Michael V.Voyloshnikov

# EVALUATION OF COMMERCIAL VESSELS, MARINE COMPANY'S ASSETS AND OCEAN RESOURCES

The textbook is recommended by the Far Eastern Regional Methodology Centre of Russian Ministry of Education for students of the professions : 080100 «Economics», 080500 «Management», specializing in : 080116 «Mathematical methods in economics», 08503 «Crisis management», as well as professions : 180100 «Naval architecture and Marine engineering», 180400 «Shipping and operation of the transport equipment» and for students of the retraining and skills improvement

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Reviewers:
Eugeny A.Gnezdilov, Ph.D., Honorable economist of the Russian Federation
Valeria V.Krivets (Goncharova), Ph.D., Certificated appraiser of RSA

**Voyloshnikov, Michael V.**

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The textbook reveals approaches, professional guidelines and subject for the classes of the investments estimation in the real assets value and the efficiency indexes in the structure of marine companies' complexes of the commercial property, particularly in commercial vessels. The object of the evaluation has a complex property, including the elements: the engineering with definite identification characteristics and particulars, marine resources and the investor as the set of the economical interests for the marine resources.

Besides the peculiarities of standard approaches application for value estimation of marine engineering complexes, the academic subject contains the basics of the systematic approach for use of the criteria and the economic optimization of real asset particulars, especially commercial vessels in the structure of marine companies' complexes of the commercial property, that is the basis of efficiency estimation of investments and business–planning in the ocean industry.

The textbook is recommended by the Far Eastern Regional Methodology Centre of Russian Ministry of Education for students of the professions: «Economics», «Management», specializing in: «Mathematical methods in economics», «Crisis management», as well as professions: «Naval architecture and Marine engineering», «Shipping and operation of the transport equipment», for example, senior students and will be useful for professionals who are united in the professional communities, as well as for a wide range of professionals and experts carrying out their activity in the industries developing the ocean.

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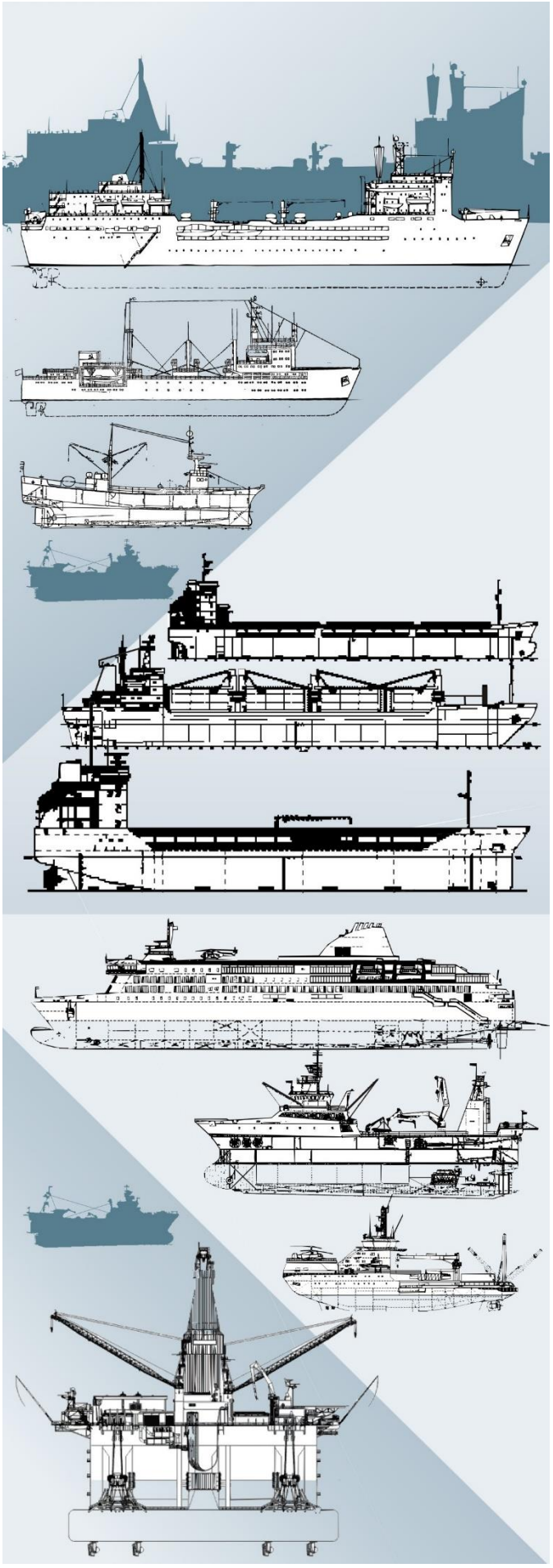

…

*He looked down into the water and watched the lines that went straight down into the dark of the water. He kept them straighter than anyone did, so that at each level in the darkness of the stream there should be a bait waiting exactly where he wished it to be for any fish that swam there. Others let them drift with the current and sometimes they were at sixty fathoms when the fishermen thought they were at a hundred.*

*But, he thought, I keep them with precision. Only I have no luck any more. But who knows? Maybe today. Every day is a new day. It is better to be lucky. But I would rather be exact. Then when luck comes you are ready.*

Ernest Hemingway
The Old Man and the Sea, 1952

# Preface

Modern shipping and shipbuilding are improving in the partner relationship on the basis of economic planning and sustainability. The shipbuilding industry is developing in partnership with the shipping and on the basis of its own investment policy and shipping companies create demand for shipbuilding.

The technological advances in the maritime commercial shipping are the assets turnover for fleet renovation and replenishment. At the level of each shipping company fleet renewal is conducted using their private capabilities and partnerships, this requires planning.

Usually to replenish fleet the new ships are of interest. In any case, whether the replenishment is provided by newly constructed vessels or by vessels bought at the pre–owned market, shipping companies need to borrow the financial resources as their own funds invested in the vessels in operation, and the repayment of the loan is made at the expense of the

profit from operations of the shipping company and the sale of the vessels which are being taking out of service.

To replenish the fleet, first of all, it is required to evaluate the assets property complex of the shipping company and all short term liquid assets. The estimated values are the benchmarks to get access to credit resources, to guarantee of the leveraged funds liquidity and to show the amount of additional funding for the replenishment of the fleet that the shipping company can spend.

The value of shipping company is the original data to determine the optimal characteristics of the vessel in order to manufacture (or purchase on the pre–owned market). Various options are possible here: either manufacturing of the maximal size vessel within limit of the shipping company financial capacity or the construction of several, more compact batch identical or different vessels – depending on the evaluation of the options from the economic point of view, keeping in mind the interests of investors, i.e. shipping companies.

This way the order for shipbuilding is generated in open economy and financial resources are promoted of toward moving production of the marine industrial resources– the commercial vessel replenishment or new vessels and the marine engineering. And this interaction takes place not only in shipping and shipbuilding, but also in other sectors in the marine resources development, and, economic activity in these spheres is of the global international nature.

The number of project subjects for the commercial vessels batch production or the choice of the commercial vessels' characteristics for the commercial order at the pre–owned market do not have the systematic approach for their solution only on the basis of the physical concepts.

For example, if the total sum of investments is set within the limits of financial possibilities of the investor it is possible to define the number of vessels of certain type and their main characteristics for the commercial order only from the economic point of view. And, the set often has such main characteristics, as the vessel size, in particular, deadweight or displacement, capacity of holds, the main engine power or the vessel operational speed, and also the age of the vessel, if purchasing is planned at the pre–owned market.

It is clear, that similar subjects can be referred to the vessel designing subject as the results are almost the project characteristics. At the same time used approaches belong to the applied economic.

To make a choice and decision concerning the commercial order – to build a new vessel, or to get it at the pre–owned market and, maybe, not one vessel within the set amount of money, or to choose some more compact vessels of certain class, instead of one large–capacity vessel – all subjects from the considered set and similar ones demand the evaluation and economic efficiency estimation and mast be elaborated systematically.

At the same time, it is impossible to find the solutions with the determining the basic project characteristics only from the point of view of physics laws in the subjects of the main project characteristics determination that are such characteristics on which the other vessel characteristics and particulars depend physically.

For example, applying only the Archimedes principle it is impossible to determine the vessel size, or, let us assume, displacement as expressly or indirectly the size of commercial vessel is required to be set, preliminary having determined what the vessel size most effective from the economic point of view within the limits of the investor's possibilities. And whichever there should be a result of the main characteristics determined

using the approaches of applied economics, it is no doubt, that Archimedes principle is observed for a vessel of any class and any size automatically and the variety of commercial vessel classes and sizes prove that fact. The same is true to other existing physical principles essential in the process of finding other characteristics and particulars of commercial vessel, which depend on the main characteristics determined on the basis of an economic evaluation.

If to assume abstractly that there were no possibilities to determine a vessel's optimal project characteristics for the commercial order in terms of economic efficiency evaluation among possible alternative approaches there only should be the way to determine of the vessel characteristics by analogy on the basis of prototypes or the expert choice of the vessel characteristics. But these approaches are not systematic.

If to select general technical and special subjects which are required for vocational training of the expert, who are able to participate in vessel designing and in organizing of shipbuilding production, including methodology of the vessel designing, ship theory and seaworthy properties, structural mechanics, vessel structure and technology of shipbuilding, ship engines mechanics and technology with all variety of their sections, the methods of applied economics intended for determining the vessel characteristics, can be considered as generalization.

Basically, the purpose of the experts' activity in economy, management and crisis management, including experts dealing with the estimation of value and efficiency of investments, is to provide the advancement of financial funds into the real economy and industry and service of these processes within the limits of the competence. Moreover, presented issues are not only of interests to the naval architects, marine engineers and experts in economic planning of the ocean development, but also contribute to the expansion of the horizons for engineers and economists working in other industrial sectors.

Not to mention commercial and professional aspects, it is possible to appreciate the social and the economic significance of the applied expert activity in area of the marine industry and economics by the following criteria.

First, the activity aimed at determining vessels' value, marine engineering and other real assets in the property complexes of marine companies, promotes an increase in the economic efficiency of the marine companies by saving working assets.

The asset value is a competitive economic concept and is formed by the parties (the seller and the buyer) on the basis of a compromise of opposite interests.

The accuracy and the professionalism of evaluation using the expert methods influence reduction of discrepancies of the market value and the price upon the transaction. This way the parties have both the reduction of losses at possible discrepancy of the value and the price, and excessive incomes, which, in the case of regular activity can be considered a risk factors, and the parties, when they receive excessive incomes, have to accumulate a surplus of working assets for covering losses.

Thus, if the value was estimated insufficiently accurately the surpluses of the working assets are formed in the non–productive sphere and are spent for the losses covering when are formed the discrepancy of the value and the price of the transaction and filled up at more successful transactions.

Improvement of the evaluation approaches, development of appraising and improvement of accuracy and objectivity of the professional evaluation favor the improvement of macroeconomic indexes and decrease in risks owing to saving of working assets and opening possibilities for transferring of financial working assets into the productive sphere – in real assets.

Secondly, applied expert activity in the sphere of efficiency of investments evaluation, in particular vessels and other real assets of the marine companies' complexes and in the subject field of the real assets characteristics economic optimization underlying the investments planning, is the kind of the innovative activity.

In the terminology of applied economics the innovative activity means the consecutive realization of the innovative projects which are the version of investment projects and investment of the financial assets into the real assets (unlike financial investment projects when the real assets are sold, i.e. invested in the financial assets). Usually all investment projects pass through innovative and financial stages.

When there are sufficient reasons in the financial stage the crisis managers can also take part in this process and try to transform the financial project of the real assets selling into the innovative project, defining corresponding strategy of the marine company and involving the additional resources, for example at the expense of inefficient assets selling.

Social and economic advantages of innovative expert activity on to efficiency evaluation of vessels and other real assets of the marine companies' complexes are that conditions of the financial assets advancement into the industry of marine technology construction and its productive operation for the ocean resources development are formed.

The basic function of experts in the field of the value and efficiency estimation of vessels, marine engineering and property complexes of vessels and other real assets of marine companies in most general statement is expert service of the financial investments advancement processes into the real assets that are useful for economic development.

For fulfillment of this function experts would possess comprehensive knowledge in the subject of the applied economics and professional skills in the field of operating company (business) evaluation, and also special knowledge concerning estimation of efficiency and value with respect to definite classes of marine industrial objects made and used with a view of investors' access to the marine resources.

The language of applied economics is mathematics, so appraisers and economists would understand it well within the requirements of university economic education. The necessary knowledge of mathematics covers a number of applications of mathematical analysis: lines and sequences, linear derivative equations, probability theory, mathematical statistics. Algebra and theory of numbers in the economic study are applied less than applications of mathematical analysis though there are economy sections to which algebraic matrixes are actively applied.

Studying of terminology and general concepts of shipping, shipbuilding, fleet maintenance service also is required. In particular, it is necessary for process of collecting data and information used for identification of the evaluated object – the vessel or the asset of the marine company, and also for the adequate mathematical models formalization.

While presenting methodological foundations of determining optimal characteristics of marine engineering in wide range – from commercial vessels to marine companies property complexes of assets and the industrial development trends with the help of the systematic approach and economic efficiency evaluation, that, in its turn, is inextricably linked with the applied expert activity in the area of creation and development of engineering and technology for ocean research and development, when this activity together with dedication can become wonderful and exciting high–paying profession, which in addition to material well–being satisfies the person's creative inspiration, one should be warned against the hasty and superficial approach. This activity requires a fundamental education, practical experience and broad–outlook, otherwise, one–sided and fragmentary

perception may cause errors with unpredictable consequences, which under certain circumstances could be regarded as large scale financial violations.

It should be added, that professional grounds of expert activity in value and economic efficiency estimation of investments into development of marine resources (including ocean resources) are insufficiently developed in the scientific and methodological literature and systematization of the given material is beneficial itself.

The book is aimed at expanding experts outlook in the field of applied economics on the industrial development of marine resources (including the development of the ocean resources) and construction, and also on the productive operation of marine engineering and ocean technology, at developing professional knowledge and forming applied skills in the field of evaluation and economic efficiency estimation of investments in construction of marine engineering, vessels and in creation of the property complex of vessels and other real assets of the marine companies' complexes, and also evaluation of the investments efficiency into productive operation of these assets.

The general ideas of evaluation of commercial vessels, marine company's assets and ocean resources are as follows:

– Marine resources are not only biological resources or minerals, but the whole set of useful for the investor properties of the marine environment, not only physical properties of the aquatic space but the ocean based activities in the ocean and on the coasts, so marine resource evaluation can be made only in terms of technological and economic opportunities for their sustainable development;

– Initial data for pricing in shipbuilding, shipping and in other industries of the ocean development serves the evaluation of the ocean resources;

– Project characteristics for selection a vessel as order for its construction or manufacturing of other marine engineering and optimal structure of the property complex of marine company are the subjects of economic viability within the financial and resource constrains of the investor;

– Optimization of project characteristics and particulars of the marine engineering, in particular the commercial vessels, or the structure of marine company's property complex should be implemented systematically, and the object selected in analyzed as a system of elements taken separately, and there are new features inherent in the system of elements and missing in parts, and for marine engineering, commercial vessel or marine company complex the new properties are connected with the investor's access to marine resources;

– Commercial vessels, the company's property complex or the individual assets regardless of the subject assignment are complex objects of valuation and economic effectively estimation, and they include three groups of elements: marine resources (pricing strategies); the marine technology for the investor's access to the resources, as well as the set of the investor's interests and rights – as a separate group of the elements, while the complex structure of marine facility in the temporal dimension means covering general repeatable process cycle – production, including designing, productive operation for the development of marine resources and recycling;

– Systematic approach and, in particular, the dialectical inexhaustible levels of division of integrated marine facility into the elements, and further division of the elements, as well as emerging of inexhaustible levels of aggregation of elements in the complexes, lead to a hierarchy of design subjects of the lower and upper levels in relation to the task at hand, as well as to definition of the constrains and the systemic concepts of options

comparability – a combinations of the vessel characteristics or variations of the marine company complex structure while optimizing by economic criteria;

– Economic criteria for the choice of project solutions conducted with the minimization of the investor's expenses are characterized by the social and economic contradictions and with the systemic use can lead to a reduction of partners incomes and oppression of economic environment; the ecological contradiction of criteria based on maximizing incomes and profits, is overspending of marine resources when we take into account the full range of properties of the marine environment useful for the investor;

– Balance of the expenditures and the savings of marine resources and economic environment in process of designing marine engineering and creating marine companies' complexes correspond to the application of criteria based on maximizing of the marine resources contribution to the value of the property complex;

– At the innovative stage of investing in marine industrial activity, particularly at the stages of commercial vessel designing and manufacturing or while creating of marine company's complex, with the account the excess of marine resources available for the development over the current functional abilities of their development and the excess of the innovative strategy value over the financial resources value the optimality of the projected vessel characteristics or the optimality of the created marine company structure are the own internal properties of that objects.

It should be noted that in all areas of the marine industrial activities economic estimation of value or efficiency in the modern understanding of the subject should be haphazard without explicitly or implicitly of marine resources factor, as well as in commercial property valuation of buildings it does not make sense without evaluating of built–up area. The same should be taken into account while developing standards, professional regulations, training programs and qualification criteria.

For creation of economic strategy for ocean resources development, including the planning of investment projects and organization of the maritime enterprise, for conclusion of commercial contracts and investments in marine engineering, particularly in commercial vessels manufacturing, for elaboration of Federal Programs of marine industries development, and for another typical subjects solved by the applied economics approaches, evaluation of marine resources and a systematic approach application are required as the basic methodological assumption.

Gathering of the initial material was carried out almost during the practical activity while working under contracts with the marine companies operating in the Far East of Russia. At a stage of collecting of initial materials the author co–operated with experts of some companies which carry out the marine industrial activity, such as: JSC Preobrazhnskaya Base of Trawling Fleet, JSC Dalmoreproduct, JSC Aquaresources, JSC South Sea Base of the Fishery fleet, JSC Far East Base of Fishery and Processing of Seafood, Shipping and Fishery Company «Polar» LTD, Fishery Company «Sea» LTD, JSC TURNIF, JSC Dalryba, Vladkristall LTD, JSC Dalrefservice, JSC Shipping Company «Berkut», Sakhalin Rybakkolkhozsoyuz, JSC Port Vanino and a number of others, and also with experts of the commercial banks which are investing into the marine companies and development of ocean resources: JSC Gazprombank, JSC Savings Bank, JSC VTB24, JSC Promsvyazbank, JSC Rosselkhozbank, etc.

The book is the personal initiative research of the author, generalization of gained in over twenty years practical experience and was not created by the commercial order. The editing of the book was carried out in 2009 and 2010 in the Canadian Victoria. This city is the capital of British Columbia, located in the south of the Vancouver Island and

characterized by good development of the marine industry. Besides the geographical location that gives an to rich sources of the various marine wealth, including those that are mentioned in the book, the city has a high level of industry and technology, and also science and education system. The successful industrial organization with the support of the governments of Canada and British Columbia makes it possible the progress of the innovative approaches of the ocean resources and wealth development.

To study the subject presented in the book, the reader should possess comprehensive knowledge of economy and the theory of an evaluation which are disclosured in the books of the Russian scientists A.G. Grjaznova, M.A. Fedotova [3], S.V. Valdajtsev [1], E.I. Tarasevich [5], etc., and also the American experts: G.M. Desmond, R.E. Kelly [2], J. Friedman, N. Ordway [6], G. Harrison [7], S. Pratt [4] etc.

With respect to the marine industry the important contribution to the development of applied economics approaches in Russia was made by L.B. Breslav [8, 9], V.I. Krayev, A.A. Pantin [15, 16], V.P. Sokolov [17], N.P. Ljubushin [18] and several other experts.

The textbook is the author relies on methodical subject and based on the scientific researches and the author's experience: a number of the general ideas of predecessors in the field of marine engineering designing methodology, among which are Russian professors: V.M. Pashin, B.A. Tsaryev, A.N. Vashedchenko, G.F. Demeshko, I.G. Zakharov, etc.

When eorking on the book the author was inspired by the experience of the known American expert Dr. J. Friedman, who has published a number of the professional books on applied economics and methodology of real estate evaluation, with whom the professional relationships are maintained.

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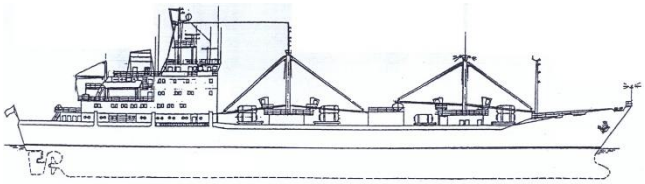


# Introduction

In the industrialized countries, the main driving force for the production of the marine engineering, in particular commercial vessels of various classes, is the industrial activity directed to the development of the ocean resources which is exclusively important from the social and economic points of view. Besides, the development of the ocean resources outside of the national jurisdiction is of great political and economical value.

The ocean resources in the methodological sense is not only the physical properties of the water space, but the ocean, as a reservoir, taking into account the size, geographical and climatic characteristics, including any useful properties of the marine environment the development activity of the investor is directed to, and among them the activity developments at the sea and the coasts, the economic potential of marine cargo transportations, the ocean biological resources, the ocean–bottom wealth at the shelf and behind its limits, the marine energy resources, the recreational properties, etc.

The evaluation of the ocean resources makes sense only in the context a of the technological, legal and other opportunities of their development. In applied subjects evaluation of the ocean resources (wealth, marine resources) can be made, for example, as an estimation of fishing quotas or ocean biological resources use, as evaluation of advantages of the access to marine cargo traffics, etc.

And value of the ocean wealth is the integral factor of the efficiency and the value of marine engineering and ocean technology for their construction and productive operation as an asset of the marine companies' complex.

Due to the specified reasons the value estimation of marine engineering (ocean technology) and their efficiency in the process of the development of the ocean resources are defined as adjacent sides of the complex subject.

The object of evaluation: the vessel, the marine engineering complex – the ocean technology, the real assets complex of the marine company, or any other marine object evaluated in a complex – in determining the value and efficiency of investments is subject to the analysis only in a system of three interacting elements:

– Subject of marine industrial activity – the investor, that is a proprietor of investments, assets and profit, a company or an individual in aggregate the rights and interests with typical motivation to development of the ocean resources and to increase the value of the assets complex belonging to the investor;

– Marine resources, where the investor directs his interests while developing these resources for increase of total value of the property assets complex belonging to him;

– Marine engineering and ocean technology which are objects of investment aimed at getting the access to marine resources and the investor possesses the property rights to them.

The concepts of «marine engineering», «ocean technology» and «marine engineering complex» actually are synonyms, as a matter of fact.

The vessel is included in the property relation as a part into the structure of the marine engineering complex (the ocean technology) or into structures of the complex of the marine company's real assets, in particular the shipping company.

On the other hand, in a structure of the marine engineering complex differently defined as the marine engineering or the ocean technology, the vessel is presented methodologically, that is the marine engineering is a more general methodological concept, than the vessel: the vessel is an object of marine engineering, but the marine engineering methodologically is not reduced to a concept of the vessel, and covers numerous enough list of other objects which are separate structural elements of the vessel, either the vessel is the element or the part of a more general object of marine engineering.

For example, the marine commercial vessel is a part of the fleet, of the fishing ground or of the marine transport line – a cargo traffic etc., out of a binding to the general proprietor. Otherwise, more general, than the vessel, an object could be defined as the property complex of real assets, and rank a vessel to its structure by property attitude.

It should be defined, that actually marine engineering is usually defined as separate structural elements of a commercial vessel or mechanisms, functionally suitable regardless other elements and mechanisms.

The marine company which is a property complex of all real assets binding within its structure, can, under certain circumstances be evaluated as several isolated property complexes belonging to the general investor.

It becomes possible when each of the property complexes binding within the structure can be defined as a separately operating set of assets (self–financing development of this structure is predetermined by current characteristics of this set), and due to any of the established reasons (industrial, functional, structural, technological, other) the unilateral exchange between the various isolated complexes of the real assets does not occur in the marine company.

The interaction of the elements as a part of the real assets complex of the marine company is the set of the properties of these elements.

The properties of the subject, the investor, are characterized by interests and the rights which can be defined economically, and also by obligations concerning the belonged assets.

The useful physical properties of marine engineering and ocean technology, in particular commercial vessels, when interacting with the water environment are the seaworthy properties. Marine engineering and ocean technology also possess internal properties among which are: strength, life time, property of the non–failure operation, maintainability, etc. Operational characteristics serve as indicators of marine engineering compliance with the interests of the investor.

When estimating the commercial vessel or the property complex of the marine company the most applicable are approaches and methods used in evaluation of business – the property complex of the operating marine company (private capital of the marine company), but estimation should be done with the account prominent features of pricing integrally inherent in evaluation of the marine company and its assets, first of all commercial vessels.

The following assets can be referred to a number of the marine company's real assets: marine commercial vessels of the various classes, ocean rigs, service facilities of vessels and ocean rigs, real estate and communications of coastal service facilities. The industrial function of the characteristic asset corresponds to the industrial profile of the marine company.

It is possible to name the general features of the vessels and other real assets of the marine companies' complexes which influence the choice of methodological approaches when estimating of the value and the economic efficiency:

– Real asset of the marine company can be an object of an estimation as a property complex, that is as an economically isolated unit using the methods of evaluation of the operating company and necessary adjustments, with the account of difference of an asset properties from the property complex;

– The vessel value or the value of the other isolated asset of the marine company is proportional to the value of the marine company as a whole;

– Characteristic asset of the marine company in the technological and functional relation is not stereotypic, and even the large batch usually does not exceed some units with significant differences, and its properties depend essentially on marine wealth for which development it is used;

– Unlike the property complex and real estate, the value of the characteristic asset of the marine company considerably decreases over the time in process of its transfer on the value of production or services,

– Characteristic asset of the marine company is made and used for the investor's access to the ocean resources that is the basic system precondition for estimation of the value and the economic efficiency.

To a certain extent close methodological features of evaluation have: the companies of the commercial transport and their assets; companies which carry out mining, power plants, communication network companies, etc., that is those which business in the technological relation is as far as possible from the financial assets economy and it is approached to the productive operation of the real industrial assets. The general methodological conclusions and recommendations of the given textbook to some extent can refer to the enterprises, the property complexes and assets of the specified types.

Despite variety of objects in the list, referred to marine engineering or to number of the marine company assets, for example the shipping company, similarity of objects of the specified type is caused not only by their complex character and marine wealth among complex elements, but also in many respects by a similar combination of characteristics or functional dependences between characteristics of various objects. In particular, the vessel characteristics can be defined as the characteristic of the shipbuilding enterprise which is capable to build those vessels, or as the data for determination of characteristics of commercial vessel's structural elements, devices and systems, that is vessel data are most general characteristics of its structural elements.

For the evaluation of real assets as a part of the marine company's property complex and efficiency of investments the objects of an evaluation are required to be isolated methodologically.

The objects of the various type, structure and designation, for example the marine commercial vessel, the real assets property complex of the marine company or the separate asset in the subjects of the evaluation and the economic efficiency estimation are isolated by the definitions rested on the complex character of each of the specified objects as systems of three co–operating elements – the ocean technology, the marine wealth and the investor. And in the general set among objects of the evaluation and the economic efficiency estimation the marine engineering, in particular the vessel, the marine company or

its separate property complex are taking special place due to the fact that the marine wealth is presented among the elements of object complex structure.

In the course of the innovative projects realization and investment of the financial assets in the real assets and the sets of the real assets are formed, total value of which exceeds the sum of the real assets values taken separately, that is the investment objective. And financial investment projects do not possess these properties, and the sum of financial assets is equal to the sum of cash, and there is no additional net value. In the process of realization of the innovative project and investment of the financial assets in the real assets property complex of the marine company the additional net value is made which under various conditions can correspond to the following economic indexes:

–The intangible asset, more exact correspond to the grouped unidentifiable intangible asset (goodwill);

– The efficiency index of the ocean development wealth where the interests of the investor are directed to, from the point of view of the estimation of their contribution to the value of commercial vessel or the property complex of the marine company;

– The value of the ocean resources as a part of the marine company complex.

The value estimation and the economic efficiency of the marine commercial vessels and assets of the shipping companies are characterized by certain specificity owing to the features. The marine vessels and the ocean technology possess characteristics and particulars which for estimation of value and efficiency are required to be considered in the process of identification of objects, choice of units of comparison and methods of an estimation within the limits of the comparable sales approach, at a choice of models of the reproduction cost or the replacement cost, determination of the depreciations and obsolescence, life time prognoses, choice of an estimation method of the income approach, formalization of the economic models for the income approach.

Besides, to a number of specific applied subjects of the value estimation of a marine industrial object, in particular a vessel or the real assets property complex of the marine company, it is necessary to include: the evaluation of the right–of–use and the charter market rate with the account of prevailing characteristic of the rent requirements, an estimation of the ocean resources, their contribution to structure of marine object complex value, an estimation of the contribution of the investors who are in common marine industrial activity, an estimation of arising economic difficulties and resale discounts when selling assets of the marine companies.

When making the efficiency estimation of investments in the marine industrial activity, it is required to keep in mind the correlation to the investments plan, and also planning of investment stages with the account the initial investment, the economic risks and the reached efficiency level.

Working out and use of economic models are considered to be the most interesting and important expert tasks of the investments planning with the account concepts of the systematic approach and economic planning of fleet structure and renovation or the real assets property complex of the marine company; the model are used for the determination of vessels optimal project characteristics and the marine engineering in the commercial order for manufacture which in modern conditions of economic globalization is done internationally (means that the consumer and the supplier are from the other states), or for purchase at the pre–owned market.

In recent years in Russia numerous recommendations and official specifications

concerning to property, including, the marine commercial vessels, developed on various professional levels are published. At the same time, there is an urgency of improvement of techniques and recommendations for the marine companies from the point of view of indissolubility of tasks of estimation of the vessels and other assets value and the economic efficiency estimation systematically they should be estimated in the property complex and in structure of subsystems of these assets, and also within the limits of the general cycle: manufacture, productive operation and recycling, and vessels and the real assets should be defined as the technology of the investor's access to marine wealth which estimation is the valuation basis in the marine industrial activity.

Besides conformity to system requirements the techniques recommended for studying and models should be vanguard enough and induce to improvement of the economic estimation of vessels and assets of the marine companies' value and efficiency. Therefore it is required to understand the basic directions of applied economics development, and it is necessary to mark the promising outlook of the evaluation and the economic efficiency estimation in the algorithmic form (that is in the digital), that the first vice–president of the Russian Society of Appraisers I.L. Artemenkov underlined at the scientific–practical conferences of appraisers.

Certainly, the electronic report is rather an authorized computer program and an element of the digital network than a text file, and serves, mainly, not as simplification of the graphical part of the appraisal (though this advantage takes place), but the most strict and systematized form of the applied economic estimation demanding from the expert good knowledge of mathematics and programming as well as economics.

Advantages of prospective estimation of value and efficiency in the algorithmic form include: the automation of the methodological standards, that is conformity of expert work with the operating standards and their updating as work is done in the specialized algorithmic environment and in the network; the automatic storage of the estimations; the application of modern filled up databases; the automatic account of experts participation in the professional organizations by means of control of their access to an algorithmic working environment, etc. At the same time, creation and maintenance of such environment making global impact on pricing, is a responsible and labor–consuming problem of high complexity which would demand essential resources and work of serious scientific personnel.

The automation of the methodological standards when making the digital appraisal do not mean only the text archivation of the standards, but is the creation of the professional algorithmic environment on the basis mathematical modeling of the basic concepts for the purpose that these environment properties exclude the opportunity to create within the environment the incorrect in the methodological sense algorithm of the appraisal and the investments efficiency estimation and the results of evaluation made by the different experts would coincide when they have the same initial data.

When performing the expert work based on methods of programming the functions of the expert are not calculations, but working out of an algorithm of an economic subject and the program, and also processing and downloading of the initial data. After finishing of the algorithm the estimation is done by one action.

As physical measurements of values are impossible the reliability of estimation of value or efficiency is characterized rather by adequacy of algorithm which serves as an economic estimation on parities of expert data than by not so much reliability of monetary

initial data which are expert and keep corresponding subjectivity even if the expert transfers responsibility to the data source.

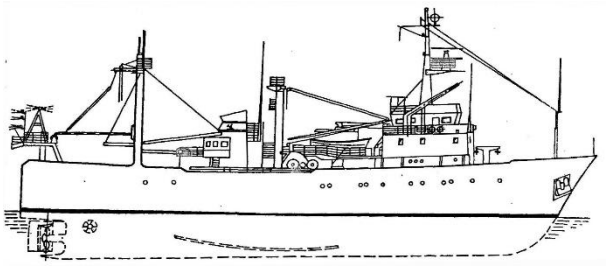
Therefore with a view of improvement of accuracy of evaluation and its correctness the algorithm should be logically enough detailed so that the inaccuracy of each of expert data did not render prevailing unilateral influence on the general result. Besides it is necessary, that the algorithm of an evaluation was an element of a system of algorithms, for example, in a network or in sequence of evaluations with the applications of updating of the basic general economic model adapted for sequence of subjects.

Using the methods of mathematical programming the estimation of both the value result and defined by the expert initial monetary data, in particular, which cannot be established by physical measurements, is made simultaneously. Thus all calculation can be reproduced regeneratively and repeated, and there is a feedback – a possibility of an estimation of influence of every expert data on the general result for the purpose of checking relevance of the assumptions accepted in the process of estimation of data and an acceptability of the elaborated degree of the model detalization. And it is impossible to carry it out systematically without the digital programming.

It is clear, that the basic directions of quality of value and efficiency estimation improvement lay in the tideway of wider introduction of digital algorithmic approaches. The prospective orientation to an applied economic evaluation of vessels, other real assets and the marine companies' complexes in the digital algorithmic form in a network makes us actively develop and introduce mathematical methods of the description of economic phenomena and processes and solution the applied subjects in practice and in process of vocational training of experts.

**Test questions**

1. Purpose of marine industrial activity.
2. Methodological interrelation of marine engineering and ocean technology evaluation and efficiency of investments estimation in the process of development of the ocean resources.
3. Object of an evaluation and its complex structure.
4. Correlation of «the vessel» and «the marine engineering» concepts.
5. Marine company and the property complex of its real assets.
6. Marine environment and the ocean resources.
7. Investor functions in the marine environment.
8. Most general features of vessels and other real assets of the marine companies' complexes.
9. Concepts of the systematic approach in the applied economic evaluation.
10. Factors of the evaluation and the economic efficiency estimation reliability.
11. Prospective digital algorithmic form of an applied economic estimation.



# 1. Shipbuilding, shipping, technical operation and maintenance (terms and general concepts)

In the process of value and efficiency estimation of vessels and assets of the marine companies, and also for creation of the adequate calculation models, for data used for identification of the object and information processing, studying of the terms and the general concepts in the area of shipping, shipbuilding, fleet maintenance service is required.

## 1.1. Classification of commercial vessels

Vessel is an object that possesses operational characteristics and seaworthy properties.

Operational characteristics are indexes of commercial vessel's conformity for the demands of the subject in the sea environment (for example, cargo capacity, cargo holds volume, register tonnage, velocity, cruising range, autonomy, etc.).

Seaworthy properties are useful physical properties of a commercial vessel when it interacts with the marine environment: buoyancy, un–sinkability, stability, water resistance and propulsion, controllability.

Classification attributes of the commercial vessels are following:

1. Vessel assignment – commercial (cargo), fishing, support, vessel of the technical fleet, special purpose;
2. District of operation – marine outdoor, raid, internal water cruising, the district cruising;
3. Available propulsion devices – self–propelled (with the mechanical engine), not self–propelled;
4. Main engine class – vessel equipped with a power–plant with an internal combustion engine, steamship, gas–turbine powered vessel, electric powered vessel, nuclear–powered vessel;
5. Propeller type – screw, wheel, with the special propeller, sailing vessel;
6. Number of propellers and deadwoods – single–deadwood (single–screw), multi–deadwood;
7. Physical phenomenon of the seaworthy – displaced (surface), underwater, gliding, hydrofoil, cushion craft, winged vessel;
8. Vessel's structural material – steel, alloys, nonmetallic materials (plastic, wood, reinforced concrete), composite (of the various materials);
9. Design–layout class – number of hulls, number and location of superstructures and cabins, number of decks, position of the surface board deck, location of the engine and boiler rooms;
10. Other attributes.

The commercial vessels (to be more exact, cargo vessels) are subdivided into classes depending on the type of cargo they carry: the dry–cargo (for transportation of the

general cargo, the bulk cargoes, the enlarged unified cargoes, the rolling cargoes, the timber cargoes, the refrigerator cargoes, etc.) and the crude cargo (for transportation of not regime and regime cargoes).

The classes of the fishing vessels – fishery, processing, fishery –processing.

1. Classes of fishing vessels: fishing vessel, mammal hunting vessel, whale hunting vessel, prawns catching vessel, calamari catching vessel, seaweed extracting vessel, etc.

Classification of the fishing vessels for the used tools (trawl, seine, catching long–line, other classes of the fishing tools):

– Trawlers – super trawler, big trawler, average, small;

– Seiners;

– Seiners–trawlers.

2. Processing vessels: autonomous, universal and canning processing mother ship, refrigerating processor, crab–processing vessel, the whale processing vessel.

3. Fishing –processing vessel.

## 1.2. Commercial vessel's devices, systems, engines and power–plants

Vessel's devices – set of the mechanisms providing operational characteristics and seaworthy properties.

Vessel's general purpose devices: steering (and thrusting), cargo, anchor, mooring and towing, hatch, emergency (other devices: rail, awning ...).

Vessel's special purpose devices: fishing, descent–lifting, offshore drilling, towing device of towing vessel, ramp device of ferry or RO–RO (rolling cargo vessel with horizontal loading), the conveyor cargo device of bulk cargo vessel, etc.

Vessel's system – set of the facilities for liquids or gases process. The engine room systems which are ensuring functioning of vessel power–plant do not concern are not referred to vessel's systems.

Vessel's systems' classification: bilge, ballast, firefighting, fresh water supply, waste, microclimate, special systems of tankers.

Vessel's systems structural elements: pipelines, armature, capacities (tanks), pumps, compressors, separators, desolaters, filters, measuring devices, other.

Vessel power–plant generally can be considered as a set of three basic parts:

– Propulsion complex as a part of elements – the main engine, the transmission, the propeller;

– Electric power plant (auxiliary diesel engines–generators);

– Auxiliaries (boilers, steam and gas generators, facilities of fuel preparation, engine room systems, machines and mechanisms control transmissions, automatics, instruments …).

## 1.3. Architecture and technology of commercial vessel construction

The metal hull of marine commercial vessel is usually made of carbon steel and consists of overlapping and structures.

Overlapping – covering or flooring (that is metal streaks), connected to framing (skeleton). The basic overlapping of commercial vessel hull are: sides, bottom, decks, platforms and bulkheads.

Hull structure of a commercial vessel consists of shields and shafts, superstructures and cabins, gunwale, shelf bar, sterns, arms of deadwood shafts, the bases and fastenings.

Set is formed by longitudinal and cross–section beams. Longitudinal framing: keel, stiffeners, edges of rigidity, shelf bar, carlings, double bottom inclined sheet, etc. Cross–section beams of a set: floors, frames, deck beams.

System of commercial vessel's hull framing is cross–sectional if the spacing between longitudinal girders is more than between cross–section beams. Otherwise, the system of framing is longitudinal.

Enterprises which construct the vessels, marine technology and provide maintenance service are classified according to the shipbuilding technique that they use and the work they are engaged into the following groups:

– Shipbuilding or ship–repair enterprises;

– Plants or shipyards.

Shipbuilding plants (or shipyards) unlike ship–repair yards can fail to have ship lifting facilities, but only the shipbuilding sites suitable for vessel launching.

In the structure of basic departments of plants (or shipyards) besides the shops are included the shipbuilding sites: building berths, slip–ways and docks dry or floating.

The main technological difference of a shipyard from a plant is the absence of mechanical manufacture at a shipyard (deliveries are used).

The factory structure includes the departments which provide the following services as:

a) The facilities specific for shipbuilding (or ship maintenance), for example, loft, hull–processing and hull–construction shops, a building berth, a slip–way or a dock (usually dry – for shipbuilding factory unlike ship–repair), thread–positional lines for a batch production of vessels – and:

b) Mechanical and machine–building manufacture which can be non specific for the shipbuilding.

More than 90 % of the world tonnage commercial vessels are made at the shipbuilding enterprises in industrially developed states of the Far East, East Asia and Pacific Rim.

At the East Asia ship yards the manufacture of large (more than 10) and average batches prevail unlike in Europe and in North America.

The batch manufacture of the commercial vessel and output of marine engineering in the Far East much is cheaper, than in Europe or in the USA.

In the majority of the states the shipbuilding industry subsidized from the budgets or has other support, and ship–repair manufacture – is self–financing.

## 1.4. Commercial vessel repair, maintenance and technical survey

Vessel repair is a complex of technical operations aimed at restoration of vessel devices, equipment or mechanisms to a serviceable or efficient condition, including their replacement, directly intended for providing their seaworthiness maintenance.

Emergency repair of commercial vessel is a repair for elimination of the reasons and consequences of the damages caused by an emergency case, and including the work, that is necessary for cruising to the ship–repair yard for the overhaul repairing.

Vessel maintenance is the current works which are carried out annually by the crew or by the ship–repair enterprise for maintenance of the commercial vessel into an operation–able state before the next maintenance service or repair.

In the process of modernization unlike in the process of repairing the vessel characteristics are not restored but changed.

The Maritime Register of Shipping is the state body of the commercial vessels technical survey and classification.

Besides, the Register under the commission and on behalf of the Government within the competence carries out technical survey of performance of the International Conventions, Requirements, Agreements and Contracts in which Russia participates.

Classification societies similar to the Register in the sphere of marine commercial shipping are available in a number of the states: the Lloyd's Register in the Great Britain, the Det Norske Veritas (*DNV*), the American Bureau of Shipping (*ABS*), the French classification society (Bureau Veritas), the German Lloyd (Germanischer Lloyd), the Korean Register (the Republic of Korea), the Japanese classification society (Nippon Kaiji Kyokai), the corresponding organizations of some the states of the former Council for Mutual Economic Assistance, and also Classification Societies of Greece, Turkey, China, Taiwan, Democratic People's Republic of Korea, Mongolia, Cambodia etc. Listed and other Classification Societies usually have regional and foreign agencies.

The examples of emblems images of the Maritime Classification Societies which provide technical survey at the stages of marine commercial vessels' designing, construction and operation are presented in the Fig. 1.

Fig. 1. The emblem images of the Maritime Classification Societies engaged in technical survey in the design, construction and operation of the marine commercial vessels

Unlike the majority of listed above and other similar existing Classification Societies the Maritime Register of Shipping is Russia governmental establishment.

Russian Maritime Register of Shipping performs:

– Consideration and approval of the engineering specifications;

– Survey of materials and products manufacturing;

– Survey of ships under construction, restoration or modernization;

– Vessels' operation survey;

– Class assignment or renewal classification;

– Supervision of International Conventions and Agreements performance;

– Elaboration and development of rules and their publishing;

– Publishing of the Register book of the marine commercial vessels.

The symbols of commercial vessel class under the Register: К – the symbol of a not self–propelled vessel class; КМ – stands for a self–propelled vessel; □ – the symbol means, that the vessel is constructed by rules and under the supervision of the Register; УЛА, УЛ, Л1, Л2, Л3 – the designations of ice categories; [1], [2], [3] – signs of division according the quantity of compartments (one – two– and three–compartment standards of the un–sinkability); I, II, IIСП, III – the signs of marine cruising district limitation; A1 and A2 – the automation signs; a designation of certain purpose operation, for example: (fishing vessel), (tow), (ice breaker), etc.

The example of a commercial vessel class designation symbol under the Register regulations is КМ□Л2 [1] (fishing vessel).

The example of a marine crude–oil tanker class designation symbol of Det Norske Veritas is

+ 1A1 Tanker for Oil ESP NAUTICUS PLUS–2 EO ICE–1B VCS–2 RPS NAUT–AW,

where the symbol «+» means, that a vessel was constructed under the survey of the Det Norske Veritas;

1A1 – the vessel corresponds to the requirements of *DNV* for the hull, the mechanisms and the equipment;

Tanker for Oil – means the class of the cargo vessel;

ESP – sign informs that the vessel complies with the special requirements of «Enhanced Survey Programme» that hull structures are subject to the inspection during all period of the operation;

NAUTICUS – means, that the vessel was projected with application of the special software which then mast be used when estimating the hull structures' deterioration and loadings during the vessel operation (for newly built vessels);

PLUS–2 – means, that loadings and designing in points of the critical loadings are based on preliminary measurements of material weariness under and beyond the basic requirements, is applied for durable commercial vessels or vessels intended for the operation in heavy marine environment (P–MAX is applied for the calculation of deterioration during 25 year in Northern Atlantic, that corresponds to 40 years of operation in other areas);

EO – informs, that the vessel can be operated without keeping the watch in the engine room as the alarm system is laid to watch at the running bridge and to the chief engineer;

ICE–1B – means, that the vessel corresponds to the ice class Ice Class 1B by the Swedish–Finnish rules for Baltic sea that means admissible speed 5 knots at a thickness of ice of 0,8 m;

VCS–2 – the indication, that the vessel corresponds to the special requirements concerning the control of evaporations from cargo oil tanks;

RPS – the instruction, that the vessel keeps at least 50 % of capacity of a power–plant in the case of any single scrap in the engine room, including a fire or flooding of any separate component;

NAUT–AW – the indication, that the vessel meets the commercial present requirements concerning navigating maintenance, including the equipment at the bridge, the project of the navigating station, the arrangement of the equipment and automatic systems for prevention of planting to a bank.

The seaworthiness and reliability control is of great importance when estimating the value and the economic efficiency of the commercial vessel and the risks connected with seaworthiness, reliability and technical condition of commercial vessel, as they make essential impact on estimation of total commercial risks and are taken into account when calculating vessel and cargo insurance coverage.

Without details, the general approach of the surveyor organizations which provide the control of commercial vessel technical state, is connected with the seaworthiness and reliability estimation and corresponds to the first of two possible alternatives:

– With the account of the distinction of seaworthy properties and technical condition, the different vessels are admitted to be equally reliable in case of certain limitations concerning operation conditions (the cruising area, the season and the ice conditions, watch presence in the engine room, periodicity of survey, etc.);

– With the account of the distinction of seaworthy properties and technical condition, the vessels reliability is evaluated as different in the similar marine environment (that is without limitations of the operation requirements).

The second approach usually is not accepted when executing the supervision and is not convenient for estimation of commercial and insurance risks, the first approach, which is presented by the rules of the supervising organizations (Classification Societies), therefore prevails.

The limitations concerning operation requirements are actually the subject of estimation of the inspector (surveyor) of the supervising organization and are reflected in an assigned class symbol of the commercial vessel. And the surveyor according to supervision rules should estimate technical condition of the commercial vessel and define specified limitations of operation requirements.

Classification requirements serve the important objective as they define the vessel characteristics and the vessel's quality standard. At the same time the requirements of Classification Societies concerning supervision of commercial vessel's technical state can be inconvenient in interpretation as many Classification Societies apply their own requirements and standards.

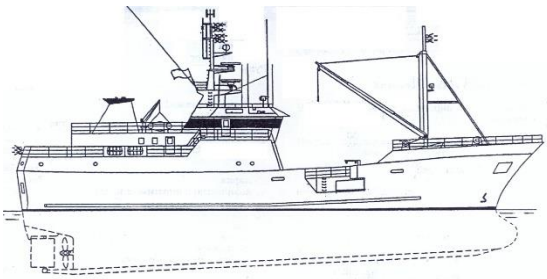
In the International organization of Classification Societies IACS (International Association of Classification Societies) the discussions of approaches coordination and joint application of the most important Classification requirements for surveying of commercial vessels are held.

The uniformity in approaches is required with the account distinctions of vessels classes, characteristics and technical condition, and also with the account the international character of technical survey. We hope, that in the future it will be easier to understand

estimation of the commercial vessel's condition, in particular when estimating safe loads, and to avoid application of double standards.

**Test questions**

1. Commercial vessel (definition).
2. Classes and types of the commercial vessels by the purpose and by the other signs.
3. Classes of the cargo vessels.
4. Classes of the fishing vessels.
5. Operational characteristics of commercial vessel.
6. Seaworthy properties of commercial vessel.
7. Vessel's devices.
8. Vessel's systems.
9. Vessel's power–plants.
10. Vessel's structure.
11. Shipbuilding and ship–repair enterprises.
12. Plants and the shipyards.
13. Vessel repair, emergency repair.
14. Vessel maintenance service.
15. Vessel reconstruction.
16. Functions of Russian Maritime Register of Shipping.
17. The Russian Maritime Register of Shipping objectives.
18. Maritime inspection societies of other states.
19. General approach of the supervising organizations which control the technical condition of commercial vessel.
20. Symbols of marine commercial vessels classes according to the Register.



## 2. Commercial vessel's data processing and recommendations of estimation process planning

To estimate the vessel value or the investments efficiency indexes it is required to process the data which are determined by the survey results and on the basis of the analysis of the documents concerning the property rights, the construction and the basic design of a commercial vessel, modernizations made or planned, her technical condition.

The documents of the basic project (are specified in order of preference):

1. Project specification (executive or contractual);
2. Acceptance report;
3. Characteristics sheet;
4. Brief characteristics sheet or vessel's passport card (it is eligible to use other documents of the vessel project, from among specified above).

The documents of the vessel reconstruction (modernization):

1) Project of re–equipment or reconstruction;
2) Sheet removed elements and the sheet of the installed items;
3) Cost estimate or the contract of the re–equipment or reconstruction.

Data concerning the time of the vessel modernization, the vessel destination after modernization, the shipyard where re–equipment was executed, with the account a national identity.

Documents of commercial vessel technical condition:

1. Documents of Maritime Register of Shipping of commercial vessel technical condition (or other entity of marine commercial vessels technical supervision and classification), list of documents with indication of the numbers, dates of issue and the periods of validity:

1.1. Classification Certificate;
1.2. Certificate of the seaworthy validity for operation;
1.3. International measuring certificate;
1.4. Certificate on the equipment and supply.
1.5. Certificates of survey of the commercial vessel according to the compartments and occupations before or after repair;
1.6. Other documents of Maritime Register of Shipping;

2. Defective or repair sheets when there are no documents of the seaworthy validity for operation:

2.1. The documents of the hull technical condition and the demands for repair;
2.2. Engine room sheets;
2.3. Other sections and managements sheets;

3. Vessel survey report of the independent technical surveyor.

In most cases the vessel is open for survey which is recommended for qualitative value estimation.

Not in all cases the survey of commercial vessel for the purpose of an estimation is possible.

The vessel can be inaccessible for the survey if natural difficulties to execute the vessel survey are incommensurable to the expected value of the information (for example if the vessel is harvesting in the remote inaccessible area).

In some cases it is required to estimate a non–existent vessel, for example a sunk vessel, in her condition before an insurance case.

The contents of the commercial vessel survey report by the appraiser and the interview with the ship–owner representative or the crew are:

1. First name, last, middle name, and the position of the expert who has executed the survey of the commercial vessel;
2. Date, the place of where the survey took place.
3. Vessel name, the year, the shipbuilding yard, the project #.
4. The year, the yard and the purpose of the modernization, the year and the yard of the last repair;
5. The prevailing district and purpose of the commercial vessel operation;
6. Opinion of the expert about technical condition of compartments and occupations:

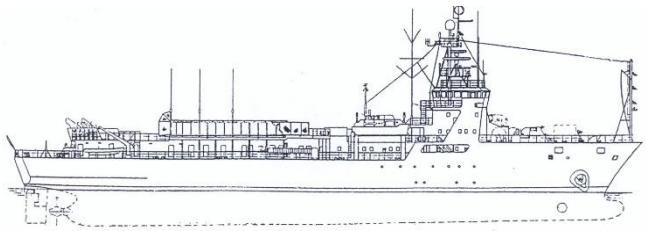
– Vessel's hull;
– Vessel's power–plant;
– Mechanisms and engine room systems;
– Generators, electric drives and electric equipment;
– Communication and the navigation facilities, including the equipment of Global Maritime Distress Safety System (GMDSS);
– Deck devices of the general purpose;
– Devices and special purpose systems, for example cargo or fishery devices;
– The special process equipment and systems, for example fish–processing equipment, refrigerator, systems for live fish saving or others.

Works sequence of commercial vessel value or efficiency estimation includes following recommended stages:

– Analysis of the vessel documentation and vessel survey;
– Interview with a crew and workers;
– Analysis of the commercial vessel technical condition;
– Market research of the analogues class vessels;
– Calculation of the vessel value.

**Test questions**

1. Documents of the basic project used for commercial vessel estimation.
2. Documents on modernization.
3. Maritime Register of Shipping documents of commercial vessel technical condition.
4. Documents need of repair of the commercial vessel.
5. Contents of the written report of the vessel survey.
6. Sequence of stages work of the vessel value estimation.



## 3. Features of standard approaches application for vessel evaluation

In the methodology of applied economic evaluation it is possible to allocate three definitions of market value concept: standard, algorithmic and theoretical.

In the bases of the theoretical definition there is an equality of the value in use and the value in exchange, which at the exchange moment are equal among themselves and the market value. More exactly, from the seller point of view the value in exchange exceeds the value in use of a distinguishable size, that correlates with margin error estimations, but from the buyer's point of view, on the contrary, the value in use exceeds the value in exchange. Market value in the process of exchange is defined in the range of values between the value in use and the value in exchange.

Apparently, the theoretical definition of market value is primary, and formation of other definitions of value, including industrial definitions, or subject definitions in special spheres, should be made keeping in mind of the market value theoretical definition as the basis of evaluation.

Specified definitions of value, except the theoretical definition, are more convenient in respect of application.

The concept of market value is standard and formulated under Federal appraisal standards or under other comparable specifications. At the same time standard definition is of little use in the expert purposes.

Algorithmic definition of market value can be a sequence of its determination recommended in the modern circumstances according to the standards by three independent approaches with the account the subsequent expert coordination of the results obtained using these approaches or the preliminary choice of the approach corresponding to a subject among standard approaches, if such preliminary choice of the approach is allowed under standards of appraisal.

In that specific case an adapted instruction can serve as algorithmic evaluation and this instruction is created according to standards on the bases of independent approaches combined by the expert opinion after or before the determination of the market value, taking into account, that this possibility of preliminary choice a separate approach corresponding to the subject, if this possibility is supposed to be according to standard, is also the way of the expert combination of independent approaches.

It should be noticed, that the structure of independent approaches within the limits of algorithmic evaluation is based on the concepts of evaluation and could be the subject of the analysis from the philosophical and historical points of view.

In days of the Middle Centuries the ethical standards which were covered by philosophy of the new–Thomism, did anticipate the possibility of obtaining profit which negatively regarded as enslaving, and noble people were not expected to sell their property for the price more expensive than the price of purchasing. The price, thus, corresponded to the set of expenses.

In administratively regulated economy, despite the fact that the profit can be a subject of evaluation, the medieval way of evaluation virtually remains as the sums of expenses have to be saved as the operation cost and investments are paid from the state budget, the income arrives to the budget where the financial result is formed, and the company actually does not possess the financial result.

Plausible concepts to accept no more, than one has spent, in the present still remain in the sphere of hired labor. Workers receive as much, as is spent for restoration of their energy and if there is a surplus the investment and commercial activity appears.

In the activity of businessmen the Christian morals concerning incomes influence with some reservations. In process of material benefits accumulation and in connection with the limited possibilities of a person in respect of material consumption, the relation of volume of consumption to the volume of accumulation naturally decreases, and, at a rather high level of accumulation there is separation of consumption level from capitalization. In a society, advanced from the different points of view, citizens with different property statuses consume proportional quantity of material benefits.

On the other hand, there are no limits for the consumption possibilities out of material sphere, including professional and creative interests of the person. The maximum satisfaction of spiritual interests is brought by professional work, including the work of businessmen in management of that part of the material property in relation of which, in view of saturation, they do not realize a possibility of consumption and extraction from the turnover in process of expenditure.

Thus, businessmen actually are the managers disposing of property, and the basic part of the property, which falls outside the limits of their own consumption, is run, kept and collected by them in the interests of other part of the society.

Along with hired workers, businessmen receive the material compensation that doesn't excess the amount that they have spent, leaving out investment activity which is not a part of personal consumption.

In the periods of Renaissance and economy development there is a possibility of comprehensive value estimation with the account the factor of the investment activity, for example using three independent approaches. That sort of evaluation harmoniously enters dialectics, which can be defined, as systems of triple concepts laws (for example the triple concepts: the individual – the especial – the general, etc.), so–called triads that corresponds to Hegel's philosophy.

Therefore many ideas in applied economics are based on triple alternatives: besides three independent approaches, there are also three theoretical concepts, corresponding to value – the value in use, the value in exchange and the market value; three rights of the ownership– the property right, the economic management and the administration; three property rights – the possession, the distribution and the use; three kinds of deterioration – physical, functional and external; three basic economic indexes – income, operation cost and investments; etc.

As, from system positions, it is possible to define the market value from three points of view independently: methodological, algorithmic or standard, it leads to an axiom based on a belief that market value, from all specified points of view (and, probably, others points of view), is a uniform concept.

To some extent, appraisal is the use of the basic axiom which is specified above. Studying of the basic axiom and the analysis of conformity with the value concept by three

independent definitions is an important incentive for the development of the applied expert evaluation methodology that means that the concepts of evaluation and approaches are developed and improved to bring independent value definitions into compliance based upon theoretical value concept. It is, exactly, the system criterion of the evaluation validity.

Use of various approaches for the vessel evaluation reduces influence of errors, but can lead to a polysemy of the received results.

The definition of the average weighed value is made at the final stage for generalization of the results usually there is an insignificant spread.

If case of a significant spread, the additional analysis for the purpose of an exception of the least authentic result and determination of preferable value is required.

The causes of the discrepancy of values received by different approaches are the variety of used data for an evaluation: the part of data is used for comparison with analogues, the part – for the determination of the net operating income, and the part – for an estimation of reproduction cost and depreciation etc.

The necessity of averaging («weighing») of results at the final stage of an evaluation is a result of breaking of logic ties and imperfection of used techniques.

It is expressed by the fact that each of approaches besides the initial data defined on the basis of market research and on the basis of the evaluated vessel characteristics analysis, contains indexes of subjective nature which can be proved, only by extending borders of the subject, increasing number of the methodological concepts and interrelations among them within possibilities of the expert.

The specified drawback of any approach cannot be eliminated completely but there is a choice of approaches for vessel evaluation (or other asset of the marine company) when subjectivity is as minimum as possible, and various methods are connected in an integrated algorithm, and each of them is used in that part of the expert work for which it is most valid.

The accuracy of the results of estimation of various approaches in many respects depends on the vessel years.

As the critical analysis of possibilities of standard approaches application for vessels estimation it is necessary to note the following.

The cost approach is more correct for new vessels when there is insignificant depreciation in view of the following reasons.

1. In process of commercial vessel ageing the replacement cost (or market value of a new vessel) can be replaced completely by depreciation, and the resultant value estimation representing the difference of the new vessel value and depreciation is much less than new vessel value and the depreciation, that is, the determination of the market value of not a new vessel based on cost approach is called as the mathematical problem of «small difference of the big values» and owing to the specified circumstances is inexact.

2. The depreciation of a commercial vessel is presented much in accumulation of value distinctions of initially identical vessels, having identical age rather than in value reduction.

With appropriate care on the part of a ship–owner and with sufficient expenses of a ship–owner for the repair, the deterioration can be insignificant, despite the age of vessels life. Circumstances of the opposite nature are possible too.

Apparently, rates of deterioration of new vessels roughly correspond to the compensation rates.

3. With the vessel's years of life the information of the expenses for her construction is lost due to the changes of economic situation and in projects of the newly built vessels.

Besides, the depreciation accumulates over the time, and the error of value estimation based on cost approach increases, since the depreciation is subtracted when estimation is made based on cost approach from the initial value of commercial vessel (the regenerative cost, the replacement cost or the new vessel market value, depending on the accepted definite assumptions) and at the maximum age the depreciation becomes equal to this initial value.

Thus, at the mandatory age the vessel value (or other marine company asset), determined by the cost approach as the small difference of the big values (initial value and the accumulated depreciation), in mathematical sense is inexact result that limits possibilities of application of the cost approach for not a new vessels (or other not a new assets).

The schematic graphs (fig. 3), characterizing within life time of commercial vessel, the dependence of the value on age, when the value is determined by standard independent approaches, the more simply correspond to the assumptions usual for appraisal.

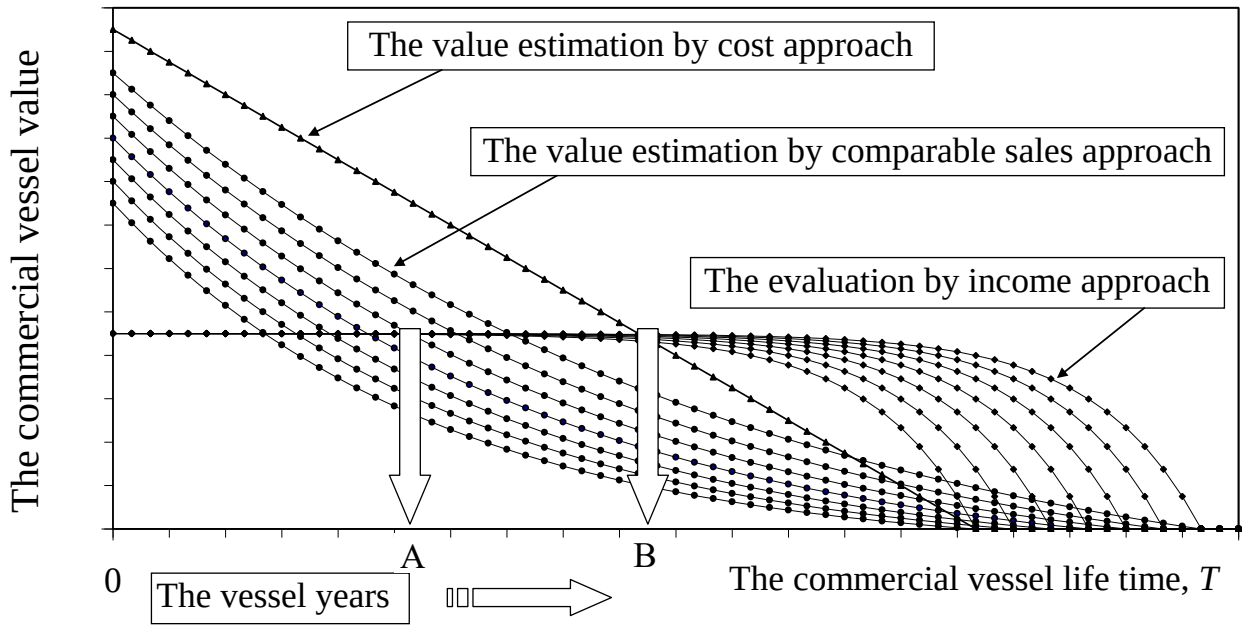



Fig. 3. The dependance of commercial vessel value on years by the the independent approaches estimation (the schematic graph)

Unlike the vessels' value (or other assets of the marine company) that decreases over the time, in some other subject domain depreciation is less appreciable over the time concerning real estate estimation (that is the property complex as a part of constructions and occupied territory lots), since the real estate is usually more durable and the factor of value changes over the time for the real estate in a greater degree are the external macroeconomic changes rather than self internal phenomena (structural or functional).

The formal difference of schematic dependence of the value on the vessel age, evaluated by the cost approach, from dependence of the value determined based on comparable

sales approach, is caused by a hypothesis of the linear proportional accumulation of the commercial vessel irremovable depreciation over the time. The specified difference is easily enough eliminated by use of a nonlinear proportion for estimation of irremovable depreciation.

There are more important causes of difference of dependence on the age of the vessel value determined based on income approach, on the one hand, and the dependences determined based on comparable sales and income approaches, on the other hand.

These causes of difference are connected with the fact, that according to the income approach, the vessel value (or other asset of the marine company) corresponds to the present value of the cash flow determined on the basis of discounting by financial functions, which has steady characteristic except the limiting age which is coming nearer to life time.

It is necessary to pay attention, that stability of the value dependence on the age of the vessel (or other asset of the marine company) actually is not observed according to marketing researches and on the basis of application for an estimation of comparable sales approach or cost approach, and by these approaches the value decreases over the time in the present value, that is, the values of a new and not a new vessels considerably differ, though the evaluation based on income approach can not have distinctions, since the efficiency of a commercial vessel changes over the time insignificantly, and the capitalization rate, in a wide range of age, varies a little and tends to increase, when the vessel years come nearer to a limiting value, owing to the increase of the compensation fund factor as the component of the capitalization rate.

The same conclusion of the vessel value (or other asset of the marine company) stability over the time, evaluated based on income approach, can be received, if the method of the direct capitalization is applied unlike the method of capitalization of the discounted cash flow of the net operating income.

The value stability of vessel or other isolated real asset of the marine company over the time is a mathematical property of present values of cash flows determined on the basis of well–known discount financial functions.

Relative conformity of values determined by independent approaches is a characteristic feature that rather corresponds to an interval from A to B of the vessel age averages. It is necessary to underline, that just middle–aged vessels basically are offered for sale at the pre–owned market.

Concerning new vessels which age makes from 0 to A (fig. 3), it should be noted that the income approach is characterized by value underestimation, that is the new vessel usually values more than the present value of a cash flow of the predicted income.

For the oldest vessels, age of which is comparable with life time *T*, the value underestimation can at this time corresponds to calculation based on cost approach, and the income approach is more logical both for value estimation and for the life time, the forecast of which for an old vessel is closely connected with economic efficiency estimation.

For an age limit of a commercial vessel the estimation based on income approach essentially depends on life time evaluation, and commercial risks tend to grow in view of probability of latent defects accumulation.

Unlike of the cost approach, the income approach is more adequate for application estimating not a new vessel, since the costs for her construction influence the market value over the time to a lesser degree, than the present profitableness, data of which collected with the vessel age.

The vessels values decrease over the time usually essentially more intensively, than, for example, the values of the real estates, depreciation collects faster, and the life time is less.

The profitableness of not a new vessels usually slightly differs from the profitableness of new vessels. Therefore the vessels market value, evaluated based on income approach, varies over the time less considerably, than the value determined by the methods of the cost approach.

For the stated reasons, it is logical to consider, that the market value determined based on income approach is more exact for not a new vessels and it is less correct for new.

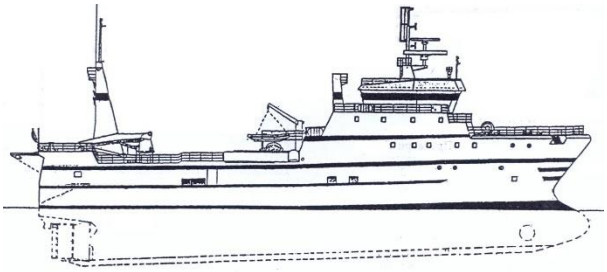
As vessels number, offered for sale at the pre–owned market, the greatest in the range from A to B of the averages of age, the comparable sales approach is less logical for new and for old vessels.

The evaluation methods based on comparable sales approach correctly enough reflect the character of the vessel value change depending on age. At the same time, the values determined based on comparable sales approach are characterized by significant spread at various values of vessel years, and, therefore, the use of the comparable sales approach for a vessel generally (not element wise) can be insufficiently exact, especially for new and for old vessels.

As conclusions on the critical analysis of the possibilities of the application of the standard approaches for an estimation of marine commercial vessels it should be noted that the cost approach is more correct for new vessels, the income approach – for not new, and the comparable sales approach – for vessels of the middle age, mainly presented at the pre–owned market. The same substantially refers to other assets of the marine companies if value essentially depends on the asset age.

**Test questions**

1. Reasons of a polysemy of vessel value estimations from the points of view of various approaches.
2. Generalization of commercial vessel evaluation results by independent approaches («weighing» of values).
3. Sphere of the cost approach application for vessel evaluation.
4. Advantages and disadvantages of the income approach.
5. Analysis of the comparable sales approach applicability.
6. Spheres of preference of standard approaches for vessel evaluation.



# 4. Concepts of the comparable sales approach in commercial vessel evaluation

In the process of value determination (or other economic index) of vessel or other real asset of the marine company's property complex based on comparable sales approach there is a simple and rather affordable way to the apply the statistical regressions on the basis of similarity with analogues at the level of specific indexes as the alternative to searching of analogues and introducing of adjustments for the analogues' values.

## 4.1. Comparability characteristics and units

The comparison signs (that is, a similarity with analogues) should be taken into account while creating of statistical regressions according to analogues.

Evaluation based on comparable sales approach is based on marketing researches and on the account of following general factors – characteristic of the comparison:

– Transaction conditions, that are mainly the structure of the transferred rights and the time of sale for analogues and for an evaluated vessel; the age is used, and the transferred rights are defined according to Article 209 of the Civil code of the Russian Federation;

– Macroeconomic limitations and market conditions, i.e. the situation which have developed in the market; in particular, considered by the statistical researches when formalizing of the regressions;

– Technological (microeconomic) conditions that are the functional or structural characteristics of similarity with analogues; the corresponding units of comparison are used, which are, on the other hand, the identification signs of a commercial vessel (see Chapter 3) or another asset of the marine company.

Concerning the features of the application of the comparable sales application for an evaluation of the marine commercial vessels, some explanation is required.

Definition of valid data of the commercial vessels–analogues is one of the key questions when using the comparable sales approach.

Apparently, the applied data about the analogues' values demand mutual check that is correlation of data – the specific indexes determined from the various sources for the objects of the same class.

For the reliability criterion for this reason, can possibly satisfy the statistical population of market data in the whole, instead of each of analogues as a part of this population, taken separately.

The requirements for reliability of the used data of vessels–analogues' reliability and the necessity for this reason of statistical sets extensive enough lead to expediency of the similarity analysis at the level of specific indexes with the account the distinctions of units of comparison values for the majority of vessels–analogues and for an evaluated vessel.

As effective option of the comparable sales approach application for the vessel evaluation can serve the regression analysis, in the frameworks of which the similarity of analogues and an evaluated vessel is reached at the level of specific indexes.

While using of the statistical sets of commercial vessels–analogues' values, that for example, have similar purpose of use not only the analogues coinciding with the evaluated vessel by the units of comparison are of informational importance, but also the other vessels of a used set since all the applied statistical set defines the regression characteristics, that is, the regression dependence of the vessel value on a unit of comparison can be restored to some extent of proximity on the basis of data not only (and not much) of the analogues which have coincided with the evaluated vessel in a narrow interval of the values of comparison units, that is the eventuality, but of any analogues from the used set. Therefore it is inexpedient to reduce the used statistical set in view of commercial vessel evaluation objectivity the comparable sales approach.

In an opposite option, in case of reduction of the used statistical set to the analogues which have occasionally coincided with the evaluated vessel by the units of comparison value, there is an illusion of evaluation accuracy increase, that actually testifies the loss of part of the information about the value and the loss of objectivity of the evaluation by the comparable sales approach.

The reliability of data about value of analogues is characterized by objectivity (authenticity) of data and accuracy. A dominating condition, apparently, is authenticity.

In case of accumulation of the statistical information on vessels values, to put it more exactly, about the specific values related to the units of comparison, the following circumstance appears: the authenticity of data is promoted by the increase of data quantity, the significant spread of values is thus characteristic.

Due to the specified reasons the objective data about the vessel value, suitable for use within the limits of the comparable sales approach at the level of specific indexes similarity, as a rule, are presented as statistical regression and characterized by a significant spread.

When using the analogues and the comparable sales approach for marine commercial vessel evaluation It should be noted the following features.

1. The market of vessels is of international character, and the original information is presented mainly in English with use of the accepted symbols.

Besides, the offers of the marine commercial vessels sale in various states are also usually presented in English for the purpose of possibility of selling abroad.

It is impossible to reduce the volume of the information at the expense of the quality of evaluation for the purpose of convenience reading or to the limited only by the data in Russian (or other local language) – these data concerning offers to marine commercial vessels sale are insufficient.

2. Marine commercial vessels do not possess the stereotypeness as in case of serial equipment (for example, vehicles, computers, office equipment) or as the serial real estate (apartments, offices and so forth). Practically there are always structural or other distinctions (age, technical, functional) besides the analogues, including the marine commercial vessels of close classes. Therefore, it is incorrect to limit yourself to a small number of analogues for use within the frameworks of the comparable sales approach, and it is required to reflect the market in general. It can be done, if an evaluation based on comparable sales approach and the similarity analysis are made at the level of statistical

generalizations, instead of introduction of adjustments to a limited number of analogues that usually is recommended for the serial equipment estimation based on comparable sales approach.

Thus, the vessel value can be determined on statistics basis by the marketing researches and the set of analogues based on comparable sales approach according to its methodological concept by the Federal Standard # 2 «The purpose of evaluation and concepts of value (FSO # 2)», approved by the Order of Ministry of the Economical Development of Russia July 20, 2007 # 255 (or by any comparable standard): «the market value of the estimated object is understood as the most probable price …». And evaluation probability is provided with probabilistic calculations and formalization of the regressions, and use of one or several isolated analogues for an evaluation of a commercial vessel with introduction of adjustments to analogues' values, usually is not a determination satisfying the Standard, as in addition, it is required to prove, that values of analogues corresponds to their most probable price.

