the purchase of a ship are shown in figures 1&2. In connection with the urgent need to restore the existing composition of the merchant fleet, which plays a leading role in the work of shipping enterprises, the issues of complex demonstrations of related projects. In connection with this, the problem of forming methodological provisions in determining critical parameter values for projects to replenish (update) the transport fleet arises. (S.P. Onyshchenko, Yu.O. Koskina, 2015). By carrying out geographical expansion, the management of the shipping company pursues the following goals: The possibility of obtaining additional income or profit; Increased complexity of direct sales to consumers by providing on-site services and developing, approving and implementing marketing strategies based on local conditions in national markets; Directly monitors the process of transportation of foreign cargo (especially transportation of general cargo, engineering cargo or commercial operations), transmits key indicators of the world freight market, presented in the form of a bar chart in fig. 3.

Shipowners are interested in voyage charter conditions with freight rates above the critical value, which ensures project profitability and provides a higher return on invested capital so that they can continue to follow the company's fleet replenishment strategy. As the number of vessels in the global freight market increases, competition in the shipping industry increases, and freight rates decrease, the distribution of the global market by year is provided in the form of a bar chart in fig. 4.

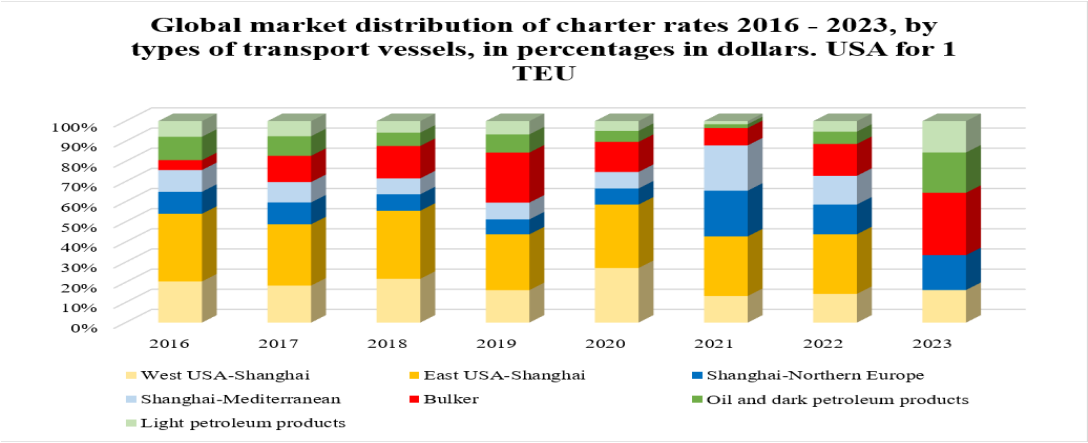

Fig. 3. Histogram of the world market of charter rates, in USD for 1TEU in the period 2016-2023

** Source: compiled by the authors based on open data of the State Customs Service, 2023.*

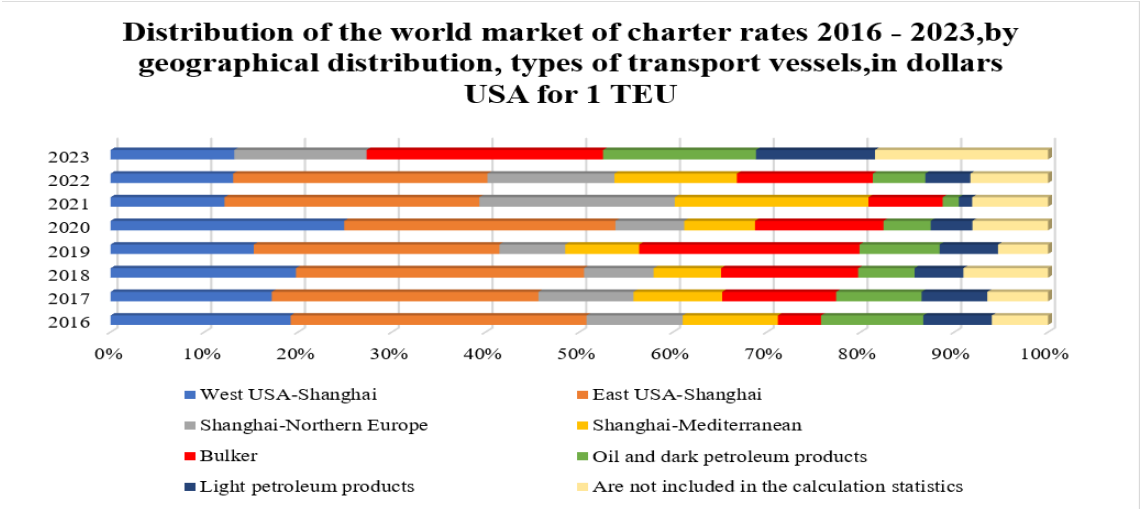

Fig. 4. Histogram of the geography of the world market of charter rates, in USD for 1TEU in the period 2016-2023

