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A method of maintaining the competitiveness of vessels on the local freight market during the repair period

Abstract. With the growing competition on local freight markets, organization and management of freight transportation and fleet operation are aimed at ensuring the competitiveness of shipping companies on relevant local freight markets and getting sufficient profit from the current market situation. There are several issues to be considered in this research: the problem of optimization of the process of vessel repair by using economic and mathematical models that would provide a shipping company within a free market, and full liberalization of the tramp shipping a sustainable position on the relevant local freight market that would contribute to obtaining the greatest possible profits by holding a particular cargo base and regular customers.

Introduction

There have been studied the issues of fleet organization and optimal fleet planning (Primachev 2004, p. 320), the strategic management of a shipping company (Lugovets, Stepanets, Moskalenko 2010), the problem of improving the competitiveness of shipping companies mainly due to the optimal choice of the markets where the fleet will be used (Kotlubay 2004, Leonov 2005), optimization of chartering conditions (Kotlubay 2009, Kulchikovskaya 2005), as well as business planning of shipping companies based on economic and mathematical models (Shymlanskaya 2005).

However, these issues do not display an integrated approach to solving this problem. Also, the effect of the forced withdrawal of vessels out of service for repairs on the competitiveness of the shipping company is not sufficiently studied yet, due to the fact that these vessels are temporarily leaving the market, which can be possibly occupied by other shipping companies. In order to keep the share at the market, a shipping company may hire vessels of other shipping companies while their own fleet is being repaired. In such a situation, there exist many options for putting the ships out of service for repair (the choice of a shipyard), as well as options to lease other vessels (Clarkson Research Studies 2011).

The purpose of this article is to develop such a fleet optimization model that would provide the shipping company with a sustainable position on the relevant local freight market and obtain maximum profits by ensuring a particular cargo base and constant clients in the free market conditions, and the full liberalization of tramp shipping.

1.   Theoretical aspects

With the growing competition on the local freight markets, organization and management of freight transportation as well as fleet operation are aimed at ensuring the competitiveness of shipping companies on relevant local freight markets, and getting a sufficient profit from the current market situation.

Formation of the client's willingness to charter a certain vessel for the carriage occurs under the influence of many factors. To assess the influence of various factors on the level of competitiveness of the vessel, it is necessary to carry out their classification and evaluation of the criteria linked to the most competitive.

All the factors relative to the vessel and the company can be defined as external and internal.

External factors are connected with the structure of maritime communications (line, trunk, feeder, and tramp), technical and operational characteristics of ports, the price level on the ships under construction, the condition of the freight market in a linear and tramp shipping, and other aspects.

Internal factors reflect the structural features of vessels, the age of vessels, the flag, the technical condition, the operational budget, and the proportion of fixed costs in the price of transportation. It should be noted that three of these factors (technical condition, the operational budget, and the share of fixed costs in the price of transportation) are largely determined by the policy of the company which holds it, in relation to the modernization and repair of its own fleet.

The attractiveness of the carrier for the clientele is largely determined also by the image of the company, the level of its corporate culture, the level of staff and management, the mission of the organization, and its strategy. All together, this can be combined into a criterion of the social capital of the organization, which largely determines its potential.

The above criteria apply to intrasystem. We should not forget about the system-wide criteria. One of them is the share of the freight component in the price of goods. Its decline is today an urgent task of the international community.

The share of sea transport costs in the cost, insurance, and the freight of imported goods in the industrialized countries amounts to an average of 4.5% and, in turn, in developing countries to 10% and more. In some developing countries this share is more than 20% (Review of Maritime Transport, 2015).

Among the above-mentioned factors, special attention should be paid to the level of fixed costs in the price of transportation. Repair costs of the fleet have a significant impact on the level of these costs. This circumstance makes especially relevant the study of the influence of technical management on the competitive position of the vessel on the freight market, both currently and in the future. This primarily concerns the issues of technical maintenance and repair of ships, the search for new approaches to the solution of problems of optimization of the repair program of vessels operating on the local freight market, as the withdrawal of vessels from service for the repair may significantly affect the shipping company's market position. And here the question arises about the choice of the output options vessels out of service and options of temporary chartering additional tonnage to hold mastered freight traffic, to reduce the ballast runs on the transition to the base repair, and, after its completion, to the place of first loading. This will ensure the competitiveness of the vessels, and, on this basis, increasing the efficiency of their use.

The influence of criteria and factors on the competitiveness of shipping companies is shown in Fig. 1.