Anyhow, the statistical research and formalization of the regressions for an evaluation of the probabilistic nature of analogues' values is required. And it to a full degree concerns an evaluation based on comparable sales approach of vessels or other real assets of the marine company, which do not possess stereotypeness as the serial equipment, in which relation the probabilistic nature of the separate analogues prices proves to be true by their stereotypeness.

The method of the comparable sales approach recommended for use for vessel evaluation includes the following sequence of actions:

– Creation of regression dependences of specific values on vessel years by the analogues coinciding with the evaluated vessel of the assignment,;

– Use of regression dependences for the vessel evaluation.

The adjustment for the difference of evaluated vessel characteristics from analogues, when making calculation, is introduced in two steps:

– When formalizing the regressions, specific values are determined by division by the value of the unit of comparison corresponding to each of used analogues;

– While using the regressions, the multiplication by the unit of comparison of an evaluated vessel is made.

The other mathematical action, reversible when working out the statistical regression dependence and when using it for evaluation based on comparable sales approach and not only multiplication can also be applied.

**Test questions**

1. Units of comparison of a commercial vessel (her similarity with analogues).
2. Similarity at the level of specific indexes for vessel evaluation based on comparable sales approach.
3. Reliability of data (objectivity and accuracy) for the evaluation based on comparable sales approach.
4. Advantages of use of regression dependences for determination of the most probable values.
5. Features of application of comparable sales approach for marine commercial vessel evaluation.

6. Sequence of adjustments application for vessel evaluation based on comparable sales approach at a level of similarity by specific indexes.

## 4.2. Concepts and the contradictions of vessels units of comparison choice for value estimation

When approximating the marketing researches data by statistical regressions, the choice of units of comparison in the structure of parametrical dependences among general characteristics of a commercial vessel or other real asset of the marine company's property complex can be done according to the following criteria:

– Characteristic makes essential influence on the value;

– Characteristic is not defined unequivocally by other characteristics which are units of comparison;

– Characteristic is variable, that is differs for analogues and an evaluated vessel (or other asset of the marine company);

– Characteristic has numerical measurement;

– The vessel age (and the life time characteristic) fully enough characterizes the technical condition in sense of latent defects probability and is a universal comparison unit, that that means that the age is a part of comparison units of comparison of any assets of the marine company (unlike the real estate);

– Number of units of the comparison should be limited;

– The phase property of the characteristic which in the process of choice of a comparison unit testifies to, whether the characteristic influences cost, or its derivative does;

– The property of an imposing appearance or conformity of statistics data for requirements of the investor (that published or, for example, presented in the Internet, data about vessel value in binding to characteristics correspond to the requirements of the consumer and are sufficient for him).

In the process of value determination by the comparable sales approach it is also required to consider, that the characteristics of each vessel (evaluated or vessels – analogues) are much more closely interconnected among themselves, than, for example, similarity characteristics when estimating a real estate.

Thus, many of differences of evaluated vessel from analogues can be natural consequences of one of differences. In this situation introduction of adjustments for each of difference can result, in essence, in the excessive repeated account of the adjustment by one of differences which predetermines the others.

The given possible situation with the excessive repeated account of one of adjustments should be considered a methodological error.

To except the specified error when evaluating the vessel based on comparable sales approach it is reasonable not to reduce all adjustments to one sequence, and to carry out independent calculations of evaluation with an adjustment of each of differences. And at the final part of evaluation based on comparable sales approach it is necessary to determine the arithmetic average or the weighed average value for all of calculations; within the limits of each of them the adjustment only for one of differences from analogue is introduced.

Except the specified criteria, in order to choose the characteristic of comparison, It should be noted also, that set (number and structure) of the units of comparison for the vessel evaluation or other real asset of marine company's property complex should correspond to a set of indexes presented by marketing researches, that is it is necessary to start with the assumption, that the published sets of characteristics of the offered for sale vessels (or other real assets of the marine company), along with the published values, correspond to notions of participants of the market concerning the structure of characteristics important for value determination.

There is no sense to recommend the electronic addresses of the broker companies sites of vessels sale as these addresses and data on sites vary over the time. It is enough to use search machines of the Internet and keywords: «ship for sale», «reefer vessel for sale», «oil tanker for sale» etc.

To use the information of vessels values, marine engineering and ocean technology, for example the data determined by the Internet network, it is necessary to understand symbols and to understand the special terms.

The most widespread abbreviations the sites about vessels sale the following: *GRT*, *NRT* – the Gross Register Tonnage and the Net Register Tonnage, the abstract characteristics of volume defined by the rules of the International Convention on measurement vessels 1969; *DW* – deadweight; *EPS* – effective power of vessel power–plant; *LOA* – the vessel length over all (Length over all), etc.

It should be taken into consideration, that indexes of the gross and the net register tonnage in information data bases are specified in units corresponding to so–called English ton (usually is called – gross ton) which can mean both a mass unit, and volume unit, and it is required to consider a context correct to define the dimension correctly. Usually unit «ton» or «gross ton» means the volume of 2.832 cubic m, that is 100 cubic feet, and «t» is the weight of 1000 kg.

Besides, it is necessary to understand symbols of various monetary units and dimension, and also to know, that the fractional part of numerals in English language is separated by a point, instead of a comma (that for example is accepted in Russian), and decimal categories of numbers can be separated by commas, and to know a number of other conventions.

It is required to know English quite well to understand technical information (if English is not a native language). In other words, to use information databases for vessels valuation one should possess certain erudition.

At the same time it is strongly advised not to narrow the marketing researches only to sites in Russian (or other local language), as the basic part of market data is thus can be missed and the quality of evaluation worsens oven if the information of Russian language sites (or other language except English) is easier to understand.

**Test questions**

1. Criteria of the choice of units of comparison for vessel evaluation.
2. Contradiction of the possible repeated account when making consecutive introduction of adjustments on dependent units of comparison.
3. Recommendations of the independent account of adjustments applied to the units of comparison for vessel value estimation.

4. Features of application of search machines of the Internet for estimation based on comparable sales approach.

## 4.3. The examples of comparison units for commercial vessels of various classes

The deadweight *DW* (difference of full cargo and empty displacement) can be one of units of comparison number for marine commercial vessels of many classes.

The rationality of deadweight use, instead of other loading component (or total cargo displacement *D*) is caused by the following reasons:

1. Majority of the most important loading components (and total cargo displacement of a commercial vessel) in the approximate value is determined by deadweight;

2. Deadweight, as the vessel characteristic, is widely applied not only in shipbuilding, but also in shipping;

3. Tonnage belongs to a number of the important characteristics of the vessels of some classes along with deadweight, however, as the specific cubic capacity of the cargo is usually known, if necessary, the expert substitution of the variable (tonnage by cargo capacity and further by deadweight) does not cause difficulties.

The power of the vessel's main engine or holds capacity, or other index depending on the purpose of the vessel can be chosen as a second unit of comparison.

As recommended units of comparison, to meet the requirement of conformity to criteria of choice of units of comparison (see article 4.2), it is possible to use the basic characteristics which are offered in the scientific text books of vessel value economic estimation methodology [17], namely:

– For universal dry–cargo vessels – the cargo capacity, the operational speed and the specific tonnage for bulk cargoes;

– For bulk cargoes vessels – useful cargo capacity, operational speed and productivity of the cargo device if it is available;

– For vessels, transporting the enlarged unified cargoes – the tonnage (including number of transported lighters or containers) and the operational speed;

– For trawlers – thrust at warp trawling (it is better – power of the main engines) and hold volume, sometimes – the number of crew;

– For seiners – the size of fishing tools (length of fitting, seine height and area), free running operational speed and the number of crew;

– For dry–cargo refrigeration vessels – the capacity of frozen cargo, the capacity of commodity fuel and the operational speed;

– For fish processing mother ships – the daily productivity of principal production and holds volume, the number of crew and the personnel of workers;

– For tug ships – the hook thrust at operational speed with a barge (it is better – the main engines power);

– For floating cranes – the hook lifting capacity and the combination of properties (marine, harbor, self–propelled, not self–propelled and so forth);

– For floating docks – the elevating force, the depth over keel block, the width between internal shelfs of towers and length on of building berth–deck;

– For passenger vessels – the passengers capacity and the operational speed.

Units of comparison (tab. 4) for commercial vessel of one or another class can be chosen using the information given above, on the basis of theoretical assumptions, expert judgments, with the account the statistical information research.

For commercial vessels of many classes in the sale announcements the deadweight *DW* and capacity (or register tonnage) are indicated.

The main dimensions, the operational velocity, the main engine power can be named as the additional characteristics.

In the third column of tab. 4 the generalized recommendations concerning choice of units of comparison are presented for the vessel value estimation.

Table 4

The recommended units of comparison for commercial vessels of various classes

| Vessel class | The characteristics in sequence of mentions number in announcements to sale | The recommended units of comparison |
|---|---|---|
| Universal dry–cargo vessels | Deadweight, draught, speed, breadth, depth, register tonnage | Deadweight, tonnage |
| Vessels for transportation of bulk cargoes | Deadweight, tonnage, draught, speed, power of main engines, length, breadth and depth | Deadweight, tonnage (except ore carriers) |
| Multi–purpose dry cargo tramp vessels | Length, breadth, draught, depth, main engine power and speed | Product of length for the breadth |
| Container ships | Deadweight, draught, container capacity, length, breadth, speed, power of main engines | Deadweight, container capacity |
| Refrigeration vessels | Deadweight, draught, holds capacity, refrigerator holds capacity, main engine power | Deadweight, holds capacity |
| Rolling cargo vessels of RO–RO class | Deadweight, draught, length, breadth, holds capacity, speed and power of main engine | Deadweight, holds capacity |
| Ferries (rail and trackless) | Capacity of passengers and vehicles, length, breadth, draught, main engine power and speed, length of received rolling cargo | Capacity, total length of received line of vehicles or rail cars |
| Crude cargo tankers | Deadweight, length, breadth, draught, tonnage, speed | Deadweight |
| Fishing vessels | Length, breadth, register tonnage, main engine power, draught and depth | Deadweight, holds capacity, main engine power |
| Deck barges | Deadweight, length, breadth, draught, tonnage | Deadweight, dimensions |
| Tug ships | Length, breadth, depth, draught, register tonnage | Main engine power, displacement |
| Passenger vessels | Register tonnage, length, breadth, draught, speed and main engine power | Passengers capacity, speed |
| Floating docks | Elevating force, length, breadth | Elevating force, breadth |
| Floating cranes | Deadweight, draught, length, breadth, deck square capacity, cargo capacity | Cargo capacity, draught |

The type of dependence which can be recommended for statistical approximation of the marketing researches data is offered as a part of three factors: general factor; factor

that includes a unit of comparison from among vessel characteristics; and factor depending on vessel age and characterizing depreciation.

To build a regression it is necessary to adhere to a certain mathematical dependence form which, in turn, can be defined, investigating the formal–logic properties of the modeled value characteristic.

**Test questions**

1. Expediency of use of deadweight is used as unit of comparison for vessel value estimation.
2. The variants combinations of units of comparison for commercial vessels classes.
3. Structure of dependence for statistical approximation of the marketing researches data.

## 4.4. Use of statistical regressions for the vessel value estimation based on comparable sales approach, the mathematical formalization of two–parametrical regression

To define mathematical form of the statistical regression concerning depreciated assets, such assets, the value of which considerably decreases over the time, for example marine commercial vessels, it is expedient to use the mathematical concept of present value potential.

The mathematical potential *dMV/dt* of present value *MV* has a dimension of net operating income cash flow of $NOI = I - C$.

The concept of the present value mathematical potential is based on the concept of the income approach. Recording to this concept the value is equated to the present value of a predicted cash flow of net operating income *NOI*. Accordingly, the value per a unit time (in particular, per year) decreases to the value of net operating income received per time unit (i.e. to the present value of net operating income). Certainly, all specified indexes are defined in present values.

The active part of present value *MV* potential is observed as a cash flow of net operating income *NOI*, that is the decrease per a time unit (in particular, a vessel) of the present value *MV* real asset occurs by present value of net operating income *NOI* received in a unit time if value *MV* is defined as the capitalized sum of the discounted cash flow

$$MV = \sum_{t_N=1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N}},$$

or as the integral form of the present value of distributed cash flow $MV = \int_0^T \frac{NOI(t)}{(1+i)^t} dt$,

taking into account that:

– Reversion *Rv* at great life time *T* of commercial vessel or other real asset of marine company is neglected, that is $MV = NOI / i$;

– The working assets index *OC* as a part of the present value of the discounted cash flow of net operating income at great life time *T* and great value of vessel (or other real asset) is neglected;

– The discounting rate is constant *i* = const within life time *T* or the period of planning, that is with the account the assumption, that $\lim_{t \to T} 1/(1+i)^t = 0{,}0$;

– Neglects of the adjustment for middle of the year of the present value of the discounted cash flow determination under the account of the distributed payment within a year – for the formula of present values of cash flow based on use of the finite sums.

Certainly, all the value indexes must be determined in their present value.

The present value potential can be determined as a sum of two parts:

– The active part which characterizes the influence of net operating income *NOI* for present year on the value of a commercial vessel or other real asset of marine company; the active part of the potential is equal to the net operating income;

– The reactive part which characterizes the influence of net operating income *NOI* for the rest of the periods within life time *T* on the asset value.

Since the value of the property complex increases at an innovative stage of investment when the profit have invested into real assets (instead of profit deducing in the financial form out of turnover); the reactive part of present value potential of the property complex is positive at an innovative stage.

For the isolated assets, which are going down in value in due time, the reactive part of the present value potential is negative.

Apparently, the reactive part of the value potential of the material property value potential is positive for separate classes growing in value over the time, for example, historical monuments, antiquarian valuables, artworks etc.

However, the approaches of estimation of material property of the specified classes evaluation which are not industrial assets, are beyond the given methodological subject.

The analogy is pertinent. The concept of value is an economic analogue of the physical concept of «potential» (in dynamic subject of the mechanics, electro–mechanics, hydromechanics and thermodynamics and in other «mechanics»).

The potential of present value characterizing the productive and spent parts of separate asset value can be presented as a finite difference $NOI(\Delta t) - dMV/dt$, and for the property complex growing in value – as a sum $NOI(\Delta t) + dMV/dt$.

The first addend $NOI(\Delta t)$ is an analogue of the physical concept of kinetic energy and the second one $dMV/dt$ is an analogue of potential energy.

The potential of the present value of commercial vessel or any isolated asset which is going down in value over the time is negative, and the property complex of the marine company at innovative stage of its development, and also unidentifiable intangible asset of the marine company which is created at an innovative stage of the investment project, is positive.

It is possible to present the potential equation of the value for the isolated asset going down in value as:

$$MV \times R = NOI(\Delta t) - dMV/dt,$$

or for the limiting assumption

$$MV \times R = \lim_{\Delta t \to dt \to 0} (NOI(\Delta t) - dMV / dt) = -dMV / dt .$$

The potential equation of the value of the acting company's property complex is $MV \times i = dMV / dt$.

The value potential *dMV/dt* is negative for the investor if the present estimation *MV* decreases owing to asset use (owing to depreciation and functional obsolescence of commercial vessel).

The sign of present value potential, adhered with the net operating income in the active part, depends on macroeconomic property of life time *T*.

The life time is limited by economic obsolescence that is by economic feasibility of updating rather by physical ageing of commercial vessel or other isolated asset of the marine company, how much.

As, unlike the structured set of assets – the acting company's property complex for any isolated asset – the life time is limited, the separate asset is going down in value, and business as a hole grows in value of assets updating process.

For the real assets property complex of the marine company raising in value over the time annually on the present value of capitalized net operating income, and every year – for the present value of the net operating income which is received annually, unlike the depreciated (also for the present value of the net operating income received per time unit) isolated asset, the mathematical potential *dMV/dt* of the present value *MV* has formal properties of cash flow *NOI*. The mathematical potential *dMV/dt* of property complex present value *MV* is positive.

As the mathematical potential corresponds to the time derivative *dMV/dt*, present value *MV* is determined by the potential integration.

When is an unlimited life time of real assets property complex of the marine company in methodological sense, that is when $T \to \infty$ after we make the potential substitution *dMV/dt* of the growing value of the assets set into the equation $MV \times i = NOI$ instead of net operating income *NOI* index the integration of equation $MV \times i = dMV/dt$ and substitution of initial conditions, and also the replacement of a designation of start–up capital value of $MV_{\Sigma}$ lead to the form of the growing value of the set of assets, namely: $i \times dt = dMV/MV$**,** that is $i \times t + const = \ln(MV)$, and further

$$MV = MV_{\Sigma} \times e^{i \times t} = MV_{\Sigma} \times FV . \qquad (4.1)$$

And discounting by the Euler' number exponential function ($e$ = 2.71828283...), defined for the set of assets by the solution of the potential equation (4.1) of growing value, at small values of the discounting rate *i* is the exponential function $e^{i} \approx 1 + i$ mathematical property and it is defined below (Chapter 13) on the basis of the mathematical properties analysis of risks probabilistic concept.

Considering the limited life time of any isolated asset as a part of the marine company's property complex, substituting mathematical equation of the capitalization rate $R = i + i/((1+i)^{T-t} - 1)$ in the formula of net operating income capitalization *MV=NOI/R*, including in the sum to the discounting rate *i* the factor of fund of compensation $i/((1+i)^{T-t} - 1)$ of the depreciated part of investments (one of discount financial functions, see Chapter 13, tab. 13.2), and replacing the net operating income *NOI* to the potential of

present value going down over the time –*dMV/dt*, it is possible to receive the equation of potential of the asset value

$$MV = -(dMV/dt)/(i + i/((1+i)^{T-t} - 1)) . \tag{4.2}$$

After the derivation the equation (4.2) becomes:

$$-((1+i)^{T-t} \times i \times dt)/((1+i)^{T-t} - 1) = dMV/MV .$$

Entering the variable replacement

$$(1+i)^{T-t} = x ,\ (1+i)^{T-t} \times dt = -dx/\ln(1+i) ,$$

it is possible to have the equation

$$(i/\ln(1+i)) \times (d(x-1)/(x-1)) = dMV/MV .$$

After the integration

$$(i/\ln(1+i)) \times \ln(x-1) = \ln MV$$

and the substitutions of boundary conditions:

– At $x = (1+i)^T$, that is at $t = 0$, $MV(t = 0{,}0) = RC$ ;

– At $x = (1+i)^{T-t}$, that is $MV(t) = MV$;

within the life time of the marine company asset, in particular, a vessel from her manufacture time, the dependence of value *MV* on age *t*, life time *T*, discounting rate *i* and cost of replacement *RC* becomes:

$$MV = MV(t = 0{,}0) \times (((1+i)^{T-t} - 1)/((1+i)^T - 1))^{i/\ln(1+i)} . \tag{4.3}$$

The surface presented on the graph (fig. 4.1) characterizes the asset depreciation over the time depending on commercial risks – discounting rates, that is, the depreciation on a relative value to a new asset value.

New vessel value *MV*(*t* = 0.0) that enters as a factor depending on characteristics *X* in initial approach can be determined by the parametrical formula:

$$MV(t = 0.0) = a_1 \times X^{a_2} \times e^{a_3 \times X} . \tag{4.4}$$

Not applying for severity of the statement numerical experiment with the statistical sets of the marketing researches has shown, that the parametrical formula presented above (4.4) in many cases corresponds to the best mathematical approximation of vessels values data.

The characteristic of comparison *X* is chosen expertly with the account the considered recommendations (see article 4.3).

Substituting mathematical equation (4.4) into the formula (4.3) it is possible to receive the regression dependences form for the vessel value estimation based on comparable sales approach:

$$MV = a_1 \times X^{a_2} \times e^{a_3 \times X} \times (((1+i)^{T-t} - 1)/((1+i)^T - 1))^{i/\ln(1+i)} . \tag{4.5}$$

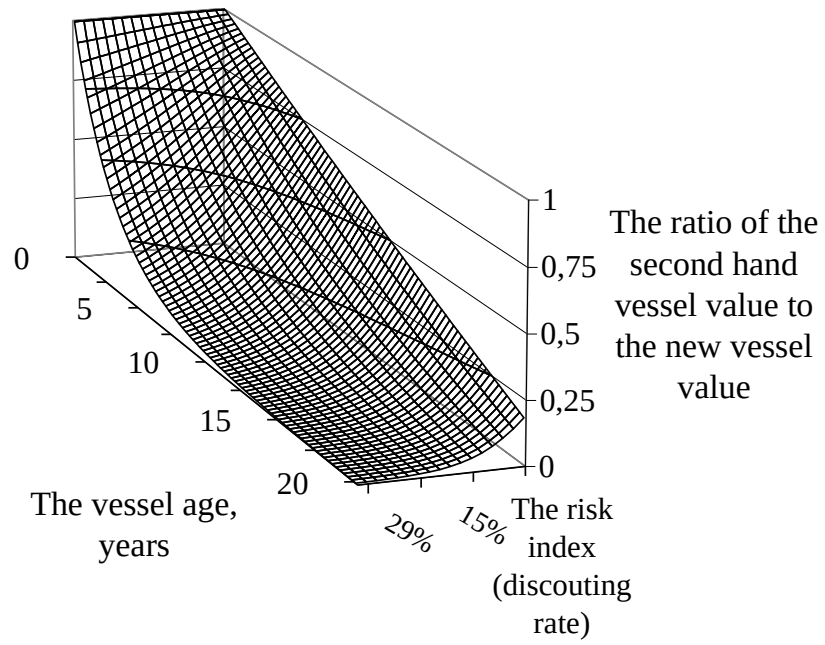



Fig. 4.1. The dependance of the present value on the commercial vessel years and the total commercial risk (making the assumption that the vessel durability is 25 years)

The additional recommendation is: when using of discounting by the Euler' number exponential function (see Chapter 13) the formula of regression (4.5) for approximation of the marketing researches data concerning vessel value (or other real asset of marine company) looks like:

$$MV = a_1 \times X^{a_2} \times e^{a_3 \times X} \times ((e^{(T-t)\times i} - 1)/(e^{T\times i} - 1))^{(e^i - 1)/i}, \tag{4.6}$$

and for small values of the discounting rate (less than 15 %), at which $i \approx \ln(1+i)$, the formula of regression (4.5) for approximation of the marketing researches data becomes:

$$MV = a_1 \times X^{a_2} \times e^{a_3 \times X} \times ((1+i)^{T-t} - 1)/((1+i)^T - 1), \tag{4.7}$$

or the regression form When using the discounting by The Euler' number exponential function:

$$MV = a_1 \times X^{a_2} \times e^{a_3 \times X} \times (e^{(T-t)\times i} - 1)/(e^{T\times i} - 1). \tag{4.8}$$

To calculate the factors $a_1$, $a_2$ and $a_3$, and also to estimate the life time $T$ and the discounting rate $i$ («cleared» of external risks) with use of the accepted forms of the regression, statistical information of marketing researches results concerning the value is processed.

The deadweight $DW$ is chosen as a unit of comparison for the universal dry–cargo vessel. When using deadweight $DW$ as a characteristic for data of marketing researches processing by the formula (4.5), it is determined, that approximation factors are:
$a_1 = 0.30$, $a_2 = 1.25$, $a_3 = -0.000065$.

There is a dependence of statistical observations of the value of the universal dry–cargo vessel relation to deadweight $MV$ / $DW$ in dependence on age $t$ and the graph of statistical regression on the graph (fig. 4.2). For statistical generalizations of the vessel

value marketing researches in some cases it is expedient to use a logarithmic scale of ordinates axis.

It is necessary to explain that the index of life time $T$ determined on the basis of given marketing researches approximation is evaluated on the basis of economic methodology on the bases of the chosen class vessels data, offered for sale, but does not characterize structural durability of vessels.

The regression dependence of universal dry–cargo vessel value on age $t$ and on the characteristics (in the example it is the deadweight $DW$), looks like:

$$MV = 2.481 \times DW^{1.30} \times e^{-0.000065 \times DW} \times (1.096^{50-t} - 1)^{1.047}, \text{ thousand US dollars.} \qquad (4.9)$$

Some useful information: the average value of age of the universal dry–cargo vessels offered for sale makes 22.5 year, deadweight – 10856 t, draught – 7.12 m.

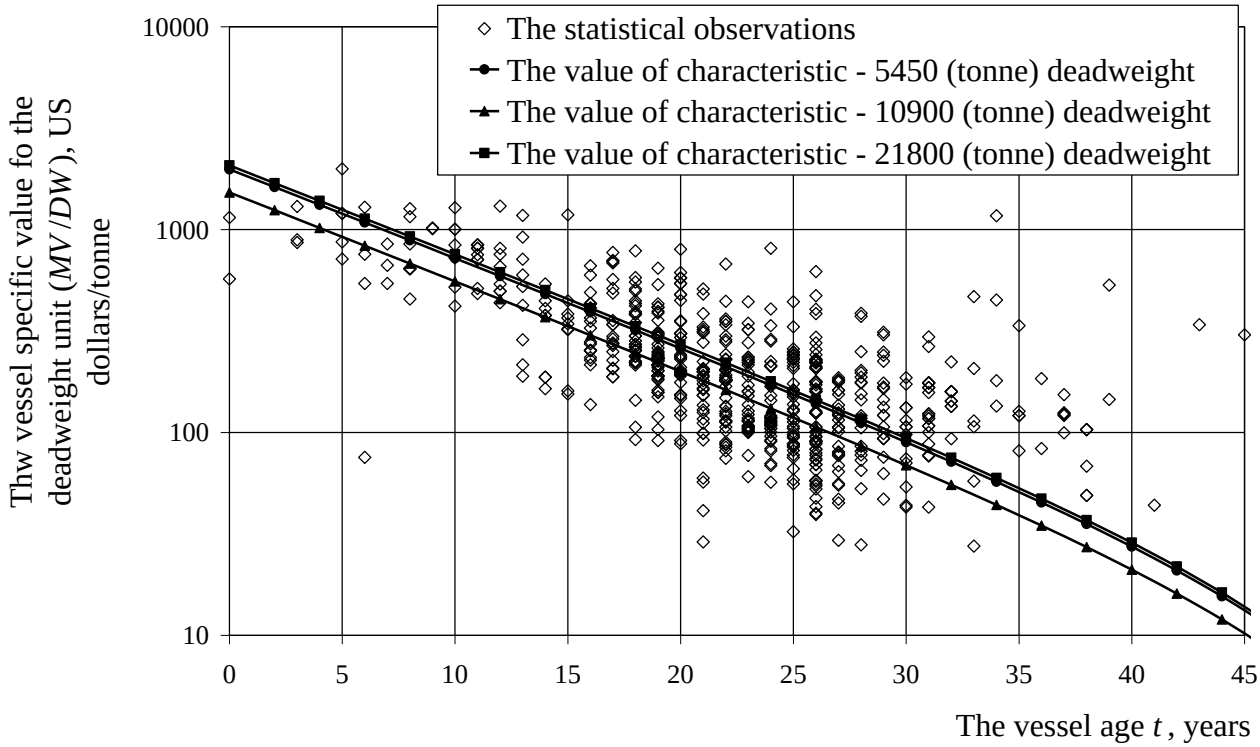



Fig. 4.2. The dependence of the dry cargo vessel specific value per the deadweight unit on years

The discounting rate $i$ counted by the market extraction from statistics and marketing researches is released from external risks and retrospective.

According to the discounting rate $i$ the efficiency of investments into construction and productive operation of the universal dry–cargo vessels determined by the market extraction method makes approximately $i \approx 8.5$ %.

When substituting the specified value of the discounting rate $i$ into the factor $(((1+i)^{T-t} - 1)/((1+i)^{T} - 1))^{i/\ln(1+i)}$ in formulas (4.5, 4.6) the greatest conformity of regression with the data of marketing researches is reached if deadweight of the vessel $DW$ is used as the characteristic.

**Test questions**

1. Formal analogy of economic concept of value to physical concept «potential».

2. Potential equation of value.

3. Sign of the present value potential for an asset which value is going down with the increase of years; the asset life time.

4. Depreciation of the isolated real asset over the time, the isolated assets growing in value with the increase of years (examples).

5. Solution of the potential equation for the isolated asset going down in value through the time (formulas derivation).

6. Property complex of real assets value capitalization in the time.

7. Solution of the potential equation of the property complex growing value with the positive potential of value (the discount formula of present value capitalization of own property).

8. Form of a value dependence on the vessel age recommended for approximation of statistical observations when formalizing of the regressions.

9. Recommended parametrical form of dependence of new vessel value on her characteristics.

10. Recommended form of statistical regression dependence of the vessel value on the characteristics and the age, based on use of discounting by the Euler' number exponential function (the formula derivation).

11. Determination of the economic life time index and the retrospective discounting rate released from the external risks by the analysis of statistical regression dependence of value on vessel years.

## 4.5. Marketing research for the commercial vessels value estimation

The market analysis of commercial vessels is based on statistical data processing.

The marketing researches of the vessels values must be conducted using the Internet sites of the broker companies.

According to the data of commercial vessels offered for sale and construction the division of the most widespread classes is presented (fig. 4.3).

The universal dry–cargo vessels are most numerous classes according to offers to sale, despite the fact that tankers have the greatest total tonnage.

The deadweight *DW* and holds volume *W* are chosen as units of comparison of the refrigeration vessel.

When using the deadweight *DW* as the unit of comparison while processing the statistical data of the marketing researches statistical data it is determined that approximation factors are: $a_1 = 1.585$, $a_2 = 1.255$, $a_3 = -0.0001$.

The regression dependence of dry–cargo refrigeration vessel value on age *t* and the unit of comparison in which the deadweight *DW* is applied after derivations looks like:

$$MV = 0.01788 \times DW^{1.255} \times e^{-0.0001 \times DW} \times ((1+0.09)^{50-t} - 1)^{1.044}, \text{ thousand US dollars.} \quad (4.10)$$

The graphs (fig. 4.4) of statistical observations of the refrigeration vessel value relation to deadweight *MV*/*DW* in dependence on age *t* and statistical regression are shown below.

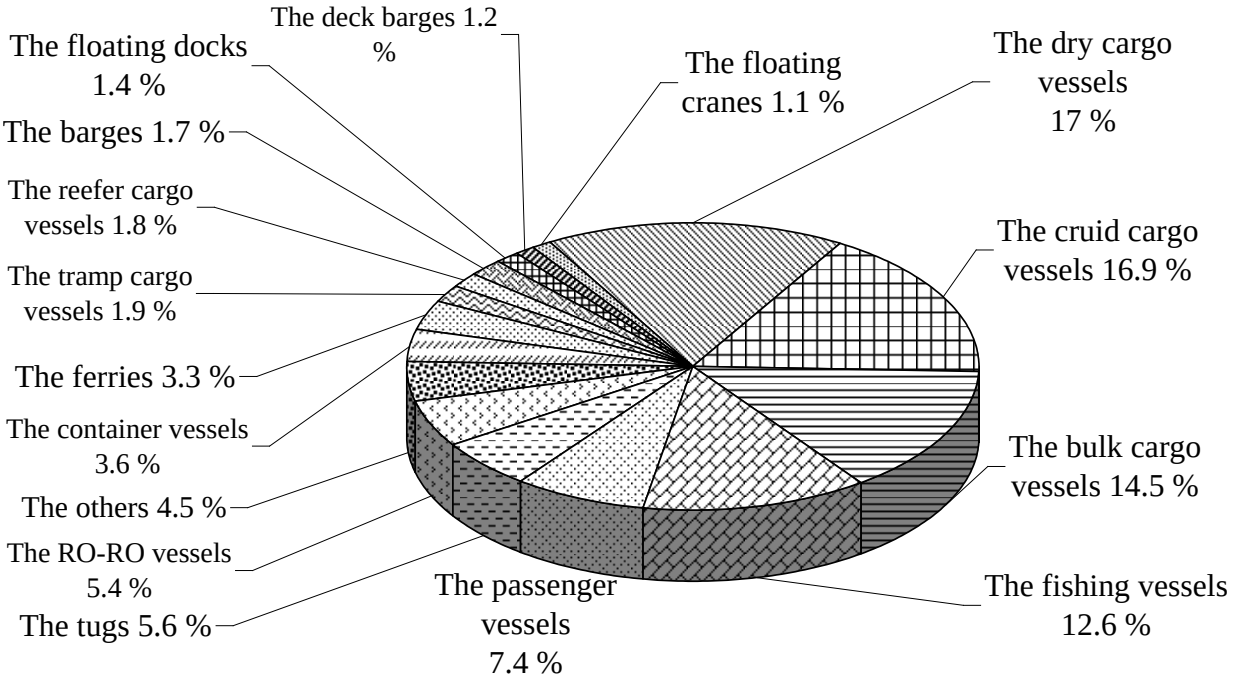



Fig. 4.3. The parity of the commercial vessel number in classes in the offers for sale and for construction

When using the holds volume *W* as the characteristic of comparison of the refrigeration vessel while processing the statistical data of marketing researches it is determined, that approximation factors are: $a_1 = 1.500$, $a_2 = 1.255$, $a_3 = -0.00011$.

The regression dependence of the dry–cargo refrigeration vessel value on age *t* and the unit of comparison, which is hold volume *W*, after derivations looks like:

$$MV = 0.01694 \times W^{1.255} \times e^{-0.00011 \times W} \times ((1+0.09)^{50-t} - 1)^{1.044}, \text{ thousand US dollars.} \quad (4.11)$$

One important remark to the formula (4.11) is: the capacity of cargo holds of the refrigeration vessel in databases is presented in cubic feet in some cases; for formula application the correct transformation of dimensions is required, keeping in mind that 1 cubic foot corresponds to 0.02832 cubic ms.

The graphs of statistical observations of the vessel value relation to holds volume *MV*/*W* in dependence on age *t* and statistical regression are shown below (fig. 4.5).

Some useful information: the average value of the refrigeration vessels age offered for sale makes 18.9 years, deadweight – 4990 t, hold volume – 6400 cubic ms.

The efficiency of investments into construction and productive operation of the refrigeration vessel makes 9.0 %, that is, the discounting rate free from external risk is $i \approx 0.09$.

When substituting the specified value of the discounting rate *i* in to the factor $(((1+i)^{T-t} - 1)/((1+i)^{T} - 1))^{i/\ln(1+i)}$ the greatest conformity of approximation results with data of marketing researches is reached.

The economic life time of cargo refrigeration vessels according to marketing researches makes approximately 50 years.

The specified value of life time is determined by extrapolation of regression dependences to its crossing with the axis of abscises for using in the structure of regression dependences of value on age.

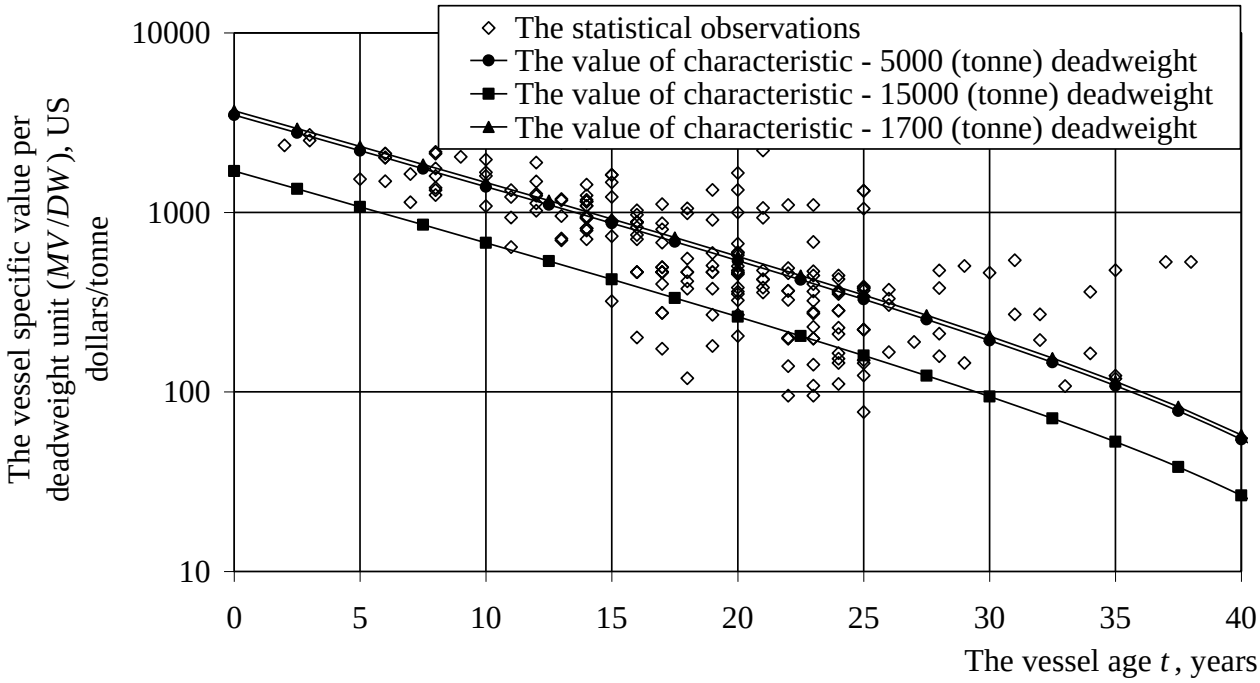



Fig. 4.4. The dependence of the reefer cargo vessel specific value per unit of deadweight on years

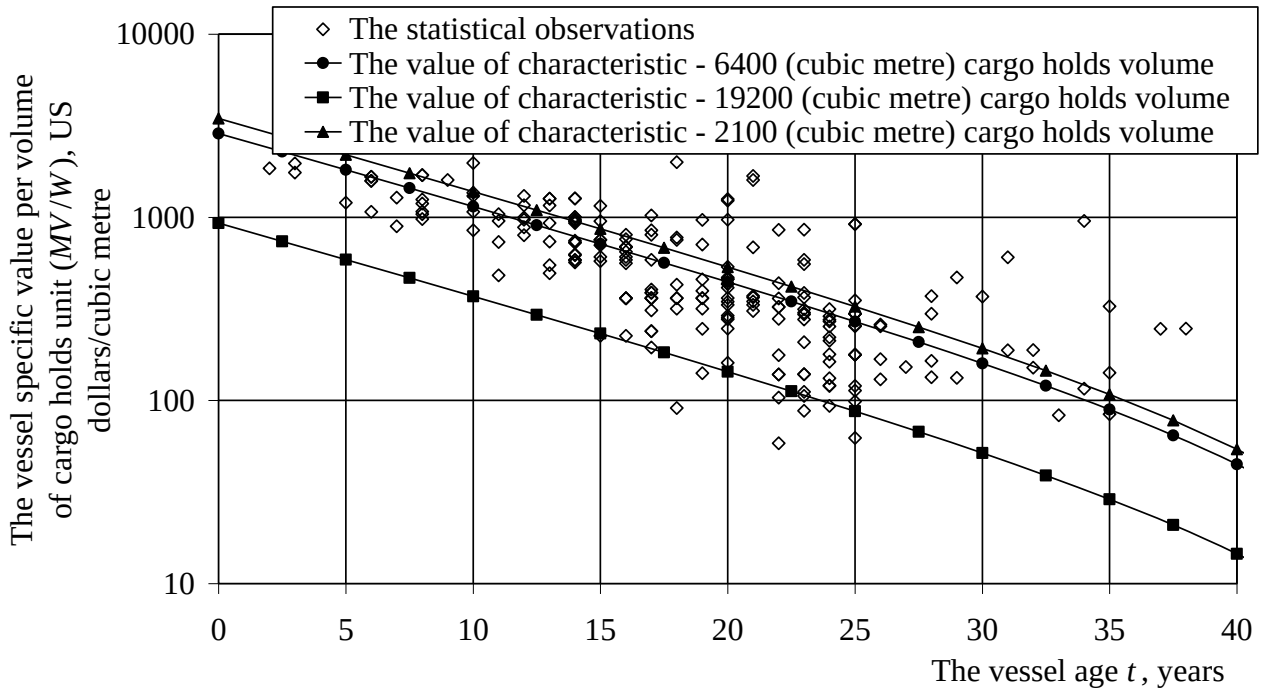



Fig. 4.5. The dependence of the reefer cargo vessel specific value per unit of cargo holds volume on years

Actually the life time of commercial vessel is a little bit less than the index of economic life time and corresponds to the value reduction below the scrap value.

The average weighed value of refrigeration vessel structural durability makes approximately 45 years.

As a characteristic of comparison of the multi–purpose dry–cargo vessel one should use the index of the commercial vessel length and breadth ($L \times B$) product which characterizes the deck and hold area, that is, capacity of a commercial vessel by the floor space.

When using the indicator of commercial vessel length and breadth ($L \times B$) product as the unit of comparison for processing of the marketing researches statistical data it is determined, that approximation factors are: $a_1 = 0.125$, $a_2 = 1.90$, $a_3 = -0.0035$.

The regression dependence of the value of the multi–purpose dry–cargo vessel on the age $t$ and unit of comparison, that is, the index of the product of commercial vessel length and breadth ($L \times B$) after derivations looks like:

$$MV = 0{,}00659 \times (L \times B)^{1{,}90} \times e^{-0{,}0035 \times (L \times B)} \times ((1 + 0{,}060)^{50-t} - 1)^{1{,}030}, \text{ thousand US dollars.} \quad (4.12)$$

The statistical observations of the multi–purpose dry–cargo vessel value relation to the index of commercial vessel length and breadth product ($L \times B$), that is $MV$ / ($L \times B$), in dependence on age $t$ and the index of the length and breadth product ($L \times B$) and also the graph of statistical regression are shown below (fig. 4.6).

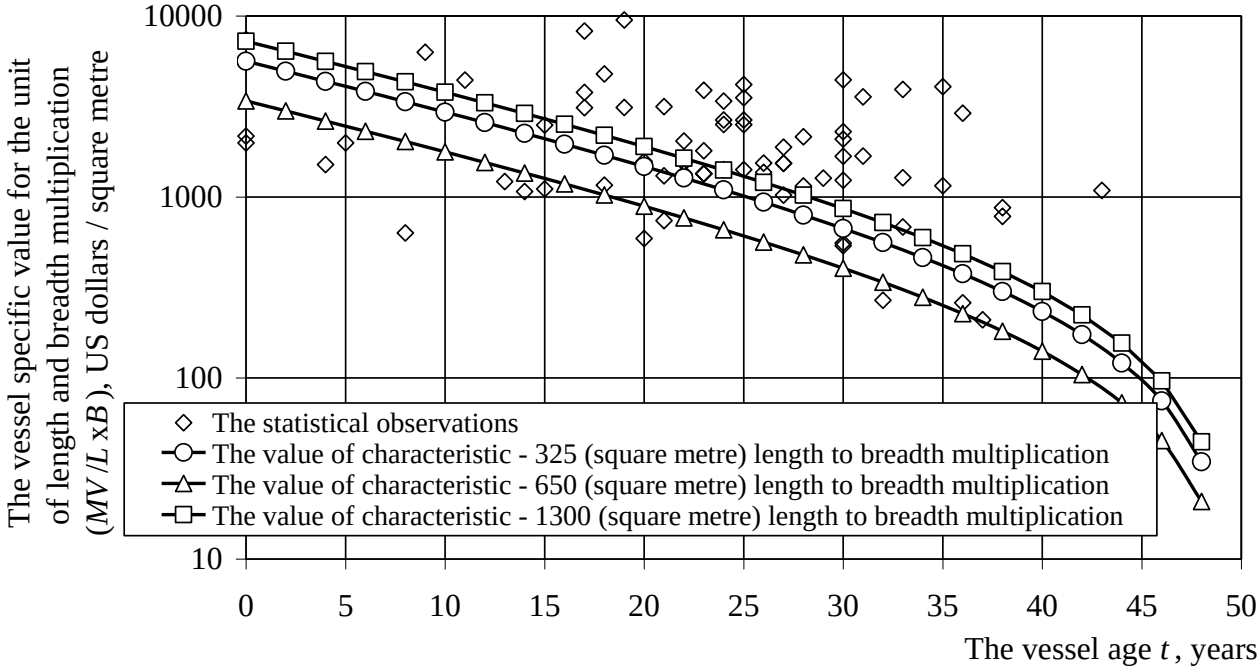



Fig. 4.6. The dependence of the dry cargo vessel specific value per the length and breadth multiplication unit on years

On the basis of the discounting rate $i$ value selection by market extraction method with the account other considered assumptions concerning statistical regression and the unit of comparison, it is determined that discounting rate $i$ value free from external risk when investing in construction and productive operation of the multi–purpose dry–cargo vessel makes about 6 %, that is $i = 0.060$.

From the statistical observations of data about value of multi–purpose dry–cargo vessels by extrapolation of statistical regression to crossing of the axis of abscisses When using the index of commercial vessel length and breadth ($L \times B$) product as the unit of comparison, it is determined that the economic life time of the vessel makes about 50 years.

The structural durability of the multi–purpose dry–cargo vessel is a little bit less, than the economic life time specified above and corresponds to the value reduction below the scrap value that makes approximately 45 years.

The regression dependence of the vessel value for transportation bulk cargoes looks like:

$$MV = 0.15 \times DW^{1.625} \times e^{-0.00010 \times DW} \times (1.063^{66.5-t} - 1)^{1.031}, \text{ thousand US dollars.} \quad (4.13)$$

Reference data: the average value of vessels age offered for sale used for transportation of bulk cargoes makes 20.6 years, deadweight – 15775 t, draught – 7.51 m.

The value of the discounting rate $i$ free from external risks for investing into construction and productive operation of vessels for transportation bulk cargoes makes $i \approx 6.3$ %.

On the graph (fig. 4.7) the statistical observations and the regression dependence of the vessel value for transportation bulk cargoes are presented.

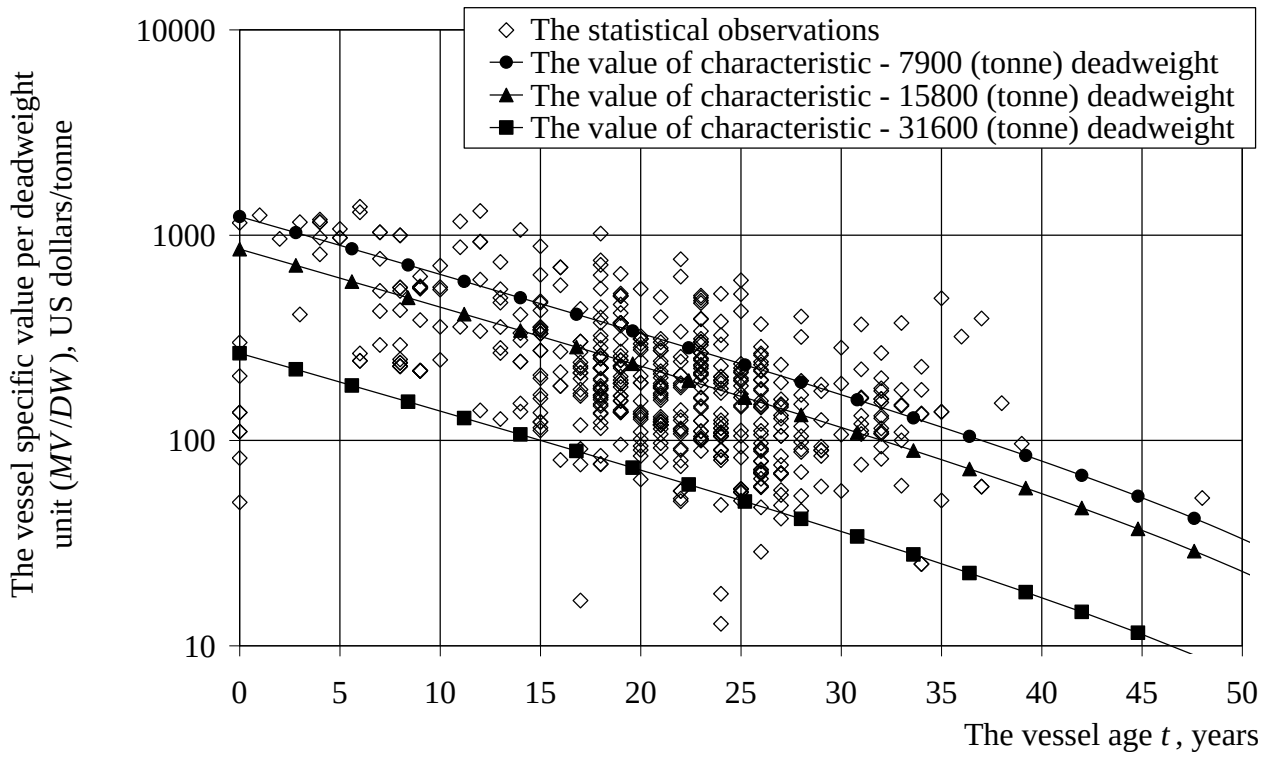



Fig. 4.7. The dependence of the bulk cargo vessel specific value per the deadweight unit on years

The regression dependence of value of the crude–cargo tanker on age and deadweight looks like:

$$MV = 0.00438 \times DW^{1.234} \times e^{-0.000038 \times DW} \times (1.09^{53-t} - 1)^{1.044}, \text{ thousand US dollars.} \quad (4.14)$$

On the schedule (see fig. 4.8) the statistical observations and the regression dependence of value of crude cargo tanker are presented.

Some useful information: the average value of the age of the crude cargo tankers offered for sale makes 21.2 years, the lengths – 109 m, deposits – 6.6 m, deadweight – 13400 t, holds capacity of bulk tanks – 28500 cubic ms.

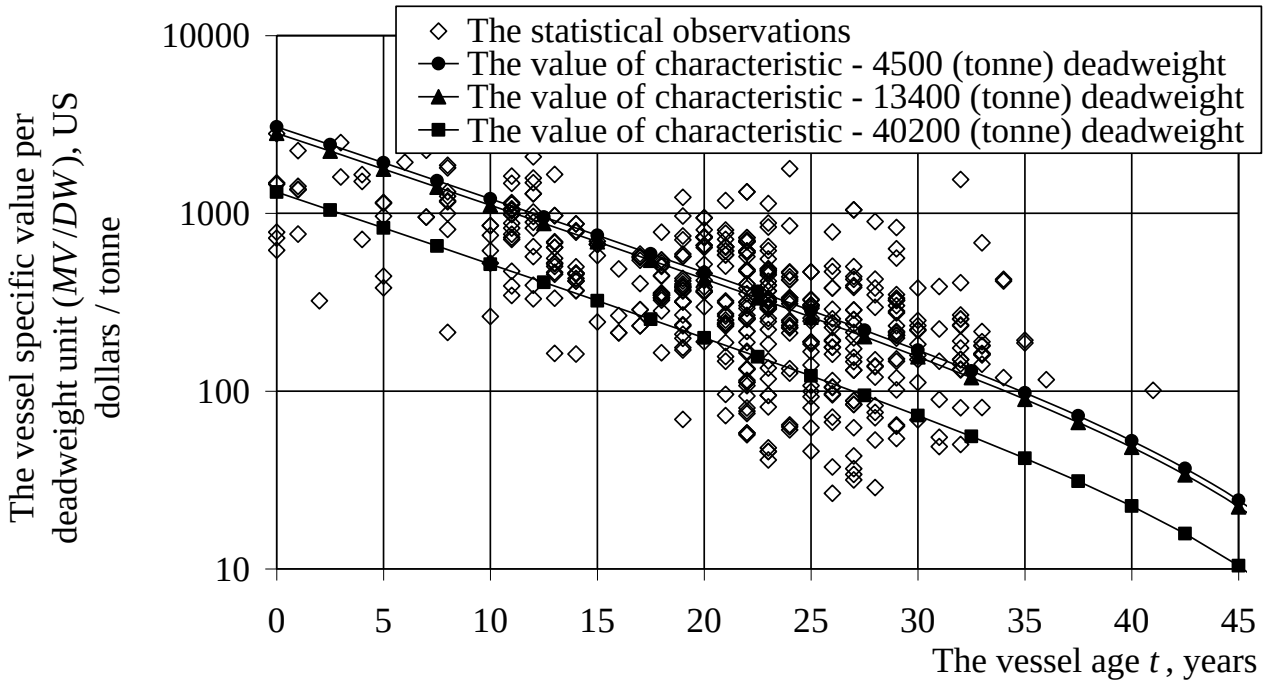



Fig. 4.8. The dependence of the cruide carrier specific value per deadweight unit on years

The discounting rate for investments into construction and productive operation of crude–oil tankers free from external risk is $i \approx 9.2$ %.

While making marketing researches concerned with offers for construction and sale of rolling cargo vessels it is possible to use deadweight or capacity as the characteristic of comparison.

To preserve uniformity with the results of researches of cargo vessels the deadweight $DW$ is used for cargo vessels of other classes.

It is considered also, that for rolling cargo vessels the relation of capacity to deadweight is basically a property of the cargo, instead of a vessel characteristic, and it makes (according to the studied statistical set) on the average 1.80 cubic ms/t, taking into account also the possibility to take the cargo on open deck.

The regression dependence of the rolling cargo vessel value on age $t$ and the unit of comparison (it is the deadweight $DW$), considered looks like:

$$MV = 0.723 \times DW^{0.722} \times e^{-0.000014 \times DW} \times (1.07^{50-t} - 1)^{1.0346}, \text{ thousand US dollars.} \qquad (4.15)$$

The statistical observations and the regression dependence of rolling cargo vessel value on years are shown on the graph below (fig. 4.9).

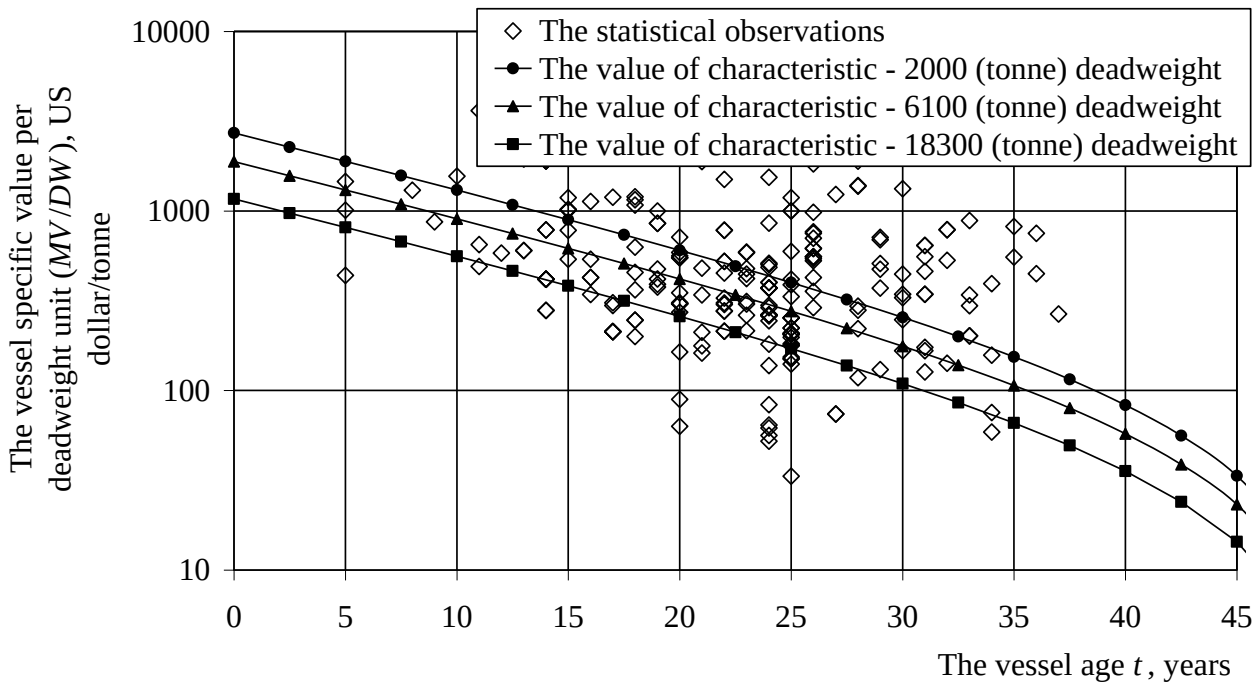



Fig. 4.9. The dependence of the RO-RO vessel specific value per deadweight unit on years

For reference: the average age of the rolling cargo vessels offered for sale makes 22.9 year, deadweight – 6029 t.

The discounting rate for investments into construction and productive operation of rolling cargo vessels free from external risk received by data processing of marketing researches was determined as $i \approx 7.0$ %.

The results of marketing research of rolling cargo vessels' value are presented on the graph (fig. 4.10).

The regression dependence of value on age $t$ and the unit of comparison that is the length $L$ looks like:

$$MV_2 = 24.05 \times L^{1.40} \times e^{-0.005 \times L} \times ((1+0.02)^{50-t} - 1)^{1.010}, \text{ thousand US dollars.} \quad (4.16)$$

Units of comparison chosen for marine steel fishing vessels are as follows:

– Net register tonnage – *NRT*, estimated under the International Convention on Tonnage Measurement of ships 1969;

– Power of the main engine of the vessel – *Ne*;

– Area index corresponding to the product of commercial vessel length (length over all, dimensional, designated *L*, of vessels offered for sale it is also designated as *LOA*) and the breadth of the vessel – ($L \times B$).

When using the net register tonnage *NRT* as the unit of comparison for data processing of statistical observations it is determined that approximation factors are:
$a_1 = 1.335$, $a_2 = 1.25$, $a_3 = -0.00035$.

According to the statistical observations and extrapolation of statistical regression to its crossing with the axis of abscises, when using the net register tonnage *NRT* as the characteristic of comparison of marine steel fishing vessel, it is determined that the life time makes 55 years.

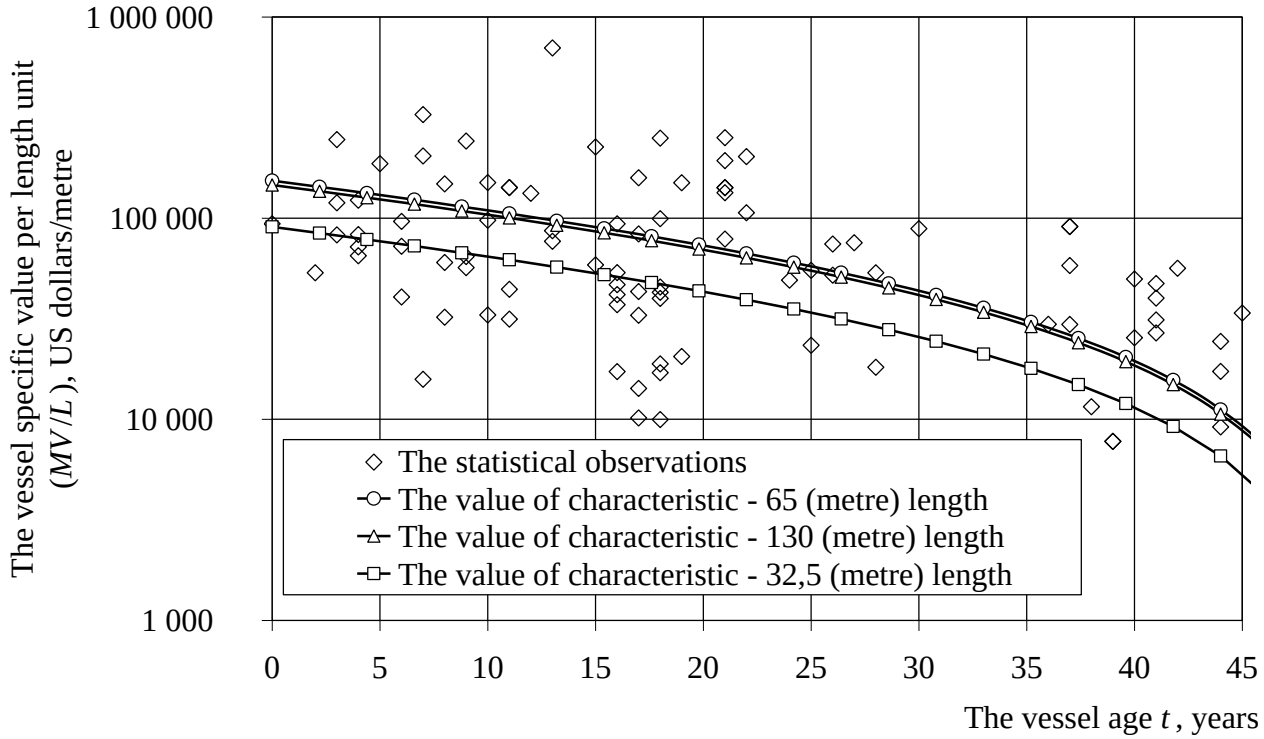



Fig. 4.10. The dependence of the RO-RO specific value iper length unit on years

On the basis of selection the discounting rate *i* free from external risk by the market extraction method is determined that is the rate value of investment in construction and productive operation of fishing vessel makes about 2 %, i.e. $i \approx 0.02$ if value is determined per the unit of net register tonnage.

While substituting the given discounting rate *i* the precise correspondence with the result of marketing researches investigation is achieved in case if the net capacity *NRT* is used as a unit of comparison.

The regression dependence of the marine steel fishing vessel value on age *t* and the unit of comparison (with the net register tonnage *NRT* as a unit of comparison) after derivations looks like:

$$MV = 0.6724 \times NRT^{1.25} \times e^{-0.00035 \times NRT} \times ((1+0.02)^{55-t} - 1)^{1.01}, \text{ thousand US dollars.} \quad (4.17)$$

The figure of statistical observations of the fishing vessel value relation to net register tonnage *MV*/*NRT* in dependence on age *t* and tonnage *NRT*, and also the graph of the statistical regression are shown below (fig. 4.11).

When the main engine power *Ne* is chosen as the unit of comparison the processing of the statistical data of the marketing researches has shown that the approximation factors are: $a_1 = 0.22$, $a_2 = 1.23$, $a_3 = 0.0$.

On the basis of selection of statistical observations results of approximation it is determined, that the value of the discounting rate free from external risks *i*, while investing in construction and productive operation of fishing vessel, makes nearby 1 %, i.e. $i \approx 0.01$ – for an option of value estimation per the main engine power unit.

The regression dependence of fishing vessel value on age *t* and the unit of comparison (with the main engine power *Ne* as a unit of comparison) after derivations looks like:

$$MV = 0.342 \times Ne^{1.23} \times ((1+0.01)^{50-t} - 1)^{1.005}, \text{ thousand US dollars.} \quad (4.18)$$

The figure of statistical observations of the fishing vessel value relation to main engine power *MV*/*Ne* in dependence on age *t* and main engine power *Ne* and also the graph of statistical regression are shown below (fig. 4.12).

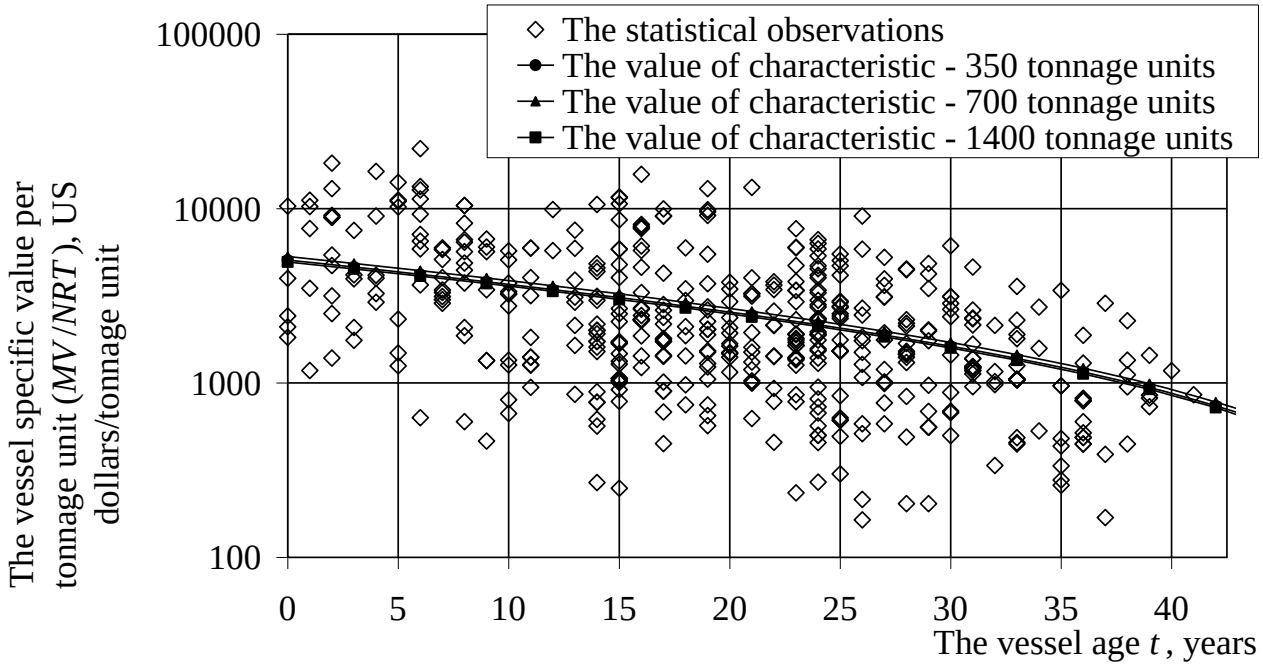



Fig. 4.11. The dependence of the fishing vessel specific value per net register tonnage unit on years

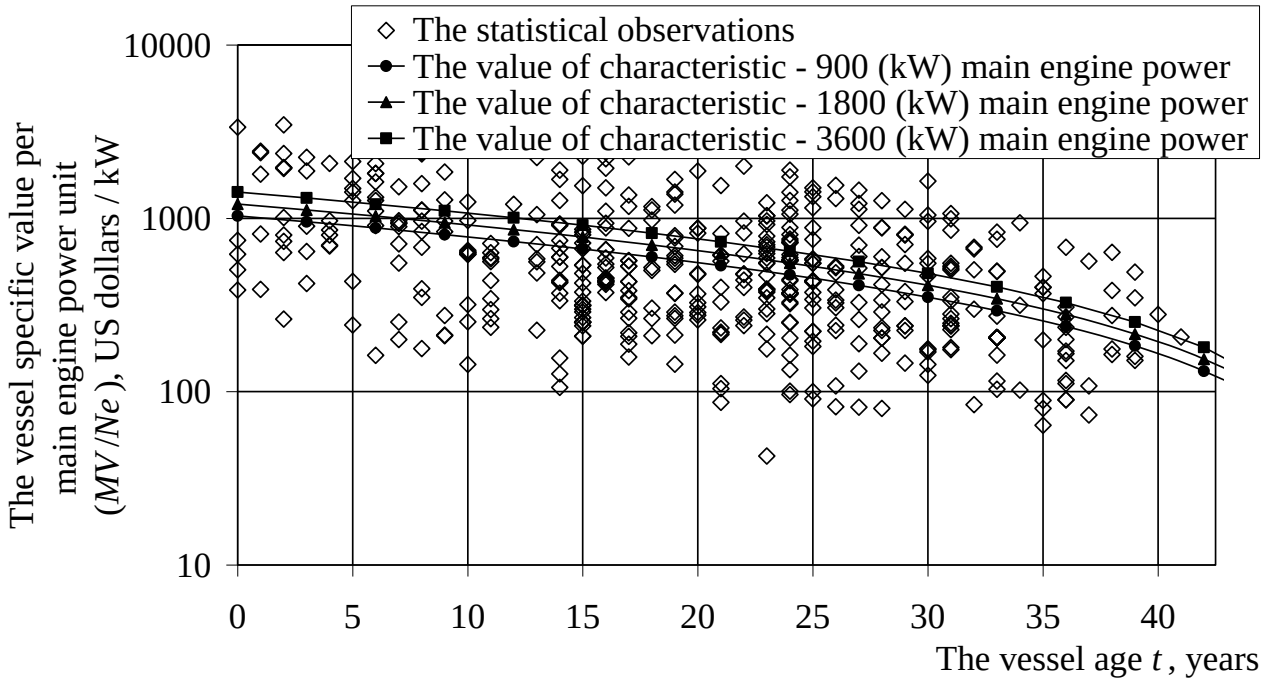



Fig. 4.12. The dependence of the fishing vessel specific value per main engine power unit on years

With the area index (the product of the vessel length over all and the vessel breadth – $L \times B$) as the unit of comparison for processing of the statistical observations data it is determined that the approximation factors are: $a_1 = 1.09$, $a_2 = 1.25$, $a_3 = -0.00026$.

Using extrapolation of statistical regression to the crossing with the axis of abscises (with the area index – product of the commercial vessel length and vessel breadth – $L \times B$) chosen as a unit of comparison it is determined that the indicator of economic life time is equal 53.5 years.

On the basis of selection it is determined that the value of the discounting rate free from external risks $i$, when investing into construction and productive operation of the fishing vessel, makes about 2.3 %, that is $i \approx 0.023$ – for option of the value estimation per the main engine power unit.

The regression dependence of fishing vessel value on age $t$ and the unit of comparison with the index of area $L \times B$ is considered (the product of commercial vessel length and the breadth) after derivations looks like:

$$MV = 0.455 \times (L \times B)^{1.25} \times e^{-0.00026 \times (L \times B)} \times ((1 + 0.023)^{53.5 - t} - 1)^{1.01}, \text{ thousand US dollars.} \quad (4.19)$$

The graph of statistical observations of the fishing vessel value ratio to index of area $MV$ / ($L \times B$) in dependence on age $t$ and the index of area $L \times B$ and also the figure of the statistical regression are shown below (fig. 4.13).

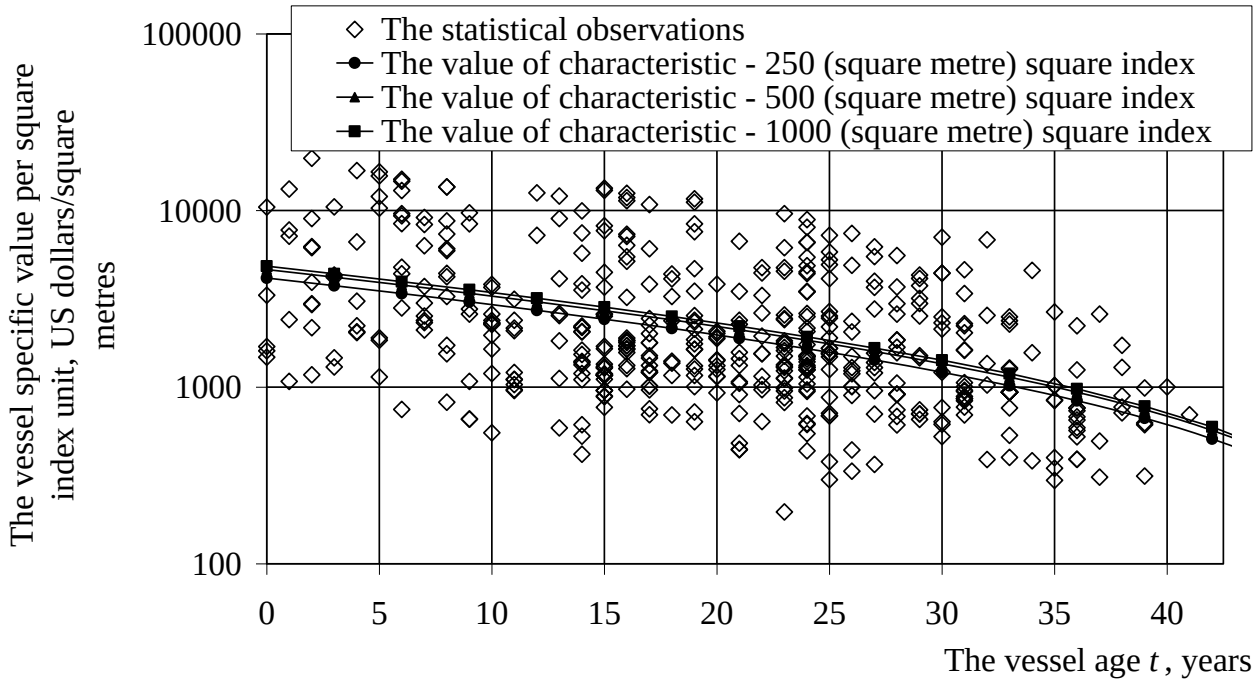



Fig. 4.13. The dependence of the fishing vessel specific value per square index unit (product of vessel length and breadth) on age

Some useful information: the average value of age of fishing vessels offered for sale is 20.0 years, the lengths – 40.5 m, the breadth – 8.8 m, the main engine power – 1790 kW, tonnage – 6316.4.

The average weighed value of the discounting rate free from external risk for investments into the construction and productive operation of the marine steel fishing vessel

determined by the market extraction method from the set of values: 2.0 %, 1.0 %, 2.3 % which correspond to use of tonnage, power of main engine and the index of area as units of comparison to create regression dependences of value on age, makes approximately 2.0 %.

The average weighed value of the marine steel fishing vessel life time determined on the basis of vessels values analysis of marketing data is determined from the set of values: 55.0, 50.0, 53.5 years and it is approximately 53.0 years. The specified values of life time are used in the structure of regression dependences of value on age and received by extrapolation of regression dependences to their crossing with the axis of abscises.

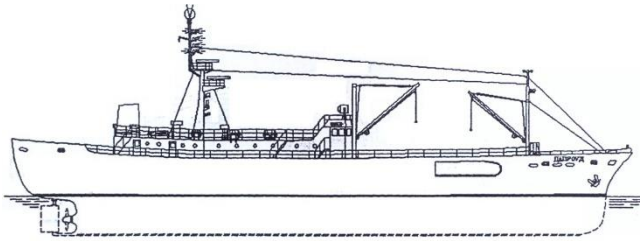
According to the marketing researches the average value of the fishing vessels offered for sale, which are more than 50 years old, is less than the scrap value.