** Source: compiled by the authors based on open data of the State Customs Service, 2023.*

Thus, if freight rates fall to critical levels or below during vessel operations, shipowners will not order tonnage from shipyards, which is reflected in the global trend of fleet replenishment and rising freight rates. Given the competitive nature of the shipping industry, market rates always reflect global trends in fleet renewal orders, taking into account the existing tonnage supply/demand ratio (or excess tonnage shortage). We use the vessel's estimated voyage time as 100% to calculate the percentage of sailing time and dock time in the total sailing time. The critical ratio is defined as the ratio that determines the operating income of the vessel, at which the elements related to its acquisition are considered neither profitable nor unprofitable. To determine the critical value of the annual flow of funds, the well-known method of annuity valuation is used, provided that the net present value is zero. Let's express the current value of the total flows of funds, if these flows are reduced to one monetary unit, C_{pv}.

$$C_{pv} = \sum_{t=1}^{T} \frac{1}{(1+\frac{p}{100})^t} = \frac{1-(1+0.01p)^{-T}}{0.01p}. \quad (3)$$

Where C_{pv}=0, the value of the critical rate of vessel operation under the terms of the charter party, will look like this:

$$f^{kp} = \frac{1}{Q}\left(\frac{I_0^{owner}}{C_{pv}} + R_{oper} + d(t)\right). \quad (4)$$

After determining the parameters of the voyage, the critical value of the ship's freight rate for the corresponding interest rate of the loan guarantee is calculated using formulas (3, 4). Therefore, the

dependence of critical freight rates on the time of the vessel's stay in the port has been established. As the parking time increases, the critical cost of transporting 1 ton of goods will increase. On the contrary, the less time the ship spends on loading and unloading operations, the smaller the value of the critical freight rate. A graphical representation of the calculation results is shown in fig. 2. Calculating the value of the critical speed, the following conclusions can be drawn: 1) The critical rate is not very sensitive to changes in credit interest rates (see figures 3 and 4); 2) The critical speed is very sensitive to changes in the ratio of flight time to dwell time, especially when the distance between ports is long. The proposed sequence of determining the cargo threshold is universal when evaluating projects for the development of transport enterprises due to replenishment (restoration) of rolling stock. (O.V. Zakharchenko, A.V. Darushin, O.V. Bileha, T.P. Riepnova, 2019).

Large shipping companies with large container fleets. However, the management of shipping companies usually prefers high performance indicators of development projects and confidence in the possibility of obtaining additional profits. In this case, the company prefers to implement projects that are not related to its existing business. The advantages of shipping companies implementing development projects in related industries are mostly related to the presence of strategic connections and correspondences between related activities. On the other hand, development projects implemented in unrelated industries open up wide opportunities for obtaining additional profit and improving financial indicators, but in such projects, the use of strategic connections is relegated to another plan or is absent at all (fig. 5).