As a rule, coming to a perspective local freight market, a tramp shipping operator begins to look for the ways to retain a particular cargo base, regular clients, or tries to change the work to the consecutive voyages, etc. At the same time, the company begins to search for possible solutions to save on different types of charges.

In addition, scientific evidence-based methods about the conditions of chartering vessels, the optimal values of operating parameters of vessels, output circuits from service for planned repair, etc. become much more important.

The current planning of a fleet shipping company is based on the following: the predicted values of a cargo base of the local freight market calculated for the corresponding year; the analysis of the materials of fleet operations for the previous year; the schemes of the fleet that take into account the features of the bunker market, the possibility of back load, etc.; and agreements and contracts for the carriage of cargo and other conditions.

The main optimization criteria are: net income and the percentage of presence (market share) of the company on the local market, which can be generally expressed in terms of the quantity of cargo in tonnes.

The major task of optimizing operations of the shipping company in operational, current, and medium-term planning are forecasting traffic, planning of fleet activity, and a plan of repair.
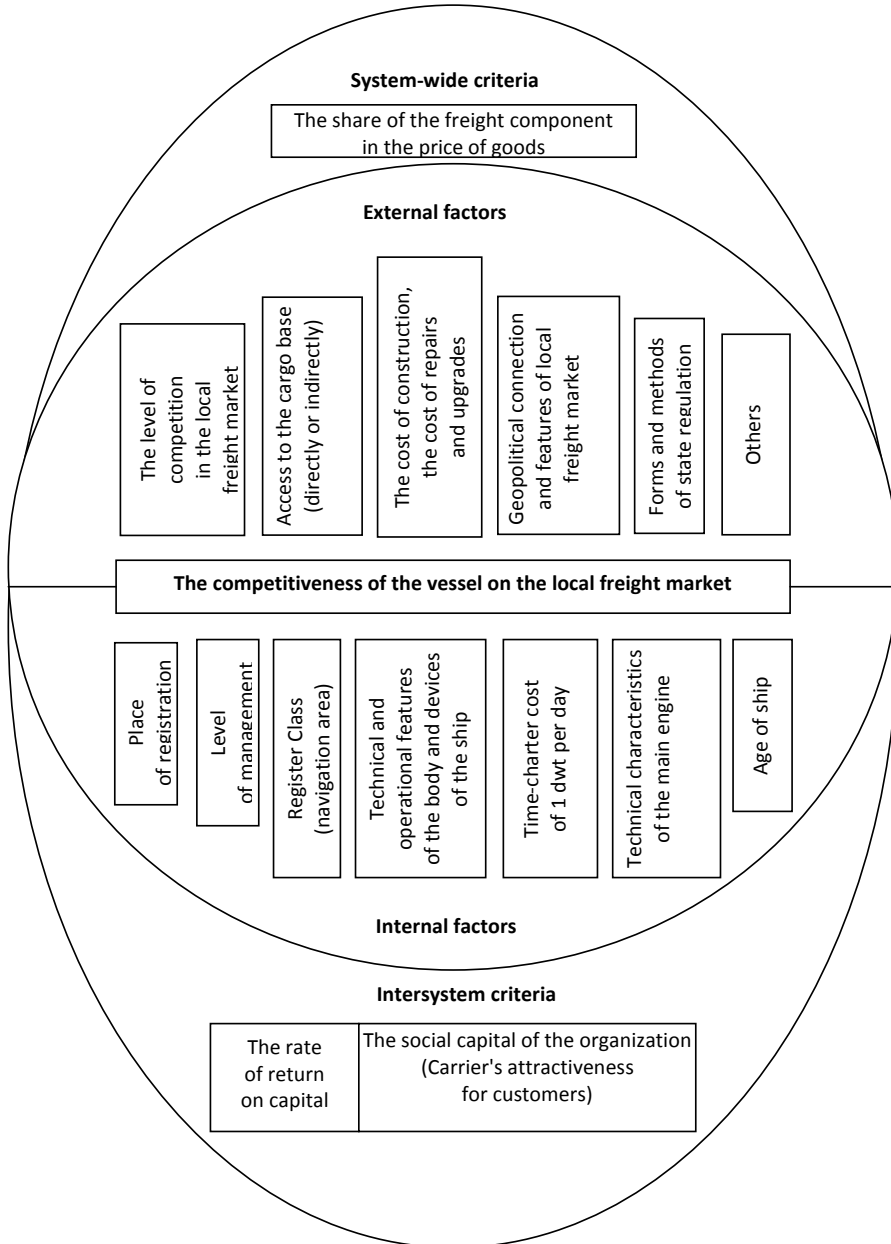
Fig. 1.   The relationship of the criteria and factors affecting the competitiveness of shipping companies

Source: own elaboration.