The life time determined by extrapolation of regression dependences of the vessel value on age before crossing with the axis of abscises should be estimated only as an element of regression and a datum for value determination by independent approaches since the real life time is also connected with arising risks and actual writing off the operating vessel for scrap is in a greater degree a result of risks estimation. This fact shows that for an operating vessel the dependence of value on age should to be correlated methodologically with the life time estimation according to the statistical regression with the account life time with the age of the vessel approaching its upper limit the error of estimation grows and at the maximum of vessel years the error of estimation becomes proportionate to the value itself.

The methodological value of the regression analysis of statistical observations of vessels' value marketing data is in the fact that keeping in mind the stated concepts and recommendations the same analysis can be done for other classes of vessel (or in case of macroeconomic changes) when the results must be used for estimation based on comparable sales approach and also for determination of life time and interest rate free from external risks (retrospective) according to the discounting rate that can be applied for estimation by independent approaches.

**Test questions**

1. Most widespread cargo vessels classes at offered to sale.
2. Cargo vessels class, offered for sale of the greatest tonnage.
3. Determination of the discounting rate free from external risks by the market extraction on the basis of the statistical approach analysis for commercial vessels classes.
4. Determination of commercial vessel life time on the basis of the regression dependence analysis.
5. Theoretical (economic) and structural durability of a commercial vessel.
6. Correlations of vessel years, life time and an error of estimation.



# 5. Methodological features of commercial vessel estimation based on cost approach

The systemic estimation of reproduction cost *RC* (or replacement cost), along with the depreciation and obsolescence is of great importance in the process of value estimation of the vessel or other asset.

Reproduction cost *RC* is a sum of expenses for construction of structural analogue in market prices on the date of estimation. Replacement cost is a sum of reproduction cost of a functional analogue. And the structural analogue is also a functional analogue.

The estimation of reproduction cost can be done separately as an independent subject, when there is a revaluation of the real assets, that except rules of an expert estimation is regulated in this case not only by the rules of an appraisal but also by book keeping standards.

For example, in Russia by Book Keeping Regulations PBU 6/01 (ПБУ 6/01) «… the commercial company can not more often than once in a year (for the beginning of fiscal year) re–estimate groups of homogeneous objects of the real assets at present (reproduction) cost by indexation or by direct recalculation based on documentary confirmed market prices».

According to methodological instructions of book keeping the real assets (the Order # 91–n (91 н) from October, 13th, 2003 of Ministry of Finance of the Russian Federation) it is defined, that «… current (reproduction) cost of the real assets objects is understood as a sum of cash which should be paid by the company on the date of revaluation if there is a need of replacement of any object ».

The revaluation is made for groups of the same real assets. If the revaluation of the real assets has already been, subsequently, the revaluation is made annually for the beginning of the present year and presented in the tax reporting from the beginning of the year following for accounting.

It should be noted that book keeping standards in some cases contain ambiguous definitions, and much leaves to the discretion of the expert.

For example, on the one hand, under book keeping Regulations, when making revaluation it is required to determine of reproduction cost in «market prices» with the account that in the case of replacement of any asset, it should be necessary to pay the sum of cash which corresponds to its market value on date of revaluation.

At the same time, according to the book keeping Regulations the expert determination of depreciation is not required when revaluating the assets, though it’s quite clear that the replacement of the asset whish was in operation and is subject to depreciation does not, mean acquisition of the same not a new asset, which is subject to depreciation.

## 5.1. Economic models of commercial vessel reproduction cost

Recommended by different authors methods of determination of reproduction cost (market costs for construction) of commercial vessel are the following:

1) Estimation is done according to usual contract prices of similar vessels constructing set for the time as much as possible approached to the date of estimation;

2) Estimation is done on the basis of data of vessels construction costs, published in specialized directories, catalogues, advertizing brochures of shipyards, standard regulations of vessels estimation and revaluation, published by corresponding services;

3) Estimation is done on the basis of expenses calculations in order to get an exact replica of the commercial vessel, or a vessel of equal utility on the date of estimation.

It is possible to see, that first two methods are based on application of the comparable sales approach and differ by data sources, and the third method is close to working out of the facility dependent cost estimate.

It's clear, that is not provided use of the income approach while determining of the reproduction cost.

Strictly speaking, it is not quite logical and probably indicates at mixing of concepts: on the one hand, the concepts of reproduction cost as the total of expenses for vessel construction in present market prices, and on the other hand, the method of expenses components summation to determine reproduction cost as under the cost estimate.

As the reproduction cost evaluated in market prices is formed not only during the vessel construction, but also while it is transferred to the shipping company which, when it makes payment is guided by expected profitableness even if terms of the contract are defined prior to the beginning of the vessel construction, it is possible to make a method of value estimation under the income approach for a new vessel, i.e. estimations of the reproduction cost which in the market conditions and the compromise interests of the new vessel seller and the buyer is closely connected with its reproduction cost, and also, with expected profitableness.

The analogy is pertinent. In spite of the fact that the displacement of a commercial vessel is equal to the total of its parts, the method of displacement determination does not necessarily consists of weights of the parts of the summation, and it is possible to determine the weight of the displaced water under the Archimedes law, that is also truly indicates the displacement of the vessel.

By the way, the application of three approaches set, if besides the use of the comparable sales approach and a method based on summation of expenses it is possible to make up and apply correctly the income approach to market value estimation of a new asset (or vessel), is methodologically more valid for expert revaluation of a fixed capital as it has to be reflected in the accounting reporting according to appraisal standards.

While determining the reproduction cost of not a new vessel it can be difficult to determine by the expert opinion the total of construction expenses in market prices on the revaluation date if the data of expenses for construction are lost or have become outdated.

At the same time, the data for not a new vessel about its profitableness in the property complex are collected. In this case the application of the income approach for determination of the market value of a new similar vessel (or another asset) and further reproduction cost on the date of its revaluation with the account necessary adjustments to the market value along with use of the comparable sales approach to determine the reproduction cost of serial vessels (or other assets of the marine company) can make a basis of the of revaluation general algorithm.

If the method of determination of the reproduction cost is based on summation the following kinds of expenses which should be taken into consideration while determining

the reproduction cost of a commercial vessel (or a vessel of equal utility if the objective is to determine the replacement cost) are usually provided.

1. Direct costs.

1.1. Cost of materials, purchased machines, mechanisms, products and equipment.

1.2. Wages of the basic industrial workers.

1.3. Special expenses, including connected with use of construction and lifting facilities: a construction berth, a dock or a building slipway.

1.4. A shop overhead charges, including charges for equipment operation and shop general charges.

1.5. General manufacturing expenses.

1.6. Non–production expenses.

1.7. Shipyard profit.

2. Indirect costs.

2.1. Expenses for payment of the designing, technical supervision and control over the vessel construction.

2.2. Payment of consultations, inspection (survey), supervising, legal and auditor services.

2.3. Expenses for financing, repayment of credits and interest.

2.4. Expenses for advertising, marketing and vessel sale.

2.5. Administrative expenses, fee and profits of developer.

3. Enterprise profit (except the profit of developer and the creditor), including taxes.

The types of expenses listed above are entered in a «technological» binding that is from the point of view of a shipyard instead of an object – a vessel and can be attributed to the structure of expenses for objects of various classes, not only for commercial vessels or marine engineering and ocean technology.

To calculate he expenses besides labor input of construction it is necessary to apply scientifically proved standard of a payment, when reproduction cost of a commercial vessel will not exceed solvent demand of the future ship–owner and it will be paid back by the profit.

In frameworks of the cost approach for value estimation of marine commercial vessels or other real assets as a part of the marine company's property complex it is rather reasonable to develop and use the models of reproduction cost.

Working out of models of cost was carried out at the branch scientific research institutes of the shipbuilding industry and shipping, at profile universities, etc. The model of reproduction cost can be defined as a data system (graphs, tables, databases and so forth) and rules of reproduction cost calculation (mathematical equations, algorithms, instructions, methodical manuals etc.).

Models of expenses summation don't always provide acceptable accuracy of the reproduction cost total value estimation and should be used in addition to other methods of the reproduction cost estimation.

The use of reproduction cost models nevertheless allows solving the structural tasks, with the account the above mentioned remark including the following ones:

– To formulate signs (characteristics) of comparability and to define units of comparison;

– To define the structure of reproduction cost that is applied further for an estimation of depreciation based on method of «separation».

The use of models of reproduction cost of commercial vessel or other real asset of the marine company allows defining:

A) The structure of reproduction cost, that is specific or percentage ratio of various components as a part of reproduction cost;

B) The correlation of reproduction cost of different vessels or ranging of vessels in sequence of its decrease or increase;

C) The monetary value of reproduction cost.

Concerning the last point from the specified tasks (C) it should be noted that not any models of reproduction cost reflect the influence of market variability on cost. Some models of cost known by industrial and scientific publications consider only vessel characteristics.

The reproduction cost (or replacement cost) is an important economic concept and can be applied for the solution of some tasks:

– For definition of requirements in contracts for fleet replenishment;

– As the optimality criterion in some design subjects;

– As intermediate value in estimation of commercial vessel market value, in economic estimation of depreciation etc.

## 5.2. Integrated structural components as a part of the commercial vessel reproduction cost

Usually reproduction cost is determined as the total of components to which can be referred the values of either the several integrated infrastructural parts (groups) or several technological parts, and sometimes the compromise option of reproduction cost separation into components – simultaneously into structural and technological groups is applied.

Reproduction cost of a vessel $RC$ as the total of addends $RC_n$ is determined as $RC = \sum RC_n$ .

The ranging of industrial expenses components, that is addends of reproduction cost into groups $RC_n$ is made on the basis of dependence on commercial vessel technical characteristics or their combinations uniformly influencing cost, for example as follows:

– Purpose;

– Displacement and its components;

– Displacement empty;

– Cargo capacity;

– Deadweight;

– Type and power of the main engine;

– Dimensions;

– Tonnage;

– Characteristics of used materials;

– Ice forcing class etc.

The following infrastructural parts of expenses can be referred as a part of commercial vessel reproduction cost $RC_n$ .

– Vessel hull (the hull of commercial vessel or its separate parts with framing, erecting parts, bulkheads, decks, platforms, piecks, cabins and superstructures);

– Vessel hull equipment (the equipment of general purpose used on commercial vessels of various classes, except for the special purpose equipment);

– Deck devices and general purpose systems (except for the systems concerning main engine and power–plant);

– Main engine and power–plant, mechanisms, systems and the engine room equipment;

– Special equipment – load–lifting, towing, etc.;

– Shipbuilding equipment.

The similar method of ranging of the integrated infrastructural parts of expenses was used in a technique of vessels economic indexes estimation [16], developed in the Central scientific research institute of a marine fleet (CNIIMF).

The advantage of the considered method of CNIIMF is the ability to take into account the influence of the vessel characteristics on reproduction cost (or replacement costs) components.

Doubtless advantage of models which are created according groups of structural separation is the possibility to make a in–depth analysis of reproduction cost of not only one vessel, but also the different projects which being constructed at one as well as at different shipyards.

It is supposed, that cost detalization within reasonable limits adds to evaluation objectivity until the error of estimation does not exceed some articles of reproduction cost. Thus, it is considered, that the error of an expert estimation of separate articles of expenses can be both positive and negative.

In reproduction cost components summation, the errors of different signs are mutually compensated, and consequently the error of reproduction cost estimation (that is costs total) is less than errors of components anyway in their relative value.

Classification of industrial reproduction costs $RC_n$ by technological signs was used in the technique of the Central scientific research institute «Rhumb» of the shipbuilding industry.

The following items can be referred to the costs components according to their technological attributes:

– Direct material inputs – materials, half–finished products, counter agency deliveries of details, assembles and units;

– Expenses for transport, communications, utilities etc.;

– Wages of the basic workers, auxiliary workers, engineers, scientists, management personnel, etc.;

– Profit and taxes.

The advantage of the industrial expenses $RC_n$ classification method by technological attributes is the ability to consider change of resources costs (materials, deliveries, work …), and also rates (taxes, insurance coverage, indexes of profitability and commercial risks …).

Professor L.B. Breslav [9] advised to use the so–called «matrix» models representing tabular forms where classification attributes of ship construction costs vary in the lines and columns for estimation of shipbuilding costs total, and double summation is made to determine the reproduction cost by components $RC_{n,m}$ of costs $RC = \sum\sum RC_{n,m}$ .

For example, expenses in various columns can refer to different infrastructural parts: the vessel hull, the hull equipment, the vessel systems and devices, the vessel power–plant …, and in various lines – to different technological groups: materials, counter agency deliveries, wages, overhead charge, taxes … profit.

Using this way of calculation, the industrial costs for each infrastructural part are determined as the total of technological groups of costs and vice versa, and different concepts of costs systematization are interrelated as a whole.

The basis of value estimation in industry is the definition of expenses for salary and for purchase of material resources. The following items: materials, electric power and energy sources, counter agency deliveries, etc. can be referred to resources.

The main part of ship hull structures of vessels is made from carbon steel which is very cheap, strong and technologically suitable for welding, and also used in rolling and punching manufacture.

For most of marine commercial vessels the weight of carbon steel makes more than 97 % of the hull weight. The same is true for vessel's power–plants, mechanisms, elements of devices and systems structures which are not made at the shipyard, but are delivered by contractors.

Besides, steel of low alloy, pig–iron, nonferrous metals and nonmetallic materials can be applied in hull structures but scarily.

For the analysis it should be reasonable to compare the cost of one t of steel and the cost of one t of shipbuilding metal frameworks construction.

Expenses for steel purchase as parts of commercial vessel reproduction cost, despite great total cost, are not a dominant component of costs and vary from 15 to 20 %, including cost of energy in expenses for metallurgical process and cost of steel which goes to waste.

The greatest quantity of power resources is consumed for metallurgical process of carbon steel and other metals used in shipbuilding.

Thermal or machining processing of structural materials at the ship yard consumes much less energy.

Thus, cost of the most part of energy sources spent for commercial vessel construction is finally included into cost framework of structural materials.

As energy expenses referred to one t for the metallurgical process much more than metal processing energy expenses it is possible to consider that the indicated specific value more completely characterizes material resources share as a part of vessel construction costs.

Thus it is necessary to underline that it is a question of the commercial vessel reproduction cost structure instead of the structure of ship yard indexes which does not carry out the metallurgical process.

The reproduction cost of a commercial vessel to a large degree includes the added value and is mainly a sum of variable components: salaries, direct material inputs, profit of the shipyard.

Reproduction cost is established with respect to the added value defined at the level to which the new vessel will be in the market demand.

That's why to estimate the reproduction cost the forecast of commercial vessel productive operation by means of working out and use of market pricing models is also required.

The breaking up of the cost into the integrated parts (vessel hull, hull equipment, systems and devices, vessel power–plant …) makes modeling of the reproduction cost of commercial vessel or other real asset more specific and informative, since classification of expenses by technological groups (materials, counter agency deliveries, salary, overhead charge, taxes, … profit) for shipbuilding and for other industries is similar in many respects.

The breaking up of reproduction cost into the integrated infrastructural parts gives the chance to establish dependences of cost by groups and in total on characteristics of commercial vessel or other real asset of the marine company and to use the received dependences for cost determination, and also for feasibility analysis and optimization of the project characteristics by economic criteria.

Besides, the dependences of reproduction cost of the infrastructural parts on characteristics of commercial vessel or other real asset of marine company can be applied for accumulation and processing of statistical data and for approximation. It cannot be executed when reproduction cost broken into technological groups.

Nevertheless, the following methodological difficulties arise while making the analysis of the integrated groups as a part of reproduction cost of commercial vessel.

The concept of a cost of the integrated infrastructural part is defined insufficiently. It is impossible, for example, to imagine the engine room equipment as a collected operating system existing separately from the vessel as a whole.

Therefore, insufficient clearness of the methodological definition of the integrated infrastructural part can cause indeterminate of its estimation.

It is necessary to specify, that it is the correct estimation of cost as a part of reproductive cost that is of practical value rather than the concept of the integrated infrastructural part.

At this point «cost of infrastructural part» definition, which could be used for determination of commercial vessel reproduction cost or other real asset of marine company, should be introduced.

To search the answer for the question, let's consider an example. We will represent the reproduction cost of vessel *RC* as a sum of two components depending on empty vessel displacement *DP* and on main engine power *Ne*, figuratively speaking, as a cost of «structures» and «power»: $RC = a_1 \times DP + a_2 \times Ne$.

Factors $a_1$ and $a_2$ define the degree of influence of empty vessel displacement *DP* and main engine power *Ne* on reproduction cost *RC* and also they are scaling as they establish correlation between displacement and power dimensionalities.

It is required, that the characteristics of the commercial vessel used in the formula as params were not interdependent. Strictly speaking, this rule is difficult to achieve.

So, in the given example the main engine power and displacement of the commercial vessel empty are used as params. Clearly, that these characteristics depend on each other. But the choice of other combination can be less successful because all characteristics of the commercial vessel are functionally interconnected.

Factors $a_1$ and $a_2$ in the offered formula are unknown. To determine the factors we masts do either statistical approximation with application of the accepted formula or use the given analogues – two vessels for which are such characteristics as: displacement

empty *DP*, main engine power *Ne* and reproduction cost *RC*, as a sum of expenses in modern market prices for construction, are known.

If, the least necessary number of analogues are applied to determine of factors $a_1$ and $a_2$ is equal to the number of unknown factors. In the considered example it is necessary to use the data of two commercial vessels of similar purpose for which we know the following indexes: reproduction cost *RC*, displacement empty *DP* and main engine power *Ne*.

According to analogues the following values of the specified indexes are accepted:

– First analogue $RC_1$ = 3370 thousand US dollars, $DP_1$ = 1160 t, $Ne_1$ = 885 kW;

– Second analogue $RC_2$ = 9510 thousand US dollars, $DP_2$ = 3220 t, $Ne_2$ = 2888 kW.

As a result we receive the factors values:
$a_1$ = 2.629 thousand US dollars / t and $a_2$ = 0.362 thousand dollars / kW.

Accordingly the parametrical formula to determine the reproduction cost of the commercial vessel as the total of two infrastructural parts looks like

$$RC = 2.629 \times DP + 0.362 \times Ne, \text{ thousand US dollars.}$$

The verifying substitution of values shows that the first item – the part of reproduction cost depending on commercial vessel empty displacement makes about 90 % of commercial vessel reproduction cost, and the second item – about 10 %.

Similarly, it is possible to define in what proportion to each other and to a total sum are the costs of the integrated infrastructural parts in other variants of the set separation depending on other characteristics of the commercial vessel and their combinations influencing the reproduction cost.

Apparently, the concept of the cost of integrated infrastructural part, used for estimation of the commercial vessel reproduction cost, should be introduced using a certain algorithm.

The first step is to work out parametrical, analytical or statistical (regression) dependences of reproduction cost on characteristics of commercial vessel which are important but whenever possible are least interdependent in system sense.

The second step is to study the degree of influence of every included characteristics of the commercial vessel on the reproduction cost and to define what part of the cost can be correlated with each of these characteristics.

The name of the integrated infrastructural part in the given definition corresponds to the characteristic of the commercial vessel with which the part of reproduction cost is correlated.

At every stage the cost of the integrated infrastructural part should be interpreted as the value of the vessel characteristic which justifies the expenses for the construction, and its name can be used to designate this infrastructural part.

Tab. 5 contains rough relative values of elements of reproduction cost of dry–cargo vessels and crude–oil tankers of structural breakdown groups by the published data [18].

Table 5

Relative values of elements of groups of reproduction cost structural breakdown, %

| Elements | Dry–cargo vessels | Crude–oil tankers |
|---|---|---|
| Metal hull | From 21 to 27 | From 35 to 42 |

| | | |
|---|---|---|
| Equipment parts | From 4.5 to 9.0 | From 1.4 to 6.4 |
| Timber, coverings, severalty | From 8.1 to 10.6 | From 5.8 to 8.0 |
| The equipment of premises | From 2.0 to 3.7 | From 1.1 to 1.8 |
| Vessel devices | From 4.8 to 7.0 | From 4.8 to 5.2 |
| Deck mechanisms | From 5.2 to 8.6 | From 2.7 to 4.0 |
| Vessels systems | From 3.6 to 5.1 | From 4.7 to 10.0 |
| Engine room pipelines | From 0.6 to 1.3 | From 0.9 to 2.4 |
| Mechanical equipment | From 4.5 to 8.9 | From 4.3 to 7.6 |
| Electric equipment | From 4.1 to 8.3 | From 3.3 to 5.3 |
| Radio– and navigating equipment | From 1.9 to 3.9 | From 0.8 to 1.8 |
| Supply | From 0.5 to 1.1 | From 0.3 to 0.5 |
| Power plant | From 9.3 to 15.0 | From 6.5 to 9.7 |
| General ship yard works | From 10 to 13 | From 9.5 to 10.5 |

The break up of reproduction cost into groups of elements opens the possibilities to estimate some kinds of depreciation and to reproduce reproduction cost value if its separate elements are known.

**Test questions**

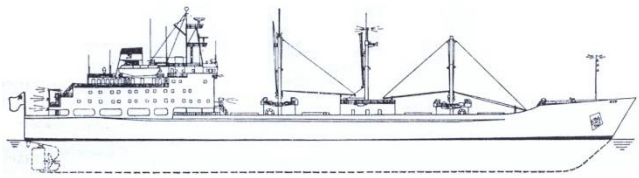
1. Concepts of reproduction cost and replacement cost.
2. Definition of reproduction cost in revaluation of the real assets, periodicity of revaluation and presentation in the reporting.
3. Methods of commercial vessel reproduction cost determination.
4. Kinds of expenses as a part of commercial vessel reproduction cost.
5. Industrial binding of economic models of commercial vessel reproduction cost.
6. Assignment of commercial vessel reproduction cost models.
7. Structural tasks of commercial vessel reproduction cost models use.
8. Advantages of reproduction cost models which are created of groups of structural breakup.
9. Tasks solved using the reproduction cost.
10. Concept of systematization of expenses for vessel construction in groups depending on uniformly influencing the cost of commercial vessel technical characteristics or their combinations.
11. Example of the integrated infrastructural parts as elements of commercial vessel reproduction cost.
12. Degree of detailed elaboration of reproduction cost structure breakup into groups.
13. Advantages of reproduction cost models which are created according to the groups of technological breakup.
14. Matrix model of reproduction cost breakup into groups of expenses.
15. Influence of expenses for materials and energy sources on commercial vessel reproduction cost.
16. Methodological difficulties in defining the concept of commercial vessel integrated infrastructural part.
17. Selection of factors in the set of analogues reproduction cost total.

18. Algorithmic approach at integrated infrastructural part definition as the element of commercial vessel reproduction cost.

19. Concept of reproduction cost.

20. Distinction of methodological concepts: the reproduction cost of a commercial vessel as the total of expenses in modern market prices for construction on the one hand, and the way of expenses summation as a method of reproduction cost determination on the other hand.

21. Other methods of reproduction cost determination within the limits of the independent approaches that are not costs summation.



# 6. Procedure of the marketing research data analysis based on prices of the newly built commercial vessels

Marketing researches are carried out for an estimation at the stage of purchase and sale of the marine company's real assets, for example vessels, that can be not only an independent approach of market value estimation, but also a method of estimation of the separate economic indexes used within the limits of other methodological approaches, for example, by the method of reproduction cost determination.

## 6.1. Reproduction cost of dry–cargo vessel

The reproduction cost *RC* (expenses for vessel construction at market prices) or replacement cost of the dry–cargo vessel, when the length *LW* is used as a unit of comparison is equal (fig. 6.1):

$$RC = 0.0201 \times LW^{2.646}, \text{ thousand US dollars.} \quad (6.1)$$

The reproduction cost *RC* of the dry–cargo vessel based on the results of marketing researches (fig. 6.2) when using the main engine power *Ne* as unit of comparison is determined as:

$$RC = 2.50 \times Ne^{0.944}, \text{ thousand US dollars.} \quad (6.2)$$

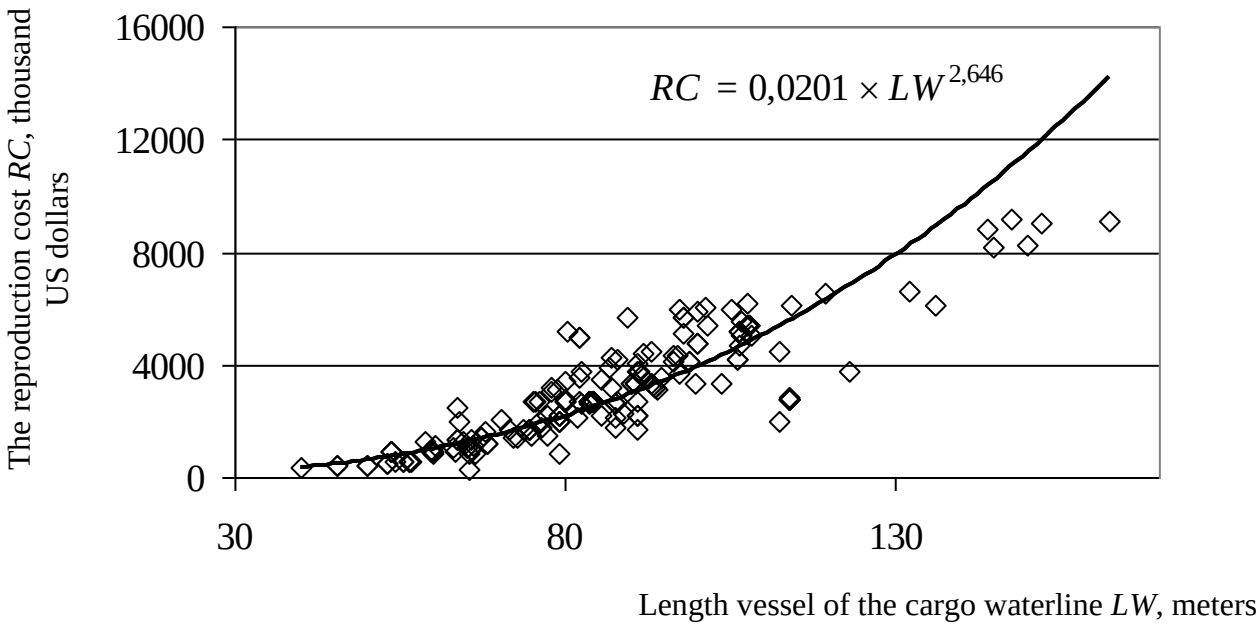



Fig. 6.1. The dependence of dry–cargo vessel reproduction cost *RC* on length of the cargo waterline *LW*

The reproduction cost *RC* of the dry–cargo vessel based on the results of marketing researches (fig. 6.3, 6.4) when capacity of cargo hold *W* is used as unit of comparison is equal:

$$RC = 5.268 \times W^{0.751}, \text{ thousand US dollars } (W < 25000 \text{ cubic ms});$$
$$RC = 0.0326 \times W^{0.951}, \text{ thousand US dollars } (W > 25000 \text{ cubic ms}). \quad (6.3)$$

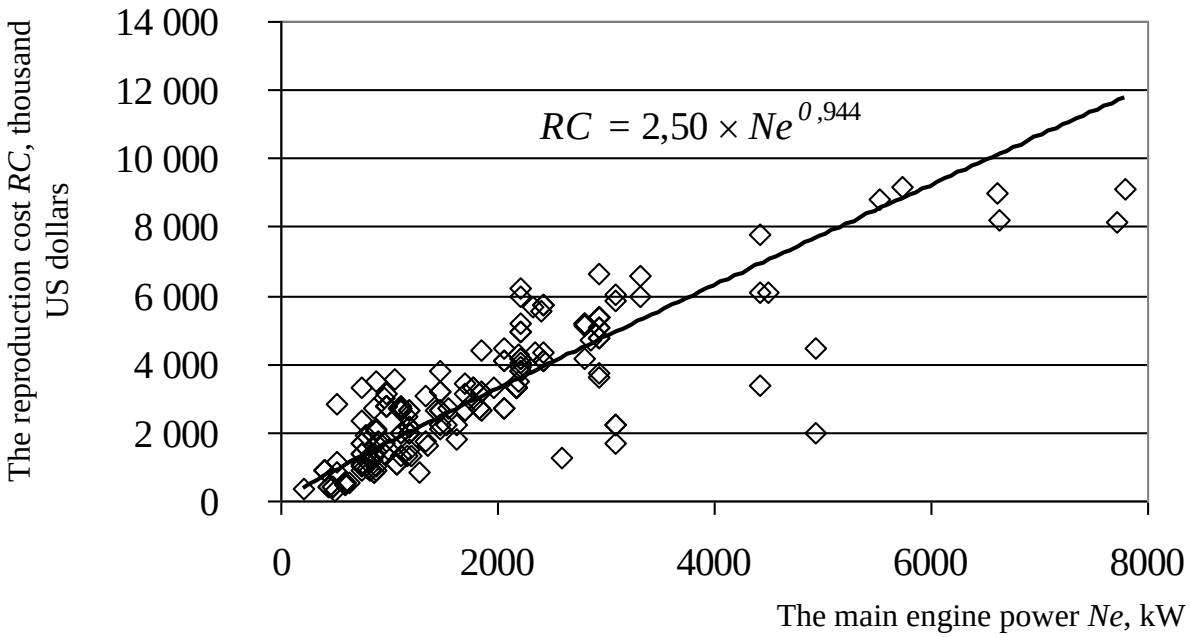



Fig. 6.2. The dependence of dry–cargo vessel reproduction cost *RC* on power *Ne* of main engine

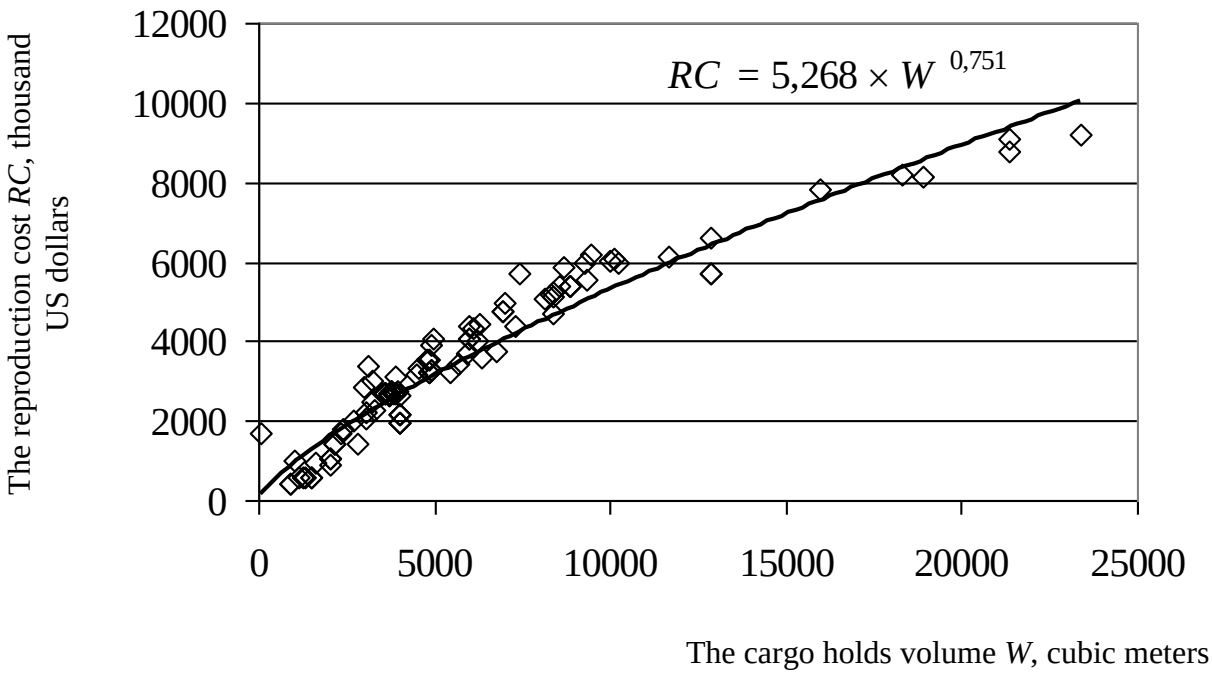



Fig. 6.3. The dependence of dry–cargo vessel reproduction cost *RC* on the cargo holds volume *W* (when *W* <25000 cubic ms)

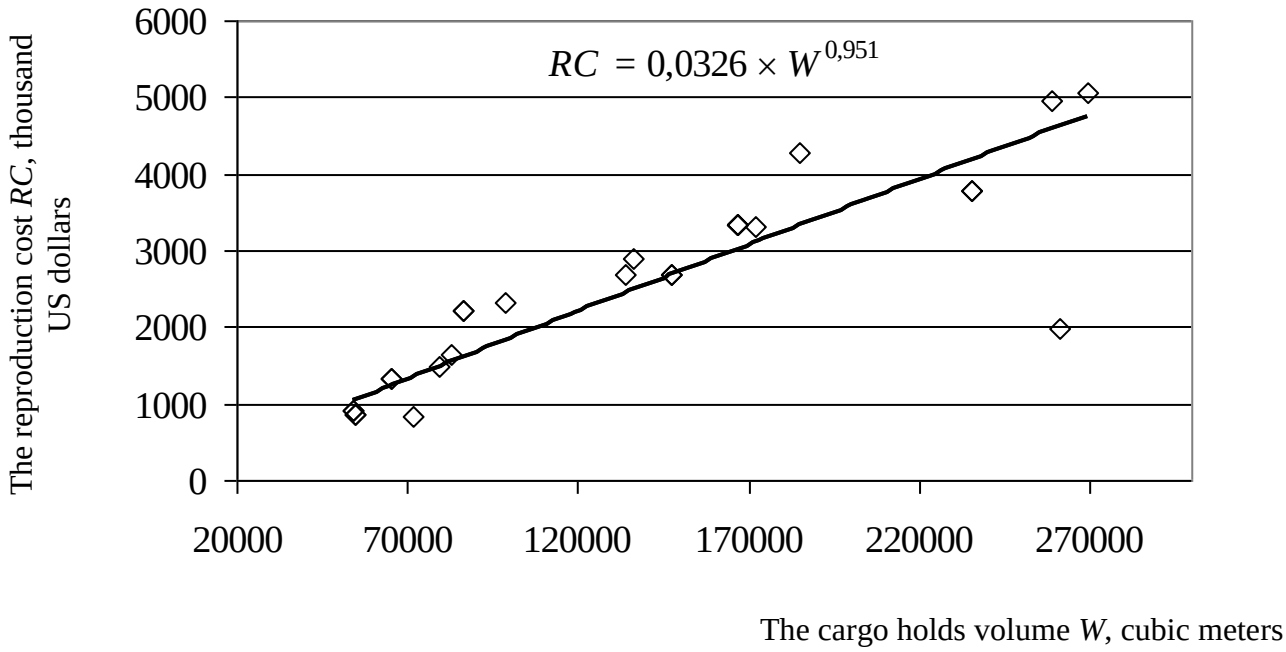



Fig. 6.4. The dependence of dry–cargo vessel reproduction cost *RC* on the cargo holds volume *W* (when *W* >25000 cubic ms)

## 6.2. Reproduction cost of crude–cargo tanker

The reproduction cost *RC* of the commercial vessel for transportation of crude cargoes (tanker) when the main engine power *Ne* is used as unit of comparison is equal (fig. 6.5):

$$RC = 4.725 \times Ne^{0.958}, \text{ thousand US dollars.} \quad (6.4)$$

The reproduction cost *RC* of tanker when capacity of cargo hold *W* is used as unit of comparison (fig. 6.6) is determined as:

$$RC = -0.00007 \times W^2 + 2.747 \times W + 546.7, \text{ thousand US dollar} \quad (6.5)$$
$$(W < 20000 \text{ cubic ms}).$$

The reproduction cost *RC* of tanker when the length of the cargo waterline *LW* is used as unit of comparison is equal (fig. 6.7):

$$RC = 0{,}1163 \times LW^{2.512}, \text{ thousand US dollars } (LW < 160 \text{ ms}). \quad (6.6)$$

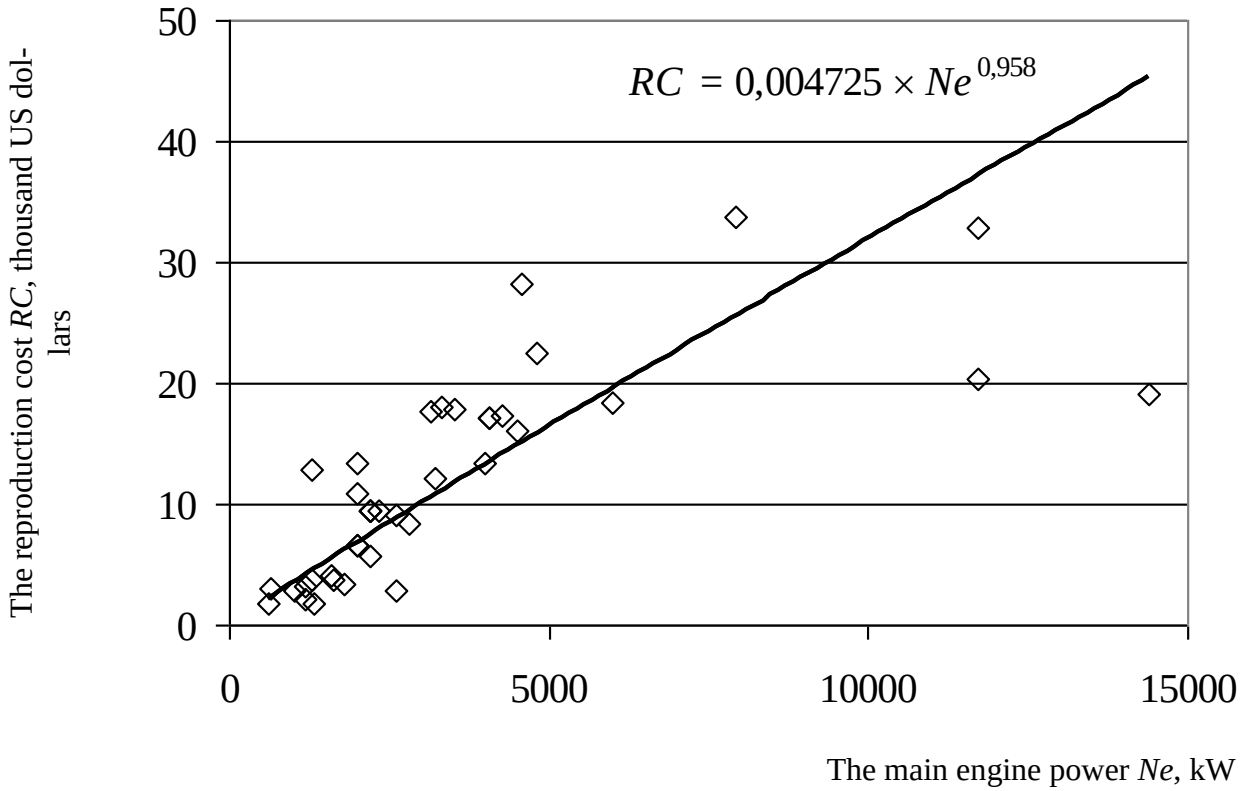



Fig. 6.5. The dependence of crude–cargo tanker reproduction cost *RC* on power *Ne* of main engine

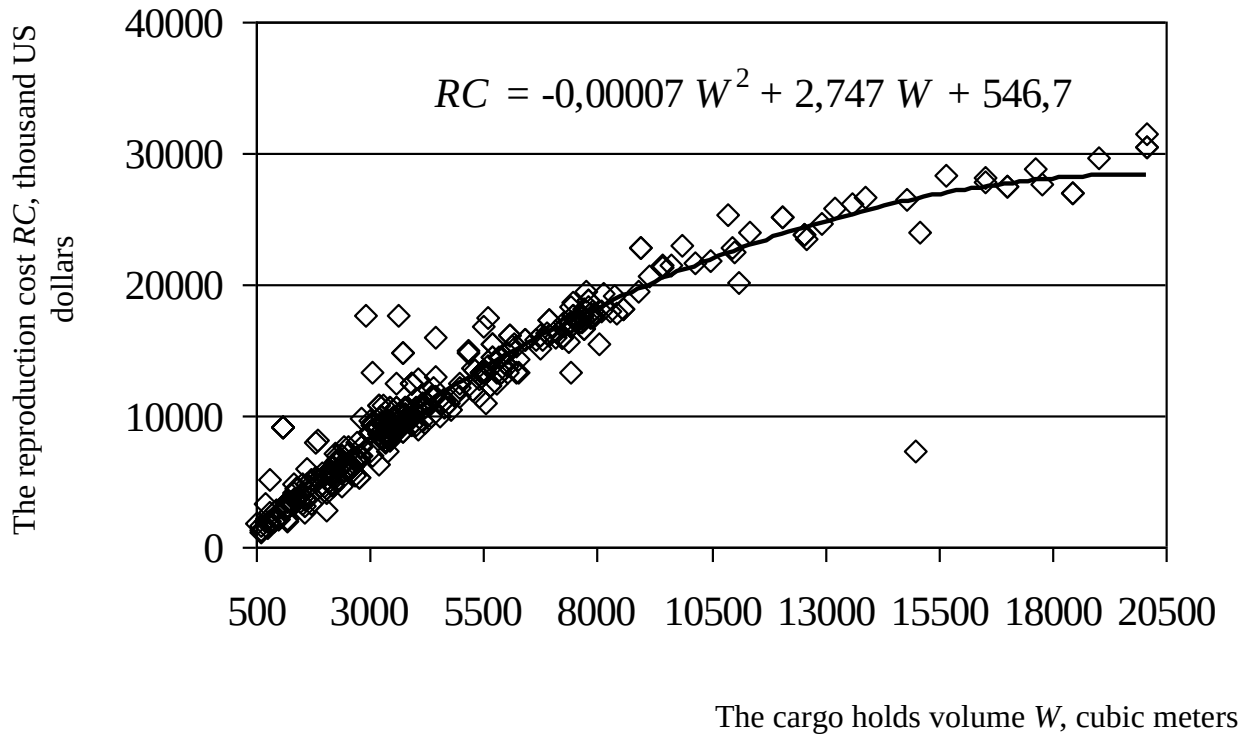



Fig. 6.6. The dependence of crude–cargo tanker reproduction cost *RC* on the cargo holds volume *W*

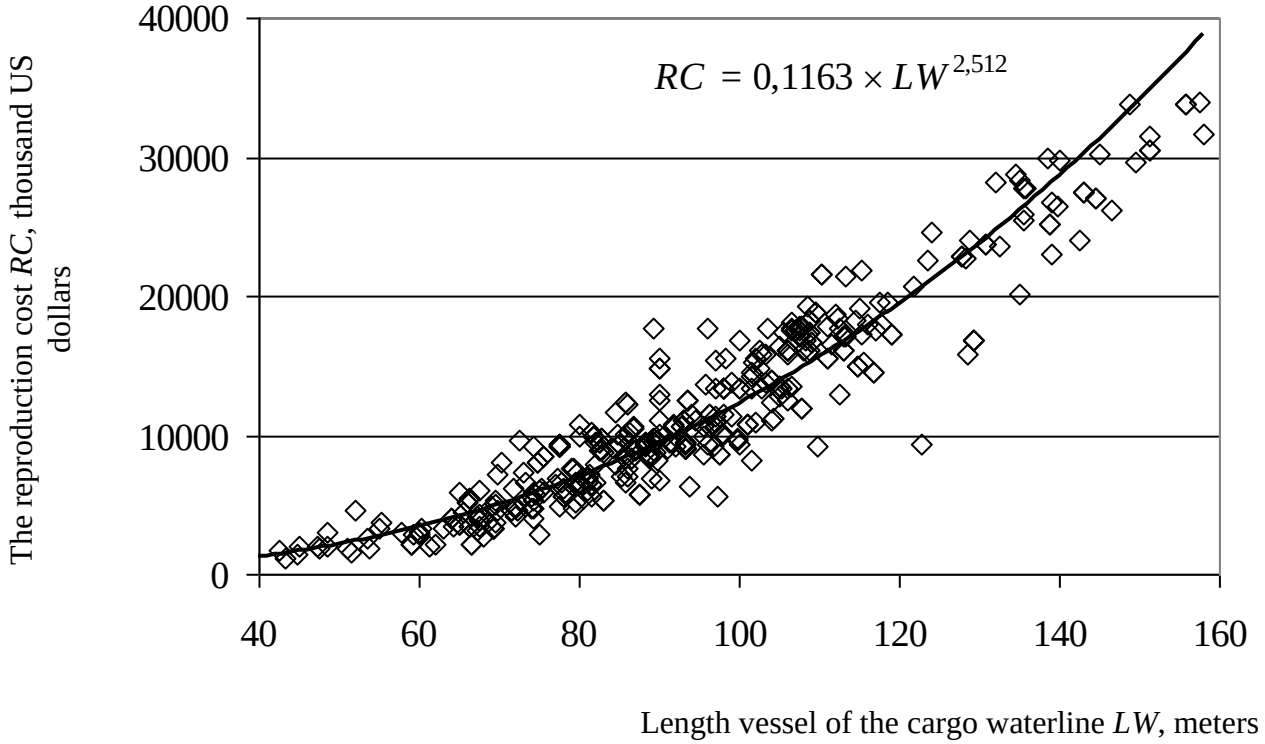



Fig. 6.7. the dependence of the crude–cargo tanker reproduction cost *RC* on length of the cargo waterline *LW* (*LW* <160 ms)

## 6.3. Reproduction cost of fishing vessel

The data about reproduction cost (or replacement costs) of new steel fishing vessels are taking into account by statistical researches when formalizing of the regressions.

The reproduction cost and replacement cost of a commercial vessel (or other asset of the marine company) can be determined on the similar informational and methodological base. The difference is an object of estimation – structural analogue for determination of reproduction cost or functional analogue for replacement value estimation.

As the units of comparison are used:

– Deadweight *DW*;

– Displacement empty *DP*;

– Length of fishing vessel at the cargo waterline *LW*;

– Main engine power *Ne*;

– Volume of cargo holds *W*.

The replacement cost of a fishing vessel (or reproduction cost – depending on preconditions and assumptions of the appraisal) when the marketing researches data and deadweight *DW* used as a unit of comparison is equal (fig. 6.8):

$$RC = 87.68 \times DW^{0.678}, \text{ thousand US dollars.} \quad (6.7)$$

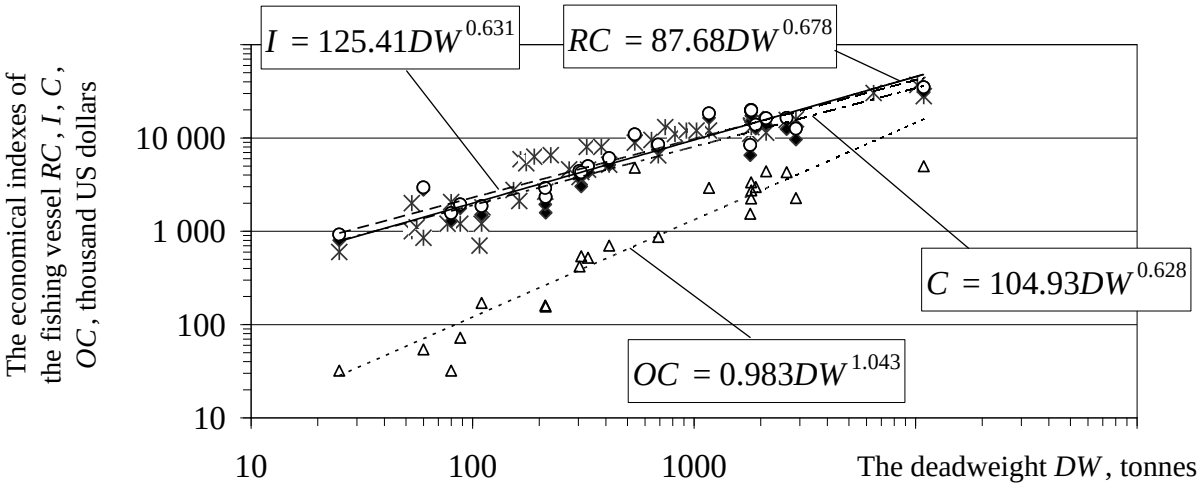



Fig. 6.8. The dependence of the fishing vessel reproduction cost $RC$, annual income $I$, operation costs $C$ and current asset $OC$ on deadweight $DW$

✳ The reproduction cost
◆ The operation costs
△ The current asset
○ The annual income
Exponential ( The annual income)
Exponential ( The reproduction cost)
Exponential ( The operation costs)
Exponential ( The current asset)

The reproduction cost of the fishing vessel (or replacement cost) when using the marketing researches data and displacement empty $DP$ as unit of comparison is equal (fig. 6.9):

$$RC = 33.1 \times DP^{0.75}, \text{ thousand US dollars.} \tag{6.8}$$

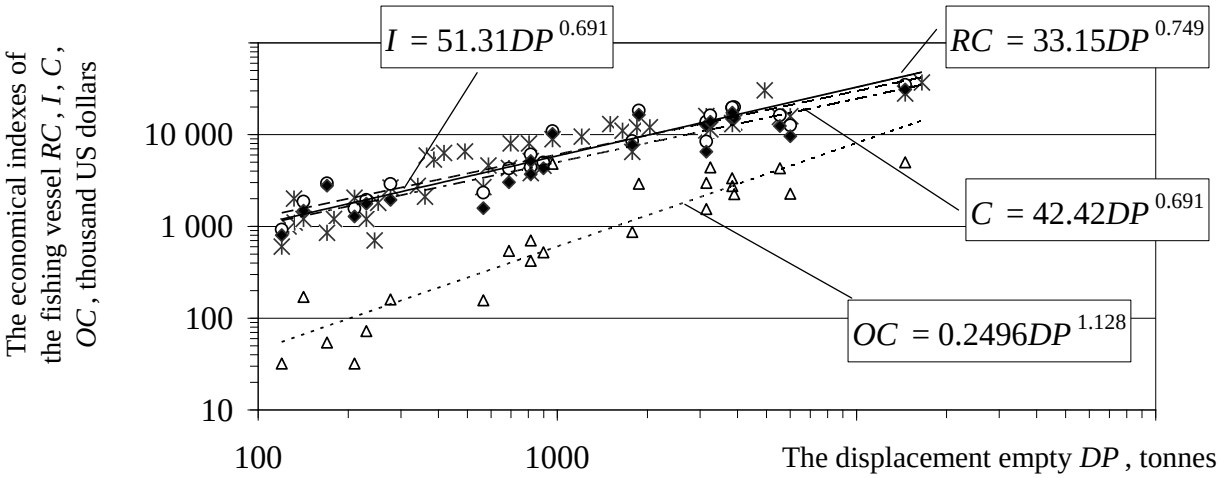



Fig. 6.9. The dependence of the fishing vessel reproduction cost $RC$, annual income $I$, operation costs $C$ and current asset $OC$ on displacement empty $DP$

✳ The reproduction cost
○ The annual income
◆ The operation costs
△ The current asset
Exponential ( The reproduction cost)
Exponential ( The annual income)
Exponential ( The operation costs)
Exponential ( The current asset)

The reproduction cost of the fishing vessel (or replacement cost) when using the marketing researches data and lengths *LW* as unit of comparison is equal (fig. 6.10):

$$RC = 5.20 \times LW^{1.77} \text{ thousand US dollars.} \quad (6.9)$$

The reproduction cost of the fishing vessel (or replacement cost) when using the marketing researches data and main engine power *Ne* as unit of comparison is equal (fig. 6.11):

$$RC = 4.23 \times Ne^{0.98}, \text{ thousand US dollars.} \quad (6.10)$$

The reproduction cost of the fishing vessel (or replacement cost) when using the marketing researches data and volume of cargo hold *W* as unit of comparison is equal (fig. 6.12):

$$RC = 57.95 \times W^{0.704}, \text{ thousand US dollars.} \quad (6.11)$$

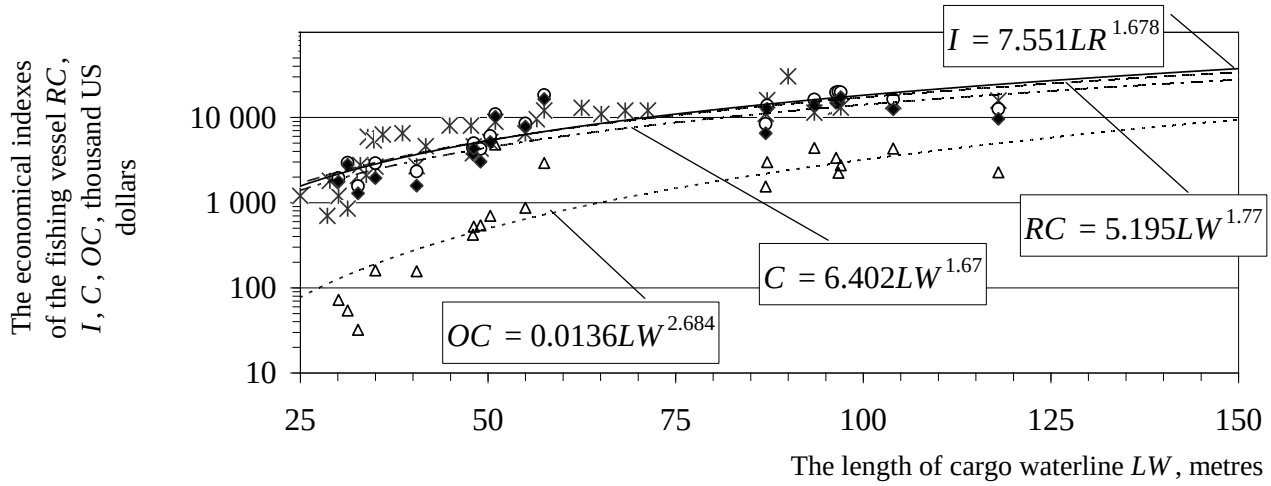



Fig. 6.10. The dependence of the fishing vessel reproduction cost *RC*, annual income *I*, operation costs *C* and current asset *OC* on othe length of cargo waterline *LW*

✳ The reproduction cost
◆ The operation costs
Exponential ( The reproduction cost)
Exponential ( The operation costs)
○ The annual income
△ The cerrent asset
Exponential ( The annual income)
Exponential ( The cerrent asset)

**Test questions**

1. Reproduction cost of the commercial vessel.
2. Replacement cost.
3. Units of comparison in regression dependences structure for the determination of reproduction cost of commercial vessels of various classes:
– Dry–cargo vessel;
– Crude–oil tanker;
– Fishing vessel.
4. Similarity of methodical recommendations and information base for determination of the replacement cost and reproduction cost.

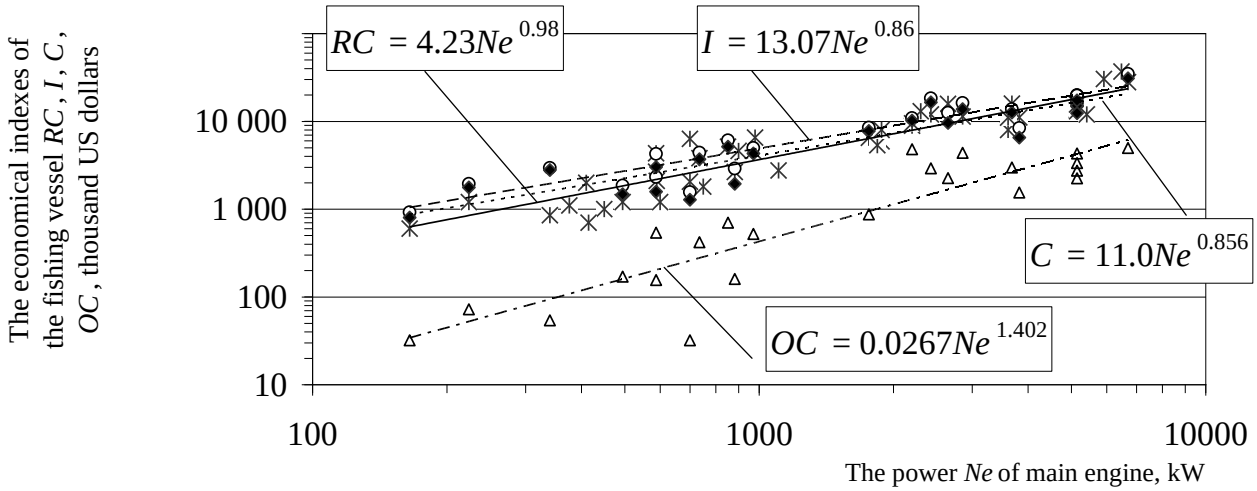



Fig. 6.11. The dependence of the fishing vessel reproduction cost $RC$, annual income $I$, operation costs $C$ and current asset $OC$ on power $Ne$ of main engine

✳ The reproduction cost
◆ The operation costs
—— Exponen- ( The reproduction cost)
····· tial ( The operation costs)
○ The annual income
△ The current asset
– – – Exponen- ( The annual income)
–·–·– tial ( The current asset)

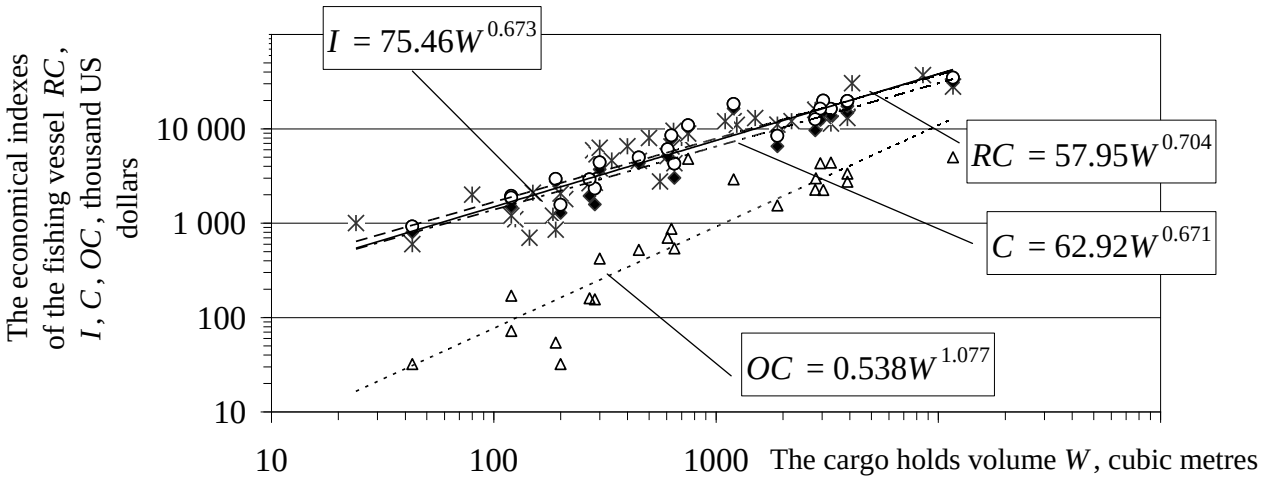
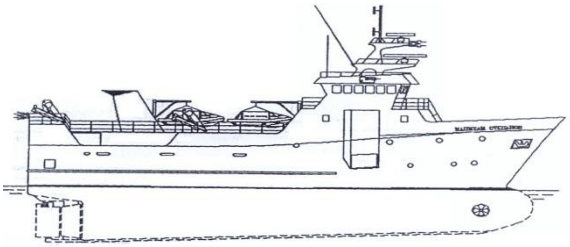



Fig. 6.12. The dependence of the fishing vessel reproduction cost $RC$, annual income $I$, operation costs $C$ and current asset $OC$ on cargo holds volume $W$

✳ The reproduction cost
△ The current asset
—— Exponen- ( The reproduction cost)
–·–·– tial ( The operation costs)
◆ The operation costs
○ The annual income
– – – Exponen- ( The annual income)
····· tial ( The current asset)



# 7. Estimation of commercial vessel depreciation and value based on cost approach

As an economic index the depreciation can be determined in monetary or in the relative measure (in percentage).

In the appraisal of the marine commercial vessels the standard classification of depreciation is applied:

– Physical depreciation removable $D_1$ and physical depreciation irremovable $D_2$;

– Functional depreciation removable $D_3$ and functional depreciation irremovable $D_4$;

– External obsolescence $D_5$ (economic).

The general list signs of depreciation of commercial vessel or other asset of the marine company can be specified by pair concepts: physical – functional, external – internal, removable – irremovable.

The functional and the external depreciations usually have irremovable property.

From the technological point the internal depreciation of a commercial vessel (physical and functional) usually has removable property.

The characteristic of irremovable depreciation is a judgment of the economic feasibility evaluation.

The depreciation is irremovable if its elimination is inefficient (unprofitable) that is if the value of a commercial vessel or other real asset of the marine company after prospective elimination of deterioration is less than a sum of value before elimination of the depreciation and the costs for its elimination.

Removable depreciation should be estimated monetary in absolute magnitude. Irremovable depreciation is usually estimated in relative magnitude or in percentage.

Assuming, that removable deterioration ($D_1$ and $D_3$) is determined in the monetary form, and irremovable ($D_2$, $D_4$ and $D_5$) – in percentage, the value of the commercial vessel or other real asset of marine company can be estimated based on cost approach as:

$$MV = RC\times(100\ \%–D_2)/100\ \%\times(100\ \%–D_4)/100\ \%\times(100\ \%–D_5)/100\ \%–(D_1+D_3). \quad (7.1)$$

Physical depreciation grows out of normal ageing of the commercial vessel (or other asset of the marine company). Such kind of depreciation can be removable or irremovable.

The removable physical depreciation can be characterized by the necessary expenses on forthcoming routine repair and maintenance which the owner should incur for profit maximization.

The ineradicable physical depreciation characterizes value reduction over the time with the account the limited life time of the commercial vessel or other real asset of marine company.

It is necessary to note the following specific feature of marine commercial vessels as objects of deterioration estimation. According to existing convention of shipbuilding and shipping which are established by survey–inspection services of the various states (see item 1.4) exercising the control over safety of shipping and human life protection at the sea, the vessel should correspond to a certain strict enough set of requirements, otherwise

her operation in the sea is impossible, and the owner cannot receive the profit. The vessel value thus accordingly cannot exceed the scrap value.

The specified earlier (in the article 1.4) organizations monitor periodically that the vessel meets the requirements.

From the formal point of view the requirement of the specified organizations cause the necessity of operating repairs, so the removable physical depreciation $D_1$ of a commercial vessel, and the same requirements, to be exact their changes, predetermine in many cases removable functional depreciation $D_3$ (that is the general removable depreciation $D_1 + D_3$ in aggregate).

Except requirements of the inspection organizations, the removable physical depreciation can be caused by the necessity of restoration of the structures lost at failure, systems and devices, and also these structures or systems which are not connected with the safety of shipping and are not inspected, but their existence on board is necessary for characteristics to be in conformity with the project data for which the replacement cost *RC* and further the market value *MV* is determined according by the cost approach.

Vessel repair includes a complex of technical operations aimed at restoration of serviceable or efficient condition of the vessel hull, devices, systems, equipment or mechanisms, including their replacement, and also general functional suitability and seaworthiness of the commercial vessel.

Unlike the repair, at reconstruction the characteristics of the commercial vessel are change, instead of being restored.

Investments into the repair and vessel maintenance service are limited by the necessity to bring the vessel into an efficient and seaworthy condition according to operating rules and are not a way of vessel value accumulation, and serve to decrease investment risks.

Further investing after restoration of seaworthiness and functional suitability according to specifications of an efficient vessel is not an increase of her value, unlike possible investing in reconstruction that causes functional characteristics of commercial vessel to change.

Functional depreciation is usually characterized by depreciation owing to designing faults. Depreciation of this kind also can be caused by age factors, for example the external obsolescence of used materials or accessories in constructing. Such can be either removable or irremovable.

Commercial vessel elements with irremovable functional depreciation can be subdivided in to two groups referred to either redundancy or insufficiency of the given element.

Functional depreciation $D_3$ and $D_4$ does not influence the value of the commercial vessel or other real asset of the marine company and is equal to zero if the replacement cost *RC* is used as a basis for evaluation based on cost approach namely the functional analogue having the same functional drawbacks.

External obsolescence of the commercial vessel or other real asset of the marine company $D_5$ (the economic depreciation) characterizes the reduction of value caused by the influence of external factors, such as the general decline of the market, the decrease in economic activity.

External economic obsolescence of the vessel $D_5$ and usually the functional depreciation $D_4$ have irremovable property.

The general recommendations concerning the application of the depreciation estimation methods of commercial vessel or other real asset of the marine company of listed types are follows:

– Removable depreciation (physical $D_1$ and functional $D_3$) should be estimated by the method of subdivision into the integrated groups on the basis of the data about the reproduction cost structure, that, in turn, influences the choice the method of reproduction cost estimation, using the advantages of its estimation as the total costs as opposed to the methods based on comparable sales;

– Ineradicable physical depreciation $D_2$ of the commercial vessel can be evaluated by the «life time» method, thus the important task here is to estimate the life time, for example, with the account profitability and actual years of not a new vessel or other real asset of the marine company and the kind of depreciation to vessel age proportion (the linear proportion or other);

– Irremovable functional $D_4$ and external $D_5$ depreciation of commercial vessel or other real asset of the marine company should be estimated by the method of income loss capitalization, thus it is necessary to define the loss of the income caused by the influence of the evaluated element of inefficiency, or based on comparable sales approach, if there is an analogue, which for the named depreciation is known (or evaluated).

Figure 7 shows the widespread classification structure of depreciation indicators for technical and economic estimations in shipbuilding and shipping.

Studying the classification structure makes it possible to arrive at a conclusion, that for the correct estimation concepts of classification of the indicators corresponding to the valid factors of depreciation have the most essential value so that the sum of the terms corresponded to the general economic index of depreciation are more important rather than the specific share of depreciation economic index into the elements which can differentiate in various expert works at presence that of the bases.

It should be added that in practice of fleet technical operation the deterioration is one or another dimensional physical indicator of deterioration, for example loss of metal plating thickness caused by corrosion of the hull or total square of plating which is deformed and is subject to replacement instead of decrease of the value. It should be noted that technical deterioration of the commercial vessel is not a proportional correspondence to economic depreciation (that is value loss).

**Test questions**

1. Kinds of economic depreciation of the commercial vessel: external and internal depreciation, removable and irremovable depreciation.
2. General list of economic depreciation signs.
3. Concept of depreciation economic irremovability.
4. Reference of absolute estimation (monetary) to removable depreciation, and a relative estimation – to irremovable depreciation.
5. Vessel value estimation by the cost approach (the formula).
6. Rules concerning the vessel operating repair influencing the estimation of the removable physical depreciation.
7. Causes of commercial vessel functional depreciation.
8. External factors influencing commercial vessel value.

9. Recommended method of determination of commercial vessel removable depreciation (physical $D_1$ and functional $D_3$).

10. Recommendation concerning estimation of ineradicable physical depreciation.

11. Methods recommended for estimation of irremovable functional and external economic obsolescence of the commercial vessel.

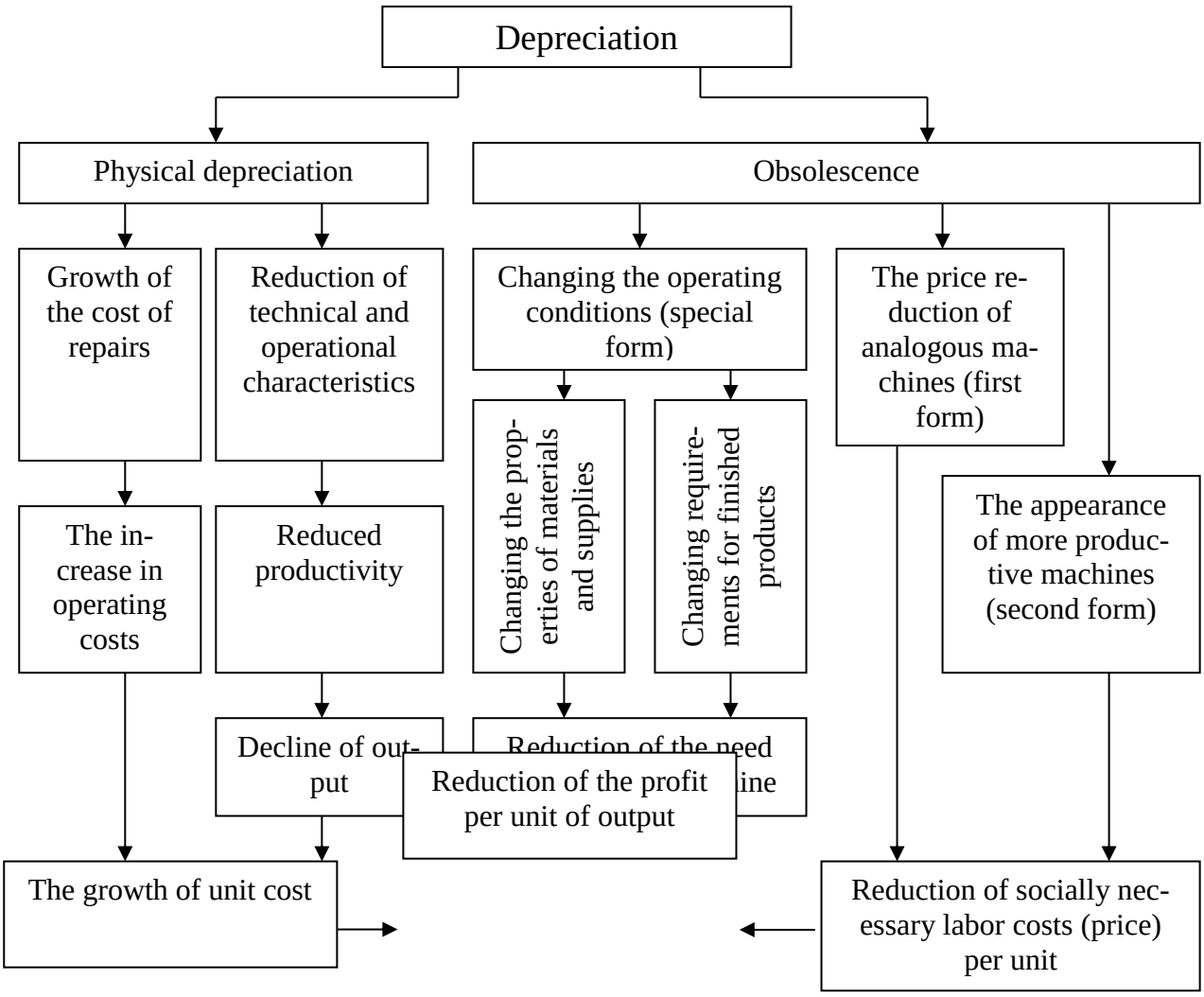
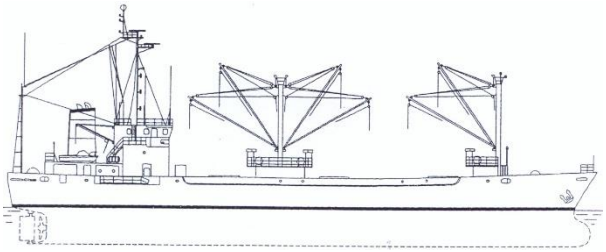



Fig. 7. The classification scheme of the depreciation performance common in shipbuilding industry and shipping



# 8. Examples of estimation of the commercial vessel depreciation

Typical examples of depreciation estimation concerning the marine cargo vessel are considered below:

A) Estimation of ineradicable physical depreciation of commercial vessel by the economic «life time» method (article 8.1);

B) Estimation of irremovable functional depreciation of a dry–cargo refrigeration vessel (insufficient cargo capacity of vessel, article 8.2);

C) Estimation of irremovable functional depreciation of a tanker for the crude oil transportation (superfluous displacement of light vessel, article 8.3);

D) Evaluation of external economic obsolescence of a passenger vessel (article 8.4).

## 8.1. Estimation of ineradicable physical depreciation of commercial vessel by the economic «life time» method

The prediction of structural durability of the commercial vessel or other real asset of the marine company to a certain degree has a conditional character, and obsolescence generally is functional.

Certainly, physical obsolescence exists, but functional obsolescence proceeds, as a rule, is essentially faster and is the factor inducing ship–owners to sell the commercial vessel in another market (in contrast to the market where the vessel was purchased), that is in the market with other macroeconomic environment and higher values of commercial risks, and the value of the commercial vessel in process of obsolescence decreases during its exhaustion and receipt as an income and profit.

As for real estate, this feature is not especially noticeable, as the value does not so essentially decreases in the present prices over construction years.

At the same time there are examples of the marine engineering having age limit, but physically remained in a very good condition: the numerous ships–museums (clipper «Cutty Sark» in Great Britain, «Aurora» cruiser in St.–Petersburg, liner «Queen Mary» in California, etc.), inhabited barges on the Seine river, on channels of Amsterdam, at the coast of the gulfs in the State of Washington, etc.

Leaving aside the physical safety of such watercrafts, it should be noted that for the long period they were subjected to some essential functional changes, and, perhaps, today such objects judging by their functional attributes cannot be named without reservations as commercial vessels or the marine engineering or the real assets of the marine companies' complexes.