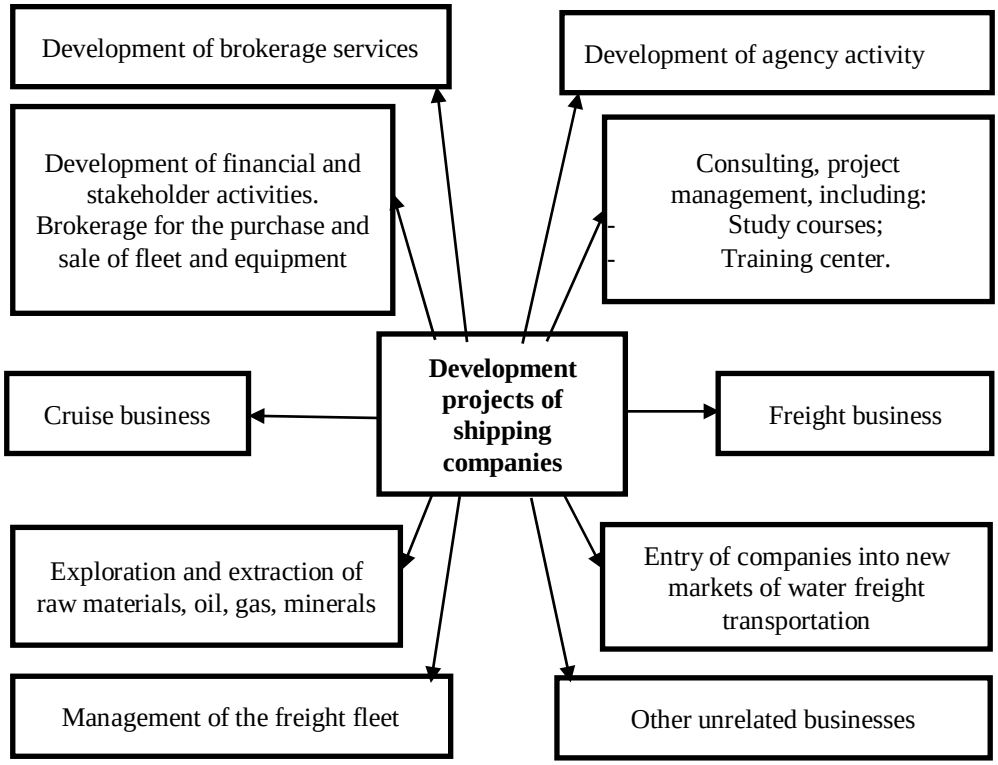

Fig. 5. Types of development business environmental of shipping companies
**Source: figure developed by the authors.*

Types of development business projects undertaken by shipping companies in non-adjacent industries include exploration and production of oil and gas raw materials and non-mineral materials. The largest foreign shipping companies are engaged in the exploration and extraction of oil and natural gas from the seabed and the extraction of underwater minerals. For example, shipping companies can participate in the exploration and extraction of raw materials from marine deposits of natural gas and oil, provide services with their own specialized fleet and operate marine platforms for the production of raw materials (natural gas, oil) on the shelf of national territorial waters (V.D. Danchuk, A.V. Sevost'yanova, 2020).

At the same time, the methodological basis of the formation of multi-projects for shipping companies is the systematic integration of strategic goals, portfolios and multiple projects, the result of which is the successful functioning of shipping

companies on the global freight market. However, the application of multi-project management methodologies and tools can broaden the shipping companies' understanding of the nature of development management projects, consider multiple development projects and integrate them into multi-projects. As the hours of parking decrease, the difference between the driving and parking components decreases. A long hour of parking increases the total flight hours and reduces the number of trips made by a vessel in a year, as well as the amount of cargo carried during these trips (T.I. Bernevek, 2018). This especially applies to the transportation of goods over long distances between ports. The determination of the critical traffic value when changing working hours indicates that the working speed can be reduced to an economical route. Table 1 shows a fragment of an example calculation for transporting 8,000 tons of cargo over a distance of 2,960 - 20,000 miles.

Table 1.

Estimated indicators of the results of the vessel's operation when the parking time is changed

Indicators of the vessel	Distance, miles					Correlation components of the ship's voyage time	
	2960	5000	10000	15000	20000	at the parking lot	under way
Parking time, days	18,7	30,3	60,7	91	121,3	70	30
Vessel running time, days	8	13	26	39	52		
Vessel voyage time, days	26,7	43,3	86,7	130	173,3		
Number of ship voyages per year	13,5	8,3	4,2	2,77	2,08		
Amount of cargo per year, tons	108000	66461,54	33230,8	22153,9	16615,4		
Vessel costs per voyage, USD	102133,3	165966,7	331933,3	497900	663866,7		
Ship expenses for the year, USD	1378800	1378800	1378800	1378800	1378800		
Loan expenses for the year (at p = 15%), USD	762667	762667	762667	762667	762667		
Parking time of the vessel, days	5,3	8,7	17,3	26	34,7	40	60
Vessel running time, days	8	13	26	39	52		
Vessel voyage time, days	13,3	21,7	43,3	65	86,7		
Number of ship voyages per year	27	16,7	8,3	5,5	4,2		
Amount of cargo per year, tons	216000	132923,1	66461,5	44307,69	33230,8		
Vessel costs per voyage, USD	63466,7	103133,3	206266,7	309400	412533,3		
Ship expenses for the year, USD	1713600	1713600	1713600	1713600	1713600		
Loan expenses for the year (at p = 8%), USD	568533	568533	568533	568533	568533		