The feature of this task is that we want to go from planning of transportation (Stopford 2013) to the planning of fleet's operations in relatively uncertain conditions, but based not on the cargo, as it was done by previous researchers (Xie, Wang 2009) and which we believe is adequately predicted, but on the competition and the number of other competitors present at the market. The latter is especially important for perspective markets, where positions have to be kept under strong competition. In this situation, any weakening of the market position will inevitably lead to the loss of some of its shares and the weakening can be expected during the periods of forced withdrawal of its fleet from operations, primarily for dry-docking and scheduled maintenance.

These circumstances suggest the desirability of developing a science-based methodology that allows a shipping company make optimal decisions concerning the choice of a particular scheme of taking ships for repair, and the other one that represents a temporary replacement on the tonnage market used by other ships.

2.   Key research findings

Summing up the experience of fleet planning and taking into account that the choice of repair facilities and terms of factory repair are the elements of the fleet's activity plan, and the main criteria for its realization are the optimization of the cost-income ratio and the percentage of presence (market share) on the relevant local market, the following model of optimization of fleet shipping company is proposed:

$$\frac{\sum_s \sum_r \sum_j \sum_t f_{srjt} x_{srjt}}{\sum_s \sum_r \sum_j \sum_t (M_{srjt} + B_s a V^e_{srjt} t_{srjt}) x_{srjt}} \to \max, \tag{1}$$

$$\sum_s q_{srjt} x_{srjt} \le Q_{rjt}, \forall r \in G, \forall j \in J, \forall t \in T, \tag{2}$$

$$\sum_r \sum_j \sum_t t_{srjt} x_{srjt} \le T_s, \forall s \in S, \tag{3}$$

$$\sum_r \sum_j \sum_s (q_{srjt} x_{srjt}) / \sum_r \sum_j Q_{rjt} \ge d_t, \forall t \in \grave{O}, \tag{4}$$

$$\frac{\sum_s \sum_r \sum_j \sum_t f_{srjt} x_{srjt}}{\sum_s \sum_r \sum_j \sum_t t_{srjt} x_{srjt} D_s} \ge \vec{\partial}, \tag{5}$$

$$f_{srjt} = f^0_{srj} - c_{srj} (\sum_r \sum_j \sum_s (q_{srjt} x_{srjt}) / \sum_r \sum_j Q_{rjt}), \forall s \in S, \forall r \in G, \forall j \in J, \forall t \in T, \tag{6}$$

$$\sum_{s \in S_p, j \in J_w^+} m_{srjt} x_{srjt} \leq N_{rwt}, \forall w \in W, \forall t \in T, r \in R_\rho, \tag{7}$$

$$\sum_{w} \sum_{j \in J_w} m_{srjt} x_{srjt} = m_{srt}, \forall s \in S, r \in R_\rho, \forall t \in T, \tag{8}$$

$$\sum_{r} \sum_{j \in J_a^+} x_{srjt} + x_{sat}^i = \sum_{r} \sum_{j \in J_a^-} x_{srjt} + x_{sat}^k, \forall t \in T, \forall a \in A, \forall s \in S, \tag{9}$$

$$\sum_{r} \sum_{j \in J_a^-} x_{srjt} \geq x_{sat}^i, \forall s \in S, \forall a \in A, \forall t \in T, \tag{10}$$

$$x_{sat}^k = x_{sat+1}^i, \forall t, t+1 \in T, \forall a \in A, \forall s \in S, \tag{11}$$

$$x_{a_{0s}, t_{0s}}^i = 1; m_{srt} = const, \forall s \in S, \forall r \in G, \forall t \in T, \tag{12}$$

$$x_{srjt} \geq 0, x_{sat}^i \geq 0, x_{sat}^k \geq 0, \forall s \in S, \forall r \in G, \forall j \in J, \forall t \in T, \tag{13}$$

where x_{srjt} – the number of voyages made by the ship s within the section j by option r in period t;

r – the kind of ship's work (shipping r, repair r etc.);

$M_{srjt} + B_s aV_{srit}^e t_{srit}$ – the variable component of the price of the local freight market, see formula (3);

d_t – the market share, which must be held for a period t;

f_{srjt} – the financial result (profit) for the trip from the carriage of cargo r by the ship s on the section j in the period t;

q_{srjt} – loading the ship s with cargo r at the section j in period t;

Q_{rjt} – the amount of cargo transportation cargo r at the section j in period t;

t_{srjt} – the time of the voyage of the ship s with cargo r for the section j in period t;

T_s – the time budget of the ship s;

D_s – s ship's deadweight;

f_{srj}^0, c_{srj} – the regression coefficients;

S – set of ships, including the possible lease options to replace the ones removed from service;

G – set of items of goods;

J – a lot of traffic areas, including ballast;

$\eth$ – normative profit per tonne deadweight per day of operation.