In applied subjects the structural durability of the vessels having an ice–forcing category often is accepted within 25 years. The specified value is connected with the rules of classification surveys which usually become essentially complicated for the owner if the vessel years exceed 25 years.

In the assumption, that the life time of all infrastructural parts as a components of commercial vessel reproduction cost is identical, ineradicable physical depreciation can

be predicted recognizing that the operation of the vessel within 25 years is planned at the stage of designing and construction and after write–off the vessel can be sold for scrap value.

The following recommendations for the approached prediction of structural durability of commercial vessel can be applied:

– To determine the vessel years and the remained period before expiration of Register Certificate of the vessel seaworthiness;

– If the sum of vessel years and the term before the expiration of the Certificate of seaworthiness is less than 25 years structural durability of the commercial vessel equal 25 years;

– If the sum of vessel years and the term before the expiration of the Certificate of seaworthiness is more than 25 years structural durability of the commercial vessel should be equal to the sum of vessel years and the term before the expiration of the Certificate of seaworthiness.

It is necessary to underline, that the value of life time specified above (25 years) is considered only as a widespread test example. More precisely the life time of marine commercial vessel can be evaluated according to statistical observations and the analysis of regressions or with the account the analysis of economic efficiency (profitability of interest rate) of not a new vessel.

Ineradicable physical depreciation $D_2$ of the commercial vessel in linear proportion in dependence on age under these assumptions makes at the date of estimation

$$D_2 = 100\ \% \times t / 25 - 100\ \% \times Rv / RC \approx 100\ \% \times t / 25 - (1.0 \div 2.0\ \%),$$

where $t$ – the vessel years; $Rv$ – the vessel scrap value after write–off; $RC$ – the reproduction cost of the commercial vessel.

The specific task when estimating the ineradicable physical depreciation of the commercial vessel is life time forecasting.

In some cases the life time can be predicted by the analysis of the statistical regressions characterizing dependence of the vessel value on years.

With considerable vessel years it is possible to predict the life time on the basis of the sum of the actual age and remaining period of operation, reasoning from the analysis of economic profitability of the vessel having the great years. For example, predicted remaining duration of operation before upon the condition of commercial vessel profitability can be correlated multiple of commercial vessel payback period with the account estimation of commercial risks which are established usually when estimating based on income approach.

Taking into account the data determined based on comparable sales approach (article 4.4), concerning rates of the vessel value reduction over the years and with the account the received analytical form of the regression dependences of the vessel value or other real asset of the marine company on age the residue from one after subtraction of irremovable internal depreciation (physical and functional) for statistical approximation is determined as:

$$(1 - D_2) \times (1 - D_4) = (((1+i)^{T-t} - 1) / ((1+i)^T - 1))^{i / \ln(1+i)},$$

or when using the discounting by the Euler' number exponential function:

$$(1-D_2)\times(1-D_4)=((e^{(T-t)\times i}-1)/(e^{T\times i}-1))^{(e^i-1)/i},$$

for small values of the discounting rate, when $i \approx \ln(1+i)$ and $e^i \approx 1+i$:

$$(1-D_2)\times(1-D_4)=((1+i)^{T-t}-1)/((1+i)^T-1),$$

when using the discounting by the Euler' number exponential function with the account an assumption of small values of the discounting rate:

$$(1-D_2)\times(1-D_4)=(e^{(T-t)\times i}-1)/(e^{T\times i}-1).$$

The estimated residue from one $(1-D_2)\times(1-D_4)$ after the subtraction of the irremovable internal depreciation (physical and functional) can be used when the vessel estimating or other real asset of the marine company based on cost approach.

In proportion of the regression dependences (article 4) the residue from one:

– For the variant of using the fishing vessel capacity as a unit of comparison is

$$(1-D_2)\times(1-D_4)=0.504\times(1.02^{55-t}-1)^{1.01};$$

– For the variant of using the fishing vessel's main engine power as unit of comparison is

$$(1-D_2)\times(1-D_4)=1.55\times(1.01^{50-t}-1)^{1.005};$$

– For the variant of using of the area index equal the product of the cargo water line length of the fishing vessel to the breadth

$$(1-D_2)\times(1-D_4)=0.417\times((1+0.023)^{53.5-t}-1)^{1.01};$$

– According to researches of the universal dry–cargo vessels market

$$(1-D_2)\times(1-D_4)=0.008329\times(1.096^{50-t}-1)^{1.047};$$

– According to researches of the market of the vessels for transportation of the crude oil and the crude mineral oil

$$(1-D_2)\times(1-D_4)=0.0086\times((1+0.09)^{53-t}-1)^{1.044}.$$

When using the comparable sales approach concepts for determination of the residue from one after subtraction of the irremovable internal depreciation (physical and functional) it is recommended to consider the following stipulation.

The offered recommendations by the form are close to the method of «life time» estimating of the irremovable depreciation, applied to depreciation internal – physical and functional, that is, the durability of the commercial vessel or other real asset of the marine company and the degrees of commercial vessel depreciation over years depending on total commercial risks as the discounting rate are determined by the comparable sales approach.

At the same time, when there are necessary data, the irremovable functional depreciation can be estimated correctly enough, for example, by the method of the income loss capitalization. And ineradicable physical depreciation can be estimated by the method of «life time» according to the data about the life time, based on structural and technical survey of the vessel rather than on marketing researches.

**Test questions**

1. Proportion of commercial vessel physical and functional obsolescence rates.
2. Recommendations for the approximate prediction of not a new vessel structural durability.
3. Forms of proportional dependences in estimation of irremovable depreciation on vessel years.
4. Recommendations concerning the use of estimation methods of depreciation commercial vessel of various forms.

## 8.2. Estimation of irremovable functional depreciation of a dry–cargo refrigeration vessel (insufficient cargo capacity of vessel)

The service loading of a cargo vessel is most fully characterized by deadweight *DW* (difference of vessel total cargo displacement $DW = D - DP$ and empty displacement or the sum of weight variables composed: cargo, fuel, supply, crew with luggage, etc.).

As a rules the specification deadweight to the displacement ratio for the vessel estimated in the given example, making about 0,424 (the relation of deadweight 530 t to total cargo displacement 1250,7 t, that is $DW$ / $D$) is much less than specification deadweight operating ratio to the displacement for dry–cargo refrigeration vessels which makes about 0,529 (Tab. 8).

Table 8

The data of dry–cargo refrigeration vessels – analogues of estimated one

| The names of analogues (construction shipyard) | Total cargo displacement *D*, t | Deadweight *DW*, t | Proportion *DW*/*D* |
|---|---|---|---|
| «Capella» (Kanassashi Shipbuilding Co., Japan) | 2357 | 1351.5 | 0.573 |
| «Luchezarny» (Khabarovsk, Russia) | 1202 | 531.5 | 0.442 |
| «Captain Voloshin» (Nikolayev, Ukraine) | 10107 | 5263 | 0.556 |
| «Talniki» (Szczecin, Poland) | 9203 | 5009 | 0.544 |
| | | The average value of the factor *DW*/*D* | 0.529 |

The vessel estimated in a considered example is subject to irremovable functional depreciation which lies in insufficient cargo capacity for received cargo and supply, in other words, in insufficient deadweight with the given displacement, or in superfluous of displacement of the empty vessel with the given deadweight.

In other words, at the same value of deadweight $DW$ = 530 t, as the deadweight of the vessel estimated in the example, the total cargo displacement of the comparable dry–cargo refrigeration vessel can make 1002 t, that is 530 t / 0.529 = 1002 t.

The unit of comparison in the given example is deadweight *DW*. The comparable vessel has identical deadweight with an estimated vessel.

Total cargo displacement *D* of the comparable dry–cargo refrigeration vessel can at the same deadweight as of evaluated vessel be roughly 20 % less than the total cargo displacement of the evaluated refrigeration vessel which makes 1250.7 t, that is

$$(1250.7 - 1002.0)/1250.7=0,199 .$$

Displacement empty *DP* of the refrigeration vessel comparable to the estimated vessel by deadweight will make (1002 – 530) = 472 t.

Displacement empty of the estimated refrigeration vessel equals 720.7 t. It is more on the size of (720.7 – 472.0) = 248.7 t than the displacement empty of the comparable vessel, that is the comparable refrigeration vessel can have the displacement empty less 34.5 % than the estimated vessel: 248.7 / 720.7×100 % = 34.5 % .

With the same deadweight *DW* as of estimated vessel, and the same operational velocity $\upsilon_S$ of the comparable transport refrigeration vessel which total cargo displacement is less 20 % than total cargo displacement of the estimated vessel, the main engine power and the fuel expense can be roughly on 14 % less than for the estimated vessel.

The proportion of the main engines powers *Ne* of comparable and estimated vessels assumed with identical velocity roughly corresponds to the proportion of their total cargo displacement in degree ⅔ (the exponent ½ is sometimes used that more closely corresponds to the low–speed commercial vessels), that is

$$100\ \% \times (1 - (1002/1250.7)^{2/3}) = 13.7\ \% \approx 14\ \%.$$

Thus, the comparable dry–cargo refrigeration vessel having the same values of the deadweight *DW* and operational speed $\upsilon_S$, as well as an estimated vessel, could have roughly on 20 % less the total cargo displacement *D*, 34.5 % less the displacement empty *DP* and 14 % less the main engine power *Ne*.

The general value of the irremovable functional depreciation $D_4$ estimated in the example of the cargo vessel in relative magnitude is estimated with the account expert values of shares which reflect the degree of influence of various discrepancies for irremovable functional depreciation:

$$D_4 = 20\ \% \times ⅓ + 34.5\ \% \times ⅓ + 14\ \% \times ⅓ \approx 22.6\ \%.$$

As a survey explanation it should be noted that the listed drawbacks of the commercial vessel, apparently, are connected with the fact that the estimated refrigeration vessel was designed on the basis of the fishing vessel project with the account technological continuity of construction and by the majority of characteristics coincides with the fishing vessel (Middle size fishing freezing trawler) of the Russian project # 502 M. In this case the structural and functional characteristics optimal for fishing vessel can be irrational for the cargo vessel.

**Test questions**

1. Estimation of an inefficiency element on the basis of deadweight specification to displacement ratio for commercial vessel.

2. Inefficiency proportion of the vessel propulsion device (superfluous of the main engine power and the fuel expense) in the relation to superfluous of commercial vessel displacement.

## 8.3. Estimation of irremovable functional depreciation of a tanker for the crude oil transportation (superfluous displacement of light vessel)

The operating ratio of the deadweight *DW* to displacement *D*, that is the relation of deadweight 4999 t to total cargo displacement 8550 t the series tanker «Kaliningradneft» (constructed at the shipbuilding yard «Rauma Repola» in Finland of the Soviet project according to rules of the USSR Register), making *D*/*DW* = 0.585 for the estimated vessel, is much less than the deadweight specification to the displacement ratio of the comparable vessel of foreign construction.

The tanker «George Frojer» for mineral oil crude cargo, constructed at the shipbuilding yard in port Chung–Mu (Republic of Korea) is considered as a comparable vessel. The relation of comparable vessel deadweight 4999 t to total cargo displacement 6750 t is equal *D* / *DW* = 0.740.

The project of the comparable vessel was developed according to the requirements of Norwegian Bureau Veritas *DNV*.

Estimated and comparable vessels have the close architectural–structural class, an identical class of the Register, including similar ice category, and identical class of the power–plants.

The estimated vessel is subject to irremovable functional depreciation which lies in insufficient cargo capacity for received cargo and supply, in other words, in insufficient deadweight *DW* at given displacement *D*, or in superfluous weight of empty vessel *DP* at given deadweight *DW* (that is in superfluous displacement empty).

The attribute of comparability attribute in the given example is deadweight *DW*. The comparable vessel has identical deadweight with the estimated vessel.

At the same magnitude of deadweight *DW* = 4999 t as of the estimated tanker for mineral oil crude cargo, the total cargo displacement of the comparable tanker which was projected for other rules, can make 6750 t.

Total cargo displacement of the comparable vessel *DP* with the same deadweight as of the estimated vessel roughly 21 % less than the total cargo displacement of the estimated vessel, that is (8550 – 6750)/8550 = 0.21 .

The displacement empty *DP* of the tanker for mineral oil crude cargo comparable to the estimated vessel for deadweight makes (6750 – 4999) = 1751 t.

The displacement empty of the estimated tanker is equal (8550 – 4999) = 3551 t. It is greater by 1800 t, that is (3551 – 1751) = 1800 t than the displacement empty of the comparable tanker, that is the comparable vessel has the displacement empty 50.7 % less than the estimated vessel 1800 / 3551 × 100 % = 50.7 % .

With the same deadweight *DW* and the same operational velocity $\upsilon_S$ as of the estimated tanker for mineral oil crude cargo, for the comparable vessel which total cargo displacement *D* is 21 % less than the total cargo displacement of the estimated vessel, the main engine power *Ne* and the fuel expense can be roughly 15 % less than of the estimated tanker for mineral oil crude cargo.

The proportions of the main engines powers of comparable and estimated vessels with assumed identical speed roughly corresponds to the proportion of the total cargo displacement in degree ⅔, that is

$$100\ \% \times (1 - (6750/8550)^{2/3}) = 14.6\ \% \approx 15\ \%.$$

Thus, the tanker for transportation of the mineral oil, having the same values of the deadweight *DW* including mainly cargo and supply, and operational speed $\upsilon_S$, as well as a comparable vessel, could have total cargo displacement *D* roughly 21 % less, displacement empty *DP* 50.7 % less and main engine power *Ne* 15 % less than of comparable vessel.

The listed drawbacks of the tanker for transportation of mineral oil apparently are connected with defects of applied rules of designing.

The relative magnitude of irremovable functional depreciation of the evaluated tanker for transportation of the mineral oil with the account values of share scales which reflect the degree of influence of various discrepancies for irremovable functional depreciation, is evaluated expertly as:

$$D_4 = 21\ \% \times ⅓ + 50.7\ \% \times ⅓ + 15.0\ \% \times ⅓ = 28.9\ \%.$$

**Test questions**

1. Definition of cargo vessel functional analogue for estimation of depreciation (analogy attribute under according to the main characteristic – deadweight).
2. Factors of functional inefficiency of the cargo vessel.

## 8.4. Evaluation of external economic obsolescence of a passenger vessel

The external obsolescence (economical) is defined as decrease of commercial vessel functional suitability owing to the environment influence that is the irremovable factor for the ship–owner. The external obsolescence (economical) can be conditioned by a number of the causes, for example the general decline of marine transport activity.

The passenger vessel, which external economic obsolescence determination is being processed in the given example, is substantially subjected to external obsolescence (economical) in view of a decline in the activity of passengers transportation both at coasting internal lines and at cruising foreign lines that can be characterized as follows.

The analysis of intensity of passenger marine traffic in the Far East of Russia during the period from 1993 to 1996 years is made for the estimation of external obsolescence (economical).

During the certain period (from 1993 to 1996), that is previous time before the vessel estimation is made, the number of passengers transportation coasting trips in the Far East of Russia was reduced 2.7 times (from 86 to 32 annually).

For the same period the number of passengers transported annually at coasting trips was reduced 4.57 times (from 34300 to 7500 annually).

The reduction of passenger traffic capacity at coasting lines has considerably exceeded the reduction of trips number. Hence, it is characteristic that passenger vessels loading at coasting lines is incomplete.

According to the specified indicators in 1996 in comparison with 1993 the reduction of commercial vessels filling by passengers at coasting lines can be determined as

$$100\ \% \times (1.0 - 2.7 / 4.57) = 40\ \%.$$

During the considered years (from 1993 to 1996), that is previous time before the vessel evaluation is made, the number of foreign passengers trips practically was not reduced (in 1993 were carried out 66 foreign trips, in 1996 – 65 trips).

For the same period the number of passengers transported annually at coasting trips was reduced approximately by 60 % (from 26200 to 10000 annually).

As the number of foreign trips was not reduced the reduction of passenger traffic capacity for this period approximately corresponds to the reduction of passenger vessels filling in foreign cruising trips.

Reduction of passenger vessels filling in foreign cruising trips from 1993 to 1996 has made – 40 %.

It is supposed, that the external obsolescence (economical) for vessel is insignificant till 1993 for the period from the construction (1990) as the considered environment crisis phenomena and the decline in passenger transport activity are most clearly shown after 1993.

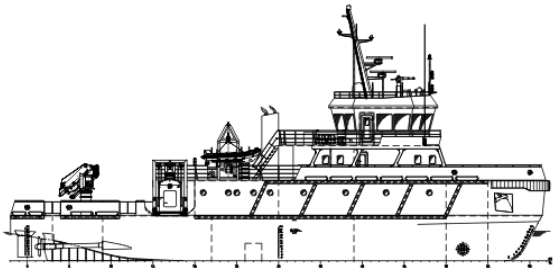
The reduction of passenger vessels filling in coasting and foreign trips characterizes the reduction of the demand for sea passenger transportations and external obsolescence (economical) for similar vessels which makes from 40 to 60 %.

Conclusion: the external obsolescence (economical) of the passenger vessel is approximately equal $D_5 \approx 50$ %. The estimated value of the external obsolescence (economical) concerns the difference of reproduction cost and irremovable internal depreciation total (the physical and functional).

**Test questions**

1. Estimation of external economic obsolescence on the basis of correlation of passenger traffic capacity changes and vessels number in operation changes.

2. Prediction of external economic obsolescence in case of vessels operation on several lines in coasting and foreign trips.



# 9. External economic obsolescence and the resale discount caused by the economic difficulties of a seller

The sale of the commercial vessel or other real asset of the marine company unlike acquisition frequently has the compelled feature and is inconvenient for the owner.

Apparently, any circumstances of the property rights sale have a compelled feature and difficulties (economical obstacles) for the proprietor of the commercial vessel as the sum of money for which the property is exchanged is usually more liquid and practically does not demand operational service.

The liquidation value (the value at the compelled sale) is a widespread standard concept of an appraisal.

The value in case of the «compelled sale» differs from the market value. The difference corresponds to the resale discount on the market value if it is supposed, that asset selling occurs in the circumstances when one of the parties experiences difficulties, and the second party is informed about the difficulties experienced by the first of the parties and (or) when selling occurs in the period too short for the adequate marketing exposure and if difficulties can be evaluated in value units.

The value at the compelled sale – the sum of money which can be received from this sale of a commercial vessel or other real asset of the marine company in terms too short for the adequate marketing exposure according to the concept of market value.

The cases with not a voluntary seller or a buyer, and also with the buyers informed of difficulties experienced by the seller are referred to the circumstances of the compelled sale.

For commercial vessel estimation or other real assets in case of the company's bankruptcy or re–structuring that is in the mode of the compelled sale, the following additional concepts of the value can be applied:

– Liquidating value systematic (the value in case of the commercially ordered liquidation) is an evaluation of a typical sum of money which is expected to be received from the sale of a commercial vessel or other asset of the marine company provided that for the seller there is a certain reasonable period of time for search of a buyer and that he is obliged to sell a vessel «in that kind as she is, in that place where she is»;

– Liquidating value compelled (the value in case of the accelerated liquidation) is an evaluation of a typical sum of money which is expected to be received from the open sale spent properly with adequate advertising provided that the seller is obliged to sell the vessel urgently «in that kind as she is, in that place where she is».

The first of the presented concepts of liquidation value can correspond to a systematic sale of property of the companies–bankrupts which is done by temporary administrations (competitive or arbitration managing directors) under the control of the supervisory boards or committees of creditors.

The second of the presented concepts of liquidation value to a greater degree corresponds to the initial value (the starting price) for vessels or assets of the marine companies sale at the auctions.

In various techniques of evaluation for the compelled sale the market value which then decreases for the liquidation discount is accepted as the basic value.

The economic bases for the compelled sale valuation are, in essence, two factors which can influence the value independently as well as jointly:

– Difficulties experienced by the parties – the seller or the buyer, shifted to the seller, and difficulties should have a value index;

– Too short period for the adequate marketing for selling of the commercial vessel or other asset by the market value, in other words, the limited term of the market exposure.

The influence of the exposure period on the value and the resale discount to the market value is considered in other section (Chapter 10).

In the given section the influence of economical difficulties of the seller or the buyer shifted to the seller on the value and the resale discount to the market value is evaluated.

The causes of economical difficulties can have external character or internal, that is integral inherent in an estimated vessel or other real asset of the marine company.

External causes of economical difficulties for sale and discounts on the value are predetermined by the characteristics of the commercial vessel and features of technology of its construction, productive operation and recycling.

External cause of economical difficulties for sale and the discounts to the value can be the decisions of administrative bodies concerning property rights: property, economic management or administration.

External difficulties of commercial vessel sale and the discount to the value are usually connected with the demand for additional investments into the transferring through the basic technological stages: manufacture, productive operation and recycling.

The subject of the determination of the discount to reproduction cost to the level of the market value of a new vessel corresponding to the solvent demand of investors arises as a link in more general expert subjects.

Considering the general technological stages – manufacture, productive operation and recycling, it is possible to show that the options of property rights transfer circumstances (sale, rent, leasing, etc.) when there is a change of proprietors according to the change of technological stages have to some extent inconvenient character for one of the parties – for the party which, before the sale, is the proprietor of the commercial vessel or other asset subject to sale.

The financial assistance for the manufacturer for indemnification of economical difficulties, let us assume, grants at the expense of an additional financial source – the subject interested in the development of industry, or an overpayment in case of superfluous demand is the basis for concession in value of commercial vessel to the company–operator purchasing vessel for productive operation.

The sale of the commercial vessel by the ship yard to the company–operator the shipbuilding company usually is not carried out by a uniform financial transfer after the finishing of construction, but stage–by–stage financing and accordingly stage–by–stage transition of the property rights is applied.

As the investor the financial institutions can be involved. Also there can be done the installment sale, the transfer to rent, including for the terms of leasing etc.

The variety of kinds of cooperation between the shipyard and the company–operator in present indexes does not affect the sale circumstances when the transfer of the property rights for the vessel is provided, connected with the difficulties for the seller.

Discount to the vessel value that is a consequence of economical difficulties of one of the parties is directly connected with the concept of economical obsolescence.

Economical obsolescence $D_5$ (in other words, external obsolescence) characterizes the reduction of the vessel value or other asset of the marine company under the influence of environmental factors.

External economic obsolescence $D_5$ does not possess properties to accumulate over the vessel years (or other asset of the marine company), as internal irremovable depreciation, for example, as ineradicable physical depreciation $D_2$ or irremovable functional depreciation $D_4$. External economic obsolescence $D_5$ influences equally any similar vessels or other real assets irrespective of age.

As the new vessel do not experience irremovable internal depreciation which will accumulate over the time and is subject only to the external economic obsolescence characterizing macroeconomic environment rather than a vessel, it is possible to determine the value by the cost approach in dependence on the market value of a new vessel $MV$ ($t = 0$) but not on the reproduction cost (or replacement cost), using the formula (8.1) and having excluded external economic obsolescence $D_5$, as:

$$MV = MV(t = 0) \times (1 - D_2) \times (1 - D_4) - (D_1 + D_3) \ .$$

The difficulties of new vessel sale or other new asset of the marine company from the methodological point of view are directly related to the concept of external economic obsolescence $D_5$ if a basis for evaluation by the cost approach is the reproduction cost $RC$, instead of the market value $MV(t = 0)$ of a new vessel (or other new real asset) which age is equal to zero $t = 0$.

On the specified methodological bases the external economic obsolescence $D_5$ in present estimation arises once – when selling a new vessel.

The external economic obsolescence $D_5$ is equal the discount for the replacement cost $RC$ to market value of new vessel $MV(t = 0)$ which is required both for the internal, and the external causes.

The external economic obsolescence $D_5$ corresponds to the difference of the replacement cost $RC$ and the market value $MV(t = 0)$. And if a basis for the vessel estimation by the cost approach is not the replacement cost $RC$ but the market value $MV(t = 0)$ of the new vessel the external economic obsolescence is equal to zero: $D_5 = 0$.

The substitution of the replacement cost $RC$ for the market value of the new vessel $MV(t = 0)$ in the formula of the cost approach (8.1) corresponds to an exception of the external economic obsolescence influencing equally on the value of the similar vessels, both new and not new.

The causes that are not predetermined unequivocally by the vessel characteristics (or other real asset of marine company) are related to the number of the external causes of difficulties in he process of sale and for the vessel value discount.

For example, the external cause of economical difficulties for sale and discount to the value which are not arises from the commercial vessel characteristics can be the decisions of administrative bodies concerning the property rights, for example, the decision of limitation of industrial quotas for ocean biological resources development if it is a question

of fishing vessel value discount, of seller difficulties and of external economic obsolescence.

The difficulties of the vessel sale arising for the internal reasons are methodologically predetermined by the connection of the components influencing the value, in particular the equipment of the commercial vessel and stocks replenishment of working assets after the vessel acquisition.

The internal causes of economical difficulties for sale and discounts to value are reasoned by the vessel characteristics, features of the «know–how» of shipbuilding, productive operation and recycling.

The obstacles to the sale of the ship and the cause to value discount are thus usually predetermined by demands for additional investments during transfer through the basic technological stages: manufactures, productive operation and recycling.

When selling the vessel (or other asset of the marine company) in the circumstances of transfer through the basic technological stages due to the natural reasons from that party which is proprietor of the vessel, to the second party are required concession as it is the owner of the ship who has no alternative for vessel sale and the second party – the owner of financial resources –does not experienced any difficulties.

Internal obstacles to the vessel sale, connected with requirements for additional investments during transformation through the basic technological stages and the corresponding reasons of the value discount can be methodologically redefined in relation to the limited time of exposure for commercial vessel sale without the discount to value, that is the obstacles to the sale of the commercial vessel and the cause of the discount to value in case of limited exposure period can be considered as transformation of equivalent difficulties to the sale connected with demands for additional investments into transformation through the basic technological stages.

At the same time during great duration of commercial vessel productive operation she can be sold at market value, excepting the circumstances of sale compelled due to causes when the compelled character can be shown in the fact of the limit period of the marketing exposure is less than demanded duration of exposure for vessel sale at market value.

The limited duration of the vessel sale is unlikely to be the reason for the value discount during the period of commercial vessel construction or during the utilization period, as the duration of these periods usually essentially less than the duration of the commercial vessel productive operation period and, possibly, less than the demanded exposure period for sale at the market value.

Hence, during the commercial vessel construction and during the utilization stage for transfer from the production phase to the stage of productive operation, and also for transformation from the stage of productive operation to utilization when determining of economic obstacles and value discounts the internal causes depending on characteristics of the commercial vessel and the sequence of technological stages are dominating.

For the internal causes at sale the difficulties are experienced by the seller of commercial vessel who should give concession to the party purchasing the asset and finance this concession at the expense of one of the following sources:

– At the expense of the economic assistance, for example, of the government or the company–sponsor that is the obvious or indirect owner of commercial vessel seller, interested in development of subordinated shipbuilding;

– At the expense of own incomes received from another activity;

– At the expense of the concession received earlier from the former owner of the commercial vessel;

– At the expense of noticeable prevalence of the demand over the supply.

The question arises, to what extent funding of shipbuilding and industry of the marine engineering manufacturing is logical, in particular, from the government or the company–sponsor and in what is the interest of this party.

Development of economy and industry in the XX–th century shows, that usually the governments of some or other states supported the development of shipbuilding or other hi–tech industries.

After the Second World War such governmental support arrived in shipbuilding of Japan (besides the investments into radio electronics and into the chemical industry) therefore this country has occupied and some tens years kept world leadership in the field of civil shipbuilding according to the total tonnage serially launched vessels, having superseded with this place Great Britain.

In the nineties of the last and at the beginning of this century the economic policy of the government aid for shipbuilding industry practices the Republic of Korea which has superseded Japan today to the second place in civil shipbuilding.

The shipyards of china are characterized by the greatest rates of shipbuilding industry growth by relative magnitude though the total amount still lags behind the shipbuilding in the Republic of Korea and Japan.

The same situation is typical for other industries which are not connected with shipbuilding but taking a similar place in the economy. The help of the USA government as tax privileges for the aircraft building industry at the Boeing enterprises can be mentioned a close example of such support.

The existence of concession and sufficient efficiency of financing sources in economy are a necessary condition of shipbuilding industry development and other hi–tech industries characterized by the great share of the added value as a part of the production price and prospective from the point of view of intangible assets manufacture and accumulation, in particular, the industries concerning ocean development. For example, the shipping company is compelled make a concession to the party buying a vessel for utilizing it as a scrap, assuming that this concession is compensated at the expense of other activity of the shipping company. In the given example the obstacle of the shipping company which is the cause of the compelled concession to the buying party is connected with the need for vessel maintenance commissioned from operation before utilization for scrap.

And the concession of the shipping company to the enterprise utilizing the vessel has been financed by advance payment as a concession of the shipbuilding yard to the shipping company the experiencing obstacles when selling the new vessel after construction.

The source of concession financing for the shipbuilding yard influences at all technological stages (construction of commercial vessel, productive operation and utilization).

To determine the discount of reproduction cost $RC$ to the market value of the new vessel $MV(t = 0)$ the following difficulties arising of the internal causes and paid finally by the investor interested in innovative development of shipbuilding and technology of ocean development are taken into consideration:

– After the construction before the sale and productive operation the vessel blocks resources of the ship–yard which could be used productively for the designated purpose and the operational expenses are required that is an obstacle for the shipbuilding company;

– For the productive operation after construction the replenishment of working assets is required that is an obstacle for the buying party expecting the discount to the value, shifted to the shipbuilding company.

The last of named obstacle is shifted by the shipping company–operator to the shipbuilding company because the company–operator owning money instead of real property has alternative possibility not to buy a vessel.

After the completion of construction the vessel is subject to sale to the company–operator that is linked with the complications of the parties shifted to the seller, as these complications are connected with vessel input at the following technological stage – productive operation.

Prospective expenses before the commercial vessel sale after the completion of construction, or the missed benefit of the ship–yard company arising, for example, in view of blocking of the capital or resources by the constructed vessel, are the basis for definition of the resale discount which represents the difference of reproduction cost and the market value of a new vessel.

It means, that the sale of a new vessel occurs in circumstances when one of the parties experiences difficulties, and the second party is informed about the difficulties experienced by the first party.

Difficulties concern:

– Missed benefit of the manufacturer when the manufactured vessel blocks the real assets of the shipbuilding enterprise before she is sold;

– Compelled expenses of the working assets replenishment connected with accepted obligations of the buyer to put the vessel into operation at the stage of productive use (the obstacle shifted to the shipbuilding enterprise – the seller).

The size of the resale discount should be correlated with the above mentioned expenses for putting the commercial vessel into operation after completion of construction or (and) with the missed benefit of the shipbuilding enterprise before vessel sale.

The methodological requirements and assumptions based on an estimation of named obstacles having the internal cause following from characteristics of commercial vessel in the circumstances of transportation between two technological stages – construction of commercial vessel and productive operation are considered below in sequence of sections (A, B and C).

The resulting dependences (9.12 and 9.13) correspond to discount estimation to the commercial vessel value in the circumstances of transfer between the basic technological stages and they take into account the obstacles having the internal cause and are integrally inherent in the vessel.

**A. Manufacturer** who is the owner of the commercial vessel prior her passing to the company–operator, makes an investments: gives the new vessel which value is equal $MV(t = 0)$ and receives the value result $I1$ representing the sum of the market value of a new vessel $MV(t = 0)$, and the certain additional income $\Delta MV_1$ consisting of evaluation of economic obstacles clearing – rights of use of released assets and of financial economy of vessel maintenance in a suitable condition after construction.

Saved finances include expenses to support the workers providing vessel safety, and also deductions and taxes, an overhead charge and financial expenses, for example costs for operating repair of the commercial vessel while keeping her before she is given to the company–operator, power supply while keeping, cleaning, etc.

The right–of–use value of the released assets of the shipbuilding enterprise occupied by keeping of a new vessel before she is given to the company–operator, and economy of finances for vessel maintenance are considered below as the precondition for additional determination of $\Delta MV_1$ income of the shipbuilding enterprise determination.

In the methodological sense the additional income $\Delta MV_1$ corresponds for the shipbuilding enterprise clearing of the obstacles following from the duties of the owner that is the enterprise before the vessel sale. Thus, the value result for the shipbuilding enterprise after vessel sale is equal $MV(t = 0) + \Delta MV_1$.

The character of shipbuilding enterprise investment into commercial vessel sale to the company–operator is illustrated by the scheme

$$MV(t{=}0) \rightarrow MV(t{=}0) + \Delta MV_1. \tag{9.1}$$

The obstacles $\Delta MV_1$ experienced before the commercial vessel sale by the shipbuilding enterprise are applied as a part of methodological preconditions for determination of replacement cost.

The net present value $NPV1$ when giving the commercial vessel to the company–operator is equal to the difference of value result $MV(t = 0) + \Delta MV_1$ and investments $MV(t = 0)$ and makes:

$$NPV1 = I1 - MV(t = 0) = (MV(t = 0) + \Delta MV_1) - MV(0) = \Delta MV_1. \tag{9.2}$$

The efficiency of investment at a value of $MV(t = 0)$ for the shipbuilding enterprise is characterized by the relative magnitude by index $R1$ which is equal to the proportion of the net present value (that is $NPV1 = \Delta MV_1$) to the investments $MV(t = 0)$ and makes:

$$R1 = NPV1 / MV(t = 0) = \Delta MV_1 / MV(t = 0). \tag{9.3}$$

The value of the economical difficulties $\Delta MV_1$ experienced by the enterprise before the commercial vessel is given to the company–operator in applied calculations should be correlated as a part of indexes of efficiency and value with operation costs and approximately determined as a share of operation costs $C$, that is $\Delta MV_1 \approx \delta_{MV1} \times C$, where $\delta_{MV1}$ – the relation of economical difficulties value to operation costs.

**B. Buyer**, the shipping company–operator buying the vessel for productive operation makes investments which are equal to the sum of payment for vessel acquisition at value $MV(t = 0)$ and the additional investments $\Delta MV_2$ for vessel input in operation and for the replenishment of working assets which are temporarily blocked assets of the company–operator (for long term – before vessel write–off).

The value result of the buyer is equal to the reproduction cost of the vessel $RC$ that is the company–operator gets the vessel which cannot be reproduced differently as having spent finances at the value equal to reproduction cost $RC$.

The character of investment for the buyer when purchasing the commercial vessel

from the shipbuilding enterprise is illustrated by the scheme

$$MV(t = 0) + \Delta MV_2 \rightarrow RC. \tag{9.4}$$

In other words, the company–operator which conducts the productive operation and being after acquisition the owner of the commercial vessel having replacement cost *RC*, in the course of acquisition pays the market value $MV(t = 0)$ and accepts the obligation to make out additional investment $\Delta MV_2$ including replenishment of working assets stock.

The net present value *NPV*2 for the company–operator buying the vessel is equal to difference of cost result *RC* and total expenses of the company–operator $(MV(t = 0) + \Delta MV_2)$ and makes:

$$NPV2 = RC - (MV(t = 0) + \Delta MV_2). \tag{9.5}$$

In the relative magnitude the efficiency of investment for the buyer is characterized by index *R*2 which is equal to the proportion of net present value *NPV*2 to investments $(MV(t = 0) + \Delta MV_2)$ and makes:

$$R2 = NPV2 / (MV(t = 0) + \Delta MV_2) = (RC - (MV(t = 0) + \Delta MV_2)) / (MV(t = 0) + \Delta MV_2). \tag{9.6}$$

The value of the buyer economical difficulties of the vessel shifted to the seller who is the company–operator when putting the commercial vessel into operation corresponds to the need in working assets *OC* replenishment, that is $\Delta MV_2 \approx OC$, where *OC* – investments into replenishment of working assets (for vessel supply).

In some cases the expenses for vessel delivery to the place of operation after purchase can be referred to the number of economical difficulties of the vessel buyer, shifted to the seller, carry. It can cause certain objections. The delivery of commercial vessel to the point of destination is usually executed together with delivery of cargoes and with arriving at various harbors that is vessel operation begins at the place where she is bought.

The same is true for the commercial vessels of other classes. For example, fishing vessel destination after sale is not the marine district of fishery but a set of geographical locations where the fishing vessel is based and where she goes to the fishing ground. The place of commercial vessel purchase usually refers to the number of these places too.

**C. The balance of interests** of commercial vessel buyer – the company of the operator – and the seller – the shipbuilding enterprise – is accepted as the methodological precondition.

The established balance of interests of the buyer and the seller consists in conformity of efficiency indexes of their investments:

$$R1 = R2. \tag{9.7}$$

It is necessary to specify, that proportional or other characteristic of interests balance of the seller and the buyer depends on a certain set of factors, supply and demand parity in corresponding market sector, the degree of the control of the parties (up to monopoly) etc. can be referred to this set of factors.

At the same time as making system assumptions, it is logical to assume the conformity under the factors defining the proportional balance of the parties interests, at least,

for, to some extent, perfect market, in which environment the definition of market value or other kinds of value depending on the market value is possible.

Substituting in the left part of the formula (9.7) the estimation (9.3) of efficiency index $R1$ of the shipbuilding enterprise – the seller of the commercial vessel, and in the right part – an estimation (9.6) of index of efficiency $R2$ of the company–operator – the buyer of the commercial vessel, it is possible to receive balance equation

$$\Delta MV_1 / MV(t = 0) = (RC - (MV(t = 0) + \Delta MV_2)) / (MV(t = 0) + \Delta MV_2), \quad (9.8)$$

or after transformations it is possible to derive the equation

$$MV^2(t = 0) + (\Delta MV_2 + \Delta MV_1 - RC) \times MV(t = 0) + \Delta MV_2 \times \Delta MV_1 = 0. \quad (9.9)$$

The equation (9.9) has the following solution concerning the interdependence of replacement cost $RC$ and market value $MV(t = 0)$ of the new vessel with the account difficulties $\Delta MV_1$ of the seller – the shipbuilding enterprise and difficulties $\Delta MV_2$ of the buyer – the shipping company–operator, shifted to the seller:

$$RC = MV(t = 0) + \Delta MV_2 \times \Delta MV_1 / MV(t = 0) + \Delta MV_1 + \Delta MV_2. \quad (9.10)$$

After substituting of assumptions concerning values of economical difficulties for sale $\Delta MV_1 \approx 0.2 \times C$ and $\Delta MV_2 \approx OC$ the formula (9.10) becomes:

$$RC \approx MV(t = 0) + 0.2 \times C \times OC / MV(t = 0) + 0.2 \times C + OC. \quad (9.11)$$

The value, when the sale of the commercial vessel is compelled for the proprietor, is called the liquidating value and it is defined by subtraction of the liquidating (resale) discount as: $MVF = MV - DF$.

According to resultants dependences (9.10) and (9.11), the discount $DF$ to replacement cost $RC$ to determine the market value of the new vessel $MV(t = 0)$, sensitive to the obstacles having the internal causes, being integrally inherent in the vessel in the circumstances of transfer between the basic technological stages, it can be defined in the absolute magnitude as:

$$DF = RC - MV(t = 0) = \Delta MV_2 \times \Delta MV_1 / MV(t = 0) + \Delta MV_1 + \Delta MV_2, \quad (9.12)$$

and in the relative magnitude (that is in relation of the discount to the replacement cost) is equal the external economic obsolescence

$$D_5 = (\Delta MV_2 \times \Delta MV_1 / MV(t = 0) + \Delta MV_1 + \Delta MV_2) / RC.$$

The received discount characterizes the external (economic) obsolescence in relative magnitude $D_5 = (RC - MV(t = 0)) / RC$ arising once after transfer from construction to productive operation, influencing the value of any vessels of similar class (or other real assets of the marine company) as the macroeconomic factor irrespectively of vessel years, and characterizing in the relative value the difference of market expenses for vessel construction, on the one hand, and market value of the new vessel, on the other hand, for which the value of depreciations of other kinds are equal to zero.

The value for the case of forced sale $MVF$, with the account evaluation of economical obstacles of the seller $\Delta MV_1$ and evaluation of economical obstacles of the buyer

$\Delta MV_2$ shifted to the seller, is defined depending on the market value *MV* and the specified difficulties by the equation

$$MV = MVF + \Delta MV_2 \times \Delta MV_1 / MVC + \Delta MV_1 + \Delta MV_2 \text{, that is}$$

$$MVF^2 - (MV - \Delta MV_1 - \Delta MV_2) \times MVF + \Delta MV_2 \times \Delta MV_1 = 0 .$$

Not applying for mathematical severity and excepting possible negative results in a quadratic discriminant, the value for conditions of compelled sale *MVF* of the commercial vessel or other real asset of the marine company depending on the market value *MV* and the specified difficulties their present values $\Delta MV_1$ and $\Delta MV_2$ is determined as:

$$MVF = (1/2) \times (MV - \Delta MV_1 - \Delta MV_2 + \sqrt{(MV - \Delta MV_1 - \Delta MV_2)^2 - 4 \times \Delta MV_2 \times \Delta MV_1}) \qquad (9.13)$$

And if the radicand is negative and the equation has no solution it means, that difficulties are more powerful than the value of the commercial vessel which should be given free of charge or to liquidate only for the purpose of economical difficulties clearing. Then the balance of interests of the seller and the buyer by the formula (9.7) is not taken into account in calculation, and the concept of liquidation value is subject to redefinition according to which the liquidation value means only an estimation of the manufacturer clearing from difficulties.

The replacement cost *RC* discounts to the market value of the new vessel *MV*(*t* = 0.0) are required due to the regular causes (external, macroeconomic or absolute), and to irregular (internal). The same concerns the definition of the causes of external economic obsolescence $D_5$.

The economical difficulties having the regular (systematic) cause influence the value irrespectively of the difficulties having irregular (non–systematic) cause. And non–systematic causes of external economic obsolescence and the discount to the cost of the new vessel usually have the natural character that was considered above and are connected with the necessity to overcome the difficulties experienced by the parties shifted to the seller. The non–systematic causes of external economic obsolescence and the value discount reveal themselves in a vessel property turnover.

The systematic (external) causes of wear and discounts to the value can have the artificial nature apart from vessel characteristics in itself and reveal themselves in process of productive operation of the vessel rather than in turnover. The external cause of economical difficulties for sale and discounts to value can be instability of the cargoes transportations market or administrative limitations, for example, the industrial quotas for the ocean biological resources development, influencing the reduction of the operational period for vessel within a year.

It should be taken into account that the reduction of the operational period is connected with the reduction of the good, associated by the owner with possession of the commercial vessel and its productive operation, and with proportional reduction of operation costs *C*.

Thus, the discount to the value of commercial vessel owing to the difficulties arising for the external causes corresponds with loss of interest rate in a proportion of reduction of the good and annual operation costs.

For example, when there are limits of annual income $[I]$ in relation to the technological capabilities of the commercial vessel for development of the ocean resources (according to the income *I*) the relative discount to the value corresponds $i \times [I]/I$ .

The given type of the external economic obsolescence arising out of the artificial causes is equal to the product of interest rate (or the total risks) by the limiting restriction of commercial vessel productive operation not to constraint of productive operation in relative value (or otherwise), and, that is the external economic obsolescence arising for the regular causes, corresponds to the value loss in proportion of relative efficiency index, let us assume, according to the discounting rate and limitation of productive operation.

And the upper estimation of the external economic obsolescence arising for the regular causes corresponds to the discounting rate, that is the sum of commercial risks as which can be considered taken place if in a prospective situation productive operation of the commercial vessel is completely limited.

The rest from one after subtraction of the external economic obsolescence arising because of the external regular causes is summed up to the reminder after subtraction from one of the external economic obsolescence arising for the internal non–systematic causes:

$$(1-D_5) = (1-i\times[I]/I)\times(1-(\Delta MV_2 \times \Delta MV_1 / MV(t=0) + \Delta MV_1 + \Delta MV_2)/RC)\,. \qquad (9.14)$$

If as the assumption to consider, that for the external regular causes intensity of productive operation of the commercial vessel and the income is limited in comparison with vessel specification possibilities to 25 % that is to $(1-[I]/I)$ = 25 %, and the discounting rate is equal *i* = 20 % the value discount owing to the difficulties arising for the external causes corresponds 5 % that is $i\times(1-[I]/I)$ = 20 % × 25 % / 100 % = 5 %.

Substituting expert assumptions concerning an estimation of economical difficulties of seller $\Delta MV_1 \approx 0.2\times C$ (clearings of the seller from obligations of the vessel maintenance) and the difficulties of the buyer $\Delta MV_2 \approx OC$ shifted to the seller, and defining the relative value of the corresponding discount affecting owing to the difficulties having both the systematic (external) and non–systematic causes it is possible to receive a resultant dependence in order to determine the external economic obsolescence:

$$D_5 \approx 0.95\times(0.2\times C\times OC/MV(t=0)+0.2\times C+OC)/RC+0.05 \qquad (9.15)$$

As, on the other hand, $D_5 = 1 - MV\,(t = 0)/RC$ there is a contradiction of the «circulativity», and the initial data and the required result ($MV\,(t = 0)$ and $RC$) are presented both in right and in a left–hand side of the received mathematical equation that complicates practical use of the following formula:

$$1-MV(t=0)/RC \approx 0.95\times(0.2\times C\times OC/MV(t=0)+0.2\times C+OC)/RC+0.05.$$

The contradiction of the «circulativity» is solved by the division of the initial data and the result in the left and right parts of the mathematical equation.

Making derivations of mathematical equation (9.15)

$$1{,}05\times(MV(t=0))^2+(0.2\times C+OC-RC)\times MV(t=0)+0.2\times C\times OC=0$$

and considering only positive results the dependence of the new vessel value $MV\,(t = 0)$ on the replacement cost *RC* and difficulties can be defined as:

$$MV(t=0) \approx 0.48\times(RC-0.2\times C-OC+\sqrt{(RC-0.2\times C-OC)^2-4.2\times 0.2\times C\times OC})\,. \qquad (9.16)$$

Consequently the external economic obsolescence $D_5 = 1 – MV(t = 0)/RC$ relative value depending on vessel replacement cost $RC$ and assumptions according to difficulties of the seller $\Delta MV_1 \approx 0.2 \times C$ and the buyer $\Delta MV_2 \approx OC$ shifted to the seller can be defined as:

$$D_5 \approx 1 - 0.48 \times (RC - 0.2 \times C - OC + \sqrt{(RC - 0.2 \times C - OC)^2 - 4.2 \times 0.2 \times C \times OC}) / RC . \quad (9.17)$$

The external economic obsolescence $D_5$ estimation with the received mathematical equation (9.17) or with the other similar formula depending on the accepted assumptions and limitations ($\Delta MV_1$, $\Delta MV_2$ and $[I]$) can be applied when estimation is made based on cost approach and the formula (8.1) if the basis for commercial vessel market value determination is reproduction cost $RC$ (or replacement cost).

The estimation of external economic obsolescence and the discount to value in case of the compelled sale of the commercial vessel (or other asset of the marine company) is made for making practical recommendations for the specified economic indexes determination and also for disclosing of the used general methodological technique (strategy) reception based on an estimation of the parties interests balance suitable for the solution of some similar issues of value estimation and for some tasks of efficiency estimation.

The external economic obsolescence as the difference of reproduction cost of the commercial vessel (or other asset of the marine company) that is expenses for vessel construction in market prices, on the one hand, and the market value of the new vessel, on the other hand, influences the value irrespectively of the vessel years which is the factor of internal depreciation.

The external obsolescence (economical) is a macroeconomic index and is directly connected with investment risks though it is earlier evaluated with the account the balance of interests and difficulties of the parties (the shipbuilding enterprise and the shipping company, shifted on the shipbuilding enterprise).

There is a sense to buy new vessels of serial construction even with the account the necessity of overcoming above mentioned economic difficulties.

The vessels bought at the pre–owned market (even new enough) cannot be optimal, this is a certain kind of the commercial risk caused by the difference of vessels characteristics from the optimal combination of characteristics of a new serial vessel rather than by ageing.

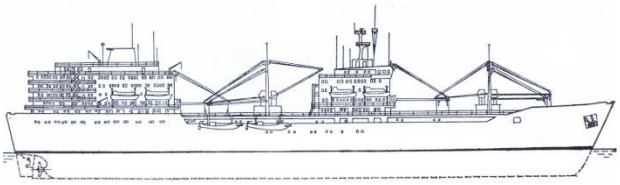
Besides the factor of discrepancy of characteristics of the bought at the pre–owned market to an optimum combination the structure of other risks of the shipping company where shipbuilding can be a way for clearing of these risks is in detail considered below (see article 18.2).

The surcharge for the shipbuilding enterprise (the grant, privilege, other) to the market value of the commercial vessel paid by the shipping company when purchasing the vessel to a size of the reproduction cost necessary for shipbuilding by the macroeconomic cause is the investment into system of the shipping company from the specified risks protection.

Thus, the surcharge to the shipbuilding enterprise necessary, on the one hand, for alignment of its interests with the buyer – the shipping company – and caused by the internal non–systematic causes, on the other hand, is justified by the external results according to macroeconomic evaluation.

**Test questions**

1. Factors which are the economic bases for evaluation in case of compelled sale.
2. Causes of external and internal property of the difficulties experienced by the parties.
3. Natural causes of economical difficulties in case of sale of the commercial vessel for circumstances of transfer through the technological stages: production, productive operation and recycling.
4. Conformity of external economic obsolescence absolute value with the difference of the replacement cost and the market value of the new vessel or other asset of the marine company.
5. Causes of the artificial property for difficulties in case of sale of the commercial vessel and for the discount to the value.
6. Probability of limits of exposure period for sale of the commercial vessel during construction and recycling phases and stage of productive operation of commercial vessel with the account duration of the listed technological stages.
7. Sources of concession financing for the buying party caused by natural difficulties for vessel transfer for sale between technological stages.
8. Internal difficulties when selling the new vessel.
9. Investments and difficulties of the commercial vessel construction and index of efficiency of clearing the manufacturer from difficulties (the formula derivation).
10. Investments of the commercial vessel buyer and his difficulties shifted to the seller – the manufacturer of the commercial vessel (the formula derivation).
11. Index of the buyer investments efficiency (the formula derivation).
12. Resale discount (the formula derivation) depending on difficulties of the seller and the buyer shifted to the seller.
13. Proportional parity of the discount to the value of commercial vessel and external economic obsolescence with loss of interest rate.
14. Estimation of external economic obsolescence of commercial vessel with the account difficulties of the seller and the buyer shifted to the seller.



# 10. Resale discount to the value caused by the limits of vessel exposure period for sale

The marine engineering, commercial vessels and other assets as a part of the marine companies' complexes are often evaluated as the objects which are sold with a discount connected with limited duration of sale exposure period. And the high capital intensity is one of preconditions of judgments about sale of similar assets in time essentially smaller the typical marketing period as for capital–intensive assets this period is rather great.

The issues of the given section about evaluation in case of limited duration of exposure period for sale of an asset has no direct relation to an estimation of the difficulties arising during transfer of the asset through the basic technological stages that is considered above (Chapter 9) as an estimation of factors of the corresponding discount and external economic obsolescence.

The matter is that technological duration of commercial vessel or other asset of the marine company construction and duration of recycling are usually short–term in comparison with duration of productive operation and there is no alternative possibility to sell an asset during acceptable exposure period if sale is made during transfer of technological stages. And mentioned alternative possibility to sell during acceptable period of exposure is included just into the structure of methodological preconditions for asset value discount estimation in case of a short exposure period.

The issues printed below are concerned with the generalization and the methodological analysis for the evaluation of the resale discount at the pre–owned market sale when limited duration of exposure period for sale is more important than the difficulties of the parties shifted to the seller, this aspect concerning new assets and constructed vessels was considered earlier (Chapter 9).

The extent of the economic importance of expensive assets exposure for sale can be judged on the basis of historical reviews as it is known, that some large fortunes were gradually formed by buying up marine commercial vessels being sold at the pre–owned market in case of limited duration of exposure period for sale with corresponding value discounts. An example is the business of the known businessman, ship–owner and millionaire Aristotle Onassis.

Some authors consider the following methods for determining the resale discount related to limited duration of exposure period for sale.

To determine the resale discount V.V. Galasjuk has offered a concept of «loss–free sales of goods at prices below their market value»: the losses arising from selling goods at the prices below their market values should be compensated by the seller's incomes from distributing cash facilities received earlier from the sale of the lesser money amount for these goods. Apparently, the «drawback» of this approach is that it is based on the analysis of the seller motivation, but not the buyer one, though the interests of the buyer should be considered as an important factor when estimating the vessel or other capital–intensive asset which the seller is forced to sell.

The technique of the qualimetric approach to estimation of the value in case of the compelled sale offered by G.G. Azgaldov is based on calculation of the resale discount by expert determination of the factors of importance forming a «tree of qualities» of an

estimated object. Working out of «trees of qualities» perhaps is a subject of researches and in applied tasks can be difficult.

The technique offered in the International academy of appraisal and consulting is that the resale discount is predetermined by two factors $F(T_{MV}, t_{MV})$ and $F(El)$, related to the limited duration of exposure period compared with the required for the adequate marketing exposure period and when one of parties is compelled to sell the vessel, and the other party aware of this.

It can be presented it as product of two functions: $DF = F(T_{MV}, t_{MV}) \times F(El)$ ,

where $DF$ – the resale discount (Discount Forced), defined as the difference between the commercial vessel (or other asset of the marine company) market value and the value in conditions of compelled sale $DF = MV - MVF$, where $MVF$ is the value in conditions of compelled sale (liquidating value, Market Value Forced); $T_{MV}$ – the duration of the typical marketing period for vessel sale at market value; $t_{MV}$ – the duration of the exposure period at the compelled sale; $El$ – the factor of elasticity of the supply in relation to the demand (marketing indicator).

When using the technique of International academy of appraisal and consulting for evaluation of the resale discount, it is required to determine factor of elasticity of the supply to demand $El$.

When the sale of the commercial vessel or other real asset of the marine company is forced and the exposure period is to short compared with the typical marketing period the value corresponds to the bottom limit of reasonable (fair) prices range that is unprofitable for the seller.

From the economic point of view the concept of the typical marketing period is connected with the possibility of commercial vessel sale at higher price provided that the exposure period is increased to certain limits.

In case of the compelled sale with the resale discount with the account reasonable benefit of the buyer the obligatory elements influencing the discount to the value $DF$ are the typical marketing period and market value $MV$ which would have developed in case of unlimited and not compelled sale.

Considering only the element of the buyer's activity, which is connected with acquisition of the commercial vessel from the owner forced to sale during the short period of time, less than typical marketing period $T_{MV}$, the resale discount $DF$ to the market value $MV$ on the basis of discounting under the rate $i$ is calculated by the formula

$$DF = MV \times (1 - 1/(1+i)^{T_{MV}}) . \qquad (10.1)$$

The resale discount $DF$ to the market value is influenced by the indicator of duration of the typical marketing period $T_{MV}$ which value demands substantiation in order to determine the resale discount $DF$ and the value in compelled sale $MVF$ correctly.

The duration of the typical marketing period $T_{MV}$ for vessel sale at market value $MV$ is a macroeconomic index and depends on following circumstances: on the general economic situation and on characteristics of the market segment.

To determine the duration of the typical marketing period $T_{MV}$ that is an exposure period selling at market value It should be noted the concept of basic definitions: vessel value in use and the value in exchange.

The value in use corresponds to estimation by the proprietor of the good concerning the possession of the commercial vessel (or other asset of the marine company). The value in exchange means commercial vessel evaluation by the economic environment.

Immediately after acquisitions that is previous exchange for a sum of money and establishments of the property rights the vessel (or other asset) economically is in a dual condition – using and exposure for an exchange, that is the vessel (or other asset of the marine company) is presented to an exchange continuously immediately after property establishments irrespectively of whether the proprietor realizes that the vessel is continuously presented to an exchange.

The owner keeps from exchange due to the insufficient sum – the value in exchange offered for a vessel in a corresponding segment of the market, which, as the exchange does not occur, is less than the value in use, therefore the exchange is excluded and productive operation proceeds.

The condition of a continuous exposure for exchange does not follow from the preliminary taken belief of the owner concerning the choice of continuation of productive operation of the commercial vessel (or other asset) or sales.

Whether the vessel will be sold and whether its productive operation will be continued, it depends on supply and demand parity at corresponding segments of the market, rather than on personal desire of the owner as he is rational. It is rationality of the owner proved by his present solvency (that is not less than the rights concerning his own vessel), which means an adequate reflexion of the market environment and his own economic interests in this environment serving as a criterion for the decision of sale.

As for the choice to sell the commercial vessel or to continue the productive operation the owner is influenced by the supply and demand parities, that is the owner of the commercial vessel is a subject influenced by an economic environment, and in this sense the owner is not free to decide to sell the vessel or not, and he searches for the answer in the market demand and supply analysis, it means that the owner is rational in his choice of decisions to sell the commercial vessel or to continue productive operation.

If the rights of the owner in respect of the vessel (or other asset of the marine company) correspond to Article 209 of the Civil code of the Russian Federation (or comparable property regulations in the USA, Britain, Canada or European Union) and include together in a complex the rights of possession, distribution and use the continuous characteristic of commercial vessel exposure for sale follows from complex property of the acquired rights among which besides the right of commercial vessel use (operation), the right of disposal is presented too. It means that the owner has the right to sell the vessel at any day, depending only on the market environment, that is, after vessel acquisition simultaneously with productive operation she is continuously offered for sale and the owner estimates the market environment in terms of analyzing whether he can continue productive operation of the commercial vessel.

The continuity of the commercial vessel exposure for the subsequent sale from the day of purchase follows only from the set of the property rights: possession, disposal and use acquired when purchasing the commercial vessel.

One can say, that the exposure of commercial vessel (or other asset of the marine company) period selling is defined by the following three objective elements:

– Beginning of the exposure period to sale – it s the time of commercial vessel acquisition;

– Structure of acquired property rights complex among which there is an right of disposal if the property rights correspond to Article 209 of the Civil code of the Russian Federation (or other comparable regulations) that means, that after acquisition the vessel (or other asset) is continuously offered for sale;

– Conjuncture of an economic environment, that is the relation between supply and demand in market environment, which predetermine the value in use and the value in exchange, taking into consideration, that the value in exchange exceeds by a distinguishable size the value in use at the day when there is an exchange and the exposure period for sale in this case ends.

It is necessary to underline, that when selling the distinguishable size of excess of the value in exchange over the value in use is not equal to the resale discount, and corresponds to a distinguishable error of estimation of the value in use, the value in exchange and the market value.

While selling the commercial vessel, for the seller the value in exchange exceeds the value in use by a distinguishable size, and for the buyer the value in use exceeds the value in exchange.

It should be added, that the first of the specified elements defining the period of an exposure to sale, namely the day of commercial vessel (or other asset of the marine company) acquisition is objective too and is a generalization of the set of two other elements only for the former owner – before vessel purchasing.

Thus, the fact that the vessel (or other asset of the marine company) is continuously offered for sale – to an exchange for money, and therefore continuously is in condition of the exposure for sale.

And the value in exchange is typically less than the value in use, except at the time of exchange, that is such in which the value in exchange is equal to the value in use or exceeds the value in use by the distinguishable size – by an error of estimation of value in use, value in exchange and market value.

The equality within a distinguishable size of the value in exchange and the value in use is the economic reason to sell the vessel – to exchange her for a sum of money.

The market value of the commercial vessel at the moment of sale is equal to the value in use and in exchange within an error, that is, within a distinguishable size which can be defined as the trade discount.

Sometimes the trade discount which methodologically concerns an error of value estimation, that is evaluated difference between the value in use and the value in exchange or difference between these values and market value, is wrongly correlated with the resale discount.

The error lies in the fact that if when defining market value, of the trade discount, that is a small size of a distinguishable error of evaluation, is applied instead of the resale discount connected with the duration of exposure period and the duration of the marketing period or with difficulties of the parties experienced and shifted to the seller, the result of the estimation is not the market value but the liquidation value.

The equality of the value in use and the value in exchange can be considered as one of market value definitions – the theoretical definition along with algorithmic definition of market value as a result of the coordinated application of three independent approaches and along with standard definition of market value under Federal appraisal standards or other comparable standards, that is, market value can be defined independently from the methodological, algorithmic or standard points of view.

It leads to introduction of the axiom based on belief that market value based on methodological definition, algorithmic and standard is a uniform concept.

During the rest of the time – the period between vessel sales at market value – the value in use depending generally on commercial vessel profitableness is typically more than the value in exchange, depending not only on commercial vessel profitableness, but

also on a relation between supply and demand and also on commercial risks. It is the excess of the value in use over the value in exchange that keeps the proprietor from selling the vessel.

Changing supply and demand parity leads to the increase of the value in exchange to the size of the value in use or to depreciation of the value in use to the level of the value in exchange – when there is an insufficient economic efficiency of the commercial vessel, the proprietor has motives to sell the vessel. And the publication of the owner decision about sale does not mean the beginning exposure to sale, quite on the contrary – it means the end of exposure and the beginning of technical procedure of sale registration which duration is much less than the duration of the exposure period to sale.

The duration of technical procedure of sale registration is short–term in relation to the duration of exposure period of the commercial vessel for sale that is in relation to the duration of the period during which the owner, after purchase, productively uses a vessel, simultaneously estimating the market about possibility to sell the vessel.

The duration of the exposure period of the commercial vessel or other real asset of marine company $T_{\mathrm{MV}}$ – the typical marketing period – is equal to the most probable duration of the period between sales at market value in the corresponding markets.

Probably, the duration of exposure $T_{\mathrm{MV}}$ for sale can be correlated with the duration of a payback period – to equate or accept multiple which, in turn, is in return conformity with the index of investments efficiency $T_{\mathrm{MV}} \sim TR \sim 1/i$ (correlated with the sum of commercial risks).

The vessel can be reoffered for sale at the markets in the states (jurisdictions) with higher rate of inflation, weaker economic and social infrastructure, not having own developed industrial manufacture that is in case of absence of national innovative economy.

And functional and physical characteristics of commercial vessel remain unchangeable, but depreciation of value in use to the value in exchange is caused mainly by transition to other market with higher commercial risks, in particular to the pre–owned vessels market – when there is a change of economic environment characteristics.

Usually the resale of marine commercial vessels or other assets (engineering and equipment) is done in less developed countries, and the resale of real estate – to less wealthy owners etc.

From the point of view of the new proprietor the vessel value in use after acquisition exceeds the value in exchange that keeps it from immediate resale which can occur only in the next market separated in space (geographically) or in time.

If in order to determine the resale discount in case of sale in a period, essentially smaller the typical marketing period the following methodological assumptions will be used that:

– Formula (10.1) transformed under the form of discounting by exponential functions (see article 13) of the Euler's number

$$DF = MV \times (1 - 1/e^{i \times T_{MV}}) = MV \times (1 - 1/(1+i)^{T_{MV}}),$$

with the account $e^{i} \approx (1+i)$ with small values of the discounting rate $i$, at which $i \approx \ln(1 + i)$, that is if $i \le (0.15 \div 0.20)$;

– There is a conformity of the duration of typical marketing exposure period exposure period with investments payback period (as a special case of proportionality) and with index of commercial risk $T_{\mathrm{MV}} \sim 1/i$;

– There is an assumption that the discounting rate $i$ is rather insignificant, and the duration of typical marketing period $T_{MV}$ for this reason is not small;

– If to consider, that from the point of the systematic approach in frameworks of the general probabilistic assumption «the average vessel» (or other real asset of marine company) is in the middle of the period ($T_{MV} \times ½$) between its previous and the subsequent sales at market value – the resale discount to value, in case of vessel sale in a period essentially shorter than the typical marketing period, can be estimated approximately as:

$$DF \approx MV \times (1 - 1/e^{i \times T_{MV} \times 1/2}) = MV \times (1 - 1/e^{i \times (1/i) \times 1/2}),$$

$$DF \approx MV \times (1 - 1/e^{1/2}) = MV \times 0.393,$$

that is, the discount for the compelled sale of «the average vessel» (or other real asset of the marine company) in a period essentially shorter than the typical marketing period makes about 40 % of its market value $MV$.

Generally, if the position during the marketing period $t_{MV}/T_{MV}$ (relative value, in the applied purposes evaluated by the expert opinion is known), the resale discount in case of sale in period essentially shorter than the typical marketing period is determined as:

$$DF \approx MV \times (1 - 1/e^{1 - t_{MV}/T_{MV}}), \qquad (10.2)$$

where $t_{MV}$ is the duration of productive operation of commercial vessel (or other real asset of marine company) after purchase.

Within the limits of the accepted assumptions the discount to value for liquidity in case of sale in a period essentially shorter than the typical marketing period for a new vessels (recently bought, when $t_{MV}/T_{MV} = 0.0$) can make about 60 % of value:

$$DF \approx MV \times (1 - 1/e) = MV \times 0.632,$$

and for not a new vessels and at the end of commercial vessel life cycle, that is when $t_{MV}/T_{MV} = 1$, the discount to the value for liquidity can correspond to zero: $DF = MV \times (1 - 1/e^{0,0}) = 0.0$.

It is interesting to note, that the resale discount in case of vessel sale in a period essentially shorter than the typical marketing period when using the discounting by the Euler' number exponential function by the factor $e^i$ according to the resultant formula (10.2) does not depend on the discounting rate and it is connected only with mathematical constant $e$, if we don't take into account that the duration of the typical marketing exposure period depends on the discounting rate $i$ in exponent $T_{MV} \sim 1/i$ in the assumption of correlation of the duration of the typical marketing exposure period with an investments payback period. And with the account the assumption of the typical marketing period correlation with a payback period and with commercial risks as the discounting rate the resultant dependence (10.2) the resale discount in relation to commercial vessel productive operation duration and period exposure for sale after purchase becomes $DF \approx MV \times (1 - 1/e^{1 - t_{MV} \times i})$.

At the same time using the discounting (10.1) by factor $(1 + i)$ unlike discounting by the Euler' number exponential function (10.2) the resale discount depends on the discounting rate $i$ in an explicit form, but there are no objective bases for definition of typical marketing period duration $T_{MV}$ in an exponent which in this case is defined subjectively.

Apparently, the expert estimation of the commercial vessel (or other asset of the marine company) position during the marketing period $t_{MV}/T_{MV}$ in the proportional relation for definition of the resale discount by the formula (10.2) derived using the

discounting by the Euler' number exponential function is more logical than definition of the absolute size of typical marketing exposure period $t_{MV}$ if for that there are no alternative convincing bases.

Anyway, to determine the position during the marketing period $t_{MV}/T_{MV}$ it is not required to consider dimensions and the expert decision should be accepted in the limited interval – from 0.0 to 1.

In applied expert researches besides the economic index of the resale discount applied to value estimation for compelled sale conditions the index of the trade discount applied in case of market value determination based on comparable sales approach according to analogues is also used.

It should be noted that mixing of these concepts is widespread enough, that, in this case should be a methodological error, namely if when estimating based on comparable sales approach the trade discount is mistakenly applied instead of the resale discount the received result is not market value and it corresponds to value for conditions of the compelled sale – liquidating value.

The probability of this error is rather great as the concept of the trade discount methodologically and regulatively is not introduced in the applied economics, and by experts the colloquial term «the discount for trade» can be applied. This indicator is usually determined intuitively and applied as the adjustment to the market value when estimating based on comparable sales approach.

To eliminate methodological error it is necessary to define what should be to understood by the term «the trade discount (extra charge)» in applied economy. Then it could be possible to find ways of the trade discount (extra charge) estimation, considering, that this index should not be mixed with the resale discount.

Possibly, unlike the resale discount, the trade discount (extra charge) corresponds to a statistical error of value estimation and cannot be defined from economic methodology point.

The value estimation error means an interval of values in which the value cannot be determined authentically that is an interval in which the value is accurate reliable.

The smart seller will not reduce the value below the bottom level of its values and the smart buyer will not pay more than the top level of accurate values.

As vessel sale (or other asset of the marine company) occurs, when the value in exchange distinguishably exceeds the value in use this distinguishable value meaning an error of estimation of value in use, value in exchange and market value, just corresponds to an error of estimation and can serve as a reference point for estimation of the trade discount (extra charge).

Taking into account, that for expert estimation if is usually used not a standard value definition under Federal appraisal standards (or under other comparable standards) and not a theoretical definition as an equivalence of the value in use and the value in exchange and algorithmic estimation as a result of the coordinated application of three independent approaches, it is possible to judge about an error of an estimation, and hence, about the trade discount (extra charge) by the correlation of the values determined by independent approaches.

The possibility of the trade discount (extra charge) estimation by the statistics depends on whether statistical regression is applied for the value estimation based on comparable sales approach or other suitable for estimation of the error model, such as, imitation, or the value is estimated based on comparable sales approach according to separate analogues and in that case it is necessary to have other expert way or a reference point to

determine the estimation error by which it is possible to judge about the trade discount (extra charge).

It is possible for example to correlate an error of estimation with the minimum value which can be estimated for real asset.

For example, if the minimum of the marine commercial vessel value is residual liquidation value (scrap cost, that is value at the compelled sale of commercial vessel as sets of materials and without functional suitability of parts), without researches of statistical sets there is a basis consider expertly the of the scrap cost as an error of market value estimation which with accumulation of irremovable depreciation can decrease to zero, but with a certain error of zero estimation which is equal to the scrap cost.

In this case, if the error of commercial vessel (or other asset of the marine company) market value estimation cannot be executed using the comparable sales approach by the statistical set of analogues, for expert determination of the trade discount (extra charge) in case of estimation by the comparable sales approach it is required to estimate also the residual liquidation value which, anyway, is not below the market value estimation error that is, it is proportional to the trade discount (extra charge).

By the considered reasons if the trade discount (extra charge) is used in case of estimation based on comparable sales approach it should be determined and applied by absolute (monetary) value, contrary to popular examples of «discounts for trade» applied on subjectively appointed relative value – in relation to the value of the vessel (or other asset of the marine company).

It is reasonable to add it is not quite clear if it is reasonable to apply the trade discount (extra charge) in case of estimation of commercial vessel or other asset of the marine company by the comparable sales approach not only because this index is not defined by the standard but also due to fact that methodologically it is not always clear what sign should be used to make the corresponding adjustment to the market value – a minus or plus.

On the other hand, as the sale of capital–intensive assets, in particular marine commercial vessels, is practically always characterized by difficulties for the seller the general discount usually includes also the resale discount, besides the trade discount (extra charge).

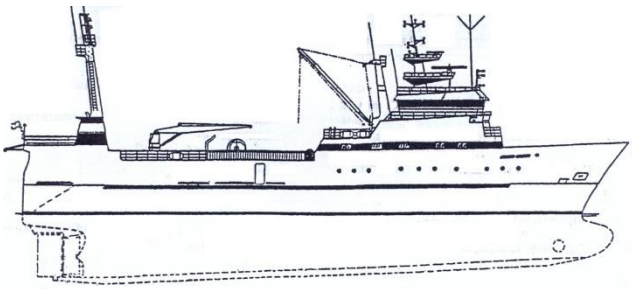
The total discount in the certain proportional relation depends on both the obstacles experienced by the seller (or on the limited exposure period selling) and the error of commercial vessel (or other asset of the marine company) estimation.

Apparently, the values offered in information databases of broker companies for vessels or other assets of the marine companies sale that is so–called «the prices of the supply (demand)» (that is also not quite a certain concept from the methodological point) are a border of market values and can differ from market value by a distinguishable error of its estimation, that, by the way, serves as a concept of the price of the supply (demand).

Between the value of the supply (demand) of the commercial vessel (or other asset of the marine company) and the market value determined based on comparable sales approach there is no present basic distinctions, and these indicators differ by an estimation error, and the value of the supply (demand) is methodologically defined through the market value.

**Test questions**

1. Causes of the commercial vessel (or other asset of the marine company) compelled sale.
2. Concept of the value in case of the compelled sale (liquidating value). The resale discount.
3. Standard definitions of liquidation value (in case of the compelled sale of the commercial vessel).
4. Techniques of the resale discount determination. The methodical limitations and assumptions of V.V. Galasjuk, G.G. Azgaldov.
5. Definition of the resale discount by the method of the International academy of appraisal and consulting. Factors and multipliers influencing an estimation of the resale discount.
6. Influence of the exposure period duration and the typical marketing period for value in case of vessel sale.
7. Typical marketing period as the duration of exposure period for vessel sale at market value.
8. Definition of the resale discount with the account the limited duration of the exposure period of the typical marketing period (the formula derivation).
9. Methodological definition of the market value by the correlation of value in use and value in exchange.
10. Methodological concepts of value in use and value in exchange, as factors of the marketing period estimation.
11. Stability of commercial vessel ownership, based on excess of value in use over the value in exchange.
12. Elements of commercial vessel exposure for sale.
13. Beginning of the exposure after buying of the right of disposal and the end of the exposure by sale of the commercial vessel as a result of excess of value in an exchange over the value in use (for distinguishable size, correlated with margin error of estimation).
14. Beginning of the marketing period after buying the right of disposal as a part of property rights set in case of vessel purchase.
15. Exposure ends with publication of the decision to sell the commercial vessel and the beginning of technical procedure of sale.
16. The hypothesis of correlation of the duration of exposure of the typical marketing period to the multiple to payback period in interrelation with commercial risks and the discounting rate.
17. Marketing causes of value in use depreciation to the value in exchange before vessel sale.
18. Methodological assumptions when determining the resale discount to the value for vessel sale in a period essentially shorter than the typical marketing period.
19. Resale discount in case of the compelled sale of a recently bought vessel, not a new vessel and «the average vessel». The relation of the discount to market value.
20. Definition of the resale discount depending on commercial vessel position during the marketing period (the formula derivation).
21. Estimation of the resale discount depending on commercial vessel productive operation duration and exposure for sale after purchases (the formula derivation).