** Source: the table was developed by the author's based on data (Rudenko S.V., Lapkina I.O., Kovtun T.A., Bondar A.V., 2018).*

The influence of the ship's navigational parameters on the profitability of the shipping company at the stage of the ship's operation. The influence of ship voyage parameters on the profitability of shipping companies at the stage of ship operation. The working time will be determined based on the calculation of the working value of the ship's speed - 16 knots (this value is constant). We will consider parking time as a variable. It should be noted that travel time increases in direct proportion to the distance between ports. This affects the possibility of performing more flights in a certain period and the corresponding type of transport. Table 2 shows calculations for the ship at transit distances of 2,960 miles and 5,000 miles, since the vessel's operating time is reduced to an economic route (9 knots), and the time of the ship's parking is a

constant value, with corresponding economic costs for the shipowner. The determined indicators depend on the speed of the relative distance of passage of vessels, see Table 2.

Thus, it should be considered that the parking time is a constant value, which is determined according to the general regulations of the port of loading (unloading) vessel's. Therefore, with a decrease in speed, the working hours and total flight time increase, the number of voyages made by the vessel during the year, the volume of transported cargo during the considered period and the critical freight cost of 1 ton of cargo decrease. It should be noted that as the distance between ports increases, the critical importance of freight rates increases.

Conclusions and prospects for further research. For shipping companies, revenue is generated on the basis of freight rates, so cash receipts for fleet replenishment projects are determined on the basis of freight rates (time charter and voyage charter). It should be noted that fleet chartering usually focuses on its own commercial operations (commercial ship management companies may be involved). Therefore, on the one hand, a complex fleet leasing model is one of the options for shipping companies to implement a development strategy, and on the other hand, to ensure the preservation of existing market positions, it is necessary to start replacing old vessels. The main factors affecting the relevance of the fleet chartering strategy are identified: trends in the cargo transportation market, transport load in developed markets, the level of vessel prices, opportunities to enter new markets, and the state of the competitive environment.

Table 2.

The results of the vessel's operation when the running time is changed during the voyage

Indicators of the vessel	Distance, miles					
	2960			5000		
	V_x = 16knots	V_x = 11 knots	V_x = 9 knots	V_x = 16knots	V_x = 11knots	V_x = 9knots
Parking time, days	11	11	11	11	11	11
Vessel running time, days	7,7	11,2	13,7	13	18,9	23,1
Vessel voyage time, days	18,7	22,2	24,7	24	29,9	34,1
Number of ship voyages per year	19,2	16,2	14,6	15	12	10,5
Amount of cargo per year, tons	153872,7	129678,8	116637,5	119724,1	96083,7	84253,3
Vessel costs per voyage, USD	78093,8	99045,5	113944,4	110125	145636,4	170888,9
Ship expenses for the year, USD	1502061,7	1605511,5	1661274,2	1648076,5	1749159,5	1799744,4
Loan expenses for the year (at p = 15%), USD	762667	762667	762667	762667	762667	762667
Loan expenses for the year (at p = 8%), USD	568533	568533	568533	568533	568533	568533

** Source: the table was developed by the author's based on data (Rudenko S.V., Lapkina I.O., Kovtun T.A., Bondar A.V., 2018).*

At the moment, the methods of replenishment of the fleet are defined: construction of ships, purchase of ships, leasing (bareboat charter), short-term and medium-term leasing of ships (time charter). The special nature of freight transportation and related contracts is reflected primarily in the distribution of responsibility between the owner and lessee of the vehicle for certain costs, which is reflected in accounting, variable and fixed costs and related cash flows. Variable and fixed costs and resulting cash flows. Another promising direction of the development of this model is the study of the task of planning optimal terms for the purchase and sale of ships, based on the expected situation of the freight market, fuel prices and the market value of vessel's. The price also determines the amount of cash outflow, given that shipping companies pay for fuel on vessels that operate on voyage charters (irregular voyages) or liner shipping (also including permanent voyages) of vessels. Further research in this area may concern the definition of freight diversification horizons by vessel types and the formation of logistics corridors for the transportation of goods by sea by shipping companies.

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