The specific feature of the task, is that the multitude of units A also includes a subset of the ship repair bases W. The index w specifies the number of the base. The set R_ρ defines the variety of types of ship repair (factory/dock/unplanned, and others); S_p – the multitude of the vessels under repair; J_w^+ – the set of the sites included in the ship repair base w. Then m_{srjt} is the scope of work according to the type of repairs r for the vessel s at the "repair" site j in the period t; x_{srjt} is for the voyage of the vessel s with the type of repair r

at the "repair" site j in the period t; N_{rwt} is for the scope of the repair work r of the ship repair base w allotted for the vessels of the shipping company in the period t; t_{srjt} is the stay of the vessel of s type, with the type of repair r at the "repair" section j in the period t; $x^u_{sat} = 1$, if the ship s is at the beginning of the period t in the unit (the base) a; $x^k_{sat} = 1$ if the ship s is at the end of the period t in the unit a; J^+_a is the set of sites, included in the unit a; J^-_a stands for the set of the sites coming out of the unit a; T is for the multitude of planning periods ; t_{0s} is the initial planning period of operation of the vessel s, a_{0s} – the starting unit of work of the ship s.

The objective function of the model (1) is aimed at achieving the maximum of the ratio results to costs. The inequalities (2) and (3) are the limits in the volume of traffic and the calendar budget of time of the vessels.

The inequalities (4) and (5) are the limits in the market share and the intensity of foreign exchange earnings for the shipping company.

(6) is a regression equation that determines the dependence of the standard of financial result f_{srjt} from the share market.

The inequalities (7) and (8) represent the dedicated power restrictions of the ship repair base's facilities and the number of types of repairs for each vessel within a given period. The expression (9) is the equation of the balance of the fleet passage through the sites. The expressions (10) and (11) are additional conditions for the equations of the fleet passage, which determine the lower limit of the departure area a and connecting the final and initial periods of fleet operation. (12) and (13) determine the conditions imposed on the variables of problem decision.

Summary

Considering that the choice of repair facilities and timing of plant repairs are the elements of the fleet activity plan, and the main criteria for its implementation is the optimization of the profits-costs ratio and the percentage of presence (market share) of the company on the relevant local market, the optimization model of fleet shipping company is offered.

The proposed model allows planning the fleet activity in a fairly high uncertainty taking into account other competitors on the market, and makes it possible to optimize decisions concerning shipping retiring at the repair, as well as the temporal replacement of such ships by other chartered vessels on the local market.

Furthermore, the specific feature of the model is that individual limitations could be considered on individual vessels of the shipping company.

Practical application of the offered model has been successfully approved in the Ukrferry shipping company.

A possible disadvantage of this model is the uncertainty of the duration of the repair period at maintenance bases.

However, it is necessary to take into consideration that such a model works well at an intermediate term level of planning. Just at this level, the problem of optimisation of the fleet operation by the specified criteria should dare.

The task of placement of ships in places of repair will be decided on the current planning level. However, this is a subject of the following research.

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JEDEN ZE SPOSOBÓW ZAPEWNIENIA KONKURENCYJNOŚCI STATKÓW NA LOKALNYM RYNKU PRZEWOZÓW W CZASIE REMONTÓW

Streszczenie: Wraz z rosnącą konkurencją na lokalnych rynkach towarowych, organizacja i zarządzanie transportem ładunków i eksploatacją floty mają zapewniać konkurencyjność przedsiębiorstw żeglugowych na lokalnych rynkach towarowych oraz uzyskanie zysków uwzględniając aktualną sytuację na rynku.

W artykule poruszono problem optymalizacji procesu remontu statku z wykorzystaniem modeli ekonomicznych i matematycznych. Wskazany model optymalizacyjny zapewni firmie żeglugowej, w ramach wolnego rynku i pełnej liberalizacji żeglugi trampowej, trwałą pozycję na lokalnym rynku towarowym i przyczyni się do uzyskania większych zysków dzięki utrzymaniu odpowiedniej bazy ładunkowej i stałych klientów.