# 11. Features of vessel estimation or marine company's property complexes of real assets based on income approach

The value *MV* of the vessel or any other isolated asset of the marine company is determined by capitalization of continuously accumulating discounted cash flow *NOI* sum by the formula

$$MV(t) + OC = (1+i)^{1/2} \times \sum_{t_N=t+1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N - t}} + \frac{Rv}{(1+i)^{T-t}}, \qquad (11.1)$$

and the reversion *Rv* for revenue–generating vessel or other isolated asset can be determined, for example, as $Rv \approx NOI_T / i$, where *NOI* – the net operating income or the similar cash flow – for the property complex; *i* – the discounting rate; *t* – the vessel years; *T* – the life time of the commercial vessel or other real asset or the duration the predicted period before the reversion reception *Rv* at the end of the period of asset productive operation; $t_N$ – the present time – discrete variable in summation of the discounted cash flow; *OC* – the working assets.

When determining the discounted present values of cash flow by summation of the sequence with the discrete variable of time with a range $t_N = t + 1, T$ (as in the formula 11.1 and in the similar) or $t_N = 1, T$, that is, with the account the indexes of cash flow in each summand at the end of the annual period, for applied tasks it is recommended to make the adjustment on accounting of the distributed payment within a year to which the summation of indexes in the middle of the annual period corresponds better than the summation of indexes at the end of the year.

The adjustment, when determining the present value present value of the discounted cash flow that accounts of the distributed payment within year, can be introduced by the multiplier $(1+i)^{1/2}$ for the sum of sequence or by the multiplier $e^{i/2}$ if the discounting by the Euler' number exponential function is used. If, when defining the discounted flows present value, the summation is made in intervals $t_N = t, T-1$ or $t_N = 0, T-1$ it is necessary to apply the correction multiplier $(1+i)^{-1/2}$ or $e^{-i/2}$.

Despite formal similarity of the symbol *NOI* and some methodological similarity, the cash flow, of the property complex value as a part of the marine company when determined by the income approach, is calculated according to the concepts of business evaluation as the sum of parts (for the invested capital): net profit (without deductions for credit use), amortization (compensation deductions for the assets depreciation), increase in current asset and reduction of long–term obligations minus investments into the real assets.

The discounting rate *i* corresponds to the interest rate or with the macroeconomic index of risks and is evaluated by the applied methods in sphere of business evaluation, for example by the market extraction according to analogues, by the models: the cumulative estimation, the arbitration pricing, the average weighed value of the capital, the estimation of capital assets, etc.

For the formula (11.1) and for other formulas based on estimations of present values of cash flows it is possible to present the discounting rate as the sum of components $i = i_0 + i_1 + i_2 + i_3 + \eta_{MV} + \eta_{INS}$, where $i_0$ – the risks free rate evaluated by the available data of the issue centers; $i_1$ – the adjustment with the account systematic (external) economic risk; $i_2$ – the adjustment with the account non–systematic risk; $i_3$ – the gain rate of consumer prices index (inflation index); $\eta_{MV}$ – the rate of the property tax in real asset value estimation; $\eta_{INS}$ – the rate of the insurance coverage depending on the estimated value.

The advice to determine the discounting rate *i* in the sum of the specified terms does not mean in this case the recommendation to determine the rate by summation, and the rate defined by any suitable approach from among used in theory of business and assets valuation shows that, by the economic sense, it is the sum of the components and generally of the commercial risks.

The planning period *T* recommended in valuation usually should not be less the investments payback period $T_R \sim 1/i$ with the account the interest rate *i* or can be accepted equal to life time – depending on the subject assumptions.

It should be noted that the estimation method based on income approach from the point of the discounted cash flow capitalization to a greater extent corresponds to the value estimation of the marine company taken as a whole entity or economically self–financing isolated property complex of real assets as part of the marine company.

The value *MV* of self–financing objects of the similar type that is the property complexes evaluated based on income approach (11.1) includes also working assets, and the result is equal to total value of all assets as a part of the company's property complex, – both the real assets and working assets including financial assets that is

$$MV = (1+i)^{1/2} \times \sum_{t_N=1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N}} + \frac{Rv}{(1+i)^T}.$$

When one estimate the marine company isolated real asset with gradually going down present value and the growing in value the economically self–financing property complex for which the financial records are kept (or it can be kept) at an innovative investment stage or for the whole company based on income approach, despite the general formal similarity (11.1) there are available methodological distinctions according to the economic indexes used in calculation: the cash flow *NOI*, the discounting rate *i* and the reversion *Rv*.

As the accounting at the level of financial result of *NOI* estimation usually is not kept for the isolated asset of the marine company, in particular separate assets can be accounted only by expenses and be used for increase of the total property complex efficiency whereas other assets generate income and the record of expenses is not kept, then when determining the net operating income in order to estimate the asset in the sum with working assets based on income approach (by the formula 11.1 or on other) it is required to work out and use an asset economic model – the sequences of dependences, on the one hand, between characteristics of an asset *X*, expert indexes *Y* – params in evaluation and external data *Z*, and, on the other hand, the basic economic indexes: the annual income *I* and operation costs *C*, that concerning marine commercial vessels of various classes is considered in corresponding sections (article 14, 15).

The reversion *Rv* when the estimation is made by the income approach of the property complex value or the whole marine company can be determined based on methods of the property costs approach or the income approach on the basis of profitableness accounting in case of the property complex profitability in the last forecasting years.

The vessel, in itself, without other property of the ship–owner used for commercial vessel productive operation for example, without taking into account of working assets for the advance payment and acquisition of fuel, supply, crew salary, vessel maintenance and other expenses, methodologically cannot be evaluated as a marine company's property complex by the income approach.

Without the connected working assets the vessel can be a source of income only in case of sale, thus it is supposed, that the new owner will resupply working assets.

It should be taken into consideration that working assets *OC* are not completely a part of investments present value as they come back by their nominal value to the owner at the time of productive operation end $T_R$.

The structure of investments includes, thus, the value of the working assets right–of–use during the period before commercial vessel or other asset of the marine company resale for the value equal the reversion *Rv* at the end of productive operation.

The part of working assets *OC* which is a part of investments present value with the account the presented explanatory, can be determined in case of limited life time by the next ways:

$$OC \times i/(i+f_m),\ OC \times (1-f_m/(i+f_m)) \text{ or } OC \times (1\text{-}1/(1+i)^{T_R}),$$

where $f_m$ – the factor of compensation of the depreciated part of investments fund (see article 13, tab. 13.2), determined by the formula $f_m = i/((1+i)^{T-t}-1)$.

It is necessary to point out, that with the great life time of an asset (vessel) or with the long enough forecasting period if risks in the sum *i* are insignificant the part of working assets *OC* which is a part of present value of investments is approximately equal to working assets completely.

Generalizing the stated material regarding the account of working assets *OC* when estimation is made based on income approach it should be noted that the present value of a cash flow (11.1) is equal to the sum of the vessel value (or other real asset of marine company) and current asset value or the value of the part of current asset – in case of the limited duration of forecasting or the limited life time. In this case when the estimation of present values of cash flow for the vessel evaluation or other asset have been done away the adjustment to working assets value should be subtracted.

On the other hand, the present value of a cash flow of the net operating income corresponds to the value of the whole marine company total property complex, and there is a task to estimate such an object and the adjustment to the value of working assets shouldn't be subtracted from the present value of a cash flow for estimation of the object of the specified class.

The correcting reference of working assets to the value of the commercial vessel or other real asset of the marine company evaluated based on income approach is an supplement of the isolated object to the property complex, that is, a supplemented economic property of the object which value estimated based on income approach is equal to the present value of corresponding cash flow.

The choice of discounted cash flow *NOI* capitalization method within the frameworks of the income approach sometimes is proved by the assumption that this method is more accurate in comparison with the direct capitalization method. In some cases it causes objections.

Unlike the direct capitalization, the increase in number of used params for the discounted cash flow accounted with the opinion on higher accuracy of this method can generate uncertainty of the specified params estimation – subjectivity of the period of planning estimation, apriority of the forecast cash flow variability during the planning period etc.

Apparently, more objective argument in favor of the discounted cash flow capitalization method can be a property of the cash flow predicted variability caused by the own properties of evaluated object, for example, an increase in a cash flow in case of reinvesting into the assets of growing innovative business, instead of properties of macroeconomic environment which can predetermine the unpredictable variability of cash flow, which is a risk factor and considered as the component of the discounting rate.

The preference area of the discounted cash flow capitalization method is limited by the objects possessing a property of cash flow predicted variability, for example, if there is a planned schedule of investment, and it is reasonable to apply direct capitalization method for other objects.

If there is no planned investment schedule even when there is a forecast of cash flow growth for the property complex or the whole marine company it is more logical to use direct capitalization method variants with the forecast of cash flow growth, for example the Gordon formula, than to summarize the discounted cash flow. When there is no planned schedule, the estimation of present value by cash flow direct capitalization is a clearer calculation and is free from superfluous illusions about higher accuracy of the sum estimation by the discount financial functions.

The predicted variability of a cash flow can be an integral property of the object of estimation when the object of estimation is an isolated business – the acting company's property complex or the part of the property complex changing in a quantitative sense in process of growth, for example unidentifiable intangible asset – goodwill.

Usually for identified assets (real and intangible, including a vessel) which are separate of the marine company's property complex variability of a cash flow has unpredictable property external in relation to the object, and variability is the characteristic of a macroeconomic environment and is taken into account in the sum of risks.

In a predicted sense the cash flow for separate assets as a part of the marine company's property complex is invariable in the present prices and depends on functional and structural characteristics, in particular on the characteristics of commercial vessel which are her steady identification attributes.

Concerning the isolated real assets it is more correctly to consider that the variability of their cash flow having unpredictable property is the macroeconomic characteristic and is considered as a component in the risks total sum. Therefore, to estimate the value of the isolated real asset of the marine company's property complex by the income approach including vessel value, owing to stability of an identification attribute it is preferable to estimate by the income approach on the basis of direct capitalization method.

Even if the vessel reconstruction or repair is predicted this circumstance can't be considered an argument in favor of preference of application of a capitalization of the discounted cash flow method instead of direct capitalization.

It is more logical to determine a present value of expenses for reconstruction and take into account it as the adjustment to the vessel value estimated based on income approach on the basis of direct capitalization method (by the formula 11.4) in the assumption of reconstruction, along with estimation of servitudes and other adjustments.

In consecutive statement of the task to determine the economic indexes of marine commercial vessels the systematized approach with account of taxes and deductions is required. In spite of the fact that in Russia and in other states the rules of taxation can partially differ generally for the size of rates of taxes It should be noted available similarity and universality of approaches.

For calculation of taxes in the states producing an overwhelming part of a cumulative industrial product, similar economic indexes are basic: income, profit, cost of assets, operation costs.

In view of universality of the taxation base in different states having generally close legal system, distinctions in taxation rules concern generally the rates of taxes, rather than the methods of taxes calculation, leaving aside separate distinctions in used terms and designations. For the specified reasons the conclusions concerning rules of taxes account for marine commercial vessels evaluation have a rather universal character for the various states.

In total amount of taxes and the deductions arriving in the budget the greatest part (more than 95 % of the general taxes and deductions receipts both federal and local) makes: the profit tax, the added value tax, the property tax, the deductions for the social insurance.

Formally it is taxes of the specified kinds that are subject for accounting in marine commercial vessels evaluations, as cumulative receipts of taxes of other kinds are insignificant by their value.

The sales tax, apparently, is not important in sphere of rather large investments into construction and productive operation of marine engineering and ocean technology, as mentioned investments are made almost exclusively by the clearing settlement.

When estimating the vessel or other real asset of marine company's property complex the cash flow of net operating income *NOI* is equal to difference between the annual income *I* and operation costs *C*, and also the property tax and some payments, for example insurance premium.

At the same time the profit and the added value taxes are not subtracted when calculating net operating income *NOI*. And deductions for the social insurance are also included into the structure of operational expenses *C* to expenses for salary payment joins also.

The property tax is taken into account when the value estimated by the income approach by adding the rate $\eta_{MV}$ of the property tax to the rate of net operating income capitalization *R*.

In the expert's activity the exception of the profit tax and the tax for the added value from the results of estimation should be an infringement of rules and approaches as the results of estimation further usually used in contracts between the parties should include

the profit tax and the added value tax unless otherwise stipulated.

Besides, while estimating of marine commercial vessel or other real asset of marine company usually it is impossible theoretically to distinguish the profit tax and the added value tax as the base of taxes of the specified kinds are indexes of the whole marine company financial recording instead of separately taken asset for which the financial record usually is not kept and it is not reproduce–able to the full.

As the profit tax and the added value tax should be a part of commercial vessel or other real asset all economic indexes as basic indicators – the annual income, the operation costs, the investments – and derivative indicators – the profits, the net operating income, etc., defined by mathematical derivations over the basic indexes the possible exception of the profit tax and the tax for the added value of any economic indexes methodologically should be incorrect.

With account taken of the profit tax and the tax for the added value when estimating the vessel or other real asset of marine company consists in preservation of the profit tax and the tax for the added value as a part of economic indexes and not exclusion of these taxes from profit and added value (and from other economic indexes in estimating of an asset).

As rules of the account of taxes in process of value estimation have a rather universal characteristic in various states, the approach of taxes inclusion in total sum of the marine company asset value is done by means of:

– Determining of economic indexes and also value without withdrawal of the tax for the added value and the profit tax, that is including the profit tax and the added value tax;

– Taking into account, as a part of operation costs, those deductions which base of determination are items of operation costs;

– Taking into account the property tax by addition property tax rate $\eta_{MV}$ for the capitalization rate when using the income approach;

– Neglecting in estimations of the basic economic indexes the numerous taxes which cumulative share in the total amount of tax revenues is little.

It should be noted that the method of accounting of taxes as a part of a capitalized index in case of estimation of the commercial vessel or the property complex of the marine company based on income approach concerns the method of determination of the capitalization rate (or discounting).

If the rate is determined on the basis of market extraction according to analogues of estimated objects the way of the rate calculation should correspond to a way of its application and the accounting of taxes as a part of capitalized index – to a way of the accounting of taxes as a part of corresponding index in rate determination. At the same time the resultant value includes taxes in full, just as analogue value when determining the rate by the market extraction.

The estimation of profit minus deductions for real assets restoration, taking into account preconditions considered above, is determined by the formula

$$p = NOI - f_m \times MV = I - C - f_m \times MV \,. \qquad (11.2)$$

The estimation based on methods of income approach assume that the equipped vessel (fuel charged, supplied etc.) is operated with all advance payments for operation

costs which correspond to working assets *OC*.

At the unlimited or rather great life time of commercial vessel (or other asset of the marine company) the discounting rate *i* (the sum of risks) as an indicator of investments efficiency *MV+OC* is equal

$$i = p/(MV + OC)\,. \qquad (11.3)$$

The formula (11.3), on the one hand, is a result out of mathematical summation by the formula (11.1) in condition of constant net operating income *NOI* on years (in the present value on the day of estimation), and also at rather great life time *T* of an evaluated asset within a summation limit (or in case of the limited life time, but with the account that reversion *Rv* is defined too by summation by the formula 11.1 or direct capitalization).

From the other hand, the formula (11.3) serves as a definition of the basic economic law: the profit *p* is proportional to capital investments *MV+OC*. And the proportionality factor corresponds to the sum of commercial risks according to the discounting rate *i*.

Substituting the equation (11.2) for profit estimation *p* in the formula of the basic economic law (11.3), it is possible to derive

$$MV + OC = (I - C)/R = NOI/R\,. \qquad (11.4)$$

The rate of net operating income capitalization $R = i + f_m$ is determined as a sum of the discounting rate *i* including rates of the property tax $\eta_{MV}$ and insurance coverage $\eta_{INS}$, and factor $f_m$ of depreciated part of investments fund of compensation, $f_m = i/((1+i)^{T-t} - 1)$ (article 13, tab. 13), where *T* – *t* is the period which has remained before write–off operation with the account life time *T* and vessel (or other real asset of marine company) years *t*, that is residual life time.

Just as the commercial vessel or other real asset of marine company estimation based on income approach of present values of cash flow (11.1), the result of calculation by the formula (11.4) is not only the value, it is more exactly – the total sum of cost of investments, that is the sum of asset value and present value of working assets $OC \times i/R$ with the account the limited life time of the commercial vessel and difference due to this case between the capitalization rate *R* and the discounting rate *i*, i.e.

**Test questions**

1. Evaluation of the discounted cash flow by capitalization (the formula derivation).
2. Elements of a cash flow.
3. Ways of reversion determination.
4. Predicted variability of the cash flow as the basis for application of discounted cash flow capitalization method.
5. Objects of estimation possessing predicted variability of the cash flow (the property complex of the marine company, unidentifiable intangible asset – goodwill, etc.).
6. Preference of the discounted cash flow capitalization of the marine company assets value possessing predicted variability of cash flow is determined by the income approach.
7. Unpredictable variability of cash flow for the isolated asset as macroeconomic risk factor.

8. Recommendations of direct capitalization method when the isolated assets of the marine company value characterized by stability of functional attributes is estimated by the income approach.

9. Assets characterized by unpredictable variability of a cash flow (the isolated real assets of the marine company).

10. Recommended period of planning when estimation is made on the basis of cash flow estimation.

11. Area of the effective application of methods on the basis of cash flows estimation.

12. Net operating income and profit.

13. Advantages of the method of direct capitalization of the net operating income for the isolated asset (vessel) estimation.

14. Accounting of taxes in expenses (operation costs).

15. Features of taxes when the net operating income and vessel value are estimated by the income approach.

16. Adjustment by the size of working assets value to the result of commercial vessel estimation by formulas of the income approach.

## 11.1. Methodological conformity of cost and income approaches in estimation of the marine company's property complex

Despite the methodological distinctions of the estimation by income and cost approaches certain formal conformity is available.

As with the account a relation of reproduction cost and the market value of the new asset $MV(t=0)=MV(0)$, $RC\times(1-D_5)=MV(0)$ corresponding to estimation of the external obsolescence (economical) in equally influencing the same assets regardless of their internal depreciation ($D_1$, $D_2$, $D_3$, $D_4$ or $D_{1-4}$) in this case defined by the absolute monetary magnitude collecting over the time, the reproduction cost $RC$ of the marine company asset based can be estimated by the income approach as:

$$RC\times(1-D_5)+OC=(1+i)^{1/2}\times\sum_{t_N=1}^{T}\frac{NOI_{t_N}}{(1+i)^{t_N}}+\frac{Rv}{(1+i)^{T}}, \qquad (11.5)$$

and the market value of not a new asset $MV(t)$ having age $t$ is possible to determine based on income approach by the formula (11.1) or, on the other hand, based on cost approach $MV(t)=RC\times(1-D_5)-D_{1-4}$, thus

$$MV(t)+OC=(1+i)^{1/2}\times\sum_{t_N=t+1}^{T}\frac{NOI_{t_N}}{(1+i)^{t_N-t}}+\frac{Rv}{(1+i)^{T-t}}, \text{ or}$$

$$RC\times(1-D_5)-D_{1-4}+OC=(1+i)^{1/2}\times\sum_{t_N=t+1}^{T}\frac{NOI_{t_N}}{(1+i)^{t_N-t}}+\frac{Rv}{(1+i)^{T-t}},$$ than the internal depreciation $D_{1-4}$ in the sum physical, and functional and for assets of the marine company mostly functional with rather great life time, corresponds to a difference between the depreciated reproduction cost with the subtraction of the external economic obsolescence

$RC \times (1 - D_5) = MV(t = 0)$ and the market value $MV$ ($t$) of not a new asset or a difference between the market value of new and not a new asset of the marine company $MV(t = 0) - MV(t)$, that is

$$D_{1-4} = RC \times (1 - D_5) - MV(t) = MV(t = 0) - MV(t) =$$

$$= (1+i)^{1/2} \times \sum_{t_N=1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N}} + \frac{Rv}{(1+i)^T} - (1+i)^{1/2} \times \sum_{t_N=t+1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N - t}} - \frac{Rv}{(1+i)^{T-t}},$$

or after derrivations of the received formula

$$D_{1-4} = (1+i)^{1/2} \times \sum_{t_N=1}^{t} \frac{NOI_{t_N}}{(1+i)^{t_N}} + \frac{1}{(1+i)^t} \times \left( (1+i)^{1/2} \times \sum_{t_N=t+1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N - t}} - \frac{Rv}{(1+i)^{T-t}} \right) -$$

$$- (1+i)^{1/2} \times \sum_{t_N=t+1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N - t}} - \frac{Rv}{(1+i)^{T-t}},$$

the accumulated internal depreciation $D_{1-4}$ of the marine company isolated real asset can be defined as the index methodologically corresponding to difference between the cash flow *NOI* of present value for period of use by an asset *t* (duration of depreciation, age of an asset) and the present value of asset use

$$MV(t) \times (1 - 1/(1+i)^t) = MV(t) - MV(t)/(1+i)^t$$

for the same period evaluated at the end of use period $MV(t) = RC \times (1 - D_5) - D_{1-4}$ and depreciation is

$$D_{1-4} = (1+i)^{1/2} \times \sum_{t_N=1}^{t} \frac{NOI_{t_N}}{(1+i)^{t_N}} - MV(t) \times (1 - 1/(1+i)^t). \qquad (11.6)$$

It should be reminded, that the choice of the mathematical form of statistical regression (4.5–4.8, article 4.4) for value estimation of commercial vessel (or other asset of the marine company) based on comparable sales approach also takes into account estimation of asset ability to generate the income and depreciation of asset value in process of transformation of accumulated net operating income *NOI* into the financial form.

The derivation of the formula (11.6) pulls together the cost and income approaches to value estimation of the isolated real assets of the marine company

$$MV(t) = RC \times (1 - D_5) - (1+i)^{1/2} \times \sum_{t_N=1}^{t} \frac{NOI_{t_N}}{(1+i)^{t_N}} - MV(t) + MV(t)/(1+i)^t \text{ or}$$

$$MV(t) = \frac{1}{2 - 1/(1+i)^t} \times \left( RC \times (1 - D_5) - (1+i)^{1/2} \times \sum_{t_N=1}^{t} \frac{NOI_{t_N}}{(1+i)^{t_N}} \right). \qquad (11.7)$$

Using the direct capitalization of the invariable net operating income *NOI* in the present value, if the factor of fund of compensation $f_m$ of investments depreciated part as a component of the capitalization rate $R = i + f_m$ of net operating income can be neglected with rather great life time of the asset, the formula (11.7) which is a combination of cost and income approaches, will be transformed as:

$$MV(t) \approx (RC \times (1 - D_5) - (1 - 1/(1+i)^t) \times NOI / i) / (2 - 1/(1+i)^t) .$$

The retrospective summation of the discounted cash flow in the subtracted part of the formulas (11.7) is a certain methodological difference from an estimation based on income approach: the cash flow is summarized for the last interval of period of vessel or other asset of the marine company use, whereas in estimation by the income approach the cash flow is summarized for the prospective forecasting period and is taken into account in an evaluation of present value with «plus» sign. Thus in order to forecast the cash flow to some extent the optimistic concept – the scenario can be used, as, for example, the scenario of the prospective highest and the best use is applied for value estimation of the real estate territory sites under the building.

Apparently, being for a vessel or other asset of the marine company a certain analogy of methods of estimation of depreciation on a basis of both the concepts of «life time» and the capitalization of the income loss, cash flow summation for the last period can be considered more objective estimation than cash flow capitalization expected in the future and even there is a possibility of keeping documentary records of cash flow in the past account.

The sum of the discounted cash flow evaluated for the last period methodologically corresponds to the scenario of the future continuity in relation to the past if the cash flow is predicted for the future continuously with estimation of retrospective flow.

One shouldn't assume that depreciation of the real asset over the time determined by the formula (11.7) does not cover the accounting of physical depreciation factors and structural durability but only characterizes asset depreciation in process of its transformation into the financial form of accumulated net operating income *NOI*. By definition of net operating income *NOI*, the operation costs are subtracted from the annual income that is $NOI = I - C$ which contain also expenses for maintenance of the marine company asset in a suitable and efficient condition.

If to consider that the factor of the cost approach in the formula (11.7) corresponds the component containing reproduction cost $RC \times (1 - D_5)$ and the factor of the income approach – the component characterizing present value of net operating income *NOI* cash flow for a period of asset use within the age *t* the proportion of these factors varies over asset years in process of the net operating income accumulation.

In estimating by the formula (11.7) over asset years the cost approach factor influence decreases and influence the income approach increases.

For a new asset (for example, a vessel) substituting $t = 0.0$ in the formula (11.7) it is possible to accept resultant dependence $MV(0) = RC \times (1 - D_5)$ that corresponds to the cost approach use.

And for not a new isolated real asset at considerable years $t \to \infty$ assuming stability of net operating income *NOI* and other economic indexes in the present values and considering that value of a steady cash flow of the net operating income is equal

$$\lim_{t \to \infty} \sum_{t_N = 1}^{t} \frac{NOI_{t_N}}{(1+i)^{t_N}} = NOI / i ,$$

substituting $t \to \infty$ in the formula (11.7) and at $MV(t \to \infty) \approx NOI / i$ based on income approach it is possible to receive a resultant dependence

$$MV(t \to \infty) \approx (RC \times (1 - D_5) - (1+i)^{1/2} \times NOI / i) / 2$$

or $MV(t \to \infty) \approx RC \times (1 - D_5) / (2 + (1+i)^{1/2})$ for the assumption that the asset of the marine company keeps ins profitability and structural durability.

The possibility of introducing to the property complex analogy of the depreciation concept applied in case of the isolated asset value estimation based on cost approach is also interesting. The depreciation corresponds to subtracted part of the formula (11.7). And investments for the property complex estimation by this formula as well as cash flow are recommended to consider by present value

$$MV(t) = \frac{(1+i)^{1/2}}{2 - 1/(1+i)^t} \times \sum_{t_N=1}^{t} \frac{(RC \times (1 - D_5) - NOI)_{t_N}}{(1+i)^{t_N}}. \qquad (11.8)$$

**Test questions**

1. Determination of the net operating income capitalization rate with the account the factor of fund of depreciated investments into vessel compensation.

2. Attributes of formal conformity and analogy when using income and cost approaches.

## 11.2. Adjustment to the value of the marine company assets estimation by the income approach with the account of the right of dispose

The isolated real assets and the property complex of the marine company are usually evaluated by the income approach for cash flow of the net operating income present value or cash flow value of other methodologically close index, for example, profit. In order to determine the present value, the corresponding factor of the capitalization or the discounting is used, and necessary adjustments are introduced, and the index of profitableness applied in estimation reflects both functional characteristics of evaluated asset or the property complex and efficiency of the ocean resources.

As the value according to the income approach is the capitalization (accumulation), the capitalized indexes can serve both the net operating income (or profit) that corresponds to the standard income approach and the expense of the value accumulated in capitalization, in itself.

It is possible to point out a well–known economic analogy that obligations under the loan include both its return and repayment of percent (interest rate) that is obligations are a two–componential index.

The capitalized index from the system methodological concepts point of view is not only the net operating income (or profit) and includes also the value expense, for example, as a value derivative in time, in other words, as value potential that in details considered above (article 4.4).

The structure of a capitalized index in estimation based on income approach is relative and should include both components which influence the evaluation based on income approach in a certain relation. The relativity concept can be borrowed from physics: as it

is impossible to distinguish in many respects the similar mechanical phenomena of inertia and gravitation they are defined as a single entity (whole).

At the same time, the expense of the value as a part of capitalized index also is considered by the factor of fund of investments compensation which are going down over the time in value. Using typical discount financial functions the factor of fund of compensation makes appreciable impact only on the value of not a new asset which years are proportional to life time.

The specified methodological contradiction in respect of underestimation of the value expense as a part of capitalized index can serve as the cause of observable discrepancy of dependence of its value estimated based on income approach on asset years.

This contradiction is noticeable for assets which present value decreases over years, for example, for commercial vessels, and the value estimated by capitalization of the net operating income (or profit) only varies over the time slightly (fig. 11.1). The discrepancies also arise when coordinating the value estimation results by the standard independent approaches.

According with the standard income approach the asset has the value if generates the net operating income (or profit). Without touching the details, according to the income approach based only on capitalization of the net operating income (or profit) the value of the asset which does not generates the net operating income is equal to zero, and the assets which generates in the equal net operating income have equal value. The specified consequences of the income approach based only on capitalization of the net operating income (or profit), come into contradictions with economic observations and cause doubts.

The standard approaches and, among them, the income approach to a certain extent are conditional methodological approximations and they should be corrected from time to time. Taking into account that the capitalized index is not reduced only to the net operating income (or profit) and is also connected with the value expense, the analysis and specification of applied recommendations of the income approach is required.

The capitalization of the net operating income (or profit) corresponds to estimation of possession of the right–of–use, thus the possession on the right of disposal is not evaluated. Inclusion of the value expense in the structure of capitalized index means the estimation of property right of disposal that is the good of possession of the right of disposal even if the asset use is not implemented.

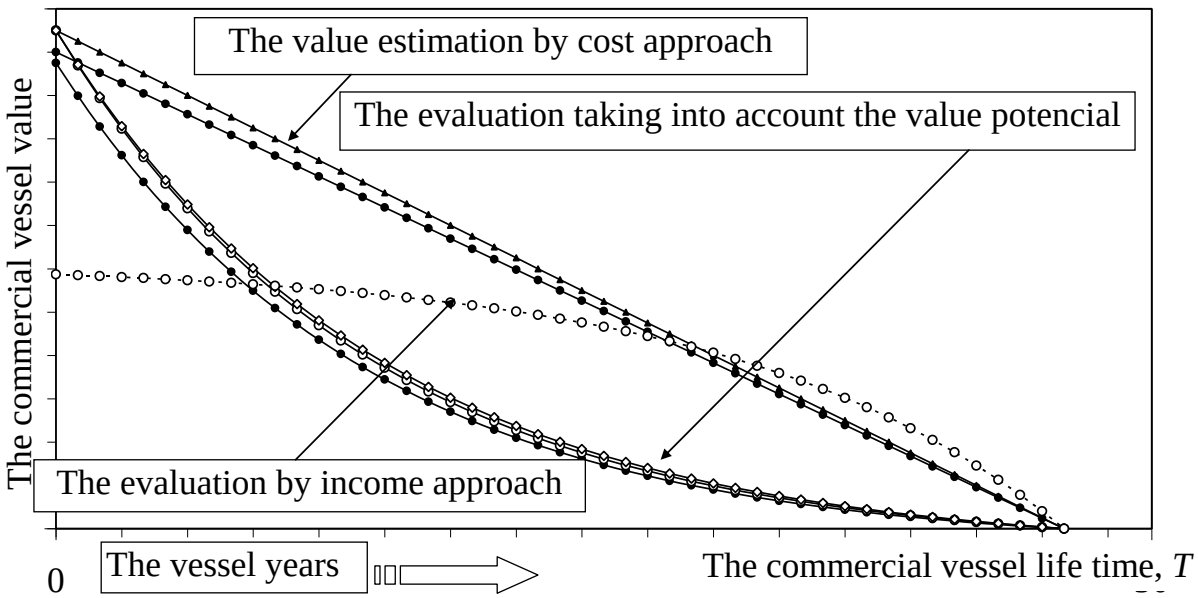



Fig. 11.1. The dependance of commercial vessel value on years, estimated by the cost and income approaches, as well as bu the value potencial account

The value estimation by capitalization of net operating income *NOI* looks like:

$$MV(t)+OC = NOI / R = NOI /(i+ f_m) = (NOI / i)/(1+1/((1+i)^{T-t} -1)) .$$

After mathematical substitutions and derivations the vessel value (or other asset of the marine company) is determined by the income approach, as:

$$MV(t)+OC = (NOI / i)\times((1+i)^{T-t} -1)/(1+i)^{T-t} . \qquad (11.9)$$

With the account the working assets the estimation can be fulfilled on the basis of the potential equation of present value (4.3, article 4.4) integration by the formula

$$MV + OC = (MV(t=0)+OC)\times(((1+i)^{T-t} -1)/((1+i)^{T} -1))^{i/\ln(1+i)} ,$$

which after replacement of symbol $MV(t=0) = MV_0$ and in the assumption about small commercial risks, that is, the discounting rate *i*, with which $i/\ln(1+i)\approx 1$, becomes:

$$MV(t)+OC = (MV_0 + OC)\times((1+i)^{T-t} -1)/((1+i)^{T} -1) . \qquad (11.10)$$

The formulas comparison shows formal partial similarity of estimation based on income approach (11.9) and integration of the present value potential equation (11.10).

After mathematical derivations the equation (11.10) becomes:

$$MV(t)+OC = \frac{MV_0 + OC}{(1+i)^t + ((1+i)^t -1)/((1+i)^{T-t} -1)} ,$$

that for the option of discounting by the Euler' number exponential function $(1+i)^t \approx e^{i\times t}$ corresponds to the formula:

$$MV(t)+OC \approx \frac{MV_0 + OC}{e^{i\times t} + (e^{i\times t} -1)/(e^{i\times(T-t)} -1)} . \qquad (11.11)$$

For a rather new vessel (or other asset of the marine company), for which $0{,}0 \le (i \times t)^n << 1$ for example, at the stage of designing or construction the linearization of the discounting exponential function with the account fast increase of the denominator *n*! with number *n* of components of exponential function of $e^{i \times t}$ decomposition in the Taylor range: $e^{i \times t} = 1 + i \times t / 1! + (i \times t)^2 / 2! + (i \times t)^3 / 3! + \ldots$, corresponds to approximate mathematical formula $e^{i \times t} \approx 1 + i \times t$.

After mathematical substitutions the estimation of present value applying the results of integration of the linearized potential equation (11.10 and 11.11) is done by the formula

$$MV(t) + OC \approx (MV_0 + OC)/(1 + t \times i + t/(T - t)), \qquad (11.12)$$

$$\text{or } MV(t) + OC \approx (MV_0 + OC)/(1 + f_{MV}),$$

where $f_{MV} = t \times i + t/(T - t)$ – the factor of present value potential, taking into account vessel depreciation (or other marine company asset) in process of the transformation to the financial form along with the net operating income accumulation.

If to continue analogy and conditionally to accept that the value of the new vessel (or other asset of the marine company) at the stage of finance investing corresponds to capitalization of net operating income $MV_0 + OC = NOI / i$, the estimation by integration of the linearized potential equation of present value (11.12) will become:

$$MV(t) + OC \approx NOI / R_{MV} = NOI/(i + i^2 \times t + i/(T - t)) = NOI/(i + f_{NOI}), \qquad (11.13)$$

where $f_{NOI} = i^2 \times t + i/(T - t)$ – the factor of the net operating income *NOI* potential, evaluated with the account the factor of present value potential, as $f_{NOI} = i \times f_{MV}$; $R_{MV}$ – the capitalization rate of the value and the net operating income potentials factors accounting $R_{MV} = i + f_{NOI}$.

Within the frameworks of the considered assumptions the rate of the net operating income capitalization, taking into account the factor of the net operating income potential defined by the factor of present value potential, is evaluated, as $R_{MV} = i + f_{NOI}$.

Without addressing the assumption of the equation linearization which is fair with rather big predicted life time, for example, for a new vessel (or other asset of the marine company), the definition of factor $f_{MV}$ of value potential according to the model of its expenditure along with accumulation of the net operating income looks like:

$$f_{MV} = (1 + i)^t + ((1 + i)^t - 1)/((1 + i)^{(T-t)} - 1) - 1, \qquad (11.14)$$

$$\text{or } f_{MV} = e^{i \times t} + (e^{i \times t} - 1)/(e^{i \times (T-t)} - 1) - 1.$$

Outside a methodological assumption of correlation of initial value with present value of cash flow $NOI / R$, that is in more general statement, and in the assumption that initial value corresponds to value estimation by capitalization of the net operating income with the confidential probability $\alpha$ and with the confidential probability (1 – $\alpha$) is the alternative evaluation with account of present value potential, the vessel evaluation (or

other marine company asset) balanced by the factor of probability $\alpha$ as dependence of value on years becomes:

$$MV(t)+OC=\alpha\times NOI/(i+f_m)+(1-\alpha)\times(MV_0+OC)/(1+f_{MV}), \text{ or} \qquad (11.15)$$

$$MV(t)+OC=\alpha\times NOI/(i+i/((1+i)^{T-t}-1))+(1-\alpha)\times(MV_0+OC)/(1+t\times i+t/(T-t)).$$

The dependence (11.15) of the vessel value (or other real asset of marine company) on age in the sum with working assets by the relative value $(MV(t)+OC)/(MV_0+OC)$ is presented on the graph (fig. 11.2) and also reflects the value estimation by the capitalization of the net operating income with confidential probability $\alpha$ and the evaluation with the account the present value potential with confidential probability (1 – $\alpha$).

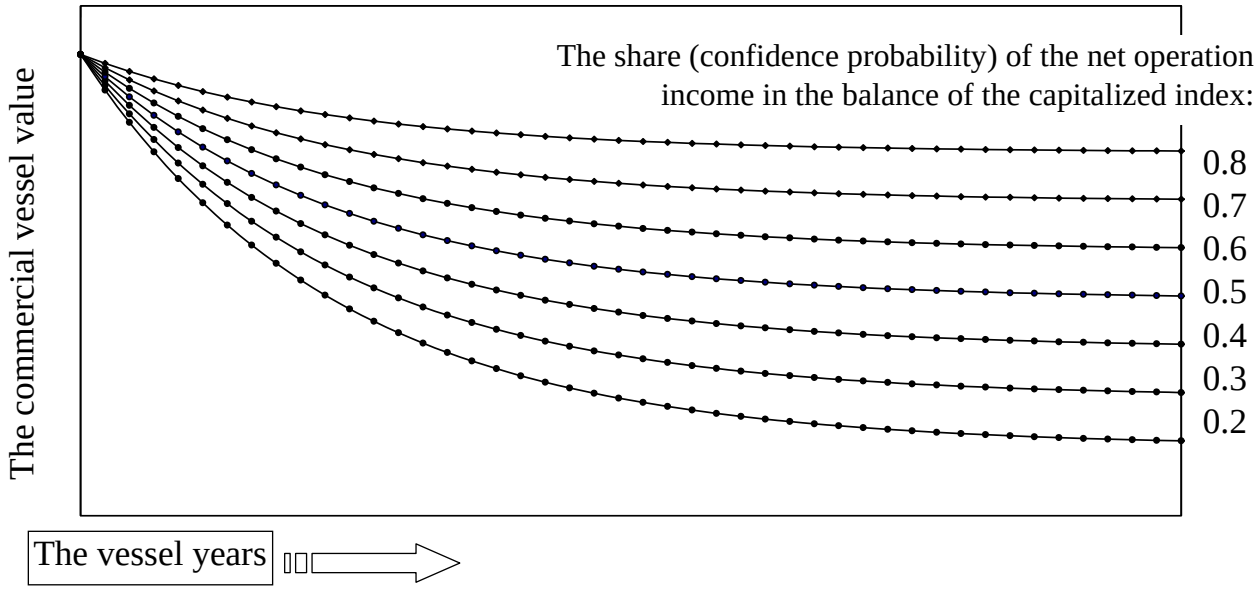



Fig. 11.2. The commercial vessel value estimated with account of the net operation income and the value expense in the balance of the capitalized index

In the assumption of rather great life time $T$ (or residual life time $T-t$), when influence of the reversion $Rv$ on the value determined by capitalization of the discounted cash flow of the net operating income by the formula (11.1) can be neglected, that is, if

$$\frac{Rv}{(1+i)^{T-t}}\approx 0{,}0 \text{ and } MV(t)+OC\approx(1+i)^{1/2}\times\sum_{t_N=t+1}^{T}\frac{NOI_{t_N}}{(1+i)^{t_N-t}},$$

in the assumption that the initial value corresponds to an evaluation by capitalization of the net operating income with the confidential probability $\alpha$ and is an alternative estimation with the confidential probability (1 – $\alpha$) with account of the present value potential, the balanced evaluation of commercial vessel (or other asset of the marine company) as dependence of value on years looks like:

$$MV(t)+OC\approx\alpha\times(1+i)^{1/2}\times\sum_{t_N=t+1}^{T}\frac{NOI_{t_N}}{(1+i)^{t_N-t}}+(1-\alpha)\times(MV_0+OC)/(1+f_{MV}),$$

or in the linearized assumption that the factor of present value potential is defined as: $f_{MV} = t \times i + t/(T-t)$, the estimation balanced on confidential probability $\alpha$ by the capitalization of the discounted cash flow of the net operating income corresponds to the formula

$$MV(t) + OC \approx \alpha \times (1+i)^{1/2} \times \sum_{t_N=t+1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N - t}} + (1-\alpha) \times (MV_0 + OC)/(1 + t \times i + t/(T-t)). \tag{11.16}$$

To estimate a new vessel (or other asset of the marine company), for example, at the stages of designing and construction (or purchase at the pre–owned market at value $MV_0$ with $t$=0) the balanced value estimation by the formula (11.16) looks like:

$$MV(t=0) + OC - (1-\alpha) \times (MV_0 + OC)/(1 + t \times i + t/(T-t)) \approx \alpha \times (1+i)^{1/2} \times \sum_{t_N=0,0+1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N - 0}},$$

with the account that $MV(t=0) = MV_0$ and

$$(1 + t \times i + t/(T-t)) = (1 + 0 \times i + 0/(T-0)) = 1$$

with $t$=0 after the mathematical derivations it is possible to receive the formula

$$MV_0 + OC - (1-\alpha) \times (MV_0 + OC) \approx \alpha \times (1+i)^{1/2} \times \sum_{t_N=1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N}},$$

or $MV_0 + OC \approx (1+i)^{1/2} \times \sum_{t_N=1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N}}$, that corresponds to value estimation based on income approach by the formula (11.1) with the account that we determine the new vessel value (or other asset of the marine company).

The same conclusion about the determination of a new vessel value (or other asset of the marine company) with rather great life time by the income approach, when $f_m \approx 0.0$, as about the result of generalization of estimation by capitalization of the net operating income with confidential probability $\alpha$ and the alternative evaluation with confidential probability (1 – $\alpha$) with account on the present value potential it is possible to receive by the derivation of the formula (11.15): $MV_0 + OC = NOI/i$.

It is possible to find that the initial value $MV_0$ estimation in the sum with working assets $OC$ does not depend on the structure of a capitalized index that is on confidential probability balance $\alpha$ of the value estimation by capitalization of the discounted cash flow of the net operating income (the same can be seen at the graph, fig. 11.2).

The initial value $MV_0$ estimation corresponds to the present value of a cash flow based on income approach $NOI/i$ that, as an assumption, is used above for derivation of the formula (11.13). Though there is a methodological difference in the fact that dependence of the value in the sum with working assets on years by the formula (11.13) does not reflect the evaluation based on income approach, taking into account with confidential probability $\alpha$ by the formulas (11.15 and 11.16) but only an alternative estimation with confidential probability (1 – $\alpha$) derived from the potential equation of present value solution.

With rather great life time $T$ (or residual life time $T - t$) with which the reversion $Rv$ influence for value of new vessel (or other asset of the marine company) can be neglected and when $f_m \approx 0.0$ the dependence of value on the age corresponding value estimation by capitalization of the net operating income with confidential probability $\alpha$ and the alternative evaluation with confidential probability (1 – $\alpha$) with the account of present value potential it can be defined by the mathematical derivation of formulas (11.15 and 11.16) and substitution of $MV_0 + OC = NOI / i$, as:

$$MV(t) + OC = (\alpha + (1-\alpha)/(1+f_{MV})) \times NOI / i, \tag{11.17}$$

$$\text{or } MV(t) + OC \approx (\alpha + (1-\alpha)/(1 + t \times i + t/(T-t))) \times NOI / i,$$

$$MV(t) + OC = (\alpha + (1-\alpha)/(1+f_{MV})) \times (1+i)^{1/2} \times \sum_{t_N = t+1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N - t}}, \tag{11.18}$$

$$\text{or } MV(t) + OC \approx (\alpha + (1-\alpha)/(1 + t \times i + t/(T-t))) \times (1+i)^{1/2} \times \sum_{t_N = t+1}^{T} \frac{NOI_{t_N}}{(1+i)^{t_N - t}}.$$

In further clarification of formulas (11.7 and 11.8) received on the basis of the methodological conformity of cost and income approaches (article 11.1) based on the value estimation by capitalization of the net operating income with confidential probability $\alpha$ and on the evaluation of potential of present value with confidential probability (1 – $\alpha$), the value of the isolated real asset of the marine company can be estimated by the formula

$$MV(t) = \frac{1}{2 - 1/(1+i)^t} \times \left( RC \times (1 - D_5) - (\alpha + (1-\alpha)/(1+f_{MV})) \times (1+i)^{1/2} \times \sum_{t_N=1}^{t} \frac{NOI_{t_N}}{(1+i)^{t_N}} \right), \tag{11.19}$$

or, for a rather new asset of the marine company

$$MV(t) \approx \frac{1}{2 - 1/(1+i)^t} \times \left( RC \times (1 - D_5) - (\alpha + (1-\alpha)/(1 + t \times i + t/(T-t))) \times (1+i)^{1/2} \times \sum_{t_N=1}^{t} \frac{NOI_{t_N}}{(1+i)^{t_N}} \right),$$

and initial value minus external economic obsolescence corresponds to an estimation by the formula $MV_0 = RC \times (1 - D_5)$.

With the account difference of investments for the years of summation $t_N$ depreciated with the account the external obsolescence (economical) $RC_{t_N} \times (1 - D_{5t_N})$, and the net operating income with expertly evaluated the confidential probability $\alpha$ and also the alternative evaluation of present value potential with the confidential probability (1 – $\alpha$) that is

$$RC_{t_N} \times (1 - D_{5t_N}) - (\alpha + (1-\alpha)/(1+f_{MV t_N})) \times NOI_{t_N} = (RC \times (1 - D_5) - (\alpha + (1-\alpha)/(1+f_{MV})) \times NOI)_{t_N},$$

the marine company's property complex value is equal:

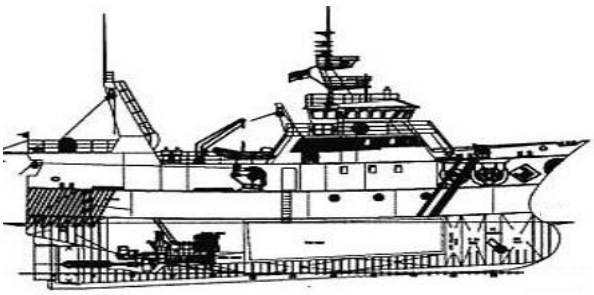
$$MV(t) = \frac{(1+i)^{1/2}}{2 - 1/(1+i)^t} \times \sum_{t_N=1}^{t} \frac{(RC \times (1 - D_5) - (\alpha + (1-\alpha)/(1+f_{MV})) \times NOI)_{t_N}}{(1+i)^{t_N}}, \tag{11.20}$$

or at the innovative stage of the marine company when financial assets are invested into acquisition of sets of real assets the marine company's property complex value can be estimated, as:

$$MV(t) \approx \frac{(1+i)^{1/2}}{2-1/(1+i)^{t}} \times \sum_{t_N=1}^{t} \frac{(RC \times (1-D_5) - (\alpha + (1-\alpha)/(1+t \times i + t/(T-t))) \times NOI)_{t_N}}{(1+i)^{t_N}} .$$

**Test questions**

1. Capitalized index in case of the isolated real assets or the property complex evaluation based on income approach.
2. Two–componential structure of capitalized index in case of evaluation based on income approach.
3. Methodological contradiction in respect of underestimation of the value expenditure when it defined by capitalization of the net operating income.
4. Attributes of the contradiction of underestimation as a part of the capitalized index of the vessel value expense (or other real asset of the marine company).
5. Evaluation of property right of disposal by inclusion of the value expenditure into the structure of capitalized index.
6. Partial formal similarity of value estimation based on income approach and by the integration of the present value potential equation (to present formulas and to compare).
7. Estimation of present value with application of results of integration of the linearized potential equation.
8. Rate of the net operating income capitalization with the account expenditure of present value potential.
9. Formulas of evaluation by capitalization of the net operating income with confidential probability $\alpha$ and the alternative evaluation based on the account of present value potential with confidential probability (1 – $\alpha$).
10. Methodological assumptions concerning reversion influence and the factor of fund of investments compensation for the value estimation with the great life time of commercial vessel (or other real asset of marine company).
11. Formulas of value estimation by capitalization of the discounted cash flow of the net operating income balanced by the confidential probability $\alpha$.
12. Independence of initial value estimation on the capitalized index structure.
13. Applied recommendations (the formula derivation) for definition of value dependence on years according to value estimation by capitalization of the net operating income with confidential probability $\alpha$ and evaluation with account of present value potential with confidential probability (1 – $\alpha$).
14. Vessel value estimation or other isolated asset of the marine company for the methodological conformity of cost and income approaches based on capitalization of the net operating income with confidential probability $\alpha$ and based on evaluation of present value potential with confidential probability (1 – $\alpha$).
15. Evaluation of the marine company's property complex based on the methodological conformity of cost and income approaches with the account an annual difference of investments and the net operating income with expertly evaluated confidential probability $\alpha$.



# 12. An interval method of net operating income cash flow capitalization in evaluation of the marine company's property complex

The marine commercial vessels, real assets and the marine companies' complexes mastering marine wealth as objects of investment possess number of specific features which can influence the kind of methods used for the investments evaluation and the economic efficiency estimation, in particular, influence recommended kinds of the income approach methods.

Namely, differences of economic properties of marine commercial vessels, the marine companies' complexes of the assets and their real assets from properties of the cash flows applied in case of present value estimation of on the basis of discount financial functions refer to above mentioned features.

Unlike cash flow which present value usually grows, the vessel value is reduced in process of depreciation, and value of the property complex varies non–uniformly, for example, by step dependence with particular reference to the plan of investment in process of large assets transfer. And it is noticeable for the marine companies, where the value of separate assets of which the property complex consist of is comparable with the value of the company total.

The recommendations for the present value of cash flow determination for estimation of the marine company's property complex consisted of separate assets which value is comparable with the value of the whole property complex by the income approach are stated below and present value with particular reference to the calendar of investing varies unevenly depending on steady functional properties of separate assets. And within separate stages of investing the present value of cash flows is invariable or varies with constant paces.

Concerning the property of predicted variability of cash flow, if the property complex of the marine company or predictably changeable part of the business for example unidentifiable intangible asset – goodwill is evaluated it is possible to define, that «stepwise» variability of cash flow with particular reference to the planned schedule of investing as a part of the business plan ($T_0$, $T_1$, $T_2$, …, $T_N$, $NOI_1$, $NOI_2$, …, $NOI_N$) is more typical.

For the companies in which structure there are no the separate assets proportional to the value of the whole company total of value and for financial institutions the assumption concerning continuous value capitalization of assets and continuous change of incomes (and expenses), in other words, an assumption about a continuity of the net profit growth is reasonable since the acquisition of any separate asset is an imperceptible step in relation to the value and profitableness of such company.

Just an assumption about growth continuity (it should be underlined: not uniformity of growth but continuity) for the property complex where there is no in its structure assets proportional in value to the whole complex value total connected with rather small non–systematic commercial risks (internal), allows to introduce the evaluation based on income

approach in the formal scheme of the discounted cash flow capitalization by the formula (11.1).

The property complex of the marine company, which separate assets values can be proportional to complex value, and accumulation of real assets and change of efficiency according to the investment business plan have a stepwise character is a more characteristic object of value estimation than the company growing in value continuous without reference to any separate planned schedule but only according to interest rate by the discount formula of present value.

By the way, predicted continuity of assets value capitalization by the discount formula of present value linearly or otherwise that is at continuity or at continuous growth of accumulation rates, can also be considered as the basis for use of primary direct capitalization method use with the account predicted rates of profit growth (or the net operating income) in alternative of the discounted cash flow capitalization by the formula (11.1).

Except the marine companies' complexes of the assets the stepwise variability of cash flow is characteristic for rather small companies, that is for the majority. And stepwise variability can be connected with necessary versatility, in other words, in process of accumulation with the purpose of reinvesting of financial assets in real asset are not used, and current accumulation of financial assets is stored or invested in other activity not of the company's basic profile if for the investments into a profile activity there are not enough financial assets. The sufficient accumulation of financial assets is required for investing in real asset if a value of a separate asset is proportional to the property complex value.

Thus, the marine company carries out at least two kinds of activity: a profile activity, which is characterized by the greatest efficiency (in particular, according to profit for the investment evaluation), that is the economic basis of the company profile and not a profile activity – storage or any other investing of financial assets in process of their capitalization for investing in real assets the value separate from which is proportional to the value of the property complex total.

Not profile investing in the marine company financial assets in process of capitalization levels a little, but does not eliminate stepwise variability of cash flow. It is possible to place, for example, financial assets to a fixed deposit for protection against inflation before investing in real assets for the marine company profile.

It should be noted that from the formal point placing of finances into the deposit most closely corresponds to accumulation of financial assets continuity according to the discount formula of present value just as to continuity of the large company assets capitalization, in the structure of the property complex where there are not the assets proportional in value to a complex.

For elimination of stepwise variability of the marine company cash flow it should be required that efficiency (in particular, of profit from the investment) of not a profile activity was equal to efficiency of profile activity. But it would contradict the general assumption that profile activity is most effective and would put in doubt the marine company profile.

The efficiency of the marine company profile activity is substantially higher than not a profile activity; otherwise the company profile is subject to change. On the other hand, with rather high efficiency of the profile activity it is reasonable to apply a loan that

can also be considered as not a profile activity, as a profile activity consists in investing of financial assets in real assets.

The loan usage as well as accumulation of financial assets at the deposit levels a little but does not eliminate stepwise variability of cash flow for the marine company own capital. The equalization of value capitalization rates and efficiency of the marine company's real assets at the expense of advance investing in assets using the extra financial assets gives to the investor the effect proportional to the cost of borrowed funds.

While estimating the value it is logical to remain within the frameworks of assumption about cash flow stepwise variability which is one of methodological properties of the marine company's property complex having separate assets proportional in value to the whole property complex for the following reasons:

– Equalization of value capitalization and efficiency rates of real assets as a part of the property complex at the expense of not a profile activity does not lead to an essential change of the results of value estimation of involved resources (loan commitments etc.) is usually proportional in size and is opposite in sign to value change of the property complex;

– Not a profile activity of the marine company does not lead to equalization of value and efficiency of real assets growth in the phase relation, that is instead of stepwise growth of efficiency and value of assets in case of equalization at the expense of involved finances the stepwise changes of the growth rates remain, but they are steady within the intervals between investing in real assets for the profile activity.

Having divided cash flow into stability intervals between investment stages under the planned schedule ($T_0$, $T_1$, $T_2$, …, $T_N$) updating of assets and change of identification attributes, the present value of cash flow can be determined as a sum of present values for each of the cash flow stability intervals changing at stages of investing under the planned schedule. And cash flow value during each interval of stability can be determined by the method of direct capitalization.

The limited duration of cash flow stability interval is taken into account by introducing of a compensating (reactive) cash flow to the asset cash flow corresponding to the net operating income for the isolated asset as a part of the marine company's property complex capitalized under the discounting rate as an infinite cash flow for direct capitalization.

The present value of cash flow is evaluated according to planning intervals of the marine company by the formula

$$MV = \frac{1}{i} \times \sum_{n=1}^{N} NOI_n \times ((1+i)^{-T_{n-1}} - (1+i)^{-T_n}) + (NOI_N / i) \times (1+i)^{-T_N}, \qquad (12.1)$$

where $N$ – the number of predicted intervals of cash flow stability or stability of rates of accumulation of the cash flow corresponding to a number of investments planning stages and the multiplier ($1/i$) in front of the sum means in sense of the approximate equality of the investments payback period $T_R \approx 1/i$, when the efficiency corresponding to the sum of risks and the discounting rate $i$, and the period of planning $T_N$ is determined as:

$$T_N = \sum_{n=1}^{N} (T_n - T_{n-1}).$$

For the investments payback period $T_R$ and for the efficiency rate $i$ in case of estimation of the property complex by the interval method and the formula (12.1) there corresponds a planning period of the cash flow of net operating income invariable in value within each interval of stability from $T_{n-1}$ to $T_n$, which is the same as the planning period of continuously collecting present value determined by the formula 11.1 and this period is not less than the investments payback period $T_R$, that is $T_R \cong 1/i \leq T_N$.

When using the cash flow capitalization interval method the variable of summation by the formula (12.1) is a number $n$ of cash flow stability interval $n$, and when estimating the present value of continuously accumulating sum of the discounted cash flow by the formula (11.1), the discrete characteristic of the present time $t$ is the variable.

Unlike the method for present value estimation by determining of continuously accumulating sum of the net operating income discounted cash flow by the formula (11.1), the method for present value determination by capitalization for the intervals of stability (12.1) to estimate the marine company's property complex considers predicted variability of a cash flow of the net profit as an integral factor of the investment plan ($T_0$, $T_1$, $T_2$, …, $T_N$).

The interval method of cash flow capitalization is «adhered» to the planned schedule of the investments ($T_0$, $T_1$, $T_2$, …, $T_N$, $NOI_1$, $NOI_2$, …, $NOI_N$), that is to the updating of assets and change of identification attributes and the general advantages of present value estimation by interval method, besides the fact that calculations by the formula (12.1) are «most compact», consist in the following:

– The first, the estimation of the present value by the interval formula (12.1) is a dependence on calendar periodicity of investing unlike estimation by the formula (11.1);

– Secondly, the estimation of continuously accumulating sum of the discounted cash flow by the formula (11.1) serves as an approximate numerical calculation, while the estimation of the present value by the interval formula (12.1) is a mathematical solution for the planned schedule of investment set.

The advantages of present value estimation by the interval method formula (12.1) can be illustrated by comparative example for the following initial data:

– Investment project of the marine company is planned for $T$=10 years with the discounting rate estimated by the sum of commercial risks $i$=10 %;

– According to the plan, the net operating income for the initial investments is 1000 thousand US dollars annually;

– Sequence of assets acquisition, in particular commercial vessels, corresponds to accumulation for initial investments with the account risks and efficiency of the marine company, and the growth of the net operating income is discrete;

– At the expense of self–financing and accumulation in 3.5 years it is planned to buy a new vessel, and the net operating income will increase in the prices on the settlement day up to 1400 thousand US dollars annually, and in 7.5 years at the expense of the next acquisition the net operating income will increase up to 2000 thousand US dollars annually;

– The reversion planned in appraisal in 10 years can be determined by capitalization of the net operating income in the prices on the day of settlement, as:

$$Rv = NOI_N / i = 2000/10\% = 20000 \text{ thousand US dollar;}$$

– For the estimation of the continuously accumulating sum of the discounted cash flow (11.1) $MV = (1+i)^{1/2} \times \sum_{t_N=1}^{T_N} \frac{NOI_{t_N}}{(1+i)^{t_N}} + Rv \times (1+i)^{-T_N}$ it is required to pass from planning of discrete cash flow of the net operating income for the investment intervals to planning for years, that is an approximate transformation of the initial data, tab. 12;

Table 12

The planning of the net operating income discrete cash flow $NOI_{t_N}$ (thousand US dollar) for the years $t_N$

| $t_N$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $NOI_{t_N}$ | 1000 | 1000 | 1000 | 1400 | 1400 | 1400 | 1400 | 2000 | 2000 | 2000 |

– By the formula of the sum of continuously accumulating discounted cash flow of the net operating income (11.1) in case of planning till the time of reversion receipt $T = T_N$ the present value which by the income approach relates to the value of the marine company's property complex, is equal

$$MV = (1+0.10)^{1/2} \times (1000/(1+0.10)^1 + 1000/(1+0.10)^2 + 1000/(1+0.10)^3 + 1400/(1+0.10)^4 +$$
$$+ 1400/(1+0.10)^5 + 1400/(1+0.10)^6 + 1400/(1+0.10)^7 + 2000/(1+0.10)^8 + 2000/(1+0.10)^9 +$$
$$+ 2000/(1+0.10)^{10}) + 20000 \times (1+0.10)^{-10} = 15684 \text{ thousand US dollar;}$$

– With particular reference to the marine company investment schedule for three intervals of planning: from $T_0$ =0 to $T_1$ = 3.5 years $NOI_1$=1000 thousand US dollars a year, from $T_1$=3.5 year to $T_2$ = 7.5 year $NOI_2$=1400 thousand US dollars a year, from $T_2$=7.5 year to $T_3 = T_N$ = 10 year $NOI_3$=2000 thousand US dollars a year, the present value according to the formula (12.1) is determined, as:

$$MV = \frac{1}{i} \times \sum_{n=1}^{N} NOI_n \times ((1+i)^{-T_{n-1}} - (1+i)^{-T_n}) + Rv \times (1+i)^{-T_N} =$$
$$= \frac{1}{i} \times (NOI_1 \times ((1+i)^{-T_0} - (1+i)^{-T_1}) + NOI_2 \times ((1+i)^{-T_1} - (1+i)^{-T_2}) +$$
$$+ NOI_3 \times ((1+i)^{-T_2} - (1+i)^{-T_3})) + Rv \times (1+i)^{-T_3},$$

that is a mathematical solution for the given example, suitable for substitution of the data of the planned investment schedule ($T_0$, $T_1$, $T_2$, $T_3$, $NOI_1$, $NOI_2$, $NOI_3$), and the value of the marine company estimated by the income approach is equal

$$MV = \frac{1}{0.10} \times (1000 \times ((1+0.10)^{-0} - (1+0.10)^{-3.5}) + 1400 \times ((1+0.10)^{-3.5} - (1+0.10)^{-7.5}) +$$
$$+ 2000 \times ((1+0.10)^{-7.5} - (1+0.10)^{-10})) + 20000 \times (1+0.10)^{-10} = 15801 \text{ thousand US dollars.}$$

The comparison of two methods of the income approach for the considered example of estimation of the cash flow of the marine company net operating income when the value relates to the schedule of investing, shows that the evaluation by the interval formula (12.1) is «more compact» by the number of actions than the estimation of the continuously accumulating over the years value of the net operating income cash flow by the formula

(11.1). Besides, the formula (12.1) is a mathematical solution for set calendar periodicity of the investments unlike value estimation by the formula (11.1).

The error of the net operating income cash flow value estimation by the formula (11.1) in the considered example is equal 15801 – 15684 = 117 thousand US dollars (0.7 %), and it should be noted that with increase of stages number *N* planned by the schedule of investments ($T_0$, $T_1$, $T_2$, …, $T_N$, $NOI_1$, $NOI_2$, …, $NOI_N$) the error of the continuously accumulating over the years value of the net operating income cash flow grows, and, for example, for more than three steps of investing in the marine company assets made within 10 years (if the sum of commercial risks is equal about 10 %) the error can be from 3 to 5 % and more.

The cause of error of calculations of the capitalized cash flow continuously accruing over the years by the formula (11.1) is the required initial data replacement and transition from planning of the investment stages to the planning over years, that can be viewed as a rather close approximation for the companies of certain types, for example: for the financial and the stocks share companies, the wholesale and retail companies for without number the marine companies among them concern.

The recommended interval form (12.1) of the methods of the present value estimation of marine company's property complex by capitalization of the discounted present values of cash flow estimation which corresponds to the planned investment schedule has advantages from the point of application as indexes of the isolated property complex are connected technologically and by the economic strategy.

This way of cash flow present value estimation from the methodological point is suitable for introducing the continuity of investments assumptions in the conditions of self–financing unlike the formula (11.1) which describes accumulation in the financial markets more precisely than in real sector.

It should be taken into account that the cash flow value $NOI_n$ for each interval of the net operating income stability from $T_{n-1}$ to $T_n$ characterizes the assets efficiency accumulation of the marine company during the previous intervals of planning.

The cash flow for investing is a source of the future investments and the result of the previous that is the accumulation of the marine company assets means the accumulation of their ability to generate cash flow *NOI*. And the rates of assets accumulation correspond to the total sum of commercial risks *i*.

In case of self–financing of the marine company's property complex the cash flow during each interval of stability depends on cash flow accumulation for the previous intervals invested in real assets and is equal

$$NOI_n = MV_n \times i = MV_n \times (1+i)^{T_n - T_{n-1}} \times i = NOI_n \times (1+i)^{T_n - T_{n-1}}, \qquad (12.2)$$

$$\text{that is } NOI_n = NOI_0 \times (1+i)^{T_{n-1}}. \qquad (12.3)$$

Using the formula (12.3) it is possible to estimate each interval of cash flow stability duration and create the planned investment schedule ($T_0$, $T_1$, $T_2$, …, $T_N$), that is the assets updating and change of the identification attributes, if for construction or replacement of separate assets in case of self–financing for the marine company preliminary to determine the sequence of values of a cash flow ($NOI_1$, $NOI_2$, …, $NOI_N$).

The conditions of investment continuity in case of self–financing of the marine company correspond to the cause–and–effect–relationship concept in the applied economic calculations.

It is possible to «adhere» the cash flow values set ($NOI_1$, $NOI_2$, …, $NOI_N$) to the planned investment schedule ($T_0$, $T_1$, $T_2$, …, $T_N$) with the condition of continuity by the formulas (12.2, 12.3) having defined the duration of stability intervals of the net operating income cash flow stages from $T_{n-1}$ to $T_n$ by the transformation by formula $NOI_n / NOI_{n-1} = (1+i)^{T_n - T_{n-1}}$, that means, that the intervals duration of cash flow stability from $T_{n-1}$ to $T_n$ before accumulation of the finance, sufficient for investing in the real assets of the marine company, depends on cash flows parity $NOI_{n+1} / NOI_n$ at the investment stage and also on the total sum of the commercial risks *i* and is equal

$$T_n - T_{n-1} = \ln(NOI_n / NOI_{n-1}) / \ln(1+i). \qquad (12.4)$$

The formula (12.4) can be recommended for working out the planned schedule as a part of the investment project for estimating the intervals of cash flow stability duration from $T_{n-1}$ to $T_n$ before accumulation of the finances sufficient for investing in the real assets of the marine company, that is, the formula (12.4) can be applied to determination of the stages duration corresponding to intervals of financial assets accumulation for investment in real assets.

And as a part of initial data for investments periodicity determination ($T_0$, $T_1$, $T_2$, …, $T_N$) the present values of cash flows ($NOI_1$, $NOI_2$, …, $NOI_N$) are to be set by the technological or functional points of view for the stage–by–stage entered assets according to the project of the marine industrial activity.

On the other hand, if the investment project is set by the sequence of cash flow values ($NOI_1$, $NOI_2$, …, $NOI_N$) in relation to the planned investment schedule ($T_0$, $T_1$, $T_2$, …, $T_N$) the value estimation of the marine company's property complex based on income approach by the formula (12.1) with the account the requirement of cash flow continuity by the formulas (12.2, 12.3) is transformed to the task of total risks determination of the general investment project in relation with macroeconomic value of risks *i* that is with the estimation to what extent the given innovative strategy is risky, when it is set by the investment plan in relation to the sequence of the predicted values of cash flow to the planned schedule.

Substituting the requirement of cash flow continuity of the interval methods of capitalization formula (12.1) in the formula (12.3) influencing the duration of planned investment schedule stages it is possible to receive

$$MV = (NOI_0 / i) \times (\sum_{n=1}^{N} (1+i)^{T_{n-1}} \times ((1+i)^{-T_{n-1}} - (1+i)^{-T_n}) + 1). \qquad (12.5)$$

The marine company's property complex value can be estimated by the income approach on the basis of the method of the direct capitalization of the initial cash flow $NOI_0$ corresponding to start–up capital $MV = NOI_0 / R_0$. And the capitalization rate $R_0$ of the start–up capital cash flow $NOI_0$ is an estimation of the own risks of the given investment project in relation to macroeconomic estimation of risks *i*, that is, the capitalization rate $R_0$ of start–up capital cash flow is the risks index of innovative strategy which is

set by the planned investment schedule – the sequence of the cash flow values ($NOI_1$, $NOI_2$, …, $NOI_N$) in relation to the planned investment schedule ($T_0$, $T_1$, $T_2$, …, $T_N$):

$$R_0 = \frac{i}{\sum_{n=1}^{N}(1+i)^{T_{n-1}} \times ((1+i)^{-T_{n-1}} - (1+i)^{-T_n}) + 1}. \qquad (12.6)$$

Thus, with the account the property of continuity of the cash flow invested in assets accumulation in case of the marine company self–financing, the value estimation based on income approach can be transformed to one of the following subjects:

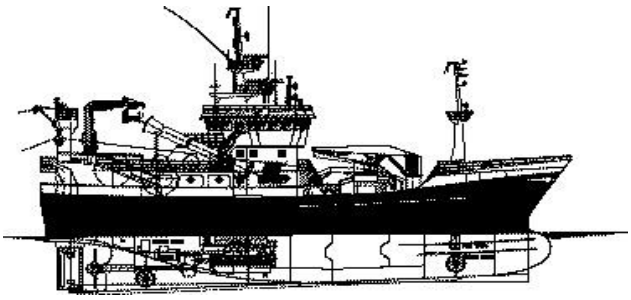
– To the determination of investment intervals of cash flow stability from $T_{n-1}$ to $T_n$ by the formula (12.4) and to planned schedule development ($T_0$, $T_1$, $T_2$, …, $T_N$) if the sequence of cash flow values ($NOI_1$, $NOI_2$, …, $NOI_N$) is set according to the functional or technological estimations;

– To the determination by the formula (12.3) of the net operating income cash flows for the investment intervals ($NOI_1$, $NOI_2$, …, $NOI_N$), if the cash flow corresponding to start–up investments $NOI_0$ and the planned schedule ($T_0$, $T_1$, $T_2$, …, $T_N$) are set;

– To the estimation of own risk $R_0$ of innovative strategy by the formula (12.6) in relation to macroeconomic estimation of risks *i* if are set: the sequence of cash flow values ($NOI_1$, $NOI_2$, …, $NOI_N$) and the schedule of the investments ($T_0$, $T_1$, $T_2$, …, $T_N$) are set.

**Test questions**

1. Properties of the marine company's complex of assets on the basis of the valuation of the complex value parity and the separate real assets (a relation of the total value and the value of a part).
2. Predicted continuity of assets accumulation and change of the marine company efficiency index as the reason to use the method of direct capitalization when estimating based on income approach.
3. Continuity of cash flow accumulation in case of self–financing of the marine company's property complex (the formula derivation).
4. Duration of the planned schedule stages corresponding to intervals of financial assets accumulation for investing in the real assets of the marine company, determined on condition of cash flow continuity (the formula derivation).
5. Interval method of capitalization with the account continuity of the cash flow accumulation influencing the stages of the planned investment schedule duration.
6. Calculation of own risks of the innovative strategy in marine industrial activity (the formula derivation).
7. Characteristic tasks of the marine company's property complex evaluation with the account the property of cash flow accumulation continuity in case of self–financing.



# 13. Discounting with the Euler' number exponential function in economic models of vessel or the property complex of marine company's real assets

The material of the given section material contains the analysis of approximation accuracy of the discounting factor determined by arithmetic summation (1+*i*) and estimations of present value for investing into development of the ocean wealth, by the discount financial functions, and it also contains the analysis of methodological advantages of formulas of the discount financial functions based on application of exponential functions of the Euler' number $e$ = 2.71828283..., that, is the bases of the natural logarithm.

It is considered that when investing in industrial activity for the ocean resources development is more effectively and accordingly more risky economically than investing in the financial deposit in respect of which the discounting by the exponential functions of the factor calculated by the arithmetic summation (1+*i*) is accepted.

In applied tasks to determine the total risk depending on its separate components the expert methods of the hypothec–investment group in particular, the following methods of the discounting rate calculation are usually recommended: the cumulative estimation, the models of capital assets estimation, the models of the average weighted cost of the capital etc., and also methods of the arbitration pricing or the extraction which though are not formally based on risks summation, but are alternative ways of calculation of the index of the discounting rate which is total of the risks.

At the same time for present values estimation is required not only correct calculation of the total risk depending on separate components, but also the development of the adequate discounting method when the properties of summable risk components which correspond to actions in sequence of innovative investing in real assets of the marine companies' complexes of the assets are taken into account.

The analysis of applicability of discounting by the Euler' number exponential function and advantages of this method, for present value estimation of the marine company's real assets with the account of the formal–logic properties of risks probabilistic concept.

The financial functions based on discounting by exponential of the factor calculated by arithmetic summation (1+*i*) based on monetary rules of interest accruing on the financial deposit determination (or the mortgage) are the approximate ways of present value and financial indexes determination and are rather exact at the limited risks *i* correlated, on the other hand, with investments efficiency.

The arithmetic summation of the discounting rate to a one in case of factor of discounting (1+*i*) determination is based on the general assumption that the risk is the one–factorial index corresponding to the discounting rate *i*, and it is rather true if financial investment strategy means a single action – the financial deposit (or the mortgage).

If innovative strategy in the marine industrial activity on investing financial assets in real assets is an actions sequence, the general risk insufficiently precisely corresponds to the estimation by the one–factorial index and each action in strategic sequence influences strategy total risk value.

It should be reasonable to research the methodological correctness of risks summation from the mathematical point and discounting by the factor (1+*i*).

The commercial risk in estimation can be correlated with the discounting index *i* or $1-(1-i)$. When determining the total risk as a probabilistic characteristic of the sequence of casual events it is necessary to take into account that the probability of events sequence corresponds to the product of probability of each event by the probability of previous events or to the multiplication of events probabilities in sequence.

If the probability of the positive result for a single *n*–th action in the general sequence of innovative strategy actions is equal $(1-i_n)$, where $i_n$ is a risk, that is a probability of negative result for a single *n*–th action, then the probability of the successful innovative strategy consisting of *n* of actions is equal: $(1-i_1)\times(1-i_2)\times...\times(1-i_n)$ and the total risk of innovative strategy makes:

$$\begin{aligned} i &= 1-(1-i) = 1-(1-i_1)\times(1-i_2)\times...\times(1-i_n) = \\ &= 1-(1-i_1-i_2-...-i_n+i_1\times i_2+...+i_1\times i_n+i_1\times i_n-...-i_1\times i_2\times...\times i_n). \end{aligned} \tag{13.1}$$

The difference of the risks total *i* (13.1) from the arithmetic sum applied usually when the discounting rate is determined by cumulative estimation is visible

$$i = 1-(1-i) = 1-(1-i_1-i_2-...-i_n), \tag{13.2}$$

the difference is

$$-(i_1\times i_2+...+i_1\times i_n+i_1\times i_n-...-i_1\times i_2\times...\times i_n). \tag{13.3}$$

And the reminder (13.3), that is a difference between the total risk value determined by the complete–probabilistic scheme (13.1) and by the cumulative estimation (13.2), apparently, can be neglected only provided that risks separately and in total are insignificant (assuming that $i \le 0.15 \div 0.20$).

To determine the discounting rate, from the methodological point, the formula (13.1) $i = 1-(1-i) = 1-(1-i_1)\times(1-i_2)\times...\times(1-i_n)$ is more correct than the formula of cumulative estimation by risks arithmetic summation (13.2) $i_1+i_2+...+i_n$ (which in total can appear to be more than 100 %, that does not mean that the real total risk *i* is more than 100 %).

If in order to determine the total risk of innovative strategy we break it into actions and as a methodological technique to break the strategy into such actions to which correspond equal parts of risk $i_n = i/n$ with the selection of macroeconomic definition for each of *n* equal parts of risk, then the total commercial risk is approximately calculated by the method of cumulative estimation of the equal parts total as: $i = \sum_n i/n$ or $i = 1-(1-\sum_n i/n)$.

Then according to the complete–probabilistic scheme (13.1) taking into account the assumption about strategy division into equally risky separate actions the value of the total commercial risk can be estimated as:

$$i = 1-(1-\sum_n i/n+i_1\times i_2+...+i_1\times i_n+i_1\times i_n-...-i_1\times i_2\times...\times i_n), \text{ or } i = 1-(1-i/n)^n.$$

The estimation of the limiting value of the total commercial risk in the given definition $1-(1-i/n)^n$ is of interest with a great number $n$ of risk divisions into equal parts by used methodical technique.

The limiting value of commercial risk at its division into the great number of the components $n \to \infty$ is equal:

$$\lim_{n\to\infty}(1-(1-i/n)^n) = 1-\lim_{n\to\infty}((1-i/n)^{n/i})^i = 1-\frac{1}{\lim\limits_{n\to\infty}((1+i/n)^{n/i})^i} = 1-1/e^i.$$

As, on the other hand, the total commercial risk corresponds (is approximately equal) to the discounting rate, then $i \approx 1-1/e^i$ or, after derivation, the factor of discounting based on the exponential functions of the Euler' number application is determined as $e^i \approx 1+i$.

The discounting rate as an indicator of the commercial risks total methodologically more precisely corresponds to the factor in exponential function of the Euler' number $e^i$ or *exp*(*i*) than the member in the sum of discounting factor (1+*i*), as the factor of discounting as exponential function of the Euler' number $e^i$ grows out in case of summation of risks in frameworks of the complete–probabilistic estimation scheme with multifactorial characteristics of the general risk (13.3) as a form of use of the discounting rate of innovative strategy commercial risk unlike the factor of the discounting calculated by arithmetic summation (1+*i*) which is more suitable for determining the present values with one–factorial risks of the financial investment in the monetary deposit (or the loan).

With rather small total investment risks $i \le (0.15 \div 0.20)$ of discounting factor the value of the discounting factor determined on the basis of the Euler' number exponential function $e^i$ and on the basis of arithmetic summation (1+*i*) are approximately equal and in applied tasks lead to a rather close present value. In case of increase in investment risks *i* there is a difference of discounting factors $e^i$ and (1+*i*), tab. 13.1, fig. 13.

Table 13.1

The dependences of the factors determined by the arithmetic summation (1+*i*) and the Euler' number exponential function $e^i$ on discounting rate *i*

| $i$ | 5 % | 10 % | 15 % | 20 % | 25 % | 30 % | 35 % | 40 % | 45 % | 50 % |
|---|---|---|---|---|---|---|---|---|---|---|
| (1+*i*) | 105 % | 110 % | 115 % | 120 % | 125 % | 130 % | 135 % | 140 % | 145 % | 150 % |
| $e^i$ | 105 % | 111 % | 116 % | 122 % | 128 % | 135 % | 142 % | 149 % | 157 % | 165 % |

It should be noted that the discounting factor as exponential function of the Euler' number $e^i$ is the form of the remainder account (13.3) that is a difference $-(i_1 \times i_2 + ... + i_1 \times i_n + i_1 \times i_n - ... - i_1 \times i_2 \times ... \times i_n)$ between the total risk values determined by the complete–probabilistic scheme (13.1) and by the cumulative estimation (13.2).

The factor of discounting as an exponential function of the Euler' number $e^i$ corresponds to present value estimation of innovative strategy with the multifactorial risks of consecutive actions if the total risk is rather great, and the strategy is as effective as in case of investing in real assets of the marine companies' complexes of the assets using which the investor gets an access to marine wealth.

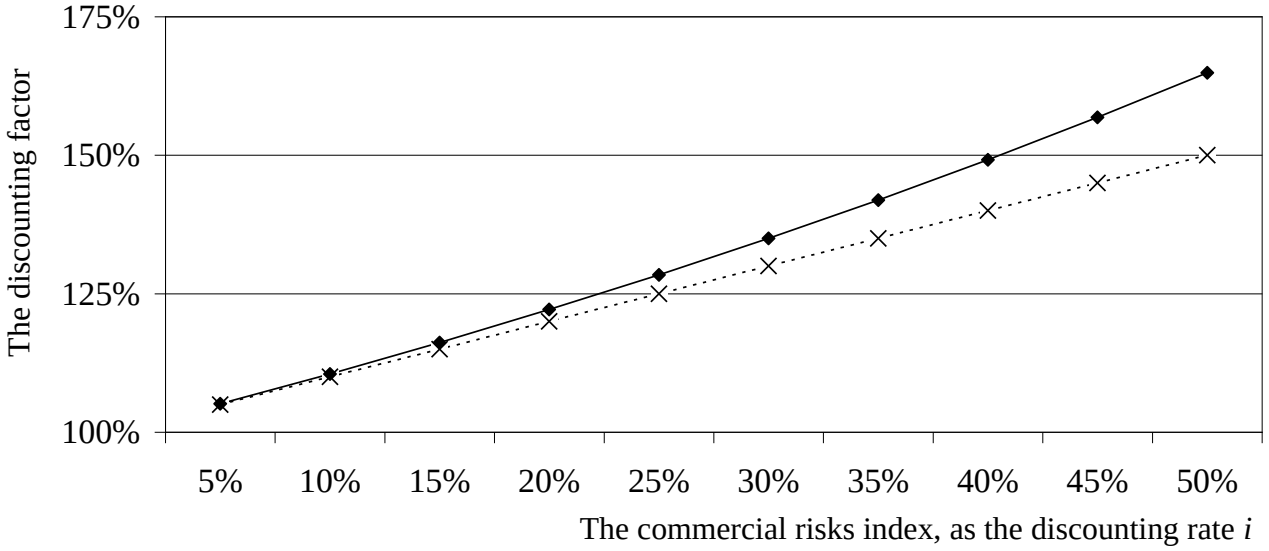



Fig. 13. The dependence of the arithmetic and the Euler number exponencial discounting factors on the discounting rate

···×··· The discount rate based on the arithmetic summation 1+i

—◆— The discount rate based on the exponential function of the Euler number

Though with smaller risks and rates, as in case of financial investing in the monetary deposit, the application of the factor of discounting as the exponential function of the Euler' number $e^i$ is quite reasonable, as the factor of discounting determined by summation (1+*i*) with small risks correlated with index of the discounting rate $i \le (0.15 \div 0.20)$, is rather close numerical approximation of discounting factor as the exponential function of the Euler' number.

Perhaps, the choice of discounting method from the two considered options with small risks depends basically on the expert's ability to determine exponential function value and on formal–logic understanding properties of risks probabilistic concept that provides the confidence of choice of present values of real assets as a part of the marine company's property complex.

It should be added that discounting by the Euler' number exponential function $e^i$ is also determined on the basis of present value potential equation integration (Chapter 4, the formula 4.1) when developing the form of the statistical regression for generalization of the marketing researches data concerning value of the assets, which pricing quite precisely can be laid in the property complex evaluation scheme with value of the asset proportional to the company complex of assets total value, for example of the marine commercial vessels and such assets, which value essentially depends on years.

With the account the recommendation concerning preference of discounting by the Euler' number exponential function the method of the discounted cash flow capitalization for vessel value estimation (or the isolated asset) as a part of the marine company's property complex becomes:

– For the continuously accumulating sum of the discounted cash flow and with the set duration of the forecasting period *T* it is determined as:

$$MV(t)+OC=e^{i/2}\times\sum_{t_N=t+1}^{T}NOI_{t_N}\times e^{-i\times(t_N-t)}+Rv\times e^{-i\times(T-t)} \tag{13.4}$$

instead of discounting by the formula (11.1);

– For the interval method (12.1) of capitalizations for the option of present values of cash flow determination as the sum of present values of *N*–th categories «adhered» to the planned schedule

$$MV(t)+OC=\frac{1}{i}\times\sum_{n=1}^{N}NOI_n\times(e^{-i\times(T_{n-1}-t)}-e^{-i\times(T_n-t)})+Rv\times e^{-i\times(T_N-t)}. \tag{13.5}$$

For designation of operations of discounting the term «money function» is not used in tab. 13.2 and the term «discount financial functions» is applied as the «functions of money» concept has own meaning in social and economic terminology (functions of: turnover, accumulation, savings, treasures etc.) other than mathematical transformations over present value indexes.

As the addition to the recommendations concerning discounting by the Euler' number exponential function it is possible to transform the received above formula (12.4) and recommended for working out of the financial assets in real assets of the marine company planned investment schedule.

With the requirement of continuity for the formula (13.6) it is possible to «adhere» the cash flow set of values ($NOI_1$, $NOI_2$, …, $NOI_N$) to the planned investment schedule ($T_1$, $T_2$, …, $T_N$) having determined the duration of stages by stability intervals of the net operating income cash flow from $T_n$ to $T_{n+1}$ using transformation by the formula $NOI_{n+1}/NOI_n=e^{\ln(1+i)\times(T_{n+1}-T_n)}$, that is, having evaluated the intervals of stability duration from $T_n$ to $T_{n+1}$ of cash flow before accumulation of the finances sufficient for investing in real assets of the marine company:

$$T_{n+1}-T_n=\ln(NOI_{n+1}/NOI_n)/i. \tag{13.6}$$

After transformation it is visible, that the duration of the net operating income stability interval from $T_n$ to $T_{n+1}$ correlates with the duration of economic payback period term $T_R\approx 1/i$, that is $T_{n+1}-T_n=T_R\times\ln(NOI_{n+1}/NOI_n)$.

It is curiously to note some formal similarity, on the one hand, the formulas of the discounting factor defined by summation conformity and the discounting factor determined by the Euler' number exponential function, that is $e^i\approx 1+i$, and on the other hand, the exponential form of a complex number $\sqrt{2}\times e^i=1+i$, where $i$ – denotes the square root of minus one $\sqrt{-1}$ – imaginary number.

The external similarity of formulas can push to a guess about interrelation with mathematics of complex numbers which opens the number of possibilities of the phenomena and the processes in applied economics modeling.

The value and efficiency of investments economic estimation should be developed on the basis of the strict mathematical logic. If the preconditions for value and efficiency definition were not formulated from the mathematical point of view their generalization

for complex marine industrial objects or the property complex should be speculative that is erroneous.

Table 13.2

Six standard discount financial functions corresponding to the discounting factors determined by summation $1+i$ and by the Euler' number exponential function $e^i$ or *exp*(*i*)

| The factor of discounting defined by summation $1+i$ | The discounting by the Euler' number exponential function $e^i$ or *exp*(*i*) |
|---|---|
| If the rate *i* is defined based on methods of hypotec–investment group (cumulative estimation, etc.) it is recommended to correct the value of the discounting rate by operation $i \approx e^i - 1$ for use in case of discounting by the factor $(1+i)$ | If the rate *i* is determined according to market research by transformation of data on the basis of discounting by factor (1+*i*) it is recommended to correct the value of the rate by operation $i \approx \ln(1+i)$ for use in case of discounting by the Euler' number exponential function $e^i$ |
| 1. The future value *FV* (complex percent), that is the present single investment, *t* – present time (or a number of the periods of interest accrual) | |
| $FV = (1+i)^t$ | $FV = e^{i \times t}$ |
| 2. The future value of annuity *FVA* (the future at the end of the period to *T* value of single cash flow of the uniform periodicity) | |
| $\sum_{t=1,T} (1+i)^{T-t} = ((1+i)^T - 1)/i$ | $\sum_{t=1,T} e^{i \times (T-t)} = (e^{i \times T} - 1)/i$ |
| 3. The factor of fund of compensation *PMT/FVA* or $f_m$ (the constant value of the periodic payment in accumulation of the single sum before the end of the period to *T*) | |
| $1 \Big/ \sum_{t=1,T} (1+i)^{T-t} = i/((1+i)^T - 1)$ | $1 \Big/ \sum_{t=1,T} e^{i \times (T-t)} = i/(e^{i \times T} - 1)$ |
| 4. The present value *PV* of unit (discounting) that is present value of future single investment after time *t* | |
| $PV = 1/(1+i)^t = (1+i)^{-t}$ | $PV = 1/e^{i \times t} = e^{-i \times t}$ |
| 5. The present value of single annuity *PVA* (the single cash flow uniform of periodicity to *T*) | |
| $\sum_{t=1,T} 1/(1+i)^t = (1 - 1/(1+i)^T)/i$ | $\sum_{t=1,T} 1/e^{i \times t} = (1 - 1/e^{i \times T})/i$ |
| 6. The payment for unit amortization *PMT/PVA* (repayment of the single loan by equal payments uniform of periodicity to *T*) | |
| $1 \Big/ \sum_{t=1,T} 1/(1+i)^t = i/(1 - 1/(1+i)^T)$ | $1 \Big/ \sum_{t=1,T} 1/e^{i \times t} = i/(1 - 1/e^{i \times T})$ |

The note. The functions in pairs 1 and 4, 2 and 3, 5 and 6 are reversible in relation to arithmetic dividing.

Concerning the interrelation with mathematics there is an interesting example that Nobel Prizes in economics are awarded usually for the contribution to science for the outstanding mathematical bases. At the same time this Prize is not awarded in the area of mathematics without economic or other applications (natural–science, etc.) and also actually is not awarded in economics, when there is no mathematical formalization.

The necessary knowledge of mathematics for the expert in the applied economics covers number of the mathematical analysis application: lines and sequences, linear differential equations, probability theory, mathematical statistics.

**Test questions**

1. Discounting rate, the discounting factor.
2. Arithmetic summation of risks for determination of the discounting rate by the formula of cumulative estimation.
3. Summation with the account probabilistic characteristic of each risk with the multiplication by the reminder after subtraction of other risks (the formula derivation).
4. Factor of discounting by the Euler' number exponential function.
5. Recommendations of discounting by the Euler' number exponential function.
6. Formal–logic sense of commercial risk index.
7. Method of cash flow capitalization in case of use of discounting by the Euler' number exponential function for the interval form (the formula at the set time interval of discounting to reversion).
8. Form of cash flow capitalization in case of using of the discounting by the Euler' number exponential function for intervals of cash flow stability.
9. Definition of investment stages duration with the account continuity of a cash flow by the transformation based on discounting by the Euler' number exponential function.
10. Discount financial functions when using arithmetic discounting and the Euler' number exponential function (the formula derivation): the future value, the future value of annuity, the factor of fund of compensation, the present value of a unit (discounting), the present value of single annuity, the payment for unit amortization.
11. Factor of discounting determined by summation, based on operation of interest accrual for the mortgage or the deposit.
12. Substantiation of the form of the discounting by the Euler' number exponential function factor depending on summation rules of probabilistic risks independent components.

# 14. Economic model of cargo vessel

The account at the level of estimation of *NOI* usually is not provided for the marine company isolated asset. Concerning marine commercial vessels of the separate classes, which are used for efficiency increase of the marine company's property complex, only expenses can be taken into account and the expenses records are not kept whereas other real assets generate income.

When determining the net operating income for evaluation of the asset of the marine company, for example a vessel in the sum with working assets based on income approach (by formulas 11.1, 11.2), it is required to work out and use the economic model – the sequences of dependences, on the one hand, between characteristics of asset *X*, params *Y* – the expert indexes in value estimation and external data *Z*, and, on the other hand, the basic economic indexes: the annual income *I* and the operation costs *C*, that is considered below.

For a complex estimation of economic indexes among which the value is defined, it is possible to use the basic economic model (the general and the most simple). The economic indexes are defined by means of the basic model.

Short description of the basic model of marine cargo vessel is shown further. The variants of more complex economic models of commercial vessel can be developed as the progress of the basic model.

The basic economic indexes of a cargo vessel: the annual income, the operation costs and the investments which are components of effectiveness and optimality criteria, are defined algorithmically depending on variables, data and params.

When determining the commercial vessel economic indexes, the characteristics, particulars (params) and data can be of various dimensions. The ability to adhere dimensions conformity and to transform dimensions correctly in applied calculations is a part of the expert's professional competence. In presented methodological material dimensions are omitted except for references to the numerical data which are accompanied by dimensions.

The annual cost *C* of cargo vessel operation (operation costs) in most general view can be determined by the components summation $C_n$ by the formula $C = \sum C_n$ or

$$C = C_{CR} + C_{FED} + C_{EXP} + C_{SOC} + C_{FL} + C_{SUP} + C_{RM} + C_G + C_{MM} + C_{DS}, \qquad (14.1)$$

where $C_{CR}$ – expenses for crew salary (labor costs); $C_{FED}$ – expenses for crew's food supply; $C_{EXP}$ – the expenses for crew delivery; $C_{SOC}$ – specific payments to the social insurance funds of labor costs; $C_{FL}$ – fuel costs; $C_{SUP}$ – cost of supplies; $C_{RM}$ – operating repair and maintenance service expenses; $C_G$ – running costs; $C_{MM}$ – administrative expenses for management; $C_{DS}$ – marketing expenses.

Due to methodological reasons when estimating based on income approach the depreciation charges calculated by rules and standards of book keeping are not subject to inclusion in a set of operation costs and to subtraction from the annual income for estimation of the net operating income, though relative value of depreciation charges in shipping

is rather considerable (from 20 to 40 % in relation to the operation cost of commercial vessel).

The annual operating expenses for crew support ($C_{CR}$ + $C_{FED}$ + $C_{EXP}$), including expenses for crew salary (labor costs) $C_{CR}$ and also for feeding $C_{FED}$ and for delivery of crew $C_{EXP}$ (determined by the general rate of expenses for crew payment, except specific payments $C_{SOC}$ for the off–budget funds calculated by standard rules) with the account operating standards and formed relations between the components makes approximately

$$C_{CR} + C_{FED} + C_{EXP} \approx (1.10 \div 1.20) \times n_{Э} \times c_{Э}$$

where $c_{CR}$ – the average annual expenses for support of one member of crew, $n_{CR}$ – the number of members of the crew, including, expenses for crew salary, are equal $C_{CR} \approx n_{CR} \times c_{CR}$.

The total rate of specific payments $C_{SOC}$ into the off–budget funds from expenses for crew salary is determined by the components summation: for social insurance, for medical insurance, a pension fund, – and depending on specified terms can be specific payments from 32 to 40 %, on the average 36 % (in Russia).

The specific payments to the off–budget funds $C_{SOC}$ are equal approximately

$$C_{SOC} \approx 0.36 \times C_{CR} \approx 0.36 \times n_{CR} \times c_{CR}.$$

The operational expenses for crew support including specific payments $C_{SOC}$ to the off–budget funds with the account the developed proportion besides the components $C_{CR}$, $C_{FED}$, $C_{EXP}$ and $C_{SOC}$ is $C_{CR} + C_{FED} + C_{EXP} + C_{SOC} \approx 1.48 \times n_{CR} \times c_{CR}$.

The operational expenses for fuel and lubricants are determined as:

$$C_{FL} = P_{FL} \times n_R \times c^*_{FL},$$

where $P_{FL}$ – the fuel stock on board (the expenditure of fuel during the voyage to be more exact, considering, that with commercial vessel characteristics rationality the expenditure of fuel during the trip usually corresponds with the specification fuel capacity); $n_R$ – the average number of trips within a year; $c^*_{FL}$ – the cost of one t of the fuel used on the vessel vessel.

The duration of cargo vessel round trip is determined as:

$$T_{RF} = t_{R1} + t_{R2} + t_{G1} + t_{G2} + t_M,$$

where $t_{R1}$, $t_{R2}$ – the running time during the trip to destination and return trip accordingly, $t_{R1} = £ / (24 \times \upsilon_{S1})$, $t_{R2} = £ / (24 \times \upsilon_{S2})$; $\upsilon_{S1}$ and $\upsilon_{S2}$ – the commercial vessel velocity during the trip to destination and return trip accordingly; £ – the extent of a trip line; $t_{G1}$, $t_{G2}$ – the duration of cargo operations in departure and arrival harbors, $t_{G1} = ĐG \times \eta_{G1} / q_{G1}$ and $t_{G2} = PG \times \eta_{G2} / q_{G2}$; $PG$ – the cargo capacity of commercial vessel; $q_{G1}$, $q_{G2}$ – the productivity of cargo operations in departure and arrival harbors; $\eta_{G1}$, $\eta_{G2}$ – the operating ratios of cargo capacity of the commercial vessel during the trip to destination and return trip; $t_M$ – the time expenditures for maneuvering.

The annual trip number is equal $n_R = T_{EXP} / T_{RF}$, where $T_{EXP}$ – the duration of the annual operational period.

The statistical values of operational period duration $T_{EXP}$ for cargo vessels in the published data [16] are at the average:

– For the universal dry–cargo vessel of deadweight to 6000 t – 341 days, with deadweight from above 6000 t – 337 days;

– For the dry–cargo vessel for transportation of mass cargoes (bulk) with deadweight to 20000 t – 336 days;

– For the bulk dry–cargo vessel of cement transportation with deadweight from 20000 to 50000 t – 334 days, with deadweight from above 50000 t – 332 days;

– For the dry–cargo vessel of wood cargoes transportation (for the timber and the kindling–wood) with deadweight to 7000 t – 339 days, with deadweight from 7000 to 15000 t – 338 days, with deadweight above 15000 t – 334 days;

– For the dry–cargo vessel for transportation of containers with deadweight to 6000 t – 336 days, with deadweight from 6000 to 20000 t – 336 days, with deadweight from 20000 to 30000 t – 334 days, with deadweight from above 30000 t – 333 days;

– For rolling cargo vessel with horizontal cargo operations (RO–RO) with deadweight to 40000 t – 337 days;

– For the refrigerator dry–cargo vessel with deadweight from 4000 to 8000 t – 336 days, with deadweight from 8000 to 20000 t – 335 days, with deadweight from 20000 to 30000 t – 332 t, with deadweight from above 30000 t – 330 days;

– For the lighter barge dry–cargo vessel – 333 days;

– For the barge carrier vessel – 335 days;

– For the ferry with deadweight to 4000 – 341 days, with deadweight above 4000 t – 337 days;

– For the oil tanker with deadweight to 6000 t – 340 days, with deadweight from 6000 to 20000 t – 337 days, with deadweight from above 20000 t – 332 days;

– For crude gase carrier with deadweight to 10000 t – 333 days, with deadweight from 10000 to 50000 t – 332 days, with deadweight from above 50000 t – 330 days.

The annual expenses for supply is equal approximately 7 % of fuel costs that is $C_{SUP} \approx 0.07 \times C_{FL}$.

The annual cargo traffic is $Q = PG \times n_R \times \sum \eta_{Gi}$, where $n_R$ – the number of trips within a year; $\eta_{Gi}$ – the operating ratio of the cargo capacity for the specification.

The annual income is determined by the formula $I = Q \times m$, where $m$ – the transport tariff rate – the cost of cargo unit (one t, one piece, unit of volume, etc.) delivery to destination.

The average annual charges for operating maintenance (the postponed expenses) are evaluated depending on reproduction cost *RC* or on construction cost of modern functional analogue of the commercial vessel.

The expenses for repair within a year make roughly 0.4 % from the reproduction cost of the vessel *RC* by data for marine commercial vessels [16, tab. 6П].

The close values of annual repair cost – about 0.8 % from reproduction cost of vessel *RC* – correspond to the analysis of the directory data [18, p. 62, tab. 3.1].

A little bit higher annual expenses for vessel repair follow from the analysis of the schedule presented in the directory data [18, p. 202, fig. 6] which is from 1.2 to 2.3 % on reproduction cost of vessel *RC*.

The figure below (fig. 14) shows the features of dependences between costs for repair accumulated over the life time and initial vessel value.

Generalizing the data it can be assume that expenses for repair and maintenance service within a year are equal approximately from 2 to 3 % of commercial vessel reproduction cost that is

$$C_{RM} \approx (0.02 \div 0.03) \times RC.$$

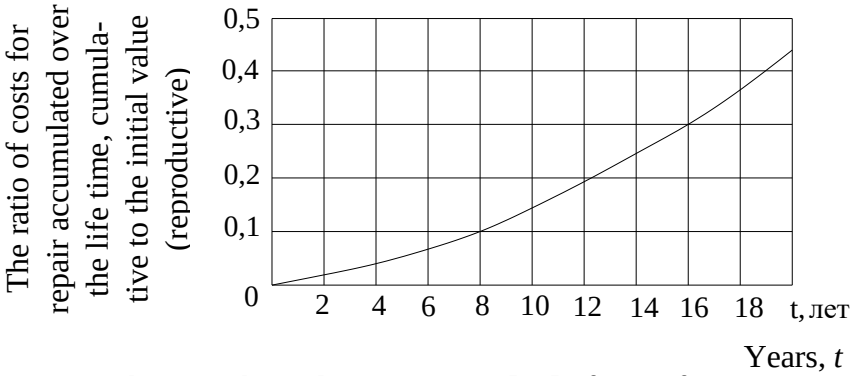
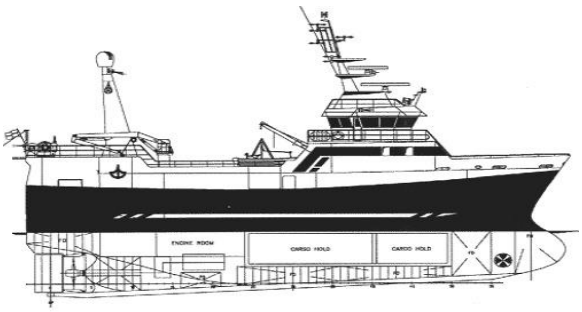



Fig. 14. The ratio depending on years *t* [18] of costs for repair accumulated over the life time to ship reproduction cost

**Test questions**

1. Structure of cargo vessel operation costs of basic model.
2. Determination of the trip duration, the number of trips, the annual carrying capacity and the annual income.



# 15. Model of fishing vessel basic economic indexes

The operation costs depend on fishing vessel operation variant: for fishing expedition, for independent fishing or other variant of fishery or for the cargo transport purposes – as the receiving–transport refrigerator. Considering the seasonal prevalence of industrial fishery and climatic conditions of the seas washing national coast, or the seas which are of interest for fishery outside the national jurisdiction almost marine steel fishing vessels of the various sizes (the small – to 400 t of displacement, the averages – to 1500 t and the big), suitable for fishery during winter time in the ice conditions of various intensity are used.

The following component of the operation costs for a fishing vessel is usually considered:

1. Expenses for crew salary $C_{CR}$ (with the service personnel), which for the majority of the marine steel fishing vessels are approximately equal from 10 to 15 % of operation costs total.

2. Specific payments for the off–budget funds $C_{SOC}$ are estimated by the acting standard rules and can average be 36 % of the expenses for salary payment with reference to the established parities and operating specifications.

3. Expenses for crew's food supply $C_{FED}$ for fishing vessels are approximately equal from 2 to 4 % of operation costs.

4. Expenses for delivery of crew $C_{EXP}$ (transport expenses) make in the range from 1 to 2 % of operation costs.

5. Expenses for the quota purchase $C_{RES}$ (a payment for ocean biological resources use under the rates provided by the tax Code). For the marine companies which operate under tax laws of Russia the payment for ocean biological resources use counting for vessel roughly is in the range from 10 to 20 % of operation costs.

6. Expenses for compensation of deterioration and for replenishment of fishing tools $C_{INST}$ are approximately equal from 3 to 7 % of operation costs.

7. Expenses for purchase of tare materials, separation and technological materials $C_{MS}$ roughly is from 2 to 3 % of operation costs.

8. Fuel costs $C_{FL}$ is in the range from 15 to 25 % of operation costs.

9. Payment for supply $C_{SUP}$ is approximately equal from 5 to 10 % on the average 7 % of expenses for fuel.

10. Average annual expenses for maintenance and repair $C_{RM}$ is determined in the range from 4 to 6 % of operation costs.

11. General service expenses, the administrative expenses for management and marketing $C_G$ and also, the administrative (agency) $C_{MM}$ and the marketing expenses $C_{DS}$ are in total equal from 5 to 10 % of operation costs.

As a part of fishing vessel operation costs the greatest value is of the following components: the annual expenses for fuel $C_{FL}$, the expenses for crew salary (and the connected expenses) $C_{CR}+C_{FED}+C_{EXP}+C_{SOC}$ and the expenses for the quota purchase (a payment for ocean biological resources use under the rates provided by the tax Code) $C_{RES}$.

Despite considerable aggregate value of the depreciation charges calculated under

the standards of book keeping due to methodological reasons are not subject to inclusion in structure of fishing vessel operation costs and to subtraction from the annual income while determining of the net operating income if value and also one or another efficiency index are evaluated on the basis of the net operating income index.

Possible other eventual components of operation costs except listed above are small and usually in total do not exceed several percent. The sum of operation costs $C$ total for basic economic model of fishing vessel is determined by the components:

$$C = C_{CR} + C_{FED} + C_{EXP} + C_{SOC} + C_{RES} + C_{INST} + C_{MS} + C_{FL} + C_{SUP} + C_{RM} + C_{G} + C_{MM} + C_{DS}. \quad (15.1)$$

It is expedient to develop the algorithm of operation costs calculation for economic model of fishing vessel depending on the basic influencing factors and to group the operation costs taking into account the factors to which number can be referred:

– Factor of crew salary expenses (labor costs) $C_{CR}$ to which can be logically referred the specific payments for the off–budget funds $C_{SOC}$, expenses for crew's food supply $C_{FED}$, the transport expenses for crew delivery $C_{EXP}$ which in aggregate (except specific payments for the off–budget funds $C_{SOC}$ defined by standard regulations) are from 20 to 40 % of expenses for crew payment (labor costs), on the average about 30 %;

– Annual expenses for fuel consumption $C_{FL}$ to which it is possible to refer the payment for supply $C_{SUP}$ – from 5 to 10 % of expenses for fuel (on the average it is possible to accept at rate of 7 % of expenses for fuel);

– Expenses for quota purchase $C_{RES}$ (payment for ocean biological resources use) should be estimated by the factor of annual catch capacity which is proportional to annual productivity of processed products and inversely proportional to the output relation for t of fresh fish, $Q / r$;

– Other components of the operation costs (except expenses for operating repair and maintenance service) namely: the compensation of deterioration and replenishment of fishing tools $C_{INST}$, the expenses for purchase of tare materials and separation $C_{MS}$, the general industrial expenses $C_{G}$, – should be correlated with the factor of annual catch capacity or with expenses for quota purchase (payment for resources).

The determination of expenses for quota purchase $C_{RES}$ (payments for ocean biological resources use) should be made proceeding from the determined fishing capacity and level of expenses for unit quota acquisition.

Planned catch capacity depends on efficiency of fishing ground for reproduction of ocean biological resources except dependence on the fishing vessel general operational characteristics influencing fresh fish capacity to which, for example, it is possible to refer the trawl area which is in functional dependence on the vessel's main engine power which in turn is proportional the volume of water filtered by trawl for time unit and also productivity of fresh fish processing facilities.

In the Pacific Ocean seas washing the Far East of Russia coast fishing vessels operation for the following catch objects is widespread:

– Fishing of pollack (without caviar) from January till April in the Sea of Okhotsk and in the Bering Sea; cods catch is possible during the same period;

– Fishing of the Okhotsk Sea herring from June till December.

For the rest of the time different kinds of fishing vessels operation are possible, namely:

– Squid catch within one month in a year during the period from June till October

around Northern Kuriles Islands;

– Prawns catch in the Tatar strait, at the offshore of Sea of Japan (the catch is most intensive from April till November, in winter months the catch of shrimp is inefficient as there is a considerable quantity of pollack whitebait the fresh shrimp fracture is);

– Flounder fishing around the western Kamchatka, a halibut in Bering Sea (almost during winter time);

– Cods fishing in the Bering Sea at the coast of Kamchatka and Kuriles during winter time;

– Fishing of salmon species of fish almost in the second part of summer.

It is clear that efficiency of fishing grounds has seasonal nature. At the same time seasonal catch prevalence possibly is not the factor of fishing vessel economic indexes evaluation, as indexes are determined counting for a year and seasonal catch prevalence has annual periodicity (repeatability).

It is supposed that the rest of the time within a year after fulfillment of considered kinds of fishery the other kinds of work, for example ship repair, re–equipment for the purpose of maximization of the subsequent income in operation are made or the fishing of other marine production species is done.

Some effective fishing vessels, according to the project specification, are equipped with replaceable fishing tools replaced seasonally.

The collecting financial rates for development of ocean biological resources in Russia are defined according the Federal Laws:

– «About changes of the second part of the Russian Federation tax Code and some other acts of the Russian Federation» # 148–FZ, November, 11–th, 2003, Article 333.3, item 4;

– «About changes of Chapter 25.1 of the second part of the Russian Federation tax code» # 285–FZ, November, 29–th, 2007; that is, financial charges for fishery of ocean biological resources are taxes.

According to Article 1 (item 3–a) of the Federal Law # 285–FZ, November, 29–th, 2007 the change of financial charges for the ocean biological resources fishing established by sub–items 4 and 5 Article 333.3 of the Federal Law # 148–FZ, November, 11–th, 2003 is provided.

The charges rates for ocean biological resources fishing for sub–items 4 and 5 Article 333.3 of the Federal Law # 148–FZ, November, 11–th, 2003 with changes under Article 1 (item 3) of the Federal Law # 285–FZ, November, 29–th, 2007 for Far East seas (the internal sea waters, the territorial sea, an exclusive economic zone of the Russian Federation and the continental offshore of the Russian Federation in the Chukchi, the East–Siberian, the sea of Okhotsk, Bering sea, the Japanese sea and Pacific ocean) by prevailing species of fish and other marine biological species are established: pollack of Sea of Okhotsk – 3500 ruble/t, pollack of other fishing grounds – 2000 ruble/t, cod – 3000 ruble/t, herring of the Bering Sea – 400 ruble/t, herring of Sea of Okhotsk during the spring–and–summer period of fishery – 400 ruble/t, herring of other areas and periods fishery – 200 ruble/t, halibut – 3500 ruble/t, rasp perch – 750 ruble/t, sea perch – 1500 ruble/t, «coal» fish – 1500 ruble/t, tuna – 600 ruble/t, smelt – 200 ruble/t, saury – 150 ruble/t, loach fish – 200 ruble/t, humpback salmon – 3500 ruble/t, Siberian salmon – 4000 ruble/t, Amur autumn Siberian salmon– 3000 ruble/t, coho fish – 4000 ruble/t, Chinook fish – 6000 ruble/t, salmon fish – 20000 ruble/t, sim fish – 6000 ruble/t, fish schiposchek

– 200 ruble/t, sturgeon fish – 5500 ruble/t, Kamchatka crab of the western coast – the rate of charges 35 thousand ruble/t, Kamchatka crab of the north Okhotsk Sea – 35 thousand ruble/t, Kamchatka crab of the other fishing grounds – 35 thousand ruble/t, dark blue crab– 35 thousand ruble/t, golden king crab – 20 thousand Ruble/t, crab–strigun – from 200 to 35000 ruble/t, crab prickly – from 13 to 25 thousand ruble/t depending on fishing ground, hairy crab– from 20 thousand ruble/t.

According to Article 1 (the item 3–b) of the Federal Law # 285–FZ, November, 29–th, 2007 «charges rates for each object of ocean biological resources use … for city–forming and village–forming Russian fisheries companies including fishing artels (collective farms), are established at rate of 15 percent of charges rates provided by items 4 and 5 Article 333.3 (comment, the Federal Law «About modification …» # 148–FZ, November, 11–th, 2003).

The fishery companies are admitted to be the organizations which carry out fishery (industrial fishing) of ocean biological resources and (or) their primary and subsequent (industrial) processing (including by the rented real assets) and marketing of this production provided that in such organizations the aggregate profit of the goods (kinds of work, services) output the share of the income from output of the trawled (fished) objects of ocean biological resources and (or) fish products process is not less than 70 percent.»

To determine some components ($C_{RM}$, $C_{CR}$, $C_{FED}$, $C_{EXP}$, $C_{SOC}$) of annual operation costs for fishing vessel the recommendations which are considered above concerning cargo vessel can be applied with corresponding updating in the presence of the reasons.

Concerning other components it is recommended to apply the economic model of fishing vessel presented below. The simplest basic economic model, which can be considered as the basis for estimation and for the further detailed elaboration is considered.

Operational expenses for fuel and lubricants in case of vessel operation at the fishing ground are determined as:

$$C_{\mathrm{FL}} = (P_{FL} \times n_R + q_1 \times t_R) \times c^*_{FL},$$

where $P_{\mathrm{FL}}$ – fuel expenditure during the trip; $n_{\mathrm{R}}$ – average number of round trips within a year; $q_1$ – daily running fuel consumption; $t_{\mathrm{R}}$ – running time of fishing vessel trip.

Concerning the data specified above and used for determining of operational expenses for fuel two explanatories should be made:

– In case of the logical project of the commercial vessel the fuel consumption for trip corresponds to the specification stock of fuel onboard with the account the necessary stocks;

– Period of fishing vessel operation in expedition between fuel bunkering is meant the round trip in the appraisal.

The running time for trip (the duration of running from port to fishing ground for example to sea of Okhotsk, Bering sea or to Sakhalin and back) is determined as: $t_{\mathrm{R}} = 2 \times £ / (24 \times \upsilon_{\mathrm{S}})$ days, where £ – distance to the fishing ground from basing harbor, miles; $\upsilon_S$ – the vessel operational speed, knots.

The average duration $T_{\mathrm{RF}}$ of fishing vessel round trip (between fuel bunkering in expedition) makes

$$T_{\mathrm{RF}} = (t_{\mathrm{M}} + t_{\mathrm{FS}} + \Delta t) \times P_{\mathrm{FL}} / P_{\mathrm{FPR}},$$

where $t_{\mathrm{M}}$ – general duration of vessel maneuvering in fishing ground for searching of fish

conglomeration; $t_{FS}$ – duration of fish products hauling before holds filling; $\Delta t$ – duration of fish transfer to cargo vessel and supply receive; $P_{FPR}$ – fuel consumption for search of fish, maneuvering and fish catching during the period between catch transfers to the processing ship or to the cargo vessel which is equal $P_{FPR} = P_{FM}(t_M) + P_{FR}(t_{FS}, \Delta t)$, where $P_{FM} = q_1 \times t_M$ – fuel consumption for maneuvering, $P_{FR} = q_2 \times (t_{FS} + \Delta t)$ – fuel expenditure in operating at the fishing ground, including catching and fish products transfer, $q_2$ – daily fuel consumption for trawling (catching).

The average quantity of raw fish or seafood $P_F$ hauled during round trip between bunkering is equal $P_F = PG \times r \times P_{FL}/P_{FPR}$, where $PG$ – the cargo capacity of fishing vessel.

The number of round trips within a year approximately is determined as:

$$n_R = (T_{EXP} - t_R - t_{AR}) / T_{RF} ,$$

where $T_{EXP}$ – the general duration of annual operational period; $t_{AR}$ – the duration of fishing vessel mooring in harbor between trips.

Concerning the seasonal limitations estimation of annual operational period $T_{EXP}$ duration of marine fishing vessel of the metal hull can follow recommendations which are above considered with reference for commercial transport vessels.

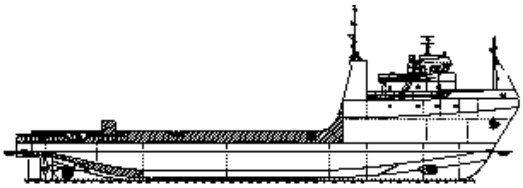
Average annual productivity of processed products in the fishing ground makes $Q = n_R \times PG_{PR}$, where $PG_{PR} = P_F/r = PG \times P_{FL}/P_{FPR}$ – the weight of the annual processed fish products (or seafood) by a fishing vessel.

The actual value of fishing vessel annual productivity is a little less, as non–productive idle periods due to various reasons are possible.

The annual income for fishing vessel is equal $I = Q \times m$, where $m$ – the income per processed fish products (or seafood) mass unit.

**Test questions**

1. Structure of fishing vessel operation costs.
2. Recommendations of fishing vessel operation costs grouping as the components of the total sum.
3. Rationing of expenses for quota purchases for ocean biological resources use by the tax Code.
4. Estimation of running time, lay time and duration of fishery as part of the general duration of fishing vessel round trip.
5. Prevailing ways of fishing vessels use in the Far East of Russia.



# 16. Economic models for the support vessel value estimation on the basis of the utility analysis and the factorial indexes prediction

To estimate the operating company's property complex there is a widespread method based on calculation of market factors which establish the relation of value to one or another economic index: to income, operation costs or profit. And the last specified way formally corresponds to the income approach of value estimation.

In their turn, the market factors should be determined based on comparable sales approach – by the analogues, for example: by the similar enterprises which capitalization is known, and, the data of the financial records are also available.

The specific precondition for an evaluation of the support vessels (tugs, ice breakers, hydrographic, etc.), and also some of the technical fleet vessels and the special purpose vessels is their «inability to generate profit (income)» unlike transport, fishery and the majority of the technical fleet vessels.

For example, the effect of the operation of rescue vessels, tugs, ice breakers etc. is rather difficult to estimate economically in a form of income.

The reasons of possession of vessels of the specified classes are defined by increase of the efficiency of the owner other divisions (or reduction of risks) rather than direct incomes.

Usually the vessels of specified classes belong to the harbors or the shipping companies operate transport or fishing vessels besides these classes with a reason of the ocean resources development and compensating charges for the support vessels maintenance at the expense of incomes, arriving for transport or fishing vessels operation.

For this reason many support vessels of special purpose and also some vessels of technical fleet can be referred to a number of vessels «unable to generate profit (income)».

Apparently, the effect from possession of commercial vessels of the specified types arrives to the owner as economy of expenses for operation of others vessels, for example transport or fishery.

The value of vessels of the vessels of «unable to generate profit (income)» classes is established by the parties when implementing of the property right (and accompanying obligations) by them as purchase and sale, transfer of the right–of–use by the contract of rent, pledge, arrest of property, etc. Thereby the correspondence of economic equivalence of values of these vessels and others, including revenue–generating is defined.

Thus, the value of «unable to generate profit (income)» vessels and the value of those which generate income, is equally objective. Therefore it is required to define formal concepts of value estimation of vessels, non–generating income in an explicit form and, nevertheless, applied, as they enhance the efficiency of other divisions of the owner.

The income can be taken from use of commercial vessel of any class. For example, the tug or the ice breaker can be used for the designated purpose as the vessels which are not bringing the income, but raising efficiency of others vessels, and it can be sold, generating the income this way. For this reason this class of vessels can be referred to a number of «unable to generate profit (income)» to a certain extent conditionally.

To estimate the value of vessels of the specified classes one should adhere to the definition according to which the vessel can be referred to the unable to generate profit (income) property if according to the concept of the prospective highest and the best use the income is not provided.

In the given definition the concept of the «unable to generate profit (income)» vessel is not a synonym of un–profitableness. The unable to generate profit (income) vessel can be quite highly effective, including according to an economic estimation.

For example, the value of the military vessel is maximum, when it is issued according to use for to the purpose – for maintenance of defense potential (we do not concern the legal rules of the military technology sale). The income in this case is excluded. At the same time scrapped vessel price is less is less, though the income arrives.

In the considered example vessel disposal for scrap, despite the actual receipt of the income to the owner, cannot be referred to the highest and the best use concept, unlike application for the purpose (in case of absence of the income).

The given statement is based on definition of the highest and the best use, as reasonable and possible operation of commercial vessel which provides the highest present value on the date of estimation.

For the vessels referring to the unable to generate profit (income) property, application of the evaluation method from the point of view of capitalization (that is accumulation) of the predicted net operating income can be interfaced with the methodological difficulties.

The determination of the part of the owner's income, arriving from other divisions or assets which should be referred into the account of an evaluated unable to generate profit (income) vessel is problematic.

When the value is estimated based on comparable sales approach and based on methods of the transactions, of the capital market and the branch factors the determination of the market factors (or multipliers) – proportional relations between factors of a financial characteristic of the evaluated company and analogues which allow establishing of the dependence between following indexes is required:

– Value *MV*, on the one hand, and the basic economic indexes, on the another hand – the annual income *I* (gain), the operation costs *C* (the annual costs of commercial vessel operation) and net operating income *NOI* (or profit *p*) determined as a difference of the basic indicators;

– Value *MV* of the commercial vessel, on the one hand, and the analogue value, on the another hand, considering, that this dependence is developed by the direct and reverse transformations on the basic indexes for the analogue and the estimated vessel which is specified above.

The similar concepts can be applied for the evaluations of the marine company isolated real assets for which one of the basic indexes – the income or operation costs is known, and the second of these indexes is unknown or depends on the first one.

To determine the financial characteristic and market factors in case of value estimation of the marine company's property complex the corrected forms of the accounting records are usually used (the official forms # 1, 2, that are balance and profit and loss statements).

However as the financial records usually are not kept in full in full usually concerning each isolated asset, even such as a marine commercial vessel, which by the set of

economic properties almost corresponds to the property complex of the marine company the alternative approach for evaluation of factors is required, for example, based on an estimation of factors depending on macroeconomic indexes, such as risks which can be determined as an estimation of the discounting rate.

The estimation of market factors dependences on total commercial risks gives the chance to use factors not only for evaluation of the property complex for which records are kept, but also for separate assets, such assets which owing to those or other reasons cannot be estimated based on income approach with the net operating income, and it is possible to estimate only operation costs or only the annual income (gain).

And if for commercial vessel it is quite possible correct estimation of the net operating income the market factor is the capitalization rate *R* or, with rather great life time of the commercial vessel, the discounting rate *i*, which in this case includes the rate of the property tax $\eta_{MV}$ and the rate of insurance coverage $\eta_{INS}$ in the general structure of the components of the sum.

The productive operation of the commercial vessel can bring the profit *p* and the net operating income *NOI*, as a difference of the annual income *I* and operation costs *C*, only if there are sufficient working assets *OC* for the advance payment of the operation costs *C* before receiving of the income *I*.

When the vessel is estimated by the income approach or the comparable sales approach on the basis of the market factors calculated depending on indexes of commercial risks, it is required to account the correcting adjustment for working assets *OC* should be made to the result.

The definition of annual income $R_I = (I - OC \times i)/MV_I$ and operation costs $R_C = C/MV_C$ factors for the commercial vessel is of interest on the basis of commercial risks estimation *i*.

Considering, that net operating income *NOI* is proportional to the investments, correlated with the sum of the value *MV* and the present value of investments into replenishment of working assets *OC*, that is $(MV + OC \times i/R)$, the rate of the net operating income capitalization can be defined by transformation of the formula (11.4), as:

$$R = NOI/(MV + OC \times i/R), \tag{16.1}$$

or, in case of value estimation based on income approach and the method of the net operating income capitalization with the account the adjustment to the vessel value (or other real asset of marine company) for the replenishment of working assets:

$$MV = (I - C)/R - OC \times i/R, \tag{16.2}$$

and the capitalization rate of net operating income *R* as it is noted above (article 11), is calculated depending on the discounting rate *i* by the well–known formula $R = i + f_m$.

**Test questions**

1. Market factors method of value estimation of the acting company's property complex.

2. Commercial reasons of the «unable to generate profit (income)» support vessels use.

3. The reasonable ground to classify a commercial vessel as the «unable to generate profit (income)» property.

4. Ways of market factors determination.

5. Vessel value estimation based on income approach by the method of the net operating income capitalization as the estimation based on comparable sales approach by the market factor (the formula derivation).

6. Adjustment to the vessel value estimated based on income approach and by the account of need of the working assets replenishment.

## 16.1. Vessel value estimation based on use of operation costs index account

If possession of a commercial vessel is connected only with expenses and, nevertheless, is reasonable and efficient by other reasons, for example in view of increase of efficiency of other divisions of the proprietor, the vessel value can be estimated using the below–mentioned formal scheme.

The net operating income *NOI* should be commensurate with the vessel annual «consumption cost» $C_U$, to be more exact, with expenses for annual consumption.

Consumption costs of the commercial vessel or other real asset of the marine company's property complex $C_U$ correspond to the sum of annual operation costs *C* and the annual deductions for the property tax $\eta_{MV} \times MV_C$, for the insurance coverage $\eta_{INS} \times MV_C$ and for the compensation of real assets depreciation $f_m \times MV_C$ and are equal

$$C_U = C + f_m \times MV_C + \eta_{MV} \times MV_C + \eta_{INS} \times MV_C . \qquad (16.3)$$

The index «*c*» means, that value $MV_C$ of the vessel (or other real asset of the marine company) is calculated according to operation costs *C*, which are rational for the investor as they raise the value or the efficiency of the property complex.

The consumption costs $C_U$ are equal to minimum income $I_{\text{MIN}}$, when vessel operation (or other asset) is not connected with losses, that is, provided that the profit and losses are equal to zero, and the net operating income *NOI* with the account the residual life time of commercial vessel ($T - t$) and the macroeconomic index of total risks *i* in case of estimation of the factor of fund of compensation $f_m$ (Chapter 13, табл. 13) corresponds to deductions for compensation of real asset depreciation $f_m \times MV_C$ in the sum with the property tax $\eta_{MV} \times MV_C$ and insurance coverage $\eta_{INS} \times MV_C$.

When the investor is typically motivated, that is, when investing in a vessel (or other real asset of marine company) for the purpose of maximization of the property complex value and with account of the annuity $OC \times i$, which present value at the time of the net operating income calculation corresponds to the needs for the replenishment of the working assets *OC*, the expenses equal to cost of consumption $C_U$, mast make profit *p* (or the equivalent good if the profit is not provided), proportional to the cost of vessel consumption $C_U \times i$, that is

$$p - OC \times i = C_U \times i . \qquad (16.4)$$

Substituting of the formula (16.3) in the formula (16.4), it is possible to define

$$p - OC \times i = (C + f_m \times MV_C + \eta_{MV} \times MV_C + \eta_{INS} \times MV_C) \times i \,. \qquad (16.5)$$

Taking into account, that cost of vessel $MV_C$ and profit $p$ (or the equivalent good if the profit is not provided) are connected by the formula

$$i \times (MV_C + OC) = p \,, \qquad (16.6)$$

then, substituting the formula (16.6) in the formula (16.5), it is possible to define

$$MV_C = C + f_m \times MV_C + \eta_{MV} \times MV_C + \eta_{INS} \times MV_C \,, \qquad (16.7)$$

$$\text{or } MV_C = C / R_C, \qquad (16.8)$$

where $R_C$ – the factor of operation costs $C$, that is proportionality factor between the asset value and the operation costs, estimated with the account residual life time ($T - t$) and a macroeconomic index of risks $i$.

The factor $R_C$ of operation costs $C$ is equal

$$R_C = 1 - f_m - \eta_{MV} - \eta_{INS} = 1 - i / ((1+i)^{T-t} - 1) - \eta_{MV} - \eta_{INS} \,, \qquad (16.9)$$

or on the basis of discounting by The Euler' number exponential function

$$R_C = 1 - i / (e^{i \times (T-t)} - 1) - \eta_{MV} - \eta_{INS} \,.$$

And the factor $R_C$ of the operation costs $C$ is estimated not on the basis of the marine company financial records indexes, as all for the isolated asset, even for a vessel, the financial records are not kept in full, but taking into account the formula (16.9) of the macroeconomic indexes of risks $i$ and characteristics: age $t$, life time $T$ and residual life time ($T - t$).

Leaving along the analysis of reasonable operation costs for the investor, when determining the value by the formula (16.8) it is supposed, that operation costs $C$ are reasonable by their utility that is the methodological precondition for value $MV_C$ estimation of commercial vessel (or other real asset).

If the income $I$ is not provided in vessel operation, it is supposed, that other good are equivalent to advantages of the income receipt according to the assumption of reasonable operation costs $C$.

For value estimation on the basis of operation costs $C$ analysis or the annual income $I$, that is in each of variants only one of the specified components of the net operating income, issued the second index, which is not used directly is supposed, to depend on the first one, and both indexes, and also their difference – net operating income $NOI$ – are proportional to the intensity of commercial vessel operation.

The basic economic indexes are methodologically interconnected, that means that: the value $MV$, the operation costs $C$, the annual income $I$ and the net operating income $NOI$ depend on intensity of commercial vessel productive operation.

The vessel value estimation based on income approach also can be problematic at some circumstances when the income, the profit and the net operating income depend on intensity of commercial vessel operation, and in supposed cases it is inconvenient to determine unequivocally only depending on vessel characteristics.

The approach of value vessel estimation, based on the application of annual income index $I$ is presented below.

**Test questions**

1. Concept of the vessel annual «consumption cost» and its structure in the sum of operation costs and deductions for compensation of real asset depreciation.
2. Conformity of commercial vessel's consumption cost break–even.
3. Typical motivation of the investor, the concept of operation costs utility.
4. Definition of operation costs factor according to risks (the formula derivation).
5. Difficulties in case of determination of the net operating income for certain classes of vessels.

## 16.2. Application of the annual income index for vessel value estimation

The possibility of value estimation *MV* of the commercial vessel (or other real asset of marine company) depending on the annual income *I*, besides the fact that it is methodologically valuable is rather important when solving certain applied tasks, for example such task as evaluation *MV* when the commercial vessel is used within the limited resources, particularly, in case of fishery operation within the amount of fishing quotas of the ocean biological resources when the annual income is limited.

When estimating value $MV_I$ the annual income index *I* is used and it is supposed, that operation costs *C* and the annual income *I* are interdependent. The index «*I*» means, that value $MV_I$ is estimated on the basis of the annual income *I* and the factor of the annual income account.

As the profit, as shown ahead, can be correlated (16.5) with the operation costs: $p = (C + f_m \times MV_I + \eta_{MV} \times MV_I + \eta_{INS} \times MV_I + OC) \times i$, so

$$I = C + p + f_m \times MV_I + \eta_{MV} \times MV_I + \eta_{INS} \times MV =$$
$$= C + (C + f_m \times MV_I + \eta_{MV} \times MV_I + \eta_{INS} \times MV_I + OC) \times i + f_m \times MV_I + \eta_{MV} \times MV_I + \eta_{INS} \times MV_I, \quad (16.10)$$

further

$$C = (I - OC \times i)/(1+i) - f_m \times MV_I - \eta_{MV} \times MV_I - \eta_{INS} \times MV_I. \quad (16.11)$$

The value $MV_I$ can be determined after substituting the formula (16.11) in the formula (16.8), that is

$$MV_I = ((I - OC \times i)/(1+i) - f_m \times MV_I - \eta_{MV} \times MV_I - \eta_{INS} \times MV_I)/(1 - f_m - \eta_{MV} - \eta_{INS}),$$

or after transformation:

$$(I + OC)/(1+i) = MV_I + OC, \quad (16.12)$$

further

$$MV_I = I / R_I - OC \times i / R_I, \quad (16.13)$$

where $R_I$ – the factor of the annual income *I* equal:

$$R_I = 1 + i, \quad (16.14)$$

or on the basis of discounting by The Euler' number exponential function $R_I = e^i$, that is

$$MV_I = I \times e^{-i} - OC \times i \times e^{-i}. \qquad (16.15)$$

Just as the factor of operation costs $R_C$ (evaluated by the formula 16.9), the factor of annual income $R_I$ is determined on the basis of the analysis of a macroeconomic index of risks *i* rather than by the financial reporting of the marine enterprise on the basis of factors, as there is a task to estimate the isolated asset.

The recommendations of the given chapter (Chapter 16) have the direct relation to the process of solving the applied expert tasks to estimate the vessel value or other real asset of marine company:

– By the formulas (16.8, 16.9) if for an estimated asset the records are kept only for operation costs, but there are no doubts about the efficiency of operation, as, for example, for support vessels in the structure of the shipping companies;

– By the formulas (16.13, 16.14) if there are limitations in the subject preconditions – servitudes concerning the intensity of asset operation, for example, the limitations of ocean biological resources development or others, and the servitude can be estimated as limitation of the annual income, keeping in mind, that operation costs depending on the annual income are also become limited;

– By any formulas specified ahead if methodologically is difficult to estimate the net operating income *NOI* index, and only one of two indexes – the annual income *I* or operation costs *C* is subject to determination, and besides if concerning the estimated asset the financial records are not fully kept.

The geometrical analogy to explain the formulas (16.8, 16.9, 16.13 and 16.14) is shown on the scheme (fig. 16).

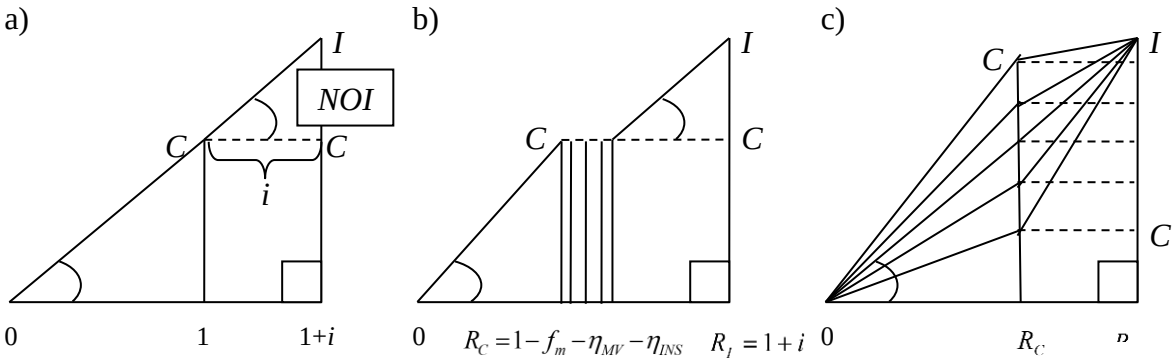



Fig. 16. The geometrical analogy (a) of economic indexes parities:
the annual income *I*, the operation costs *C*, the investments (cost *MV*, $MV_I$ and $MV_C$), the factors $R_C = 1 - f_m - \eta_{MV} - \eta_{INS}$ and $R_I = 1 + i$, with the account variations of factors (b) and ratio of the annual income *I* to operation costs *C* (c)

With rather large durability of the commercial vessel (or other asset of the marine company), that is, if to neglect the factor of fund of compensation of the value depreciation, the capitalization rate of net operating income *R* can be estimated as the discounting rate *i*.

Taking into account that *R*=*i*, the value can be estimated by the income approach as *MV*=*NOI*/*i*. On the scheme of the geometrical analogy (fig. 16, a) the corner ∠*ICC* tangent – the relation of leg of the triangle *NOI* = *I*–*C* to a leg of the triangle *i* of rectangular

triangle *ICC* corresponds to value *MV*.

At the same time the corner $\angle ICC$ is equal to corners $\angle I0$ (1+*i*) and $\angle C01$. Thus, tangents of all listed corners correspond to value *MV*.

If, that is more exact, the legs of triangle of rectangular triangles adjoining to corners $\angle ICC$, $\angle I0$ (1+*i*) and $\angle C01$ which tangents correspond to the value, to define by the formulas 16.9 and 16.14 as factors $R_I$ and $R_C$ of the annual income and operation costs (fig. 16, b) the geometrical analogy serves as value estimation by the formulas 16.8 and 16.13.

Thus factors $R_I$ and $R_C$ of the annual income and the operation costs are defined as macroeconomic indexes with the account the total risks estimated as the discounting rate *i* rather then according the results of the financial records which usually are not kept in full concerning the isolated assets.

The geometrical analogy where the value corresponds with the tangent of the corresponding corner at the scheme, also shows, the influence of efficiency of the ocean resources on the vessel value (or other asset of the marine company), and it is taken into account when formulating the economic optimality criteria in marine industrial activity.

As a whole it is clear, that the vessel value essentially depends on the intensity of the cargo traffic, the vessel is used for which development, or on the productivity of marine fishing ground etc.

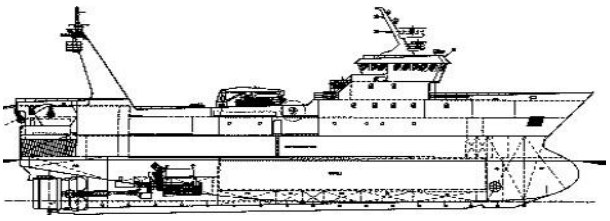
The superfluous marine wealth (economic advantages) or the lack of resources transform the diagram of geometrical analogy (fig. 16, c), that leads to a change of corners of the diagram ($\angle ICC$, $\angle I0$ (1+*i*) and $\angle C01$) and corresponding value estimations (*MV*, $MV_I$ and $MV_C$), which parity is used to define the economic criteria of the ocean resources contribution to the vessel value (or other asset of the marine company, see Chapter 26).

The results obtained by the formulas 16.8, 16.9, 16.13 and 16.14 should be considered as approximate and directly connected with the assumptions used in a substantiation of specified formulas.

**Test questions**

1. Assumption of conforming the annual income and operation costs conformity with the intensity of productive operation of the commercial vessel which is characterized by the net operating income.

2. Determination of the annual income factor according to risks (the formula derivation).



# 17. Forms of commercial vessel charter, evaluation of the right–of–use and the charter market rate

The value estimation of the commercial vessel, other real asset of the marine company or the property complex right–of–use has a close relation to value estimation of the property rights: possession, disposal and use and to application of the income approach for market value determination.

The various combinations of conditions of commercial vessel or other asset of the marine company rent (freight) which differ by the set of transferred rights can be applied and the value of the charter market rate corresponding to the value of right–of–use depends on the kind of renting contract.

There are different types of commercial vessel charters: the bare boat charter, the demise charter when the tenant (renter) should besides the payment of rent charges for the owner, bear also the operation costs connected with commercial vessel productive operation and expenses for maintenance, repair, insurance, management of operation and all other operational expenses.

Besides, for a shorter interval of use, smaller than the technological period of the maintenance servicing of the commercial vessel, the contract can consist of a time charter rent when the equipped vessel is transferred into the tenant's operation and the obligations of vessel maintenance lay with the ship–owner. Thus the tenant should not supply, repair, manage operation, etc. the vessel.

For example, the following items can be transferred to a tenant for short time interval of use: the vessel charged and served by the crew, the working equipment served by workers, the premises with service and etc. In some cases the obligation of property servicing can remain on the proprietor, as well as in case of long term renting if servicing concerns the joint use of the property, for example, in case of renting of separate premises.

Besides, the commercial vessel can be rented with the redemption by the leasing contract which can be applied as the economic analogue of crediting with the commercial vessel as a security of the debt if instead of pledge obligations the borrower sells his own vessel to the leasing company and rents the same vessel with the condition of redemption of the last one at the end of the period of use.

When estimating of the rights of the commercial vessel rent contract it is necessary to adhere to certain recommendations concerning terms the «right–of–rent» and «right–of–use». It is the right–of–use which is transferred instead of the right–of–rent.

The right–of–rent that is the right to conclude the rent contract naturally is available for each capable person and is free. The right–of–rent is not estimated. The right–of–rent is not exclusive. The right of each person (physical or legal) to lease vessel that is the right of the person to conclude the rent contract is not a negation of this right of the other person.

The property rights – possession, disposal and following from the rent contract the right–of–use, – are exclusive as the necessary assumption of value and the right of any person to use an asset excludes this right from another person (according to the civil law).

It is required to pay for the rights which follow from the contract of rent. And the right–of–use which is provided under Article 209 of the Civil code of the Russian Federation (and the right–of–rent is not provided) follows for the tenant.

It is the right–of–use of commercial vessel under the contract of rent which is subject for estimation instead of the right–of–rent if we are about primary access to the right–of–rent that usually is not a subject of estimation.

The determination of the charter market rate value can correspond to estimation of the right–of–use of the contract of rent for various provisions:

– Only to the value of the right–of–use, if obligations for vessel maintenance (or other asset of the marine company) lay on the tenant by the contract of rent during the period of use;

– To the sum of the right–of–use value and the present value of obligations flowing for vessel maintenance if service obligations lay with the owner instead of on the tenant;

– To the value of the sum of the right of commercial vessel use by the leasing contract (rent with the repayment) and property right present value at the end of the period of use that is on the day of carrying out the pledge with the repayment performance etc.

**Test questions**

1. Estimation of property rights set and the part of property rights.
2. Types of commercial vessel charter (freight).
3. Property right following from the contract of rent.
4. Leasing – commercial vessel transfer for use with the repayment, the analogy of commercial vessel leasing and the pledge crediting.

## 17.1. Right of use estimation as a difference of the vessel present values at the beginning and at the end of the period of use

The value of the right of commercial vessel use transferred in rent should be defined as difference of present values of market value *MV* at the beginning $t_1$ and at the end of $t_2$ of the period of use.

And the market value at the beginning of the period of use and at the end characterizes in aggregate the right of possession, disposal and use and should be estimated by standard approaches.

The other, logical, at first sight, possibility of the right–of–use evaluation as a capitalized sum of the discounted cash flow of net operating income $NOI_t$ for the interval $t_1$, $t_2$ time of use

$$(1+i)^{1/2} \times \sum_{t_1+1}^{t_2} NOI_t /(1+i)^t$$

it is not quite exact methodologically as, when determining the value by the application of standard approaches set is not covered: the comparable sales, the income and the costs.

The same remark concerns the application of separately taken approaches for right–of–use evaluation: the comparable sales approach (by the data of estimations of analogues use) or the cost approach (by calculation of all expenses total connected with use, including taxes, specific payments, and also with the account the profit estimated by a certain rate).

In some sets of the circumstances the supposed methodological contradictions in process of estimation can be results of concepts confusion. For example, it is known, that

in some cases the task of asset estimation based on income approach is based on use of the charter rate index that can intuitively be perceived as similar tasks of the value estimation of the right of asset use and the estimation of asset market value based on income approach.

The contradiction can arise, if, on the one hand, it is required to estimate the charter market rate, and on the other hand, the base of an estimation from systematic point is the market value depending on which the value of the right–of–use and further the charter market rate is determined, and there is a mistaken impression that the charter market rate is both the initial data and the result of estimation.

It should be noted that the similar confusion in case of an insufficient professional experience of the expert is not only a feature of tasks of the value estimation of the right–of–use and the charter market rate, it concerns any value estimation. The same erroneous impression about the contradiction of data and results can arise in case of estimation of the market value by the independent approaches, as among the data of the comparable sales approach the market values concerning analogues are used.

In general, among professional qualities of experts ability to distinguish initial data from results is great importance; it demands knowledge of applied economic estimation methodology including understanding the relationships of cause and effect, the subject, the object and the method.

The object of estimation is a set of property rights. The subject is the purpose and the assignment of estimation that is a type and purpose of the determined value.

At the initial stage of market reforms in Russia (in the 90–s of the XX century) when the professional expert estimation was being formed and methodology it was not sufficiently finished, and some times there was the mixing of methodological concepts and sometimes it had a regular character.

For example, in the course of mass revaluation of the real assets in the second half of 1990–s the balance cost of assets which was reflected in the financial and tax records was estimated. As the methodology of the real assets revaluation did not provide expert determination of depreciation the estimation of reproduction cost was made which corresponds to the sum of market expenses for reproduction of the real assets.

It is possible to guess that for subject simplification usually appraisers determined the reproduction cost on the basis of the expenses summation concept though the comparative approach was often used too but the income approach was not applied for estimating the reproduction cost, as there was no sufficient understanding, that market expenses in the sum should be paid back, that is, they can be determined based on income approach too.

It cam be to explain by an abstract example: if commercial vessel displacement is equal to the total weight of all her parts, not necessarily the method of displacement determination consists in summation of weight parts and it is possible to determine the weight of the superseded water, that by the Archimedes law is correct determination of displacement.

Coming back to contradictions of the enterprises property revaluation in 1990–s, it should be noted that in case of reproduction cost calculation (together with other types of value, methodologically and algorithmically truly defined through the market value concept as a base of valuation) the appraisal standards should have been followed and if there was such possibility, and in many cases such possibility was, standard independent

approaches should have been applied for reproduction cost estimation, including the income approach, instead of to confuse the subject and the method – the concept of reproduction cost as the market expenses total and the method of estimation on the basis of expenses summation.

Note, that the specified methodological contradiction and mixing of the subject of revaluation and the method had a negative influence on the appraisal as with great demand there was a limited range of offered expert services which were incomplete and low quality (in sense of insufficient conformity to appraisal standards), and also extensive style of some appraisers job with customers was generated – an aspiration «to take a bite of all apples» (including the desire to have the whole staff but be unable to make it qualitatively) that negatively influences the appraisal indexes today in lack of demand.

On the other hand, as the purpose of applied expert activity in the economy is assistance for the financial assets advancement in the real sector the specified tasks of the economic estimation which reasons originate in insufficient methodological finishing can also make negative impact on the real economic sector.

To complete the professional profile of experts dealing with value estimation in applied economic, besides the examples showing erroneous mixing of cause and effect (that is the data and the results), the subject (that is the value concepts) and the method, it is necessary to pay attention on necessary experts abilities to distinguish the objective methodology in the applied economics from the conventionalities and to understand the primacy of methodology.

The area of regulation by standards in an economic estimation usually corresponds to the extent of generalization at the level of approaches, and detailed elaboration of approaches to the level of methods is done by experts independently on the basis of professional methodology application which is rather extensive and improved.

The vocational training of the expert is insufficient, if, for example, he just has a task of present value estimation by the discount financial functions, and there is a question whom the standard of these formulas is accepted and approved, by which, of course, were not accepted by the standard and grew out of the formal logic.

By the way, any objective laws and not only in applied economics have no standard status, for example, it is not required the approval of any parliament for the law of universal gravitation or for any other materialistic law.

In each case more detailed analysis usually shows that an obstacle for the expert is an insufficient own professional experience taking into account the level of considered task and applied methodology complexity rather than the absence of the standard status of the methodological appendices. Thus the absence of the regulating standard is not a difficulty for the expert if the level and methodological complexity of the task correspond to his qualification.

If the expert is not capable to develop and to apply within the limits of independent approaches the objective estimation methods independently he searches for instructions and standards which for specified conditions don’t exist and will not exist and, finally, he can wrongly apply an inadequate method.

The vocational training of experts who are responsible for working out standards for experts in the field of applied economics is of great importance. On the one hand, the standards for experts should not regulate particular and they should have a universal character. On the other hand, conformity of these standards to the formal logic of economic

valuation is required instead of to instruct the experts on conventions which have nothing in common with formal logic.

The right of use is evaluated with systematic approach, and methodological concepts and standard rules are observed if to adhere to the concept of market value as a base of estimation of a set of the property rights: possession, disposal and use, – and if to estimate other kinds of value through market value, including to define the value of the separate right from set – the right–of–use, that is concerning the value at the beginning $MV_1$ and at the end $MV_2$ of the period of use and concerning market macroeconomic index of total risks according to the discounting rate *i* the present value of the right–of–use from the systematic approach point of view can be evaluated as a difference of present values: the market value at the beginning and at the end of the period of use $MV_1/(1+i)^{t_1} - MV_2/(1+i)^{t_2}$.

From the systematic point of view to determine rent charges cash flow $RN_t$ the present value of the right–of–use should be equal the present value of rent charges cash flow.

The estimation of rent charges cash flow $RN_t$ is determined by solving the equation

$$MV_1/(1+i)^{t_1} - MV_2/(1+i)^{t_2} = (1+i)^{1/2} \times \sum_{t_3+1}^{t_4} RN_t/(1+i)^t, \qquad (17.1)$$

where $t_3$, $t_4$ – the beginning and the end of rent charges payment interval.

Charter market rate *RN* means a rent charge of the equal value and uniform periodicity, which present value corresponds to the value of the right–of–use of commercial vessel (or other asset of the marine company).

The value of charter market rate *RN* or cash flow of the rent charges $RN_t$ corresponding to the value of the right–of–use by the condition (17.1can be determined by selection in Excel tables.

The payments by the rent contract generally can be fulfilled by the advance payment at the beginning of each payment period or by installments – credited vessel use with payment at the end of the payment period.

It is unessential, if the time interval of rent charges payment (that is the beginning $t_3$ and the end $t_4$ of the interval) coincides with interval of vessel use (the beginning $t_1$ and the end $t_2$).

To estimate the right of use there should be a coincidence of the time reference points, coincidence of time of estimation of both the market value of the commercial vessel and rent charges cash flow, that is conformity of the time of estimation.

And the concept of the appraisal time means any moment at which both present values are estimated, the values of the rights and obligations concerning vessel use (or other asset of the marine company) by the rent contract and the value of the tenant obligations, for example, present value of payments cash flow, that is, the appraisal time is any day at which present values of all commercial vessel rent indexes are determined.

In particular, the uniform appraisal time for estimation of all present value indexes of the contract of rent can be the time of the beginning $t_1$ or the end $t_2$ of an interval of use, the time of the beginning $t_3$ or the end $t_4$ of rent charges payment interval.

But the best way is define the day when the contract of rent was made as an appraisal time at which all present values are determined, for example, combined with the beginning of use $t_1$ or the beginning of rent charges payment $t_3$ from which the indexes are counted in years $t_1$, $t_2$, $t_3$, $t_4$. And are applied not only the whole numbers are applied, but fractional values and also zero in case of coincidence to the time of settlement.

**Test questions**

1. Evaluation of the right–of–use of the vessel as difference between the present market value at the beginning and at the end of interval of use (the formula derivation).
2. Unilateral character of the right–of–use estimation by the methods of the income approach or other approaches separately.
3. Confusion in case of concepts mixing of kinds of the value and the methodological approaches applied to evaluation.
4. Reproduction cost with the account payback of a new asset of the marine company.
5. Systematic approach in case of estimation of various kinds of value through market value, as a base of estimation.
6. Conformity of standards to the formal logic of applied economic estimation.
7. Value of the right–of–use estimated as difference of asset present value at the beginning and at the end of the use term in the prices of time of settlement.
8. Rent charges cash flow and the charter market rate.
9. Concept of the present time in case of the right–of–use evaluation.

## 17.2. Calculation of the charter market rate on the basis of equality of rent charges flow present value and the right of vessel use present value

The value of annual charter market rate *RN* when the value of the right of commercial vessel (or other asset of the marine company) use is equal to the present value of rent charges cash flow, is:

$$RN = \frac{MV_1/(1+i)^{t_1} - MV_2/(1+i)^{t_2}}{(1+i)^{1/2} \times \sum_{t_3+1}^{t_4} (1+i)^{-t}}. \qquad (17.2)$$

The values at the beginning $MV_1$ and at the end $MV_2$ of the period of use in applied tasks have the forecasting character and the value at the end of the period of use $MV_2$ is more unclear as the predicted value at the end of the period of use is more distant in time from the settlement day.

If the vessel value (or other asset of the marine company) can change essentially during the period of use, the vessel (or an asset) shouldn't have been transferred in use but sold.

In case of value estimation of the right of vessel use, as methodological precondition, it can be assumed that the value varies a little during the period of use that is $MV_1 = MV_2 = MV$.

Then value of the right–of–use is approximately equal

$$MV \times (1/(1+i)^{t_1} - 1/(1+i)^{t_2}).$$

This assumption is more obvious for durable assets, for example, for real estate.

With the account an assumption about minor alteration of the vessel value during the period of use (for example, year), having connected time readout with the beginning of the period of use ($t_1 = 0$) the value of the right–of–use depending on the base market value *MV* can be estimated approximately as $MV \times (1 - 1/(1+i)^{t_2})$.

The interval of rent charges (the beginning of interval $t_3$ and the end $t_4$) fractioned to the periods.

The determination of the charter market rate value in relation to a calendar periodicity of payments – to a year, a half a year, a quarter, a month, a week, a day is of interest. And the recommendations for value estimation of the right–of–use and charter market rate *RN* concerning the general meaning of the set interval of the period of use (the beginning of period $t_1$ and the end $t_2$) and interval of rent charges (the beginning of interval $t_3$ and the end $t_4$) are considered above (17.1, 17.2).

The value of annual charter market rate *RN* corresponding to the value of the right–of–use depending on the little varying market value of the vessel *MV*, when sousing the discount financial functions, is equal:

$$RN = MV \times i \times (1+i)^{-1/2} \times (1/(1+i)^{t_1} - 1/(1+i)^{t_2})/(1/(1+i)^{t_3} - 1/(1+i)^{t_4}), \qquad (17.3)$$

and if the beginning and the end of the period of use, on the one hand, both the beginning and the end of an interval of rent charges, on the other hand, accordingly coincide that is if $t_1 = t_3$ and $t_2 = t_4$, the formula for estimation of the annual charter market rate for the advance payment *RN* paid at the beginning of each year is :

$$RN = (1+i)^{-1/2} \times MV \times i. \qquad (17.4)$$

The value of annual charter market rate *RN* of the payment paid by installments at the end of the year is determined as:

$$RN = MV \times i \times (1+i)^{1/2}. \qquad (17.5)$$

The value of the charter market rate of advance half–yearly payment *RN*(½) paid at the beginning every half a year is equal:

$$RN(1/2) = (1+i)^{-1/2} \times MV \times i/(1 + 1/(1+i)^{1/2}). \qquad (17.6)$$

The value of the charter market rate of half–yearly payment *RN*(½) paid by installments at the end of every half a year is determined as:

$$RN(1/2) = MV \times i/(1 + 1/(1+i)^{1/2}). \qquad (17.7)$$

The value of the charter market rate of advance quarterly payment (that is for ¼ part of year) *RN*(¼) paid at the beginning of each quarter, is determined as:

$$RN(1/4) = (1+i)^{-1/2} \times MV \times i/(1+1/(1+i)^{1/4} + 1/(1+i)^{1/2} + 1/(1+i)^{3/4}),$$

or after derivation by the geometrical progression sum it is possible to receive the formula

$$RN(1/4) = MV \times (1+i)^{-1/4} \times ((1+i)^{1/4} - 1)/(1+i). \quad (17.8)$$

The value of the charter market rate of the advance payment which is done at the beginning of the payment period for any duration of the period ($t$/365 – part of the year, where the time index $t$ is set in days) is equal:

$$RN(t) = MV \times (1+i)^{t/365} \times ((1+i)^{t/365} - 1) \times (1+i)^{-3/2}. \quad (17.9)$$

The value of the charter market rate of the payment by installments which is done at the end of the payment period for any duration of the period is determined as:

$$RN(t) = MV \times (1+i)^{2\times t/365} \times ((1+i)^{2\times t/365} - 1) \times (1+i)^{-3/2}. \quad (17.10)$$

The value of the charter market rate of quarterly payment $RN$(¼) paid by installments at the end of each quarter is equal

$$RN(1/4) = MV \times ((1+i)^{1/4} - 1)/(1+i). \quad (17.11)$$

The value of the charter market rate of advance monthly payment $RN$(1/12) that is the 1/12 part of the year paid at the beginning of each month is

$$RN(1/12) = MV \times (1+i)^{1/12} \times ((1+i)^{1/12} - 1) \times (1+i)^{-3/2}. \quad (17.12)$$

The value of the charter market rate of monthly payment $RN$(1/12) paid by installments at the end of each month is determined as:

$$RN(1/12) = MV \times ((1+i)^{1/12} - 1) \times (1+i)^{-8/6}. \quad (17.13)$$

The value of the charter market rate of the advance payment $RN$(7/365) paid at the beginning every week (that is 7/365 parts of year) makes

$$RN(7/365) = MV \times (1+i)^{7/365-3/2} \times ((1+i)^{7/365} - 1). \quad (17.14)$$

The value of the charter market rate of payment $RN$(7/365) paid by installments at the end of every week is determined as:

$$RN(7/365) = MV \times (1+i)^{14/365-3/2} \times ((1+i)^{7/365} - 1). \quad (17.15)$$

The value of the charter market rate of $RN$(1/365) advance daily payment or by installments (the specified condition in this case is insignificant in view of close conformity of the result in case of moderate risks) is equal

$$RN(1/365) = MV \times (1+i)^{1/365-3/2} \times ((1+i)^{1/365} - 1). \quad (17.16)$$

It should be noted that the present value of rent charges cash flow in case of weekly transfer (or daily transfer) practically does not depend on, whether transfer is made by advance payment at the beginning of each payment period or by installments – at the end of the period.

The similarity of present values of advance payment and payment by installments is mathematical property of cash flow summation in case of reduction of the payment period duration.

When defining the charter market rate value and the present value of rent charges cash flow the discount financial functions (17) based on estimation of reinvestment are

applied. At the same time it should be taken into consideration, that the reinvestment and accumulation for the discount financial functions is characteristic at enough big duration of payments intervals.

Apparently, for the short payments intervals the present value of rent charges cash flow is subject to estimation on the basis of arithmetic summation instead of by discount financial functions, as the resultants of present value for both variants of summation at moderate risks practically do not differ. It is fair if investors do not possess continuous access to stock exchange market.

The value of the charter market rate with daily payment by equal parts excluding the reinvestment payments with the account the small duration of the payment period is equal $RN(1/365) \approx RN(7/365)/7$, or

$$RN(1/365) \approx MV \times (1+i)^{7/365-3/2} \times ((1+i)^{7/365} - 1)/7 . \qquad (17.17)$$

By the formula (17.17) of the charter market rate value per day is determined on the basis of the charter market rate in week estimation (with use of discount financial functions – 17.14 or 17.15) and the subsequent division of the payment into seven days.

Besides, in order to determine of the charter market rate per week *RN*(7/365) depending on the market value *MV* of the commercial vessel (or other asset of the marine company) and on interest rate (discounting rates *i*) the formulas 17.12 and 17.13 can be used instead of formulas 17.14 and 17.15 – for determination of the charter market rate payment *RN*(1/12) per month and the subsequent arithmetic division of result into number of weeks in month 365/(12×7) ≈ 4,345.

The value of the charter market rate per week *RN*(7/365) depending on the charter market rate per month *RN*(1/12) is equal $RN(7/365) = RN(1/12)/4.345$.

The formulas (17.4–17.17) are applicable for estimation of the right–of–use value and the charter market rate in case of:

– Use of market value concept as bases of estimation;

– Assumption of constant market value during the period of vessel use;

– Task that the vessel maintenance is the tenant’s obligation instead of the proprietor’s one;

– Conformity of intervals periodicity of payments as the preconditions of formulas (17.4–17.17);

– Assumption of uniform periodicity and uniformity of the charter market rate payments value.

**Test questions**

1. Equality of the right–of–use value to the present value of rent charges cash flow.
2. Value estimation of the right–of–use in the assumption of market value invariance during the interval of use (the formula derivation).
3. Value of annual rent charge corresponding to the value of the right–of–use in case of little varying of the commercial vessel market value (the formulas based on account of the value, the discounting rate and the period of use).
4. Preconditions of formulas applicability and practical recommendations for evaluation of the right–of–use with the assumption of unchangeable asset value during the period of use.

## 17.3. Estimation of the adjustment to the charter market rate taking into account predictable change of the vessel value by the end of the period of use

If the value an asset of the marine company predictably varies during the period of use, for example, it decreases in process of expenditure of a certain resource or grows in process of accumulation, that is, if $MV_1 \neq MV_2$ the value of the right–of–use is accordingly equal

$$MV_1/(1+i)^{t_1} - MV_2/(1+i)^{t_2},$$

and to determine the value of the charter market rate *RN* the adjustment to the values received above (17.4–17.17) should be applied.

If to designate the value at the beginning of the period of use $MV_1 = MV$, then, with the account used designation, the value of the right–of–use $MV(1/(1+i)^{t_1} - 1/(1+i)^{t_2})$ should be determined with adjustment $(MV - MV_2)/(1+i)^{t_2}$, that is,

$$MV/(1+i)^{t_1} - MV_2/(1+i)^{t_2} = MV/(1+i)^{t_1} - MV/(1+i)^{t_2} + MV/(1+i)^{t_2} - MV_2/(1+i)^{t_2} =$$
$$= MV(1/(1+i)^{t_1} - 1/(1+i)^{t_2}) + (MV - MV_2)/(1+i)^{t_2}.$$

With the account the change (depreciation) of the value $\Delta MV = MV - MV_2$ by the end $t_2$ of the period of use the adjustment to the value of the right–of–use is equal $\Delta MV/(1+i)^{t_2}$ or $(MV - MV_2)/(1+i)^{t_2}$ – the second component in the resultant mathematical equation.

The value of the annual charter market rate $RN(\Delta MV)$ with the account the reduction $\Delta MV$ of the value by the end $t_2$ of the period of use should be determined with application of adjustment $RN(\Delta MV)$ to the value of the charter market rate *RN* calculated by formulas (17.4–17.17) with the assumption that the value during the period of use did not vary.

And if the value by the end $t_2$ of the period of use increases the index $\Delta MV$ is of negative value.

With the account the reduction $\Delta MV$ of the value by the end $t_2$ of the period of use the value of the charter market rate in the sum with the adjustment is determined as:

$$RN(\Delta MV) = RN + \Delta RN(\Delta MV)\,. \qquad (17.18)$$

The adjustment $\Delta RN(\Delta MV)$ to the estimated annual charter market rate *RN* determined by the formula (17.3) with the account the reduction $\Delta MV$ of the value by the end $t_2$ of the period of use is equal

$$\Delta RN(\Delta MV) = \Delta MV \times i/((1+i)^{t_2} \times (1/(1+i)^{t_3} - 1/(1+i)^{t_4}))\,, \qquad (17.19)$$

and if the beginning and the end of the period of use, on the one hand, both the beginning and the end of the period of rent charges, on the other hand, accordingly coincide, and if the beginning of the period of use coincides with the time of settlement, that is $t_1 = t_3 = 0$ and $t_2 = t_4$, the adjustment $RN(\Delta MV)$ to the value of annual charter market rate *RN* of the advance payment paid at the beginning of the year determined by the formula (17.4) is

$$\Delta RN(\Delta MV) = \Delta MV \times i/((1+i)^{t_2} - 1) \text{ or } \Delta RN(\Delta MV) = \Delta MV \times f_m\,, \qquad (17.20)$$

where $f_m = i/((1+i)^{t_2} - 1)$ is the factor of the fund of compensation of the depreciated part of investments by the end $t_2$ of the period of use adhered to the value reduction $\Delta MV$.

The general recommendation applied to determine the adjustment $\Delta RN(\Delta MV)$ to the charter market rate *RN* calculated for calendar periodicity of rent charges by each of formulas (17.4–17.17) with assumption, that the value *MV* does not vary by the end of the period of use is that if to make a replacement of symbols: $MV \times i \times (1+i)^{-1/2}$ for $\Delta MV \times f_m$, or $MV$ for $\Delta MV \times f_m/(i \times (1+i)^{-1/2})$ the result will be a corresponding adjustment $\Delta RN(\Delta MV)$ to the charter rate with the account the reduction $\Delta MV$ of the value by the end $t_2$ of the period of use, but not the charter market rate *RN*.

The adjustment $\Delta RN(\Delta MV)$ to the value of annual charter market rate *RN* of the payment paid by installments at the end of year determined by the formula (17.5) is equal

$$\Delta RN(\Delta MV) = \Delta MV \times i \times (1+i)/((1+i)^{t_2} - 1)\,, \text{ or } \Delta RN(\Delta MV) = \Delta MV \times f_m \times (1+i)\,. \qquad (17.21)$$

The adjustment $\Delta RN(\Delta MV, 1/2)$ to the value of the charter market rate of advance payment *RN*(½)determined by the formula (17.6) paid at the beginning every half a year taking into account the reduction $\Delta MV$ of the value at the end of the period of use is

$$\Delta RN(\Delta MV, 1/2) = \Delta MV \times f_m/(1 + 1/(1+i)^{1/2})\,. \qquad (17.22)$$

The adjustment $\Delta RN(\Delta MV, 1/2)$ to the value of the charter market rate of payment *RN*(½)determined by the formula (17.7) paid by installments at the end of every half a year taking into account the reduction $\Delta MV$ of the value at the end of the period of use is equal

$$\Delta RN(\Delta MV, 1/2) = \Delta MV \times f_m \times (1+i)^{1/2}/(1 + 1/(1+i)^{1/2})\,. \qquad (17.23)$$

The adjustment $\Delta RN(\Delta MV, 1/4)$ to the value of the charter market rate of advance quarterly payment *RN*(¼) determined by the formula (17.8) paid at the beginning of each

quarter (that is ¼ part of year), taking into account the reduction $\Delta MV$ of the value at the end of the period of use is

$$\Delta RN(\Delta MV, 1/4) = \Delta MV \times f_m \times (1+i)^{1/4} \times ((1+i)^{1/4} - 1)/((1+i) \times i). \quad (17.24)$$

The adjustment $\Delta RN(\Delta MV, t)$ to the value of the charter market rate *RN*(*t*) of the advance payment determined by the formula (17.9) which is done at the beginning of the payment period for any duration of the period (the *t*/365 part of the year where the indicator *t* is set in days) taking into account the reduction $\Delta MV$ of the value at the end of the period of use is equal

$$\Delta RN(\Delta MV, t) = \Delta MV \times f_m \times (1+i)^{t/365} \times ((1+i)^{t/365} - 1)/((1+i) \times i). \quad (17.25)$$

The adjustment $\Delta RN(\Delta MV, t)$ to the value of the charter market rate *RN*(*t*) of the payment by installments determined by the formula (17.10) which is done at the end of the payment period (for any duration of the period), taking into account the reduction $\Delta MV$ of the value at the end of the period of use is determined as:

$$\Delta RN(\Delta MV, t) = \Delta MV \times f_m \times (1+i)^{2\times t/365} \times ((1+i)^{2\times t/365} - 1)/((1+i) \times i). \quad (17.26)$$

The adjustment $\Delta RN(\Delta MV, 1/4)$ to the value of the charter market rate *RN*(¼) the payment paid by installments at the end of each quarter, taking into account the reduction $\Delta MV$ of the value at the end of the period of use is equal

$$\Delta RN(\Delta MV, 1/4) = \Delta MV \times f_m \times ((1+i)^{1/4} - 1)/i. \quad (17.27)$$

The adjustment $\Delta RN(\Delta MV, 1/12)$ to the value of the charter market rate of the advance payment *RN* (1/12) paid at the beginning of each month determined by the formula (17.12) taking into account the reduction $\Delta MV$ of the value at the end of the period of use is

$$\Delta RN(\Delta MV, 1/12) = \Delta MV \times f_m \times (1+i)^{1/12-1/2} \times ((1+i)^{1/12} - 1)/i. \quad (17.28)$$

The adjustment $\Delta RN(\Delta MV, 1/12)$ to the value of the charter market rate of payment *RN*(1/12) determined by the formula (17.13) paid by installments at the end of each month, taking into account the reduction $\Delta MV$ of the value at the end of the period of use is equal

$$\Delta RN(\Delta MV, 1/12) = \Delta MV \times f_m \times (1+i)^{1/6} \times ((1+i)^{1/12} - 1)/((1+i) \times i). \quad (17.29)$$

The adjustment $\Delta RN(\Delta MV, 7/365)$ to the value of the charter market rate of the advance payment *RN* (7/365) paid at the beginning of every week (that is 7/365 parts of year) determined by the formula (17.14) taking into account the reduction $\Delta MV$ of the value at the end of the period of use is

$$\Delta RN(\Delta MV, 7/365) = \Delta MV \times f_m \times (1+i)^{7/365} \times ((1+i)^{7/365} - 1)/((1+i) \times i). \quad (17.30)$$

The adjustment $\Delta RN(\Delta MV, 7/365)$ to the value of the charter market rate of payment *RN*(7/365) determined by the formula (17.15) paid by installments at the end of every week taking into account the reduction $\Delta MV$ of the value at the end of the period of use is equal

$$\Delta RN(\Delta MV, 7/365) = \Delta MV \times f_m \times (1+i)^{14/365} \times ((1+i)^{7/365} - 1)/((1+i) \times i). \quad (17.31)$$

The adjustment $\Delta RN(\Delta MV, 1/365)$ to determined by formulas (17.16, 17.17) of the value of the charter market rate a day $RN(1/365)$ taking into account the reduction $\Delta MV$ of the value at the end of the period of use is

$$\Delta RN(\Delta MV, 1/365) = \Delta MV \times f_m \times (1+i)^{1/365} \times ((1+i)^{1/365} - 1)/((1+i) \times i). \qquad (17.32)$$

It should be noted that adjustment $\Delta RN(\Delta MV)$ determined by the formulas (17.19–17.32) is applied in the formula (17.18) to the charter market rate with the account the predicted reduction $\Delta MV$ of the value by the end $t_2$ of the period of use which can be estimated.

If the reduction adjustment $\Delta MV$ of the value by the end $t_2$ of the period of use can't be predicted the unpredictable variability of value should be considered as an additional risk factor and it should be taken into account as a part of the discounting rate *i*.

In this case market rate *RN* should be estimated by the formulas (17.4–17.17) derived at an assumption that the value *MV* does not vary by the end of the period of use instead of the adjustment determination $\Delta RN(\Delta MV)$ to the charter market rate by formulas (17.19–17.32), but unpredictable variability of the value by the end $t_2$ of the period of use should be considered as an additional risk factor and a component of the discounting rate *i*.

**Test questions**

1. Value of the right–of–use in case of the predicted change of the asset value of the marine company or the property complex during the period of use.
2. Adjustment to the estimated value of the right–of–use estimation with the account the change (depreciation) of the asset value at the end of the period of use.
3. Estimation of the right–of–use in case of unpredictable variability of the value during the period of use.

## 17.4. Calculation of the adjustment to the charter market rate in view of ship–owner's obligations for charges and maintenance

If the obligations of vessel maintenance lay on the proprietor, instead of on the tenant that is if by the contract in using the equipped vessel is transferred to the tenant that is quite widespread by the type of contract called «time charter», the value of the charter market rate is determined with the account the sum of the value of the right–of–use and the present value of vessel maintenance obligations.

The value of the right–of–use in case if obligations of the maintenance lay on the proprietor instead of on the tenant is equal

$$MV_1/(1+i)^{t_1} - MV_2/(1+i)^{t_2} + (1+i)^{1/2} \times \sum_{t_1+1}^{t_2} C_t/(1+i)^t,$$

where $C_t$ – the cash flow of operation costs (the annual cost of commercial vessel operation).

With the account the obligations of vessel maintenance (or other asset) lying on the proprietor the value of the charter market rate $RN(C)$ in the sum with the adjustment is determined as:

$$RN(C) = RN + \Delta RN(C), \tag{17.33}$$

where, $\Delta RN(C)$ is the adjustment with the account the obligations for the commercial vessel charges and maintenance lying on the proprietor and correlated with operation costs to the value of the charter market rate *RN* calculated by formulas (17.4–17.17) derived with the assumption that obligations of the maintenance lay on the tenant.

In case of the short interval of the period of use (smaller, than the technological period of maintenance) the determination of the adjustment to the value of the charter market rate $\Delta RN(C)$ on the basis of the reinvestment account and discount financial functions is inappropriate and the adjustment is equal to the nominal value of operation costs during the payment period for the rent contract.

With a uniform within year and constant cash flow of operation costs $C$ for years if to estimate the short period [*t*] between payments by the rent contract in days the adjustment to the value of charter market rate $\Delta RN(C)$ with the account the obligations for the commercial vessel charges and maintenance lying on the proprietor is

$$\Delta RN(C,[t]) = C \times [t]/365.$$

In case of a uniform cash flow of operation costs through years $C$ for the option of the commercial vessel or other asset transfer for a long period of use the adjustment $\Delta RN(C)$ to with the account the obligations of the proprietor determined by the formula is (17.3) equal to the value of the annual charter market rate

$$\Delta RN(C) = C \times (1+i)^{1/2} \times (1/(1+i)^{t_1} - 1/(1+i)^{t_2})/(1/(1+i)^{t_3} - 1/(1+i)^{t_4}), \tag{17.34}$$

and if the beginning and the end of the period of use, on the one hand, both the beginning and the end of the period of rent charges, on the other hand, accordingly coincide, that is $t_1 = t_3$ and $t_2 = t_4$ the adjustment $\Delta RN(C)$ to the value of the annual charter market rate *RN* of the payment paid in the advance payment in the beginning of year determined by the formula (17.4) is

$$\Delta RN(C) = C \times (1+i)^{1/2}. \tag{17.35}$$

The general recommendation for determination of adjustment $\Delta RN(C)$ to the charter market rate *RN* estimated for a calendar periodicity of rent charges by each of formulas (17.4–17.17) derived in the assumption that obligations of the maintenance lay on the tenant consists that if in any of these formulas to make a replacement of the symbols: $MV \times i$ for *C*, or *MV* for $C/i$, – the result will be a corresponding adjustment $\Delta RN(C)$ to the charter rate with the account the obligations of the proprietor for vessel maintenance (or other asset of the marine company), rather than the charter market rate *RN*.

The adjustment $\Delta RN(C)$ to the value of the annual charter market rate *RN* of the payment paid by installments at the end of the year determined by the formula (17.5) is

$$\Delta RN(C) = C \times (1+i)^{1+1/2}. \tag{17.36}$$

The adjustment $\Delta RN(C,1/2)$ to the value of the charter market rate of advance payment *RN*(½) determined by the formula (17.6) paid at the beginning every half a year with the account the obligations of the proprietor is equal

$$\Delta RN(C,1/2) = C \times (1+i)^{1/2} / (1+1/(1+i)^{1/2}) . \qquad (17.37)$$

The adjustment $\Delta RN(C,1/2)$ to the value of the charter market rate of payment *RN*(½) determined by the formula (17.7) paid by installments at the end of every half a year with the account of the proprietor obligations is equal

$$\Delta RN(C,1/2) = C \times (1+i) / (1+1/(1+i)^{1/2}) . \qquad (17.38)$$

The adjustment $\Delta RN(C,1/4)$ to the value of the charter market rate of advance payment *RN*(¼) determined by the formula (17.8) paid each quarter at the beginning (that is ¼ part of the year) with the account the obligations of the proprietor makes

$$\Delta RN(C,1/4) = C \times (1+i)^{3/4} \times ((1+i)^{1/4} - 1) / ((1+i) \times i) . \qquad (17.39)$$

The adjustment $\Delta RN(C,t)$ to the value of the charter market rate *RN*(*t*) determined by the formula (17.9) of the advance payment which is done at the beginning of the payment period for any duration of the period (*t*/365 of the year where the indicator *t* is set in days) with the account the obligations of the proprietor is equal

$$\Delta RN(C,t) = C \times (1+i)^{t/365+1/2} \times ((1+i)^{t/365} - 1) / ((1+i) \times i) . \qquad (17.40)$$

The adjustment $\Delta RN(C,t)$ to the value of the charter market rate *RN*(*t*) determined by the formula (17.10) of the payment by installments which is done at the end of the payment period (for any duration of the period) with the account the obligations of the proprietor is determined as:

$$\Delta RN(C,t) = C \times (1+i)^{2\times t/365+1/2} \times ((1+i)^{2\times t/365} - 1) / ((1+i) \times i) . \qquad (17.41)$$

The adjustment $\Delta RN(C,1/4)$ to the value of the charter market rate *RN*(¼) determined by the formula (17.11) the payment paid by installments at the end of each quarter with the account obligations of the proprietor is equal

$$\Delta RN(C,1/4) = C \times ((1+i)^{1/4} - 1) / i . \qquad (17.42)$$

The adjustment $\Delta RN(C,1/12)$ to the value of the charter market rate of the advance payment *RN* (1/12) paid at the beginning of each month defined by the formula (17.12) with the account obligations of the proprietor makes

$$\Delta RN(C,1/12) = C \times (1+i)^{1/12+1/2} \times ((1+i)^{1/12} - 1) / ((1+i) \times i) . \qquad (17.43)$$

The adjustment $\Delta RN(C,1/12)$ to the value of the charter market rate of the payment *RN*(1/12) determined by the formula (17.13) paid by installments at the end of each month taking into account the obligations of the proprietor is equal

$$\Delta RN(C,1/12) = C \times (1+i)^{1/6+1/2} \times ((1+i)^{1/12} - 1) / ((1+i) \times i) . \qquad (17.44)$$

The adjustment $\Delta RN(C,7/365)$ to the value of the charter market rate of the advance payment *RN* (7/365) paid at the beginning every week (that is 7/365 parts of year) determined by the formula (17.14) with the account obligations of the proprietor makes

$$\Delta RN(C,7/365) = C \times (1+i)^{7/365+1/2} \times ((1+i)^{7/365} - 1)/((1+i) \times i). \quad (17.45)$$

The adjustment $\Delta RN(C,7/365)$ to the value of the charter market rate of the payment *RN*(7/365) determined by the formula (17.15) paid by installments at the end of every week taking into account the obligations of the proprietor is equal

$$\Delta RN(C,7/365) = C \times (1+i)^{14/365+1/2} \times ((1+i)^{7/365} - 1)/((1+i) \times i). \quad (17.46)$$

The adjustment $\Delta RN(C,1/365)$ to the value of the charter market rate a day *RN* (1/365) determined by formulas (17.16, 17.17) taking into account the obligations of the proprietor is

$$\Delta RN(C,1/365) = C \times (1+i)^{1/365+1/2} \times ((1+i)^{1/365} - 1)/((1+i) \times i). \quad (17.47)$$

**Test questions**

1. Components of the value of the right–of–use if obligations for vessel maintenance lay on the proprietor.
2. Estimation of the adjustment to the charter market rate with the account the present value of the obligations for vessel maintenance.
3. Evaluation of adjustments by the general universal formulas with symbols replacement.

## 17.5. Estimation of the adjustment to the charter market rate taking into account the conditions of the vessel repayment at the end of the period of use

By the contract of leasing–rent contract with the repayment by the end $t_2$ of the period of use, when the property rights concerning the vessel (or other asset of the marine company) after of all obligations by the leasing contract are transferred to the tenant, the value of the right–of–use is equal $MV/(1+i)^{t_1}$, if to designate the value at the beginning of the period of use $MV_1 = MV$.

The adjustment to the value of the right–of–use with the account the redemption is

$$MV/(1+i)^{t_2}.$$

The value of the annual charter market rate $RN(L)$ by the contract of leasing–rent contract with the redemption at the end $t_2$ of the period of use should be determined with application of adjustment $\Delta RN(L)$ to the value of the charter market rate *RN* calculated by the formulas (17.4–17.17).

The charter market rate $\Delta RN(L)$ by the contract of leasing–rent contract with the redemption at the end $t_2$ of the period of use is determined as:

$$RN(L) = RN + \Delta RN(L). \quad (17.48)$$

The adjustment $\Delta RN(L)$ to the value of the annual charter market rate *RN* determined by the formula (17.3) with the account the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is equal

$$\Delta RN(L) = MV \times i \times /((1+i)^{t_2} \times (1/(1+i)^{t_3} - 1/(1+i)^{t_4})), \tag{17.49}$$

and if the beginning and the end of the period of use, on the one hand, both the beginning and the end of the period of rent charges, on the other hand, accordingly coincide, and if the beginning of the period of use coincides with the time of settlement that is $t_1 = t_3 = 0$ and $t_2 = t_4$ the adjustment $\Delta RN(L)$ to the value of the annual charter market rate *RN* of the payment paid in advance at the beginning of year determined by the formula (17.4) with the account of the terms of leasing–rent contract of the commercial vessel with the redemption at the end $t_2$ of the period of use is

$$\Delta RN(L) = MV \times i /((1+i)^{t_2} - 1), \text{ or } \Delta RN(L) = MV \times f_m, \tag{17.50}$$

with substituting the factor of the fund of compensation $f_m$ of the value by the end $t_2$ of the period of use – before the fulfillment of obligations by the leasing contract.

The adjustment $\Delta RN(L)$ to the charter market rate *RN* taking into account the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use for corresponding to contract conditions of the rent charges calendar periodicity by formulas (17.19–17.32) if to make replacement of symbols: $\Delta MV$ for *MV* in any of these formulas.

The adjustment $\Delta RN(L)$ to the value of the annual charter market rate *RN* of the payment by installments at the end of year determined by the formula (17.5) is equal

$$\Delta RN(L) = MV \times f_m \times (1+i). \tag{17.51}$$

The adjustment $\Delta RN(L,1/2)$ to the value of the charter market rate of advance payment *RN*(½) determined by the formula (17.6) paid at the beginning of every half a year by the terms of leasing–rent contract of the redemption at the end $t_2$ of the period of use is

$$\Delta RN(L,1/2) = MV \times f_m /(1+1/(1+i)^{1/2}). \tag{17.52}$$

The adjustment $\Delta RN(L,1/2)$ to the value of the charter market rate of payment *RN*(½) determined by the formula (17.7) paid by installments at the end of every half a year by the terms of leasing–rent contract of the commercial vessel with the redemption at the end $t_2$ of the period of use is equal

$$\Delta RN(L,1/2) = MV \times f_m \times (1+i)^{1/2} /(1+1/(1+i)^{1/2}). \tag{17.53}$$

The adjustment $\Delta RN(L,1/4)$ to the value of the charter market rate of advance payment *RN*(¼) determined by the formula (17.8) paid at the beginning of each quarter (that is ¼ part of year) by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is

$$\Delta RN(L,1/4) = MV \times f_m \times (1+i)^{1/4} \times ((1+i)^{1/4} - 1)/((1+i) \times i). \tag{17.54}$$

The adjustment $\Delta RN(L,t)$ to the value of the charter market rate $RN(t)$ of the advance payment which is done at the beginning of the payment period determined by the formula (17.9) for any duration of the period ($t$/365 of the year where time index $t$ is set in days) by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is equal

$$\Delta RN(L,t) = MV \times f_m \times (1+i)^{t/365} \times ((1+i)^{t/365} - 1)/((1+i) \times i)\,. \qquad (17.55)$$

The adjustment $\Delta RN(L,t)$ to the value of the charter market rate $RN(t)$ determined by the formula (17.10) of the payment by installments which is done at the end of payment interval (for any duration of the period) by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is determined as:

$$\Delta RN(L,t) = MV \times f_m \times (1+i)^{2\times t/365} \times ((1+i)^{2\times t/365} - 1)/((1+i) \times i)\,. \qquad (17.56)$$

The adjustment $\Delta RN(L,1/4)$ to the value of the charter market rate $RN(¼)$determined by the formula (17.11) of the payment by installments at the end of each quarter by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is equal

$$\Delta RN(L,1/4) = MV \times f_m \times ((1+i)^{1/4} - 1)/i\,. \qquad (17.57)$$

The adjustment $\Delta RN(L,1/12)$ to the value of the charter market rate of the advance payment $RN$ (1/12) paid at the beginning of each month determined by the formula (17.12) by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is

$$\Delta RN(L,1/12) = MV \times f_m \times (1+i)^{1/12-1/2} \times ((1+i)^{1/12} - 1)/i\,. \qquad (17.58)$$

The adjustment $\Delta RN(L,1/12)$ to the value of the charter market rate of payment $RN$(1/12) determined by the formula (17.13) paid by installments at the end of each month by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is equal

$$\Delta RN(L,1/12) = MV \times f_m \times (1+i)^{1/6} \times ((1+i)^{1/12} - 1)/((1+i) \times i)\,. \qquad (17.59)$$

The adjustment $\Delta RN(L,7/365)$ to the value of the charter market rate of the advance payment $RN$(7/365) paid at the beginning of every week (that is 7/365 part of thr year) determined by the formula (17.14) by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is

$$\Delta RN(L,7/365) = MV \times f_m \times (1+i)^{7/365} \times ((1+i)^{7/365} - 1)/((1+i) \times i)\,. \qquad (17.60)$$

The adjustment $\Delta RN(L,7/365)$ to the value of the charter market rate of payment $RN$(7/365) determined by the formula (17.15) paid by installments at the end of every week by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is equal

$$\Delta RN(L,7/365) = MV \times f_m \times (1+i)^{14/365} \times ((1+i)^{7/365} - 1)/((1+i) \times i)\,. \qquad (17.61)$$

The adjustment $\Delta RN(L,1/365)$ to the value of the charter market rate a day *RN* (1/365) determined by formulas (17.16, 17.17) by the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of use is

$$\Delta RN(L,1/365) = MV \times f_m \times (1+i)^{1/365} \times ((1+i)^{1/365} - 1)/((1+i) \times i)\,. \qquad (17.62)$$

As the size of the factor of fund of compensation $f_m$, which is a multiplicator in formulas 17.50–17.62 of the adjustment to the value of the charter market rate *RN* with the account the terms of leasing–rent contract with the redemption at the end $t_2$ of the period of vessel use, is little with enough big duration of the period of use, it should be noted that the adjustment $\Delta RN(L)$ aspires to zero and in case of the big duration of the period of use the value of the market rate for the contract of leasing $RN(L)$ differs little from the rate *RN* by the contract of rent without the redemption (with identical periodicity of payments).

It should be added that if transfer to rent with the redemption by leasing contract terms is analogue of crediting with the commercial vessel at a security for a debt (or other asset of the marine company) that is if instead of obligations on pledge the borrower sells his vessel in the leasing company and rents the same vessel with conditions of redemption, then among the considered formulas for determination of adjustments (17.50–17.62) those are suitable which take into account the advance payments.

The condition of advance payments should be taken into consideration: the first payment coincides with the time of vessel sale to the leasing company, and the leasing company pays to the tenant for vessel the value minus the first payment that is the guarantee of commercial vessel liquidity by analogy to liquidity of the pledge which value should exceed the mortgage for the value proportional to the resale discount.

If, besides, are provided the payments by equal parts and equal periodicity (that is at the constant rate by the leasing contract), the number of payments in proportion to the number received after dividing of the vessel value (or other asset of the marine company) by the value of the resale discount, and it is also possible to estimate the duration of vessel use before the redemption with the account the number and periodicity of payments.

By the way, if the market rate is determined for the rent contract with the vessel redemption in the specializing leasing company, as well as when the value is determined for the optional variant of the periodic payment for the mortgage (with a vessel as a pledge in case of borrower partial own investments or payment for the mortgage with the commercial vessel as the security of the debt) the discounting rate *i* should be accepted according to the estimation of the corresponding organization.

The general recommendations for the determination of the charter market rate value of the right of vessel or other real asset of marine company and the basic steps as sequence of the expert actions are follows:

– Analyze of the data – vessel characteristics (or other asset of the marine company) and terms of the rent contract – obligations of the parties, periodicity of payments;

– Estimate the market value on the basis of standard approaches application;

– Evaluate the right–of–use as difference between present values at the beginning and at the end of the period of use;

– Calculate the charter market rate by the formulas (17.4–17.17) on the basis of equality of the present value of rent charges and the present value of the right–of–use;

– Determine the adjustment to the value of the charter market rate by the formulas (17.19–17.32) with the account the predicted change of the value at the end of the period of use;

– Determine the adjustment to the value of the charter market rate by the formulas (17.34–17.47) with the account the obligations for the maintenance lying on the proprietor;

– Determine the adjustment to the value of the charter market rate by the formulas (17.49–17.62) with the account the redemption of the vessel (or other asset) in the end of the period of use;

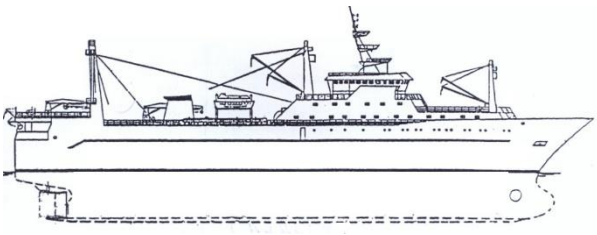
– Calculate the charter market rate with the account adjustments by the formulas (17.18, 17.33 and 17.51).

It should be taken into consideration that taxes are a part of the value of the right–of–use, the charter market rate and the adjustments determined by the recommended formulas in the same proportion in which taxes are included into the base market value.

In a more complex task of valuation of the right–of–use when the payments by the rent contract are fulfilled by non–uniform parts, for example when the tenant obligations are divided in parts of investments, if according to the leasing contract the vessel is bought on installment, and the investments into replenishment of working assets – in vessel equipment are fulfilled separately, the fractioning of estimation of the market rate of payments into the separate obligations of the tenant is recommended.

**Test questions**

1. Leasing is the commercial vessel transfer for use with the redemption.
2. Methodological analogy of leasing, the vessel acquisition (or other asset of the marine company) with payments by installments and the loan.
3. Determination of payments schedule by the contract of leasing–rent contract with the redemption or payments for the mortgage contract (the formula derivation).
4. Valuation of uniform cash flow payment by the contract of leasing (the formula derivation).
5. Determination of payment cash flow by the leasing contract if the beginning of payments period and effective date of estimation coincide (the formula derivation).
6. Conformity of economic terms of the contract of leasing–rent contract with the redemption and the contract of mortgage.
7. Data used for value estimation of the right–of–use as values of rent charges cash flow.
8. Expert tasks that should be solved to determine the conditions of commercial vessel transfer in rent provisions.
9. Recommended sequence in rent charge estimation.



# 18. General structure of the marine company's property complex of assets and the organization of the marine industrial activity

The object of the evaluation and efficiency estimation of investments is the isolated asset or property complex (business, private capital) the marine company.

In accordance with the Federal law «The Appraisal activity in the Russian Federation», July, 29th, 1998 # 135–FZ to objects of an evaluation are included: the separate material objects (property); the set of goods consisting property of the person, including property of a certain class (equipment or real estate, including the enterprises); the property right and other real rights to property or separate goods of the property set; the rights of demand, the obligations (debts); the works, services, the information; other objects of the property rights in which relation the legislation of the Russian Federation establishes possibility of their involvement in commercial turnover.

According to the developed practice the objects of sale and purchase, pledge, rent and other contracts concerning the marine companies connected with an establishment, change and the termination of property rights, and also object of appraisal usually are: commercial vessel or other real asset of the marine company, the isolated property complex, a share of the right or a share holding, the enterprise as a whole or separate property (that is the rights concerning property), identified as the structured set as a part of the operating company, and in a specific case – as a single set consisting of one asset, the separate rights or servitude, etc.

The examples of sets which can be defined methodologically as assets of the marine company:

– The marine commercial vessel of a certain purpose and the characteristics, the separate right concerning commercial vessel;

– The equipment and a real estate, including, facilities of the marine company coastal infrastructure;

– The intangible assets, including goodwill – unidentifiable part of intangible assets associated with identified assets of the marine company, including intangible or (and) tangible;

– The packages of securities and Contracts for property turnover – of the identified property rights, including personified;

– The liabilities and rights concerning certain (identified) quantity of uncertain property.

The structure of assets as a part of a property complex of the marine company is presented on the scheme

The property complex of company is defined as «all kinds of property intended for its activity, including the land plots, buildings, structures, equipment, stocks, materials, production, rights of demand, debts, and also the rights of the company to have a symbol individualizing the enterprise, its production, works and services (the company name, trade marks, service marks), and other exclusive rights unless otherwise provided by the law or the contract» (article 132 of the Russian Federation Civil code, Part 2).

The structure of assets as a part of a property complex of the marine company is presented on the chart (fig. 18.1).

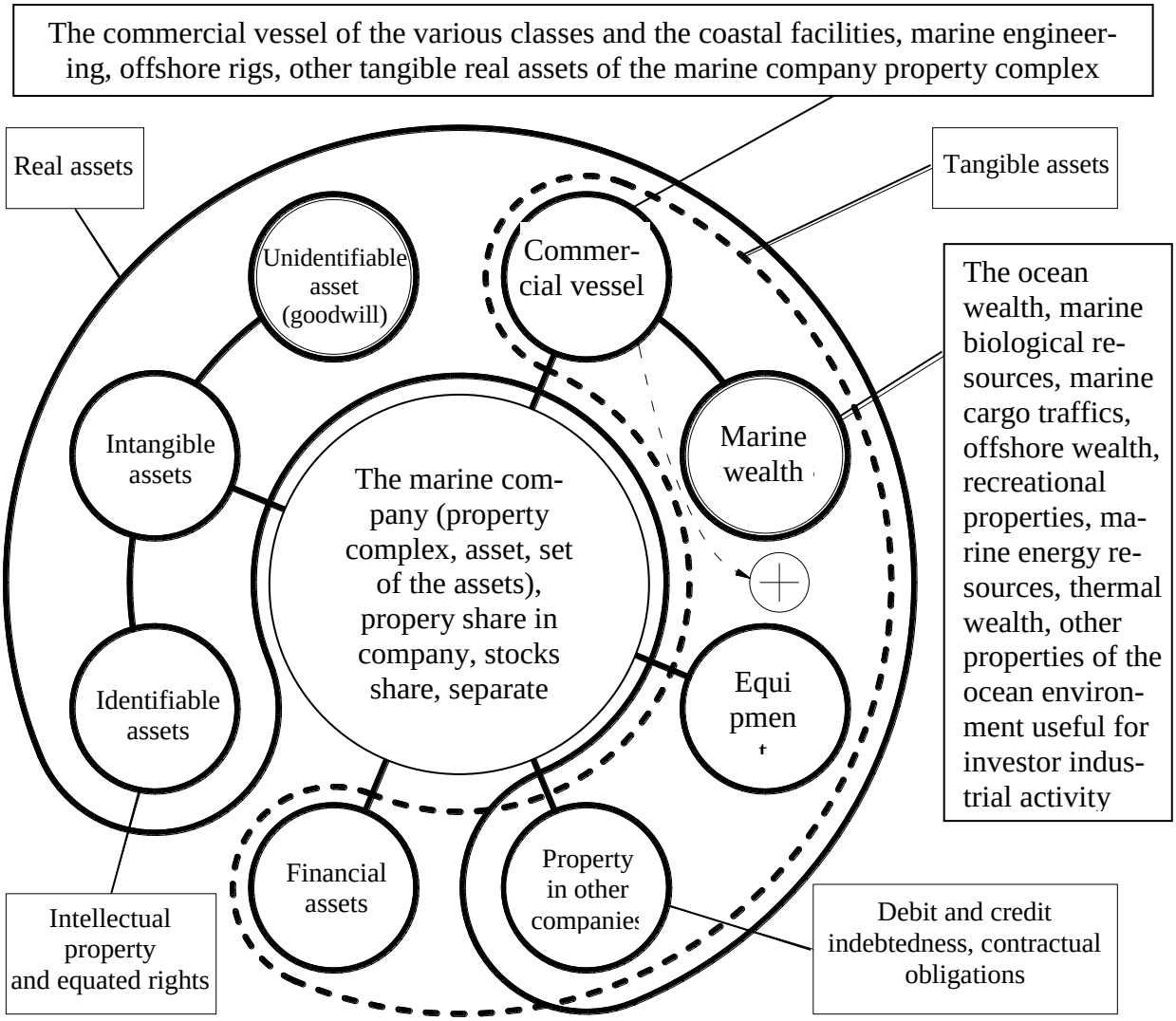
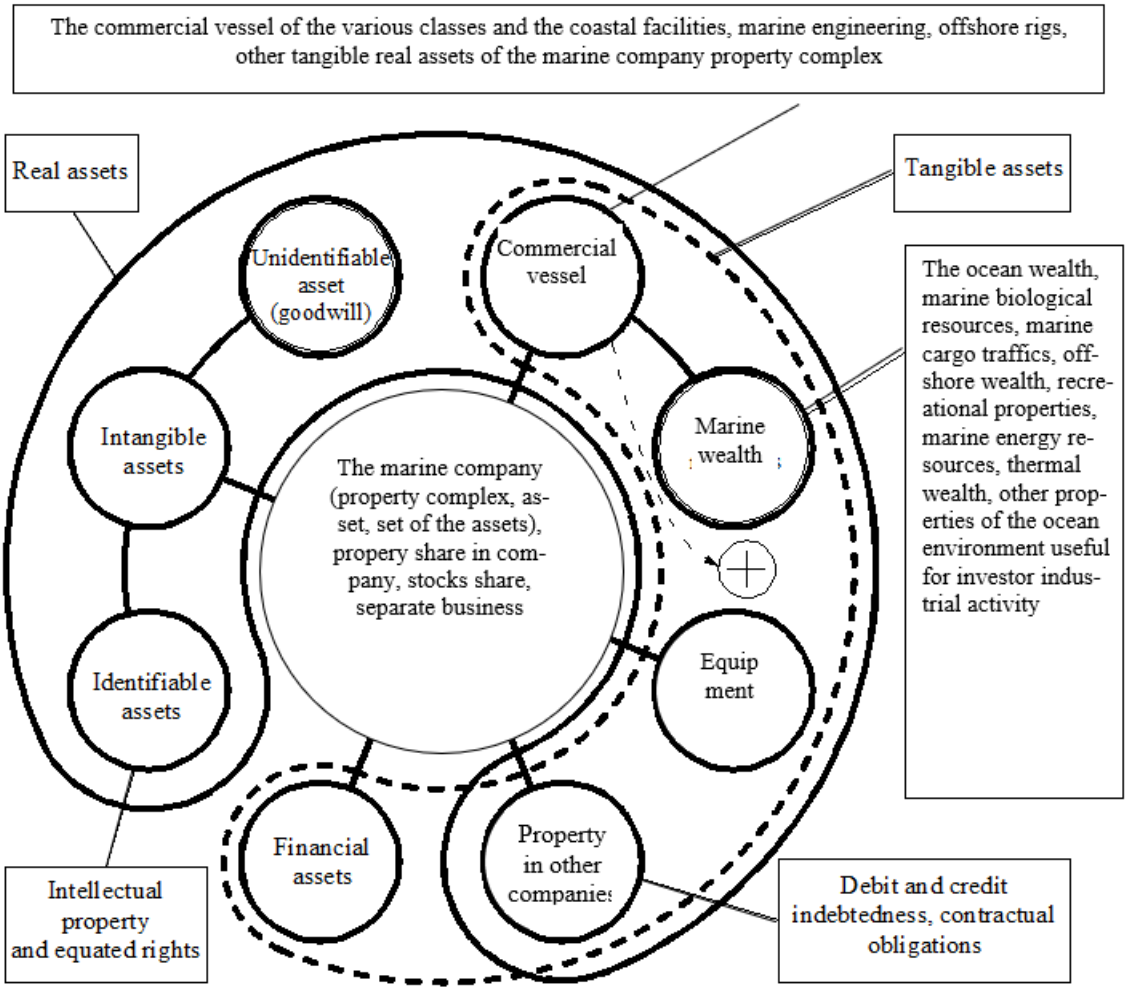



Fig. 18.1. Assets as a part of the marine company's property complex:
_ _ _ _ – outlined material assets; _____ – real assets, i.e. all assets, except for financial; – direction of investing the financial assets in the real assets carrying out the innovation part of the investment project, i.e. producing the non–identified intangible asset – goodwill and reproducing the value of the marine wealth




There is a following scheme of assets classification:

– Company (the property complex) as a form of generalization of assets;

– Financial assets;

– Marine vessels and marine engineering;

– Real estate, including natural resources;

– Equipment, devices and mechanisms;

– Intangible assets identified as intellectual property and property rights equal to it;

– Unidentifiable intangible asset – goodwill, including access possibilities to ocean resources, for example, to ocean biological resources or marine cargo traffics.

From the methodological point of view the industrial economy is a network of co–operating property complexes and general structure of each of them corresponds to the scheme. External interaction between property complexes is carried out on the basis of commercial contracts, and management and distribution inside of them has administrative character and is subordinated to interests of investors.

Assets of the marine company can be classified into the following sets: the financial assets and the real assets, the tangible and the intangible. All sets of assets are referred to real assets (tangible and intangible) except the financial.

The purpose of investing of the financial assets in sets of the marine company's real assets can be:

– Generation of unidentifiable intangible asset – goodwill which is formed as a difference between the marine company's property complex value and the sum of values of its separate identified assets that is as an added value in case of merging of real assets in structured sets – in case of gaining parts in whole, that by the formal point of view is the purpose of real assets property complex creation and the reason of its stability;

– Reproduction of the ocean resources value as difference between the value of property complex of the marine company which is the investor means of access to ocean resources and which depends on efficiency of ocean resources, and total value of investments into the marine company, that is the sum of value of financial investments and values of separate real assets.

Natural resources are a wider concept of economics, than ocean resources in aggregate properties of the marine environment which is the aim of investor's interests. The natural resources, part of which are marine resources, also include other ones, such as territories, suitable for construction, soil and agricultural productivity, minerals of subsoil resources, fresh water resources, useful properties of materials, properties of ether to transfer the information in various ranges, climatic and natural advantages in certain territories, etc.

An abstract example concerning the property complex of the company based on use of real estate is the fact that unidentifiable intangible asset and natural resources (for example, occupied sites of territory) growing in value in process of recreating of «improvements» (real estate) have in many respects the close economic value.

So, when the real estate is located in a brisk place the value advantage of the property complex can be estimated dually rather as goodwill the company using loyalty of clientele in a crowded place, or as advantages in value of real estate as a part of the property complex of the company located in an expensive site of a busy place.

The estimation of ocean resources as a part of marine company's property complex or as resources, associated with a certain real asset of the marine company, also has a close relation to unidentifiable intangible asset and is shown in the scheme of the marine company property complex structure (fig. 18.1).

The structured set of marine company's real assets has the properties which are absent in other parts – in the invested real assets taken separately. The dialectic law of transformation of quantity into quality operates here. The value of the whole set should differ from the sum of values of the parts. The value of the marine company's property complex is more than the total sum of values of separate assets for a size of the unidentifiable intangible asset – goodwill.

And bankruptcy of the company can mean exhaustion of unidentifiable intangible asset that will lead to re–structuring of the property complex and sale on assets if the sum of parts values becomes more the value of the property complex. The similiar reason – the loss of the value of an occupied territory site owing to inefficiency of the superstructure – will lead to its liquidation.

The property complex of the marine company (the definitions – «maximum» and «minimum») methodologically can be defined as:

– Set of the invested real assets and the produced unidentifiable intangible asset corresponding to the value influence of ocean resources and associated with the set of invested assets, that is as a set of the properties presented in parts, and the properties which

are arising in case of combining the parts and which are absent in parts taken separately (in separate real assets);

– Unidentifiable intangible asset in case of combining the associated with a set of the invested assets that is as the additional properties arising parts (real assets in the structure) except the properties presented in separate parts.

Concerning financial assets (sums of money as a part of a property complex) it is should be explained, that the characteristic is a nominal sum of money.

The subject of an applied economic estimation is to estimate the market value or other value of the object, that is, estimation of real assets in terms of financial assets. Thus the value of financial assets is equal to the face value.

The characteristics of marine company assets are identification signs or associative signs with identified assets for unidentifiable assets. Other characteristics are secondary; they are particulars of identification signs – primary characteristics of assets.

The investment project includes innovative and financial stages that influence the estimation of investment risks.

The analysis of the classification structure of assets as a part of the marine company's property complex (fig. 18.1) allows to define the investment projects types (or the stages of the investment project):

– Innovative project, when investment of financial assets is made in real assets of the marine company (tangible and intangible) for the purpose of value growth of the set of real assets bought separately;

– Financial investment project as receiving of financial assets in the form of profit in process of productive operation and sale of real assets.

The greatest risks correspond to an innovative stage of the investment project – an initial stage when profit is reinvested in real assets and during which the value of the marine company's property complex is rather insignificant, that is, the relation of profit to the value of the business, associated with cumulative commercial risks is great, and the value of the property complex is insignificant in comparison with the profit concerning the characteristic industrial proportions, but is characterized by growth.

At the innovative stage of the investment project the asset that has the greatest influence on the value of the marine company's property complex is an unidentifiable intangible asset – goodwill, which is an estimation of innovative strategy of the investor of ocean resources development.

The implementation of investment projects of the innovative stage in marine industrial activity, that is innovative activity, is made by joint efforts of investors, hired workers, and first of all highly skilled experts, authorities and the government.

The financial stage of the investment project on receiving of financial assets in the form of profit or in case of sale of real assets, that is the financial investment project is characterized by less commercial risks that testifies, on the one hand, the exceeding of the business value in relation to the profit, on the other hand, the smaller profit (profitableness) in relation to the capitalization of the marine company at the financial stage of the investment project.

Thus, receiving of profit in the financial form is provided at the expense of depreciation of the set of the marine company assets and transformation of a property complex in the financial form that means the tendency of industrial turning.

The specified processes lead to reduction of commercial risks and profitableness to zero, and the value of the property complex of the marine company in process of realization of the financial project becomes equal to the total sum of values of the assets sold separately.

Finally, the financial stage of the investment project usually is followed by bankruptcy and liquidation of a property complex (sale on assets) if effective management which should be capable to give a new innovative strategy is not applied and to show the investors other ocean resources available for development.

The economic estimation of the relative value of the marine company's property complex, that is of a parity of the marine company value and the values of its isolated assets, and also the value of separate functional property complexes as a part of the marine company is of interest.

The question is if it's economically more reasonable to combine selected functional property complexes in a single marine company or it's better to form property complexes as independent companies.

The advantage concerning small marine companies, whose isolated assets or separate property complexes in value are proportional to the enterprise as a whole, is that the financial result is more available to investors (participants – owners).

The practice of market reforms in Russia shows the tendency of re–structuring of the large marine companies and isolation of participants. This tendency is characteristic in case when the state doesn't take part in this process.

It should be noted that re–structuring of the large marine companies and isolation of functional property complexes to a certain extent is a progressive process of advancement of investors to the property that in reasonable limits corresponds to the increase of economic efficiency of the marine companies, property complexes and assets.

In the methodological relation the tendency of isolation of functional marine company's property complex in which structure there can be single real assets proportional in value to a property complex, in particular marine commercial vessels, is one of the reasons of the specified feature.

It should be added, that large marine companies, as sets of several functional property complexes, in spite of the fact that they are characterized by difficulty of access of investors to financial result (for example as joint–stock companies uniting numerous investors – shareholders), can be not only the result of a purposeful policy of administrations on protection of their integrity, but also the result of locally formed conditions of prevalence of demand over the supply or surplus of resources.

Usually it is not a long–term factor, so the probability of re–structuring of the large marine company therefore remains and small enterprises can be considered as steadier.

For example, opening of a prospective offshore deposit and formed surplus of resources for development can be a reason of establishing the joint–stock company which will accumulate funds by issuing shares of stocks and grow fast, though the access of a considerable quantity of shareholders to financial result of the company will be complicated.

In view of the fact, that for capital–intensive industries to which the marine companies, in particular, belong, can be characterized by the unbalanced market and the lag between supply and demand is, that, by the way, it is peculiar for shipbuilding at the beginning of the XXI–st century too there can be temporarily formed the conditions when

integration of the shipyards (or integration of the shipping companies provided that there is a great demand in transport or fishery shipping) becomes rather reasonable.

At the same time, when there is no government policy concerning support of the large innovative enterprises, small marine companies (usually in the form of limited liability companies) with separate assets in their structure, whose value proportional to the value of the whole company proved to be more stable economically.

And this is one of the most important features of the marine business underlying pricing from the point of economic methodology, along with other important features including the orientation to development of ocean resources and original system of external and internal communications: industrial, technological, functional, etc., as well as global international economic relations.

**Test questions**

1. Object of evaluation – the property complex or the isolated asset of the marine company.
2. Sets which can be methodologically defined as assets.
3. Standard definition of the property complex.
4. Classification of marine company assets.
5. Tangible and intangible assets.
6. Financial and real assets.
7. Purpose of investing the financial assets into real assets.
8. Methodological concept of the property complex.
9. Subject of appraisal.
10. Identification signs of assets.
11. Concept of intangible assets.
12. Kinds and stages of investment projects in view of classification of assets: the innovative project and the financial investment project.
13. Commercial risks at an innovative stage of the investment project with the account the capitalization of business.
14. Business value and risks in process of implementation of financial investment project.
15. Features of the marine companies underlying pricing from the point of the economic methodology.

## 18.1. International specialization in shipbuilding and shipping

In connection with global processes of technical improvement of the commercial vessels designs, accompanied by complication of technology and accumulation of assets value of shipbuilding industry, and also due to increased prices for resources and labor there is an un–surge in prices for shipbuilding manufacturing and the prices at the pre–owned market of commercial vessels. The rise in prices proceeds, despite the growth of volume of shipbuilding output and the general phenomena of crisis in economy.

According to the consulting company Clarkson Research Service, the volume of release of shipbuilding tonnage output in 2005 has reached 27.5 million CGT (Compensated Gross Tons), or 69.3 million t of deadweight.

The average size of capital investments per t of cargo vessel deadweight is 1.1 thousand US dollars that roughly corresponds 2.0 thousand US dollars per t of displacement empty.

To a greater extent these data characterize investments into construction of batch large–capacity crude carriers, bulk cargo vessels, container vessels and vessels for transportation of the liquefied gas, having the greatest total displacement and deadweight – about 95 % from total values of displacement and deadweight of marine cargo vessels.

Growth of capital investments in world shipbuilding more than twice from 2000 is caused not only by growth of the shipbuilding output, but also by general increase in cost of shipbuilding tonnage. Distribution of investments into construction of cargo vessels looks as follows: container carriers – about 36.5 % of all investments, crude carriers – 29.0 %, gas carriers – 16.0 %, vessels for transportation of bulk cargoes – 13.6 %.

In numerous researches published by the research organizations and consulting agencies show the data on the contemporary global shipbuilding market of marine cargo vessels.

The diagram (fig. 18.2) shows the dynamics annual output growth of the marine commercial vessels manufacture (according to the data of: Report on Marine Affairs. Maritime Bureau, Ministry of Land, Infrastructure and Transport, http://www.jpmac.or.jp/english/report_on_maritime_affairs/index.html.)

At the beginning of XXI century more than 90 % of marine commercial vessels tonnages are manufactured at the shipyards in the countries of Pacific Rim. The general tonnage of the vessels manufactured in Republic of Korea in 2005 is about 37 % of all world shipbuilding industry output. The second place by the manufactured vessels tonnage is occupied by Japan – 30 %, the third – by China (13 %).

The manufacture output in the European states in relation to the world output can be characterized as follows: Germany – 4.1 %, Poland – 2.0 %, Italy and Croatia – round 1.5 %, Turkey and Denmark – about 1.1 %.

The leader among the states marine manufacturing commercial vessels is the Republic of Korea. Shipbuilding orders for its shipyards in 2006 have made half of orders in the world.

Scale: one division on the scale corresponds to 10000 units of gross registered tonnage (2.832 cubic meters, i.e. 100 cubic feet)

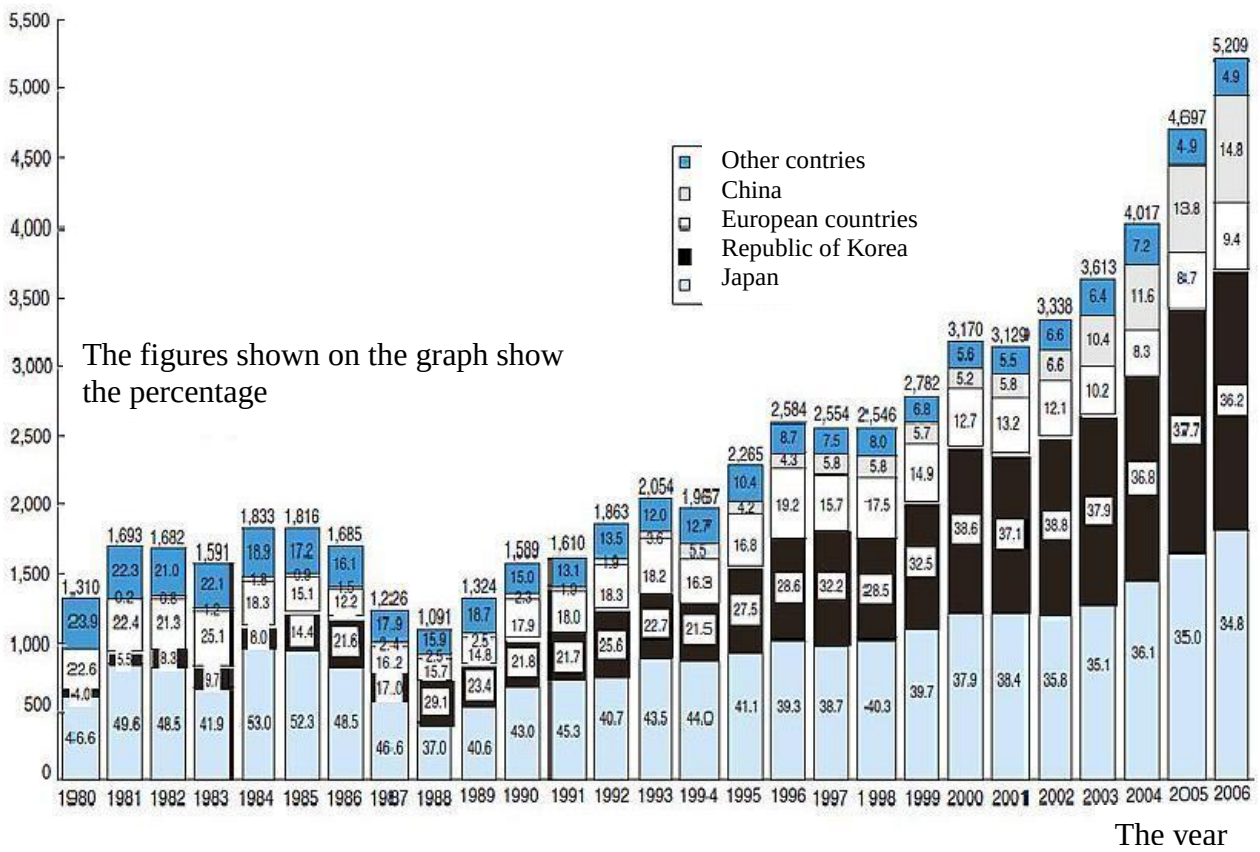



Fig. 18.2. The growth and structure of manufacturing of marine commercial vessels completed by the specified year in the world

There was a following world distribution of output the volume of in first ten shipyards (where the shipyards of the Republic of Korea occupy fro the first to the seventh places):

1. Hyundai Heavy Industries;
2. Samsung Heavy Industries, united with company–contender Daewoo Shipbuilding and Marine Engineering Co.;
3. Daewoo Shipbuilding;
4. Hyundai Mipo Dockyard – the branch of Hyundai Heavy Industries;
5. Hyundai Samho Heavy Industries – the branch of Hyundai Heavy Industries;
6. STX Shipbuilding;
7. Hanjin Heavy Industries and Construction Co.;
8. China's Dalian New Ship Heavy Industry Co., China;
9. Shanghai Waigaoqiao Shipbuilding Co., China;
10. Mitsubishi Heavy Industries Ltd., Japan.

The features of a marketing policy of the shipyards of Republic of Korea are estimated in Allen Walker's report (Allen Walker, President, Shipbuilders Council of America) at the conference Shipbuilding Decisions ' 99 in 1999: South Korean shipbuilding pricing policies. Impact on the World shipbuilding market.

The report points, that from 1994 to 1996 the shipbuilding output in Republic of Korea has tripled.

During the period from 1997 to 1999 the prices for shipbuilding tonnage for a number of classes of cargo vessels at the shipyards of Republic of Korea were established below cost. For example, the average cost of built container vessels Panamax from 1997 to 1999 decreased almost by 30 %, bulk cargo vessels Panamax – by more than 30 %, container vessels with the capacity of 1100 TEU – by 15 %, bulk cargo vessels Capesize – by 22 %.

Dumping consequences in the Korean shipbuilding are estimated as by Council of ship builders of America dramatic. The share of the market of the Korean shipbuilding companies in sphere of container vessels output has increased from 15 % in 1997 to 70 % in 1999.

The similar economic policy during rather a long period is characteristic for the industry of East Asia states.

It should be noted that before the Republic of Korea, Japan had a similar economic strategy after World War II in the commercial shipbuilding branch of industry, having superseding Great Britain from the first position.

The policy of international price competition is also typical for China in a broad industrial spectrum. In general, due to price competition, the industrially developed nations of East Asia support the positive export–import balance.

In order to hold back cheap imports and to increase export in other countries, such as in the USA and Russia can apply the depreciation of local currencies to stimulate exports as one of the measures, for example, such a measure can be a depreciation of dollar to keep the trade balance of the USA with China.

Probable consequences of such measures: reducing investment qualities of US dollar as a world reserve currency, the rising cost of energy, real estate, food products and others, the deterioration of macroeconomic indicators, and the specified effects may have a wave–like manner.

It may be noted that the characteristic national qualities of the Chinese, the Korean and the Japanese – hard work and discipline – open the competitive possibility of competition with the other states, influencing the global economic development.

Except the shipyards of the Republic of Korea the commercial shipbuilding is actively carried out by the Japanese shipbuilding companies among which are the following:

– Hakodate Shipyards, Hakodate Dock Co., Ltd., Hakodate;
– Hayashikane Yards, Shimonoseki;
– IHI Corporation, Marine United Inc., Tokyo Shipyard, Tokyo, AMTEC Aioi Shipyard;
– Imabari Shipbuilding Co., Ltd., Imabari yards, Imabari;
– Ishikawajima–Harima Heavy Industries (IHI) Co., Ltd., Tokyo;
– Kanda Yards, Kure;
– Kawasaki Heavy Industries, Ltd., Kawasaki Shipbuilding Corporation;
– Kochi Heavy Industries;
– Koyo Dockyard Co., Ltd., Koyo Yards, Mihara;
– Minami yard, Usuki;
– Mitsubishi Heavy Industries Yards, Shimonoseki, Nagasaki;
– Mitsui Engineering AND Shipbuilding Co., Ltd.;
– Naikai Zosen Yards;
– Namura Shipbuilding Co., Ltd.;

– Onomichi Dockyard Co., Ltd.;
– Oshima Shipbuilding Co., Ltd.;
– Sanoyas Hishino Meisho Corporation;
– Sasebo Heavy Industries Co., Ltd.;
– Shin Kurushima Dockyard Co., Ltd.;
– Sumitomo Heavy Industries, Ltd., Sumitomo Yards, Yokosuka;
– Toyohashi Shipbuilding Co., Ltd.;
– Tsuneishi Holdings Corporation;
– Universal Shipbuilding Corporation.

The Chinese shipbuilding companies united in the state corporation are also actively developing, for example:

– Chengxi Shipyard;
– Donghai Shipyard;
– Guangzhou Shipyard International Co., Ltd.;
– Guijiang Shipyard, Guangxi;
– Huangpu Shipyard, Guangzhou;
– Hudong Shipyard;
– Jiangnan Shipyard (Group) Co., Ltd.;
– Jiangxin Shipyard, Jiangxi;
– Jiangzhou Shipyard, Jiangxi;
– Qiuxin Shipyard;
– Shanghai Shipyard;
– Wenchong Shipyard, Guangzhou;
– Wuhu Shipyard;
– Xijiang Shipyard;
– Zhonghua Shipyard.

Besides the enterprises of East Asian region the influential shipbuilding companies and groups are:

1. A group of companies Aker Yards ASA, Oslo, Norway, the European group of companies in Norway, Germany, France, Finland, Romania, Ukraine with the separate enterprises in the South America (Brazil) and South East Asia (Vietnam), and Westamarin, Norway;

2. The German enterprises:

– Flensburger Schiffbau–Gesellschaft mbH & Co. KG, Flensburg;
– Lloyd Werft Bremerhaven GmbH, Bremerhaven;
– Schichau Seebeckwerft AG;
– Aker MTW Werft GmbH, Wismar;
– Aker Warnemünde Operations GmbH, Rostock–Warnemünde;

3. The Finnish enterprises:

– Wärtsilä Shipyard, Turku;
– Kvaerner Masa–Yards, Helsinki;

4. The Norwegian enterprises:

– A/S Fredriksstad mek. Verksted;
– Framnæs yards, Sandefjord;
– Fosen, Trondheim;
– Westamarin Building Yard.

A number of the shipbuilding companies productively operate in Great Britain, Sweden, France, Poland, Greece, Turkey, Croatia, Holland, Italy, Spain, the USA, Canada and Brazil, and also in Australia, Singapore, Vietnam, Malaysia and Indonesia.

The international specialization and cooperation are global factors of industrial development in modern shipbuilding and shipping.

The shipbuilding and shipping prospects should be predicted from positions of the investor, that is, subject of marine industrial activity and as general incentive motive to industrial development is an access of the investor to ocean resources.

The investor (in the aggregate of its qualities – interests, the rights and investment possibilities), as well as the marine environment, is an element of a complex into which marine engineering, the marine commercial vessels used by the investor to get an access to ocean resources, are also included.

In each separate case the complex in the specified structure is presented as the industrial enterprise, the part of the enterprise which can be estimated separately from other parts, or business of the several enterprises which part is the commercial vessel or some vessels.

Methodological importance of concepts «the marine company» or «property complex of the marine company's real assets» is based on repeatability of properties of these objects, that is shipbuilding and shipping industries in separate states and in the world consist of the enterprises (operating property complexes), and repeated properties of the enterprises are transformed into properties of the industries, and the heart of each marine company is the complex including the investor with incentives to get an access to ocean resources, and the engineering, mostly marine vessels.

It makes sense the joint forecast of shipbuilding and shipping prospects, as the results of the forecast are presented in many respects by the general combination of indexes: characteristics of the shipyards correspond to characteristics of constructed batch commercial vessels, and intensity of shipbuilding and concentration of the capital, finally, are determined by shipping intensity. For the specified reason it is expedient to isolate methodologically shipbuilding and shipping as a single set in order to analyze of the general prospects.

The contemporary shipbuilding and shipping are developing in conditions of world political globalization. Basic similarity in understanding of the civil society order which is created in each separate state is characteristic. Due to this reason the political borders gradually lose their importance, the capital and labor can freely transfer, the international cooperation in separate industries and in groups of industries, in science and education is developing, and, finally the states unite in the political unions. Besides partial loss of importance of political borders in the process of globalization predicted for the XXI–st century, the general world political structure is changing.

In the geopolitical relation the global society gets multipolar structure (instead of borders there are centers and directions), that is, the centers of political system located, for example, in the North America, Europe and in East Asia are created. The centers of the political systems of a global society coincide with the centers of education, science and technologies.

During the previous historical period, including the XX–th century, there were general preconditions for formation of modern world shipbuilding and shipping structure by

the beginning of present century. Preconditions can be characterized by the following factors:

– On the one hand, the greatest local concentration of the world capital in industries of commercial shipbuilding in East Asian countries – in Japan, in the Republic of Korea and in China, and also in European countries, but to a lesser extent than in East Asia, and export of the capital of the listed states to shipbuilding of other countries;

– On the other hand, the widespread distribution of the ocean resources developed mostly by industries of commercial shipping on the basis of operation of the real assets (marine vessels of different classes, fishing and others) constructed in the shipbuilding yards located in industrial centers.

And the commercial shipbuilding in East Asian countries and to a lesser extent in European countries is carried out mostly by a batch manufacturing on the basis of use of standard typical elements, and standardization is already provided at commercial vessel design stage. In other words, the modern commercial vessel is projected and made from standard typical elements.

It should be mentioned, that global distribution of ocean resources on the Earth, both with limits and outside of national jurisdictions of the majority of the states, does not coincide with the basic centers of world shipbuilding. The marine cargo traffics, the ocean biological resources, and also other resources of the ocean environment which are subject to development by industries of shipping, generally are outside the countries which carry out shipbuilding.

By the way, not all specified global centers of the modern industry are characterized by the developed commercial shipbuilding, but mostly the industrial centers in East Asia.

The basic marine cargo traffics are carried out from extensive territories in harbors of industrial centers in Europe, North America and East Asian industrial countries, having in mind cargo traffics of raw resources, and mainly the mineral oil which final users are located in industrial centers. Besides, transport cargo traffics are carried out between the ports located in global industrial centers.

Reverse cargo traffics (of resources and mineral oil) proportional in intensity in ports of departure are not provided, and from industrial centers cargo traffics in other industrial centers are made. In other words, after delivery of raw materials into the industrial centers the further freight traffic has «internal» charter between harbors of the industrial centers as the global markets of consumption geographically coincide with these industrial centers. Marine cargo traffics of goods between the industrial centers essentially are not so intensive, as cargo traffics of mineral resources and power resources from vast marine and coastal districts into the global centers.

It should be noted that the main final geographical points for marine transportations are industrial centers and cargoes are collected mostly in these points, and points of departure are distributed everywhere.

The indexes of a cargo traffic capacity considering both the amount of cargo (by weight, by a cubic capacity, by number of places etc.), and distance, for example t–miles, etc. should be used as units of measuring the intensity of marine cargo shipping. When using similar indexes the cargo traffic capacity depends on the range of marine rout which can begin and in the main part pass outside the areas of global industrial centers.

On considered indexes of cargo traffic irrespectively of the amount of transported cargo intensive shipping in industrial centers is not provided, considering the limited range

of the route within the occupied area, as industrial centers are placed locally. Thus, main sea cargo traffics are formed mainly outside of the global centers, but they are directed from the outside to these centers.

The shipping companies are inclined to be located geographically and nationally by the sources of cargo traffics. As sources of cargo traffics are located mostly outside the global centers, where shipbuilding industry is partially concentrated it is possible to view differences in respect of national identity of shipping and shipbuilding.

In particular, to locate the shipping companies the preference can be given geographically in so–called «offshore» zones, in the «convenient» countries and in those countries which possess ocean resources in abundance (countries which are sources of cargo traffics of mineral oil, are washed by the fishery seas, have a big length of a coastal line etc.), for example, in the countries Northern and the South America, in Russia, in Australia, in African countries. The listed states do not possess the developed commercial shipbuilding which level could be commensurate with shipbuilding manufacture in East Asian countries which do not have sufficient ocean resources.

In spite of the fact that most of population in East Asian countries lives in proximity to the ocean coasts, to a greater extent functions vitally thanks to the use of ocean resources (imported mineral oil extracted on the offshore in other countries, and national coastal fishery) and has the basic part of the world capital in commercial shipbuilding, it's hardly possible to say, that East Asian countries are rich with ocean resources if to correlate the amount of national ocean resources with the population or with population density living in East Asia near coasts.

The basic areas of fishery in the World ocean are the Northern and the South America offshore (for example, Chile and USA offshore), the African offshore, the seas washing the north of Europe (Norway offshore), the seas washing the Russian east coast, and also open areas of the World ocean in geographical middle widths of Northern and Southern hemispheres where the plankton from equatorial areas is taken out by ocean currents (the districts of the pelagic fishery).

It's clear, that the offshore and territorial waters of East Asian countries having the basic part of the world capital in commercial shipbuilding, although used quite intensively for the coastal fishery, they do not make the basic part of fishing grounds of the World ocean, proportional to a population of these countries and to a concentration of the capital in shipbuilding.

In other words, the basic sources of ocean biological resources to which in the national and geographical relation the marine industrial fishery gravitate are located outside the countries in which shipbuilding manufacture is concentrated, and it gives the basis to define the differences in respect of a national identity of fishery shipping and shipbuilding.

Ocean mineral deposits such as: stocks of hydrocarbonic raw materials on a offshore and mineral resources everywhere, including deep–water resources, can be referred to a number of basic objects of ocean resources which is the aim of investors activity and is a pricing basis in marine industrial activity. Besides, the basic objects are sea cargo traffics, almost half which, it is located between the Persian gulf and the Arabian peninsula offshore, on the one hand, and global industrial centers in the North America, Europe and East Asia, on the other hand, as well as ocean biological resources at coast and in geographical middle widths of oceans (fig. 18.3).

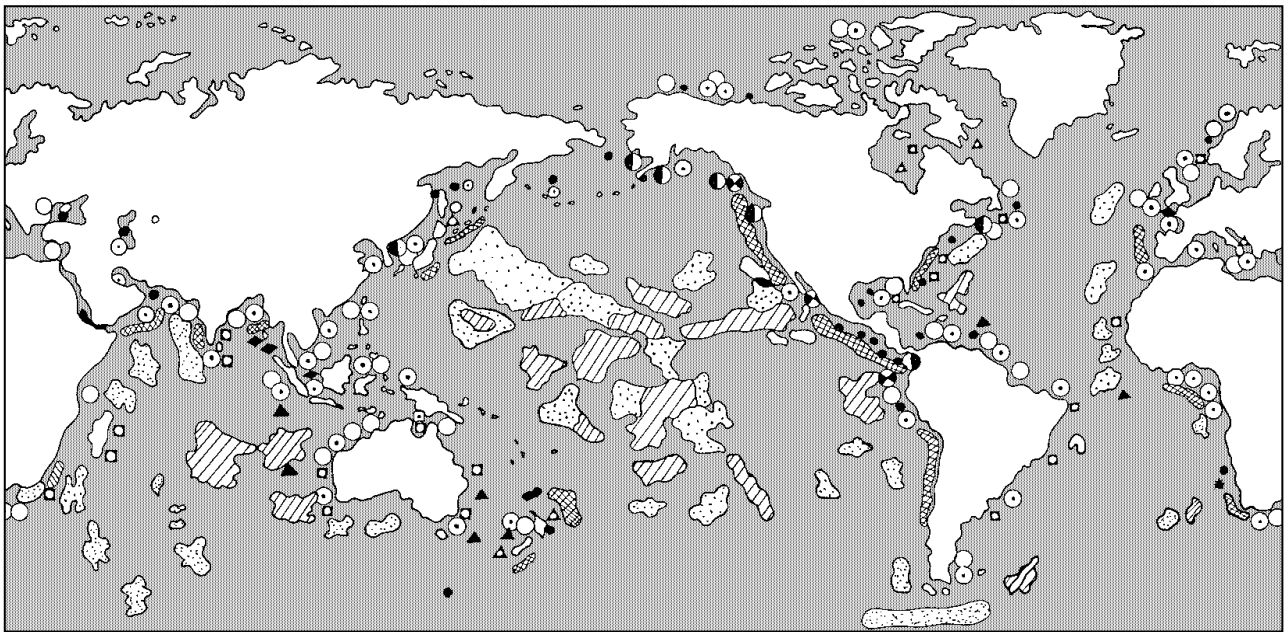


Fig. 18.3. Places of mineral deposits in the oceans:

– rich deposits of ferro – manganese nodules;
– deposits of ferro – manganeze nodules average density;
– phosphorite deposits;
– oil;
– gas hydrate;
– natural gas;
– metalliferous brine;
– placer deposits of nonferrous and precious metals

The mineral deposits are located in the World Ocean outside the global centers of industry and shipbuilding and rather distantly.

The analogical conclusions concerning the industries of offshore development have no qualitative differences. The enterprises manufacturing of the marine engineering for development of oil and gas offshore resources are concentrated in global industrial centers, for example in the southeast of the USA – along the coast of the Gulf of Mexico, and the enterprises developing the offshore resources, besides the coast of the Gulf of Mexico are extensively distributed at the coasts of the seas, for example, washing Arabian peninsula, as well as an equatorial part of South America and Africa, Alaska, Sakhalin, the coast of the North Sea.

Note, that the development for defensive purposes of naval shipbuilding, with the general tonnage of the constructed ships by 1.5 % less than commercial shipbuilding (with the account tendencies of the further reduction of the tonnage in the naval shipbuilding), is more characteristic in the USA, Russia and in the states of European union, unlike the commercial shipbuilding which is carried out mainly in East Asia, and this fact is not negation of the general conclusions about national differences between shipping and shipbuilding, referring shipbuilding mostly to East Asian countries, and shipping – to the countries, including industrialized ones, among those which possess ocean resources.

It is the development of naval shipbuilding and shipping to control the ocean resources in these countries, which less intensive than in East Asia commercial shipbuilding

that supports the general conclusions about non–uniform distribution of ocean resources and capitals of shipbuilding industries by the national identity.

It should be noted that in early XXI–st century due to a non–uniformity of distribution of shipbuilding and shipping there are no countries «self–sufficient» in these industries, that is such which commercial shipbuilding could completely satisfy the needs of shipping in domestic market and would not be export–oriented, there are no separate countries, that can develop modern shipbuilding and shipping separately from other countries, and the international cooperation is required, and the specified circumstance is the global factor of industrial development in shipbuilding and shipping.

Large–scale objects of the further and prospective development are the Arctic seas and the Southern ocean washing Antarctica. And motives of the polar seas development have basically global character.

There are no separate states interested in investing in polar shipping in areas with low density of population in the general territories, considering, that ability to live in these areas can be first of all a subject of international interests and should be carried out mainly on the basis of the international investments, instead of at the expense of separate countries.

Otherwise, that is in case of independent national investment by separate countries in polar shipping, other states which did not participate in investing, cannot be admitted to results of the development of the Arctic seas and Southern ocean in a corresponding part that will hamper both the development of the polar seas and coasts and the development of international cooperation in shipbuilding and shipping.

Thus, in the early XXI–st century the possibilities of national development of shipbuilding and shipping are generally exhausted and the international cooperation is the global factor of prospective development.

The international cooperation makes appreciable impact on stages of commercial vessel manufacturing, including designing, productive operation and even utilization.

**Test questions**

1. Causes of the growth of prices for shipbuilding production of the pre–owned market marine commercial vessels.
2. Global distribution of shipbuilding manufacturing output in relation to the national factor.
3. Features of a marketing policy of the South Korean's shipbuilding companies.
4. International specialization and cooperation as global factors of industrial development in modern shipbuilding and shipping.
5. Geographical localization of shipping companies in «offshore» territories and in those countries which possess marine wealth in abundance.
6. Geography of ocean mineral deposits.

## 18.2. Investor as a subject of the economic interests in marine industrial activity and the property rights

Generally the investment project is not carried out by one legal entity, and there is a set of interested parties. Construction and productive operation of marine vessels or other assets of the marine company is characterized by capital intensity, planned for the long period, involves to commercial risks, and carried out usually by several participants who are independent investors uniting by the terms of contracts.

Advancement of financial investments into real sector in sphere of marine industrial activity is connected with considerable commercial risks and with necessity of protection against risks that influences the value and efficiency of innovative projects.

Risks of investing should to be reduced, and the value and efficiency of innovative projects in marine industrial activity should be increased on the basis of available possibilities and first of all on the basis application of all–round and universal long–term contracts application between participants. Detailed forms of contracts are accepted in the sphere of marine commercial shipbuilding in those countries where it is developed.

Estimation of investments efficiency into commercial vessels shipbuilding (or purchase at the pre–owned market) and productive operation are made from the points of view of the investor which set of all Participants (Parties) is, generally: the Creditor, the Borrower (Buyer), the Ship–owner, the Shipyard, the Seller, the Charterer, united by the contracts:

– Between the Creditor and the Borrower of the loan for commercial vessels shipbuilding financing (or purchasing at the pre–owned market);

– Between the Shipyard and the Buyer, who is the Borrower by the contract for the loan, for commercial vessels shipbuilding (or purchase at the pre–owned market); or

– Between the Seller and the Buyer who is the Borrower, for purchase of commercial vessels (at the pre–owned market); and

– Of commercial vessels charter by the tenant – the Charterer and the Ship–owner, who is the Buyer by the contract for the vessel manufacturing (or purchase at the pre–owned market) and the Borrower by the contract for the loan; and

– Of the Charterer's participation in the business of the Buyer (the Borrower and the Ship–owner); etc.

The specified structure of the Parties is not the unconditional fact, and corresponds to a set of functions of the investor at the vessel manufacturing phases (or purchases at the pre–owned market), productive operation and utilization. The structure of the Parties can be other if those or other Parties combine various functions or functions are divided in some other way.

As the investor is an association of Participants, it is possible to determine its structure in a general way specifying the basic Participant who is the initiator of investments and has the right for the general result after fulfillment of obligations to other Participants by the contract of the loan and by the contract of commercial vessel manufacturing (or purchase at the pre–owned market).

The basic (initiating) investor, who in a system of contracts is in the centre, is the Borrower (the Buyer of commercial vessel). The initiating investor accepts commercial risks and releases the Creditor from these risks.

Shifting of commercial risks to the basic investor from the Creditor is the subject of the loan contract for financing commercial vessel manufacturing (or purchases at the pre–owned market).

The basic investor redistributes part of commercial risks to the Shipyard (or the Seller) – by the contract for commercial vessel manufacturing or by the contract for purchase at the pre–owned market.

In sphere of marine industrial activity Participants can be the legal entities registered in the various countries. For example, the Buyer (the Ship–owner and the Borrower) can be registered in the country, which fleet possesses a so–called «convenient» flag (in Cyprus, Libya, Honduras, Cambodia, Cayman Islands, Mongolia etc.), in «offshore» territories. The Seller is probably registered in the same countries where purchasing the vessel at the pre–owned market.

The shipyard generally is located in one of the East Asian countries or in Europe (in Germany, Finland, Poland etc.). The Creditor can be located at the same place (very likely, in Europe).

And the Shipyard in the structure of the investor can be presented in aggregate parts too. As the best combination of the commercial vessel price and the quality of its manufacturing usually corresponds to the enterprises located in East Asian countries (that in more details explained above), in interests of the investor there can be an implementation of a modern project of a commercial vessel, for example the European project, for shipbuilding at yards of the Republic of Korea, Japan or China.

And the Charterer can be registered everywhere. And in national reference the Charterer geographically gravitates towards the sources of the ocean resources: cargo traffics, fishing grounds etc. It should be noted that the same economic impetus is characteristic for the Buyer of the commercial vessel (the Ship–owner and the Borrower), but as a part of requirements of the Creditor to the Borrower other national jurisdiction of the Borrower can be defined.

The Creditor, determining the percent rate for the loan for commercial vessel manufacturing or purchase at the pre–owned market, aims to control the commercial risks that are the cause of the requirements of the Creditor concerning the national jurisdiction of the Borrower registration.

It is quite probable, that in order to fulfill of the Creditor's requirements the basic Participant registered in the country controlling the access to ocean resources, can establish and supervise the Ship–owner (the Borrower and the Buyer of the commercial vessel) in the country approved by the Creditor, and to operate commercial vessel on charter basis (freight) with the controllable Ship–owner. In that case the basic Participant is the Charterer, participating in business of the Ship–owner (the Borrower and the Buyer of the commercial vessel).

At the same time, if, according to the basic investor, the considered conditions influencing the structure of the co–operating Parties are not essential, the considered functions: the Creditor, the Borrower (the Ship–owner, the Buyer), the Charterer, – can be combined in one legal entity.

But if the specified conditions matter, then first of all interconnected contracts can be put in the basis of the organization of the investor as sets of the Parties:

– Contracts for the vessel manufacturing (or purchase at the pre–owned market);

– Contracts for the crediting of shipbuilding (purchase).

The economical indexes of the investor in the form of Participants association are formed at a level of the basic Participant – the Borrower (the Buyer or the Charterer –

within participation of the Charterer in a business of the Buyer) minus obligations of the basic Participant to the Creditor and the Shipyard (or the Seller).

It is the economic indexes of the investor in the specified definition that are the criteria of efficiency of investments into commercial vessel manufacturing (or in purchase at the pre–owned market) and into productive operation, as the indexes of efficiency and economic impetus of the separate Parties are subordinate in relation to efficiency estimation of the investor as an association of Participants.

By the contract for a loan for shipbuilding financing of series of vessels (or purchases at the pre–owned market) the basic object can be the share of the loan corresponding to a purchase price of one vessel, and the general size of the loan is determined by the number of the loan shares. Each share of the loan corresponds to a commercial vessel purchase price, but it is not equal to a purchase price. The share of the loan for each of bought vessels approximately can be equal 110 % of purchase price (if the need for replenishment of working assets and commission expenses to estimate as 10 %).

There is a form of the loan contract for in vessel manufacturing (or purchases at the pre–owned market) according to which the Creditor gives each share of the loan for commercial vessel manufacturing financing by three parts, and each part by the contract for the loan has its own schedule of return and repayment (with interest).

By the loan contract the vessel purchase price is approximately equal to the sum of the first and the third parts of the loan share. The second part of the loan share by the contract for vessel batches shipbuilding is intended for financing the input of commercial vessel in operation and used for return financing of first two payments of repayment of the first part of the loan share, that is, the second part of the loan share approximately corresponds to a need for replenishment of working assets of the Borrower (Buyer) – the Ship–owner or the Charterer within participation of the Charterer in a business of the Ship–owner.

The optimum combination of vessel characteristics methodologically is the only thing, therefore the vessel from a batch of the same vessels is a desirable object of investment. The vessel class is chosen from the assortment offered by the shipbuilding yard, or there is a batch production under the chosen project. The vessel choice in the offered assortment of series doesn’t contradict a widespread marketing policy not to buy «from warehouses», and serialty does not mean the absence of choice.

The serialty means repeatability of optimum characteristics which from methodological point are unique, and therefore for any set combination of data these characteristics coincide for all vessels which are, thus, the batch. In a specific case the batch can be one vessel. If other optimum vessel is built, her characteristics will be serial too.

The purchase of a serial vessel should be inconvenient at the pre–owned market of not a new vessels if they were not presented by a batch. Purchase of a serial commercial vessel does not mean absence of a choice in assortment. That is, serialty is not a negation of assortment, and the object of a choice in assortment is a batch vessel (or other assets) manufactured and bought for creation of a marine company. Serialty and assortment of optimum vessels (or other assets of the marine company) is the pair concepts defined in relation to each other.

Among the vessels–applicants proposed for construction, there should be chosen one with the optimum combination of the characteristics which should be included in the contract for manufacturing (or purchase at the pre–owned market), and the further

management of investments is made at the level of choosing the quantity of serial vessels of the same type.

Differences of the invested sums should not be considered as a methodological reason influencing the optimum combination of the vessel main characteristics, since possible difference of the invested sums influences the choice of number of the vessels of the same type proposed to be built and that have optimal characteristics, instead of to change the characteristics for one or several vessels in a batch.

For the specified reason the basic object for the shipbuilding contract is not the whole batch, but a single typical vessel. Transition to vessel batches is carried out by means of transition to series of contracts for the shipbuilding of each of the same type of vessels or by ordering a series of vessels.

The set of basic differences in the obligations in contracts for commercial vessel manufacturing and for vessel purchase at the pre–owned market concerns mostly technological conditions of Shipyard which are fixed in the contract for vessel manufacturing.

This set of differences also influences the estimation of commercial risks and the general investments efficiency, since the Seller at the pre–owned market does not take over the following works and obligations:

– Working out of drawings and specifications;

– Taking upon the obligations under the project;

– Selection of companies–manufacturers, subcontracting;

– Reception of the delivered products and materials;

– Guarantees of vessel characteristics conformity to the contract for purchase at the pre–owned market (since the vessel is bought de facto);

– Guarantees of clearing from obligations for patents and other intellectual property.

The level of commercial risks influences to the commercial vessel value and the characteristic of efficiency. The limitations of the Seller responsibility can be referred to a number of essential factors of commercial risk of vessel purchase at the pre–owned market, unlike purchase of a new vessel at the Shipyard.

The Seller of the commercial vessel at the pre–owned market, unlike the Shipyard which carries out manufacturing and sale of the new commercial vessel, is not responsible for observance of some requirements:

– Does not bear responsibility for compliance of commercial vessel properties, its mechanisms, armatures, equipment, materials and work execution with the first class shipbuilding practice in the field of manufacturing and fitting–out, equipping and furnishing of the vessels of certain class;

– Is not responsible for choice at approval of the Buyer of firms–manufacturers of the equipment, details and the materials installed onboard the commercial vessel (as though the vessel was manufactures at the Shipyard by order), for a choice of suitable methods, materials, equipment or products required during construction;

– Does not bear responsibility and does not accept guarantee obligations for the delivery of products, transfer of a part of work to contractors in coordination with the Buyer for concluded subcontracts between the Seller and subcontractors for both main and auxiliary diesel engines and generators, the propulsion installation, the gear box, the special equipment, cargo, hatch and other equipment on the main deck, at bow and aft, for the electronic and navigating systems;

– Does not accept guarantees, that manufacture conditions at the subcontract company are not worse, than at the Shipyard (if the new vessel was got at the Shipyard);

– Does not transfer to the Buyer the benefits received from guarantee obligations of any of the Shipyard subcontractors;

– Does not bear obligations of vessel manufacturing in all aspects according to the project, of the vessel project as a whole, its mechanisms, armature and equipment, accuracy and sufficiency of all aspects of commercial vessel design (as if investments were made in manufacturing of a new vessel);

– Does not bear responsibility for conformity of commercial vessel deadweight sufficiency that the vessel safely and with necessary height of a surface board could transport cargo with full filling of holds (in case of the maximum capacity) with 100 % of stocks, crew, etc. (and also 10 % of fuel and fresh water);

– Does not give guarantees of sufficient capacity (volume) of holds and fuel tanks, and also sufficient temperature of cooling of refrigerator holds and other operational characteristics (depending on a vessel class);

– Does not bear responsibility for conformity of commercial vessel operational speed and the specific fuel expenditure by the main engine.

In case of vessel purchase at the pre–owned market, unlike the purchase of a new vessel at the Shipyard, it is not provided:

– Participation of observers of the Buyer in the process of commercial vessel manufacturing and of testing of the commercial vessel during shipbuilding, and also in the process of approval of the documentation, works, materials and products;

– Quality control of defects of molding or forging, defects of other materials or the equipment irrespective of whether they are delivered by the Shipyard, its subcontractors or suppliers;

– Management of patents in a design of commercial vessel, trademarks or the copyright.

At the pre–owned market possibility of acquisition of a series of the same vessels is excluded, hence, the vessels bought at the pre–owned market, generally are various and cannot simultaneously all have the best combination economically optimal characteristics from the point of view of the investor.

For the specified reason the vessels bought at the pre–owned market, cannot be optimum, rather a certain kind of commercial risk is caused and the form of functional depreciation – lacks of design characteristics and particulars combinations of the marine vessels offered at the pre–owned market, in relation to optimum for investment combination of characteristics of new serial vessel.

The reason of the specified additional risk in case of purchase at the pre–owned market (even rather a new vessel) is not ageing which influences the value and the price of purchase too, but the difference of characteristics of the vessels offered for sale at the pre–owned market, from an optimum combination of characteristics.

Partially the deviation from optimality of vessel characteristics in case of the pre–owned market purchase and arising additional commercial risk can be to compensated by of concessions to a purchase price if the Seller is interested to sell the commercial vessel and makes such concessions.

Concessions to a purchase price in case of vessel purchase at the pre–owned market should be entered according to discrepancy of optimum combination of the main

characteristics: deadweight, capacity, operational speed, excess operation fuel expenditure or excess main engine power, considering, that the degree of conformity of operational speed to optimum speed is estimated separately. For this purpose the optimum characteristics of the commercial vessel should be preliminary estimated from economic point.

The purchase price should be estimated taking into account each of the main characteristics (concerning optimum deadweight, capacity, operational speed and excess operation fuel expenditure, etc.) in the form of concessions that is, reducing the vessel value if the vessel fails to be optimum by this characteristic, on the basis of determination of «losses estimated in advance».

The organization of commercial vessel manufacturing is rather difficult and minimization of risks is required, therefore the detailed and universal contract for shipbuilding which is usually connected with the contract for the loan, is developed. Certainly, in case of vessel purchase at the pre–owned market or at buying up of assets of the companies–bankrupts the contract is essentially simpler in structure, than the contract for vessel manufacturing.

The contract for serial vessel manufacturing, as a rule, contains the following sections (or similar):

– Description of the vessel;

– The drawings of the vessel and the specification;

– Classification of the vessel, certificates, subcontracts, obligations under the project, registration;

– Purchase price;

– Terms of payment: the first payment, the second payment, the third payment, the fourth payment, a payment by delivery, a way of payment, deposition of the first payment on the account (if the contract for vessel manufacturing is not connected directly with the contract for the loan the term of payment through deposition in the trust company can be stipulated);

– Firms–manufacturers;

– Representatives of the Buyer (ways of the customer rights implementation during vessel manufacturing);

– Changes and additions (order of);

– Vessel testing – survey by divers, lifting in dry dock, running and speed testing, the methods of commercial vessel acceptance or refusal, responsibility of the Shipyard in the case of the refusal right of the Buyer from vessel acceptance, acceptance of commercial vessel after testing and issuing Certificate about acceptance, financial guarantees of the Shipyard to the Buyer under indemnification of commercial vessel defects;

– Vessel delivery (a complete set, time and a place – geographical position);

– Purchase price updating (discounts to a purchase price on the basis of «losses estimated in advance» determination in case of deviation of vessel's characteristics from the description, drawings and the specification) by factors – delay in the delivery, the guaranteed deadweight (a conformity estimation), the guaranteed register capacity, holds volumes and fuel tanks, a deviation of operational speed, excess limit of operation fuel expenditure, etc.;

– Conditions of the maximum sum «losses estimated in advance»;

– Conditions of the refusal of commercial vessel acceptance and contract cancellation;

– Delay and prolongation of delivery term by force–majeur circumstances – the reasons of the delay, the notice about delay, the occurred delay in delivery, cancellation of the contract in view of an excessive delay;

– Fulfillment of guarantees – the guarantee engineer and experts (the procedure, the status, the rights);

– Vessel insurance during manufacturing – the degree of insurance coverage, the notification of claim, termination of the Shipyard responsibility by insurance (in case of transfer of the commercial vessel to the Buyer);

– Failure to meet obligations by the Buyer (responsibility and consequences);

– Failure to meet obligations by the Shipyard (responsibility and consequences);

– Arbitration and the Law regulating the contract, – the order of consideration; the expenses connected with arbitration; the arbitration name; the proofs accepted by the arbitration commission; the notification on the arbitration decision; the legislation and jurisdiction;

– Patents, trademarks, copyright;

– Contract transfer;

– Rights of the contract transfer;

– Taxes;

– The date when the contract comes in force;

– Notifications.

Besides private financing, credit resources for new vessel manufacturing, and also for purchase at the pre–owned market usually are involved. And construction of the vessel requires minimization of risks and use of the loan (credit) at the terms of the minimum value of extra financing.

The expediency of a loan objectively corresponds for the investment purpose. Since the best investment variant is determined by the economic criteria, for example, the best combination of vessel characteristics in the order for vessel construction or purchase at the pre–owned market the effect is proportional to the investments. That is, no matter how much private financing are provided by the investor, with the account that the innovative strategy is effective and at least is more effective than the loan, from the point of view of the investing party, private financing is not enough and the loan used in the interests of the investor raises the economic result, since the value of the investment project is more than the loan value. And also loan use bears public advantage as besides the improvement of economical indexes of the investor indexes of the partners improve too, in particular the creditor's ones.

The probable parity of private financing $MV_P$ and extra financing $MV_D$ of their shares in investments $MV_P / MV_\Sigma$ and $MV_D / MV_\Sigma = 1 - MV_P / MV_\Sigma$ with the account the total value of investments $MV_\Sigma = MV_P + MV_D$ can be determined by the model of the average weighed value of the capital.

With the account the extra capital value $i_D$, the efficiency of private financing $i_P$, determined, for example, by the internal rate of return *IRR*, and the average weighed value of capital $i = i_P \times MV_P / MV_\Sigma + i_D \times (1 - MV_P / MV_\Sigma)$ estimated for property complex or the investment project by alternative methods as a sum of risks and a macroeconomic index of discounting, the probable parity of the private financing $MV_P$ and extra financing $MV_D$

in the assumption of the conformity of the average weighed value of the capital to the valid sum of risks in considered market and industrial sector is determined, as

$$MV_P / MV_\Sigma = (i - i_D)/(i_P - i_D),\ MV_D / MV_\Sigma = (i_P - i)/(i_P - i_D) \text{ and } MV_P / MV_D = (i - i_D)/(i_P - i). \quad (18)$$

The expediency of the loan in case of investing in the innovative project corresponds to a certain proportional parity of private and extra financing which estimation by the average weighed value of the capital according to the formula (18) corresponds to the planned efficiency interest rate, the loan value, the macroeconomic index of risks and the private investments amount.

Among the most known financial institutions which actively participate in crediting of commercial vessels manufacturing, fleet renovation and replenishment, can be named the following ones:

– In the USA and Great Britain – Barclays Bank (London), Chase Manhattan Bank (New York and London), Chemical Bank (New York), Citibank (New York and London);

– In Norway – Det Norske Bank (DNB, Oslo), Christiana Bank & Kreditkasse (CBK, Oslo);

– In Germany – Shiffshipotekenbank zu Lubeck (Hamburg), Deutsche Schiffsbank (Bremen);

– In Netherlands – AMRO Bank (Rotterdam), Nedship Bank (Rotterdam);

– In France – Banque Indosuez (Paris);

– In Hong Kong – Hongkong Bank.

Usually at the heart of the decision of the loan is based on the estimation of the following conditions:

– Currency in which the loan is given;

– Amount of the loan;

– Interest rate (percent for which the loan is granted);

– Term of the loan return.

The bank (in structure of the investor) estimates the company that applies for a loan for fleet replenishment or renovating, by following four criteria (so–called 4C criteria): character – business reputation of the company; cash flow; collateral – additional maintenance; contribution – a share of private investment.

The contract for the loan for financing of manufacturing of the serial vessel (or series of certain number of vessels) or a vessel purchase at the pre–owned market usually includes the following sections (or the close):

– Definitions and explanations;

– The loan and its purpose;

– Preliminary conditions;

– Security and guarantees;

– Repayment and the loan advance payment;

– Bank interest rate for the loan;

– Compensation of expenses;

– Commission fee of the creditor;

– The commercial vessel flag;

– Disclosing of financial and other information;

– Obligations of the Parties by the contract;

– Responsibility of the parties in case of failure to carry out obligations;
– Indemnification;
– Assignment of the contract or joint participation;
– Payments, obligatory preliminary payments, requirements of reserves, adequacy of the capital;
– Notifications;
– Legislation and jurisdiction;
– Supplement to the contract for the loan – the contract for serial vessel manufacturing (or purchase at the pre–owned market).

**Test questions**

1. Structure of the Investor (the participants of the Parties) of the marine industrial activity and necessity of investment risks minimization.
2. National identity of the Ship–owner and the Charterer (in the Investor structure, with the account the Creditor opinion).
3. Expediency of the investment loan for the efficiency of the Investor.
4. Advantages of commercial shipbuilding at the shipyards of East Asian countries.
5. Sequence of investment stages since the formation of the Investor structure.
6. Characteristic risks in case of manufacture of a batch vessel and in case of vessel purchase at the pre–owned market.
7. Determination «losses estimated in advance» in the contract of vessel manufacturing.
8. Proportional parity of private and extra financing with the account the average weighed value of the capital.
9. Examples of the large financial institutions which fulfill the vessel construction and shipping crediting.
10. Criteria of estimation of a borrower by the credit institution.

## 18.3. Value and investments efficiency estimation of the marine object as a separate entity

The estimation of economic efficiency of marine object (the property complex, the commercial vessel or the asset) is possible, if the object is isolated, that is, if the marches, the object set and structure are defined.

Determination of the boundaries of the object is included into a number of system requirements and allows establishing of the external data list – characteristics of the environment of the object and characteristics of the interacting objects.

Isolation of the marine commercial vessel, that is, a possibility to evaluate vessel as a working enterprise, usually means necessity to consider the adjustment corresponding to working assets since the vessel should be equipped for the voyage, that is, the isolated object acting as an enterprise or a property complex can be an equipped vessel as a whole with working assets.

Isolation of the marine object is an integral precondition for the evaluation and investments efficiency estimation and means the following:

– Financial and property flows through the boundaries of the object of evaluation can be made only on the basis of civil–law contracts;

– Concerning the isolated object of evaluation the financial records are kept (or can be conducted);

– Financing sources are with in the isolated object of evaluation; if extra financing is used it is provided with liquidity of assets in object and cannot exceed liquid pledge; there are no sources of financing outside of the evaluated object, directed to object which would not be paid at the expense of the resources of the evaluated object;

– The financial result is formed within the isolated object of evaluation and distributed for its development in interests of the investor; there is no financing outside the boundaries of the object of evaluation in other interests;

– Concerning the isolated marine object it is possible to determine the rights of the investor – the physical or legal entity interested in increase of the value of the project (standard motivation of the investor).

While determining the boundaries of the object the part of the assets (a property complex), which within the limits of certain assumptions about the evaluation and efficiency estimation of investments from the economic point of view can be considered irrespective of other part of property, should be selected.

The isolated marine object – the commercial vessel, the property complex or the marine company as a whole, as a typical assumption in applied expert studying, is evaluated separately from other property (assets).

Other property is considered as a means of additional security (guarantees) in the course of the investment activity directed for fleet renovation, branch activity (transport, fishery or other shipping) and financial activity of a profit capitalization in the course of branch and investment activity which is used further for investment activity, that in aggregate with replenishment of resource base – with development of cargo traffics or quotas for ocean biological resources development – leads to maximization of the property complex value.

The models of the evaluation and efficiency estimation of investments into real assets of the marine company – in fleet renovation and replenishment – is carried out with the account financial constrain of the investor. Within the limits of financial constrain it is supposed, that any investments from the outside are not received, except accumulation of the profit within the limits of the isolated object of evaluation in the process of fulfillment of branch activity and investment activity.

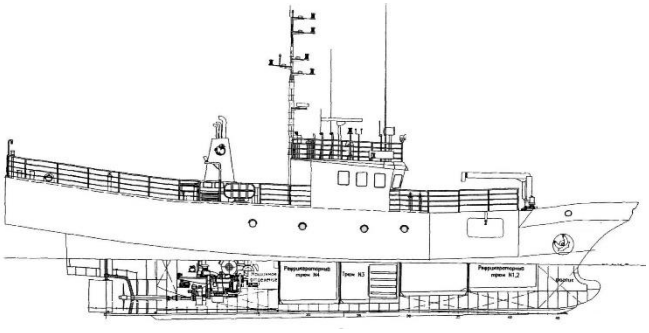
Besides, within the limits of financial constrain it is supposed, that financial assets are not spent over the limits of the isolated object of evaluation – an asset or a property complex, and capitalized in the monetary form for investing in object.

To estimate financial constrain real assets should be evaluated as a part of the property complex. It should be taken into consideration, that if extra financing are used for fleet renovation and replenishment, then the loan is determined with the account the value of assets in the pledge as a part of the property complex, or with the account the factor of a cash flow according to property complex estimation, i.e. also in interrelation with the assets value.

So the use of the loan for fleet renovation and replenishment is not a negation of financial constrain of the investor which is an important methodological precondition for investment planning, and prospective extra financial assets, with the account the liquidity of the loan, are proportional to the value of assets collected earlier as a part of the property complex of the marine company.

**Test questions**

1. Determination of the boundaries delimitation of the evaluated object as a system precondition of the evaluation and economical efficiency estimation.
2. Isolation of the commercial vessel as an object of an evaluation when making adjustment to the working assets value.
3. Conditions of the economic isolation of the object of evaluation.
4. The limitations of the commercial vessel value and efficiency estimation and replacement of the rest part of the property complex with the adjustment to vessel evaluation.
5. The financial constrain of the investor in the process of investments planning (when estimating the value and efficiency).



# 19. Methodological approaches of efficiency estimation of the investments in marine industrial activity

In the marine industrial activity the estimation of investments efficiency as the business planning element is made mostly with a view of attraction of investors and the venture capital for serial vessel manufacturing (or vessel batch) or for manufacturing of another real asset of the marine company, and also for purchase at the pre–owned market.

The evaluation of investments efficiency is an integral task in the sphere of applied economics, since the value estimation and efficiency are pair dialectic categories: value is defined in relation to efficiency and vice versa, and thus any subject of applied economics is directed to the value or efficiency determination.

And more, in some subjects the value and the economic efficiency are interchangeable concepts. So, the value of investments (that is the characteristic index of a sum of money for which the investments are bought), for example, the loan value, can be defined by the interest rate which, on the other hand, is the characteristic of investments efficiency.

In this sense the concept of appraisal activity is a synonym of applied economics that is a scope of economic laws in the subjects of investment planning and expertise, unlike the theoretical research economy aimed at studying the economic laws.

The systematic approach is used as bases of methodology of efficiency estimation. The marine industrial object estimated in view of evaluation or efficiency is considered as a complex system, that is, a kind of a system which can not be evaluated, other than the structure consisting of subsystems.

And the marine industrial object estimated as a complex system consisting of subsystems, possesses the properties which are present in separate subsystems, and the new properties arising when combining subsystems in the structure of the marine industrial object.

For example, if to present a marine cargo vessel figuratively as a structure of two elements: the hull characterized by the property of tonnage (among other properties), and the ship main engine characterized by power, then the combination of these elements gives a new property – carrying capacity, which absent in the specified separate parts of the commercial vessel.

This a new property arising when combining of subsystems in a structure of marine industrial object that has the basic value in tasks of evaluation and economic efficiency estimation.

According to it the marine industrial object can be defined at two levels of generalization as a whole:

– Definition «maximum» as a set of all inherent properties, including presented in subsystems and arising when combining subsystems (continuing a figurative example concerning a marine cargo vessel: as a set of carrying capacity, tonnages and the of the ship main engine of the vessel);

– Definition «minimum» as new properties (for a commercial vessel – carrying capacity), arising when combining of subsystems and which are absent in the subsystems estimated separately.

It should be noted that for commercial vessel the new property arising when combining the subsystems is usually connected with estimation of developed ocean resources: for the cargo vessel – the cargo traffics which when combining the subsystems of the cargo vessel are developed per formed property – the carrying capacity.

For the fishing vessel a new property, this arises when combining the subsystems, can be the productivity of ocean biological resources development. Examples can be continued concerning other kinds of marine industrial activity: development of deposits at offshore and also deep–water deposits, in the field of marine hydraulic engineering building, the mariculture, the water–power engineering etc.

Concerning property complex of the marine company, a new property arising when combining of real assets in a structured set, is a group unidentifiable intangible asset – goodwill estimated as advantages in access to resources and the purpose of innovative investment of financial assets in real assets which thereby at least corresponds to definition of a property complex.

On the basis of the systematic approach for the evaluation and efficiency estimation of the marine industrial object which is of the complex structure, the presence of a more general object is dialectically defined where the estimated object is a part of this structure.

Thus, the multilevel hierarchical system of objects of estimation is a consequence of marine industrial object complex structure at each level.

The investment planning of the marine industrial activity is evaluation of economic efficiency and a choice of optimum innovative strategy (in particular, optimum vessel characteristics in the order and quantities of vessels in a series) among comparable variants of investment. Thus, the concepts of investment variants comparability necessary for the economic evaluation are based on the systematic approach. It is impossible to compare, let us assume, a commercial vessel and a shipping company and to evaluate them by economic criterion (for example, by the profitability) for the purpose of a choice of the best variant of investment.

The marine industrial objects on case of estimation of variants efficiency of investment should be comparable, should be similar in everything, except the estimated differences. And the estimation and the choice among non–comparable variants of investment should be the methodological error.

From the point of the systematic approach view methodologically similar objects evaluated in the structure of a more general object that is for comparability of innovative strategy variants it is required to determine what object is more general among other marine industrial object for all compared variants estimated by the efficiency index.

The algorithm for comparison of variants is based just on identifying the most general marine industrial object. Characteristics of a more general object are initial data (limitations) for estimation of efficiency of investments.

For example, in order to choose the optimum vessel characteristics for commercial order among the vessel of the same cargo line the variants of marine commercial vessel with different characteristics should be compared by the economic criterion. Thus the comparison of variants on the basis of estimation of their efficiency indexes should be carried out in the structure of an identical more general object, in particular the marine

cargo traffic with the account its intensity, extent, standards of transport service, characteristics of cargo base etc.

**Test questions**

1. Purposes of efficiency estimation of investments into assets and the property complex of the marine company.
2. Methodological proximity and interchangeability of the concepts of value and efficiency.
3. Systematic approach as basis of economic methodology.
4. Vessel, as a probabilistic system in a structure of subsystems.
5. Methodological definition of marine industrial object in the aggregate of its properties.
6. Properties of commercial vessel connected with developed marine wealth.
7. System definition of a more general object in relation to the evaluated one.
8. Methodological comparability of marine industrial objects.
9. Characteristics of a more general object as initial data for a comparative evaluation of options.

## 19.1. Economic indexes and the efficiency criteria of a commercial vessel or any other marine company asset

To estimate investment estimation for renovation or replenishment of commercial vessels fleet, and also to choose a new–building vessels or to estimate investments efficiency for the construction of other assets of the marine company the following economic criteria are usually applied:

*DCF* – discounted net income (discounted cash flow), the present value of the cash flow of net operating income;

*NPV* – net present value (newly reproduced value), corresponding to the difference between values of the marine industrial object and investments into the object;

*IRR* – internal rate of return, as the relation of profit to investments usually minus an index of rate of consumer price index gain (predicted «rate of inflation»);

$T_R$ – payback period of investments outlay – the economic index dependent on internal rate of return *IRR*, $T_R = 1/IRR$.

The index of internal rate of return *IRR* is equal: $IRR = NOI / (MV+OC)$.

The criteria of efficiency of the commercial vessel, other real asset or property complex of the marine company are estimated the basic economical indexes which are not reflecting critical judgments of the investor and therefore are not criteria of a choice when comparing investment variants.

The following indexes can be referred to basic economical indexes used for estimation of investment efficiency: the annual income *I*, the operation costs *C* (the annual operation prime cost), the investments which correspond to the sum of value and working assets *MV+OC* (or *RC+OC* – for the variant of investment in manufacture of a new asset of the marine company).

The value of investments *MV+OC* for use as a part of efficiency criteria is usually determined by the comparable sales approach or cost approach as a value estimated based on income approach in the sum with the working assets corresponds to the discounted cash flow *DCF*.

Thus the criterion of the net present value *NPV* is a dependent index on discounted cash flow *DCF*:

$$NPV = DCF - (MV+OC). \tag{19.1}$$

Estimation of comparative variants of investment in real assets of the marine company a certain order of preference corresponds to each of economic efficiency criteria.

In particular, the criteria of discounted cash flow *DCF* and net present value *NPV* as well as internal rate of return *IRR* are maximized, and the variant of investment in real assets of the marine company (the best variant of a commercial vessel for manufacture, namely, a combination of vessel characteristics, or the best variant of an asset for manufacture or acquisition, etc.) with the maximum value of applied criterion from the set: *DCF*, *NPV* and *IRR* is used.

The investments payback period $T_R$ from the point of preference is a minimized criterion.

It should be noted that under the theory of capital investments efficiency the economic criteria which are economic evaluations in the macroeconomic environment are usually referred to indexes of general efficiency namely they show, which is better: to invest in evaluated real asset of the marine company or to search for the alternative option for investing. And the economic criteria which characterize which comparable options of the marine company assets are better referred to the indexes of the relative (comparative) efficiency, though the estimation in relation to a macroeconomic environment is not.

Usually the criteria of comparative efficiency are estimated in monetary units and general efficiency indexes by the relative value, in percentage or in time units (as, for example, a payback period of investments).

Indexes of general efficiency in case of comparability of investment options in real assets of the marine company also characterize comparative efficiency.

Among the criteria specified above, indexes of comparative efficiency are: the discounted cash flow *DCF* and net present value *NPV*, and efficiency indexes are the internal rate of return *IRR* and a payback period of investments $T_R$ depending on internal rate of return.

In the broadest sense the indexes of economic efficiency in the form of the net present value *NPV* and internal rate of return *IRR* are independent and it is impossible to replace unequivocally the criterion of net present value with the criterion of internal rate of return, as in case of such a replacement of criteria. The index of investments (*MV+OC*) also should be considered additionally:

$$NPV = (IRR / i - 1) \times (MV+OC). \tag{19.2}$$

At the same time, as the macroeconomic index of risks in the form of the discounting rate *i* is as initial datum in case of efficiency and value estimation, that is, it is known before the estimation of criteria *DCF*, *NPV* and *IRR* or $T_R$ and investments (*MV+OC*), and if to estimate the criterion of the net present value by the relative value – in relation to investments *NPV* / (*MV+OC*) – as a general efficiency index, then the criteria of net

present value and internal rate of return *IRR* could be re–determined by each other as similar evaluations *NPV* / (*MV*+*OC*) = *IRR* / *i* – 1.

The criteria of efficiency from among considered above have in many respects close economic sense and are based on indexes of income *I*, net operating income *NOI* and profit *p*.

The methodological sense of criteria considered above depends on assumptions and data in applied tasks of the evaluation and efficiency estimation of investments, and also on the level of object generalization, with the account, that the object is not only a set of physical (technical) characteristics and properties, but also a certain structure of the investor's interests, rights and obligations.

In particular, the net present value is equal to a difference between the asset value and the costs (the value of investments into the asset), and this definition is pertinent, if the investor is a buyer, that is, if the estimation of investments efficiency is made from the point of the buyer's interests. In other case if the investor is a seller (or an owner) its investment costs correspond to the asset value. And in both cases it is a question of estimation of the same asset, by the same criterion, but from the points of view of various investors.

On the other hand, in case of a certain combination of preconditions the economic criteria *DCF* specified above, *NPV*, *IRR* and $T_R$ can be to a certain extent the similar efficiency estimations.

Among the four specified above criteria based on estimation of the income, the net operating income and the profit which are indexes of marine company real asset (or innovative strategy) efficiency: *DCF*, *NPV* and *IRR* or $T_R$, the independent indexes of efficiency usually are two of them taking into account the definition of independence, mostly as applied property concerning their ability of data account and characteristics of marine company asset for various available models, techniques and expert estimations.

By the way, in applied economics the efficiency criteria which are not based on indexes estimation of income *I*, net operating income *NOI* and profit *p*, but created taking into account the minimized expenses are also known (Chapter 22). However preferences of investors are largely adhered to application of the criteria determined with account of income, net operating income and profit.

The elements of efficiency criteria are investments by the asset evaluation (*MV*+*OC*) according to the professional standard «Market value as a base of evaluation» and the investment value defined proceeding from asset profitableness for a definite entity with the preset investment purposes that corresponds *DCF*.

The index of discounted cash flow *DCF* from the point of view of prospective profitableness (under the formula 19.1, combining a reference mark with the date of an estimation of the discounted cash flow and estimating life time starting from this date) can be counted as the sum of the discounted net operating income *NOI* flow shifting in time *t* as

$$DCF = MV_3 + OC = (1+i)^{1/2} \times \sum_{t=1}^{T} \frac{NOI_t}{(1+i)^t} + \frac{Rv}{(1+i)^{T-t}} . \qquad (19.3)$$

Besides, for the estimation of the discounted cash flow *DCF* in case of constant in time net operating income *NOI* (invariable in the prices of the estimation date) the method of direct capitalization can be used

$$DCF = MV_3 + OC = NOI / R. \quad (19.4)$$

Thus, investments *MV+OC* which for commercial vessel as a part of shipping company's property complex correspond to the sum of the value *MV* and the working assets *OC*, are determined on the basis of cost and comparable sales approaches as

$$MV + OC = a \times MV_1 + (1 - a) \times MV_2 + OC, \quad (19.5)$$

where $a$ – the weighing factor; $MV_1$, $MV_2$ – the value indexes estimated on the basis of cost and comparable sales approaches when determining efficiency; $MV_3$ – the value estimated based on income approach.

This criterion of investments efficiency in the form of the net present value *NPV* for a commercial vessel or other asset as a part of the marine company's property complex can be estimated as

$$NPV = MV_3 - a \times MV_1 - (1 - a) \times MV_2. \quad (19.6)$$

It is clear, that the efficiency criterion in the form of the net present value *NPV* is based on the difference between the value of investments «in the future» $MV_3$ estimated accounting to the forecast of the prospective profitableness, the values «in the present» $MV_2$ (with share weight 1–*a*) determined in comparison with analogues, and the value of investments «in the past» $MV_1$ (with share weight *a*) determined in a retrospective based on cost approach on the basis of «cost accumulation» concept.

The dependences of the economic criteria of the internal rate of return *IRR* and the net present value *NPV*, illustrated as an example for optimum displacement choice for investing in the manufacture or purchase of a new fishing vessel of batch, are presented on the charts (fig. 19.1, 19.2).

The investments evaluation *MV+OC* is an economic limitation. Thus, the efficiency criteria of investments: the net present value *NPV*, the internal rate of return *IRR*, – are in economic dependence on investments *MV+OC*.

The criterion of the net present value *NPV* is better reflects prospective profitableness of a commercial vessel or other asset as a part of the marine company's property complex, more exactly, prospective benefits for the investor, and the criterion of the internal rate of return *IRR* – present benefits.

In case of the two independent maximizing criteria there is a problem of their «weighing», in other words, their coordination as a part of the generalized criterion. To coordinate the independent criteria of economic efficiency with identical order of preference (maximization or minimization) it is necessary to bring the independent criteria to a general dimension and to estimate the degree of importance of each of them.

The following parity for generalization of independent particular maximizing economic criteria of the net present value *NPV* estimated by the relative value *NPV* / (*MV+OC*), and the internal rate of return *IRR* as a part of a complex criterion is recommended

$$IRR + i \times (NPV / (MV+OC) + 1). \quad (19.7)$$

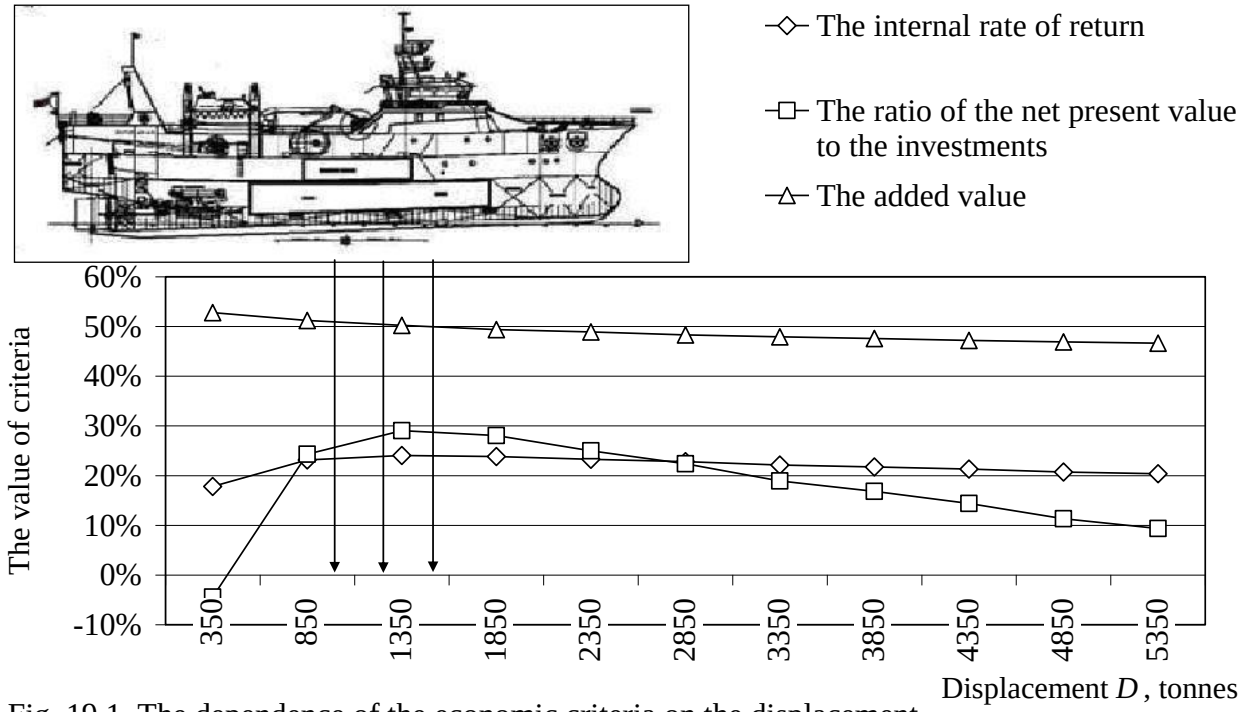



Fig. 19.1. The dependence of the economic criteria on the displacement of a new fishing vessel

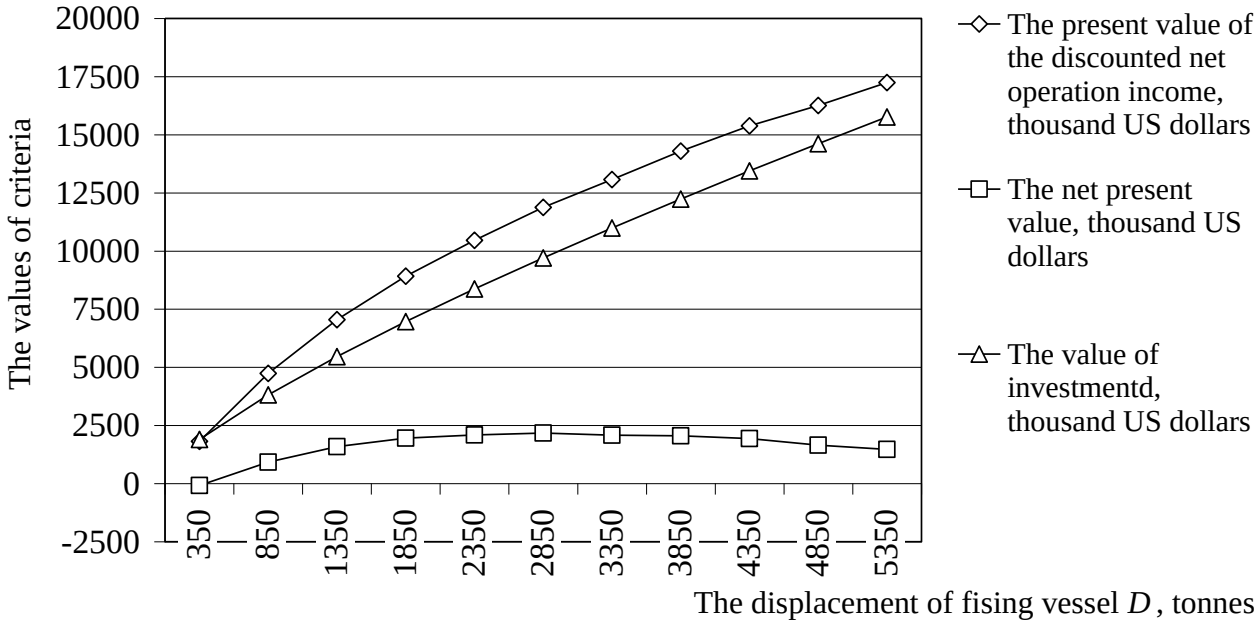



Fig. 19.2. The dependence of the discounted net operation income value, the value of investments and the net present value on the displacement of a new fishing vessel *D*

The dependences of the economic criteria of the internal rate of return and the net present value from years of the fishing vessel planned to be purchased at the pre–owned market, and also the dependence of the generalized criterion (under the formula 19.7) are presented on charts (fig. 19.3).

As an additional index of investments efficiency, if the criteria of the internal rate

of return *IRR* and net present value *NPV* do not give the chance to make exact choice among comparable variants of investment (vessel characteristics in the order or other asset as a part of the marine company complex, options of innovative strategy), that is, to specify the results among the limited quantity of the options chosen by the specified indexes of efficiency, it is possible to apply the additional criterion which should be formulated on the basis of alternative judgments about economic efficiency.

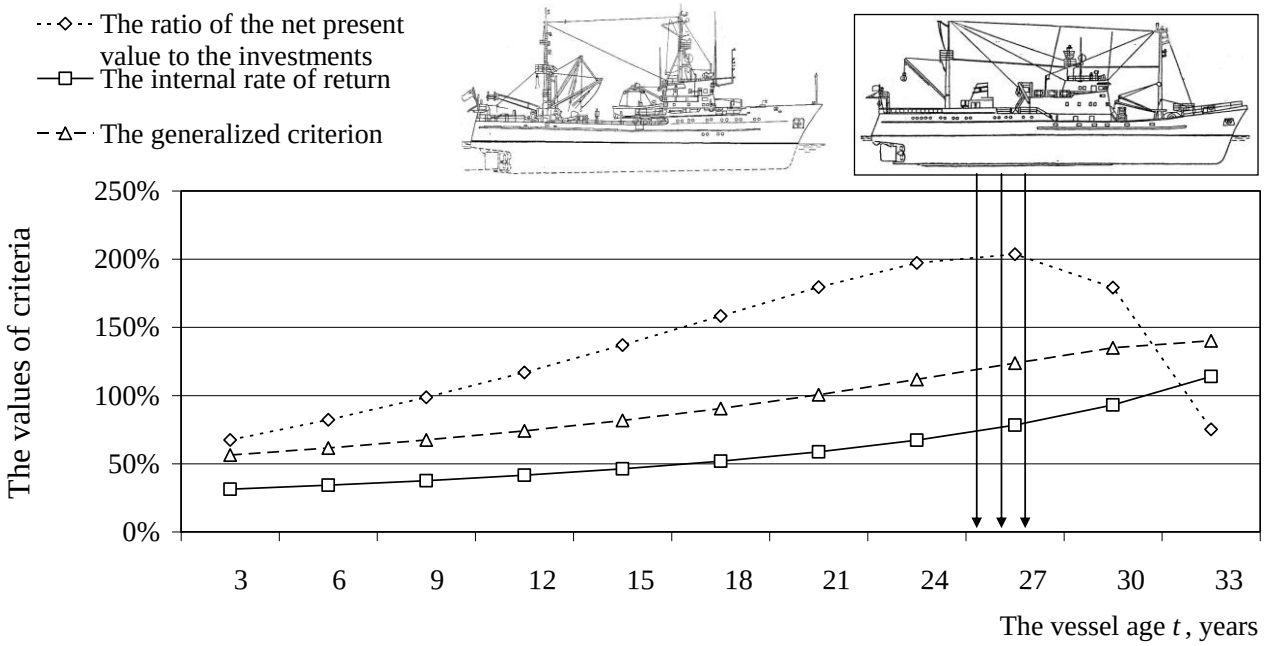



Fig 19.3. The dependence of the economical indexes on years: the internal rate of return $IRR$, the ratio of the net present value to the investments $NPV/(MV+OC)$ and the generalized criterion $IRR+i\,(NPV/(MV+OC)+1)$ on vessel age

For example, in order to determine the vessel's optimal characteristics it can be recommend applying the value added index as an additional (specifying) criterion which can be determined using commercial vessel economic models as

$$I - C + C_{CR} + C_{FED} + C_{EXP} + C_{SOC} + C_{MM} + C_{DS},$$

or to evaluate this index relative value as a part of manufacturing or services value per unit of income

$$(I - C + C_{CR} + C_{FED} + C_{EXP} + C_{SOC} + C_{MM} + C_{DS}) / I, \text{ or}$$
$$(NOI + C_{CR} + C_{FED} + C_{EXP} + C_{SOC} + C_{MM} + C_{DS}) / I, \text{ or } (NOI + \sum C_{NC}), \qquad (19.8)$$

where $\sum C_{NC}$ – the sum of the operation costs terms related to the added value according to manufacturing or services (except services of the contractor companies, material expenditures etc.) estimation.

**Test questions**

1. The economic index of the net discounted income.
2. The economic criterion of the net present value.
3. The criteria of the internal rate of return and investments payback period.

4. The basic economic indexes which are not criteria.

5. The approaches used in investments evaluation for determining the economic criteria.

6. The criterion of the commercial vessel net present value from the point of the parties – the buyer and the seller.

7. The independence in the combination of indexes and the criteria of the net present value, internal rate of return and investments.

8. Estimation of the value of investments of the property complex as a starting limitation for assets accumulation and capitalization.

9. The dependence of economic efficiency criteria on investor's financial constrain.

10. The reflexion of the present and prospective profitableness by the criteria of internal rate of return and net present value.

11. The recommended parity of the net present value criteria and the internal rate of return in the structure of the generalized criterion.

## 19.2. Determination of cargo vessels characteristics for the commercial order based on example of ferries for Pacific transportations

Further the vessels with horizontal loading (rolling cargo, ferries) are considered as an example of the comparative estimation of options, comparisons by economic criteria and the choice of cargo vessel in the commercial order with the account comparability.

Rolling cargo vessels with horizontal loading – ferries and RO–RO (roll on – roll off) can be used for transportation trackless or rail cargoes. In the second option usually the vessel is multipurpose, that is, she serves for transportation both rail cargoes and trackless ones.

Despite the big specific cubic capacity of the cargo and the tonnage, rolling cargo vessels in shipbuilding terminology are low–board in view of the main deck arrangement of transverse water–proof bulkheads since the cargo premises are continuous along the vessel.

Available in information databases projects of rolling cargo vessels offered for manufacturing and sale can be presented with the account the nomenclature of structural options:

1. The marine passenger–and–freight ferries for average and long distances transportation. The propellers are placed in the aft peack, the superstructure is along the vessel length, and the engine room is in the aft. There is a full or a rather considerable quantity of cabins on board the vessel.

2. The marine passenger–and–freight ferries for transportation at small distances. Passengers take places mostly in salons; there is a small amount of cabins. The propellers are in both peaks. The vessel is symmetric concerning the midel–frame.

3. Rolling cargo vessels with horizontal loading RO–RO differ from ferries where places for passengers are not provided (or only few places or cabins are provided). The superstructure is located at the fore or aft parts, the engine room – in the aft part.

The closest class of vessels to rolling cargo vessels with horizontal loading RO–RO by the project are the deck car ferries manufactured and operated for transportation of

large lots of cars without passengers (or with the minimum facilities for passengers transportation), for example for transportation of new cars from enterprises for sale.

4. High–speed marine passenger–and–freight ferries one–hull and multihull may conceptually be projected as two–regime and depending on loading to be operated as in displaced mode with economic speed from 15 to 25 knots, and in high–speed mode (from 30 to 40 knots) – for transportation cargoes of the big cubic capacity and small specific weight, that is with less loading.

The further development of the concept of high–speed marine passenger–and–freight ferries vessels are the cushion–crafts or wing in surface effect ships (wing ships) which are an intermediate link between the ferry and a seaplane by the design. Structural similarity to the ferry is that the ramp is also used for loading–unloading, and a cargo premise is continuous along the vessel length.

As there are structural analogies of marine vessels and planes (and even there is a well known fact that the construction of planes started from the first «Boeing»– a seaplane), it is possible to consider, that among commercial vessels the closest structural analogues of planes are vessels with horizontal loading (marine passenger–and–freight ferries and RO–RO). And high–speed ferries can be equipped with a power–plant with gas turbines, entirely or partially made of aluminum alloys that prove analogy.

Concerning designing of vessels, comparisons of options and choice of characteristics it should be mentioned the contribution of professors: V.M. Pashin, B.A. Tsaryev, A.N. Vashedchenko, G.F. Demeshko, I.G. Zakharov made to the development of systematic approach methodology. Unlike the majority of their works the basic part of the given book is devoted to economic concepts which should be used in vessels and marine engineering designing, as well as in process of the formation of the structure of marine company's property complex, that is, for dealing with of financial assets innovative advancement in the ocean industry.

The first step for a comparative estimation is the formation of the set of compared so that, keeping to similarity and system concepts of comparability the compared variants for determination of vessel characteristics for the order should have sufficient distinctions which must reflect the variety of the investor's possibilities. At the same time, compared options should cover all the basic alternatives.

To estimate efficiency of investments by the economic criteria of internal rate of return and net present value the following variants of new marine vessels with horizontal loading are compared.

*Variant 1*. Concerning the possibility of commercial vessel purchase at the pre–owned market the marine twin–screw passenger–and–freight ferry «Amelia» constructed in 1989 (the shipyard of Sunderland, converted in 1997 at the shipyard in Greece) is analyzed.

*Variant 2*. The commercial vessel with horizontal loading RO–RO with the container capacity 397 TEU constructed in 1985 with an ice class 1A (shipyard Rauma–Repola, Finland).

*Variant 3*. The marine passenger–and–freight ferry offered for construction at enterprise Flensburger Schiffbau–Gesellschaft mbH and Co. KG, Flensburg, Germany.

*Variant 4*. The commercial vessel with the horizontal loading RO–RO 5200 (5000), offered for construction at Flensburger Schiffbau–Gesellschaft mbH and Co. KG.

*Variant 5*. High–speed marine passenger–and–freight one–hull ferry offered for construction by the project of the company Tenix Defence Pty Ltd project, Marine Division, Australia.

The specified five possible alternatives cover a range of modern functionally comparable vessels which are estimated at the cargo traffic between continental the coast of East Asia and Japan.

To make comparative estimation of options, the comparisons by economic criteria and to make a choice of rolling cargo vessel for the commercial order it is necessary to execute a complex study and to solve a number of tasks, among which are:

– Analysis of development prospects of marine cargo traffic between Japan harbors and the continental part of East Asia;

– Analysis of investment risks into passenger–and–freight shipping;

– Market research, cargo and passenger traffic amount and prospects of passenger–and–freight transportations development in the seas of western and northern districts of Pacific ocean;

– Marketing researches and statistical generalizations concerning the market of vessels with horizontal loading (vessels of new construction and the pre–owned market vessels which have already been in operation);

– Estimation of a prospective shipyards–contractors for marine vessels manufacture with horizontal loading (with the account the national accessory);

– Formation of the set of the options for fleet replenishment with marine vessels with horizontal loading estimated by economic criteria with the account the following characteristics – the structural class of the commercial vessel, the vessel size, the vessel years (for assumptions of investment in manufacturing of the new commercial vessel or the vessel that were in operation);

– Working out of the economic models of marine vessels with horizontal loading, including dependences between the data (the characteristic vessels–applicants and data of cargo traffics), on the one hand, and results (economic criteria of investments efficiency), on the other hand;

– Estimation of investments efficiency into the purchase / manufacturing of vessels with horizontal loading on the basis of application of the developed models and working out of recommendations concerning future vessel among the studied set of alternative options.

The evaluation and efficiency estimation in northwest area and the coastal seas of Pacific ocean is made for prospective operation of vessels of studied set on a similar methodological basis which covers approaches and mathematical models of economical indexes determination for each of vessels as a part of a property complex of the shipping company with similar external data: the characteristics of trip line, the date of the estimation, tariff rates for transportation of passengers, the cars and rolling cargoes, the quotations for fuel, the commercial risks calculated according to the discounting rate, the other macro economical indexes, etc.

As independent criteria of economic efficiency the following indexes are used: internal rate of return *IRR* and net present value *NPV*. And in order to compare two values the index of the net present value *NPV* is considered by the relative value – in relation to investments $NPV / (MV + OC)$.

The diagrammes for the compared variants of rolling cargo vessels show the estimation of investments demand (fig. 19.4), the general structure of operation costs (fig. 19.5), the estimation of economic criterion of the net present value (referred to investments, fig. 19.6), the estimation of internal rate of return (fig. 19.7).

The basic disadvantage of the high–speed sea passenger–and–freight ferry under project Tenix Defence Pty Ltd. in the present macroeconomic conditions is the excessive

fuel consumption that limits possibilities of application of similar (high–speed) vessels for transportation of cargoes at the considered line.

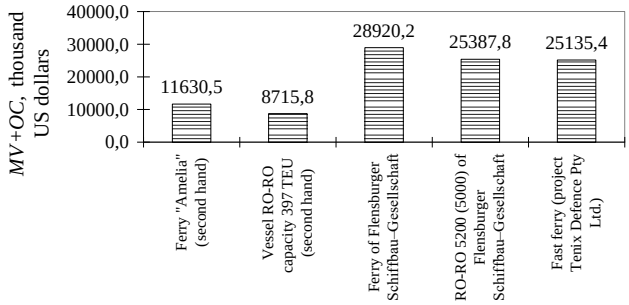



Fig. 19.4. The investments, including the vessel value in the amount of current asset

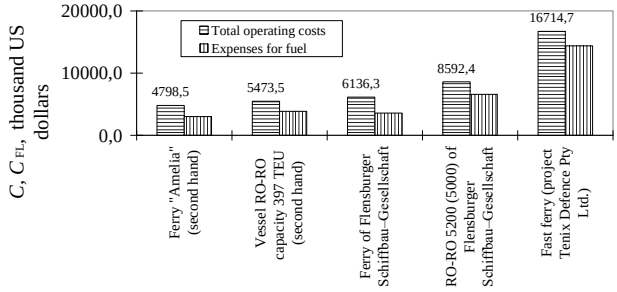



Fig. 19.5. The structure of the annual operation costs: total operation costs $C$, expenses for fuel $C_{FL}$

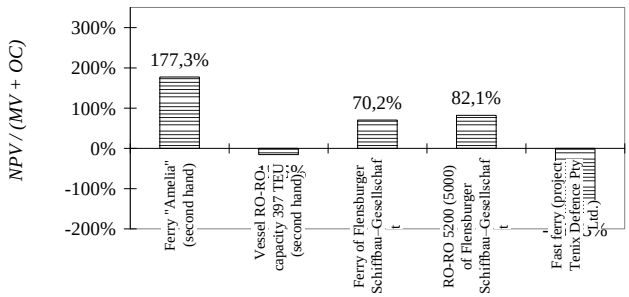



Fig. 19.6. The ratio of the net present value to the investments $NPV / (MV + OC)$

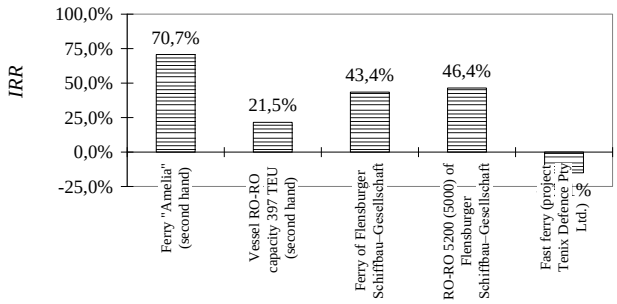



Fig. 19.7. The internal rate of return ratio to investments $IRR = NOI / (MV + OC)$

The generalized criterion on the basis of indexes of internal rate of return and net present value (fig. 19.8) allows to judge advantages of the following options of the rolling cargo vessels: the ferry "Amelia" offered at the pre–owned market and variants of the marine passenger–and–freight ferry and commercial vessel with horizontal loading RO–RO 5200 (5000) offered for manufacturing at shipyard Flensburger Schiffbau–Gesellschaft mbH and Co. KG.

By the relative value of criteria the best indexes of efficiency (the internal rate of return, the net present value referred to investments) correspond to variant of marine twin–screw passenger–and–freight ferry "Amelia" of 1989 year manufacture of the shipyard of Sunderland offered at the pre–owned market.

It should be noted that the vessel «Amelia» is estimated at the pre–owned market and has considerably smaller value, than a comparable new vessel, besides, the functional vessel characteristics vary over the time not so substantially, as the value does.

The vessel depreciation causes over the time the difference of economic criteria in comparison with the new vessels. On the other hand, investments into purchase of vessels at the pre–owned market are more risky. The all–round analysis and a choice with the account the estimation of risks of the pre–owned market is required (paragraph 18.2).

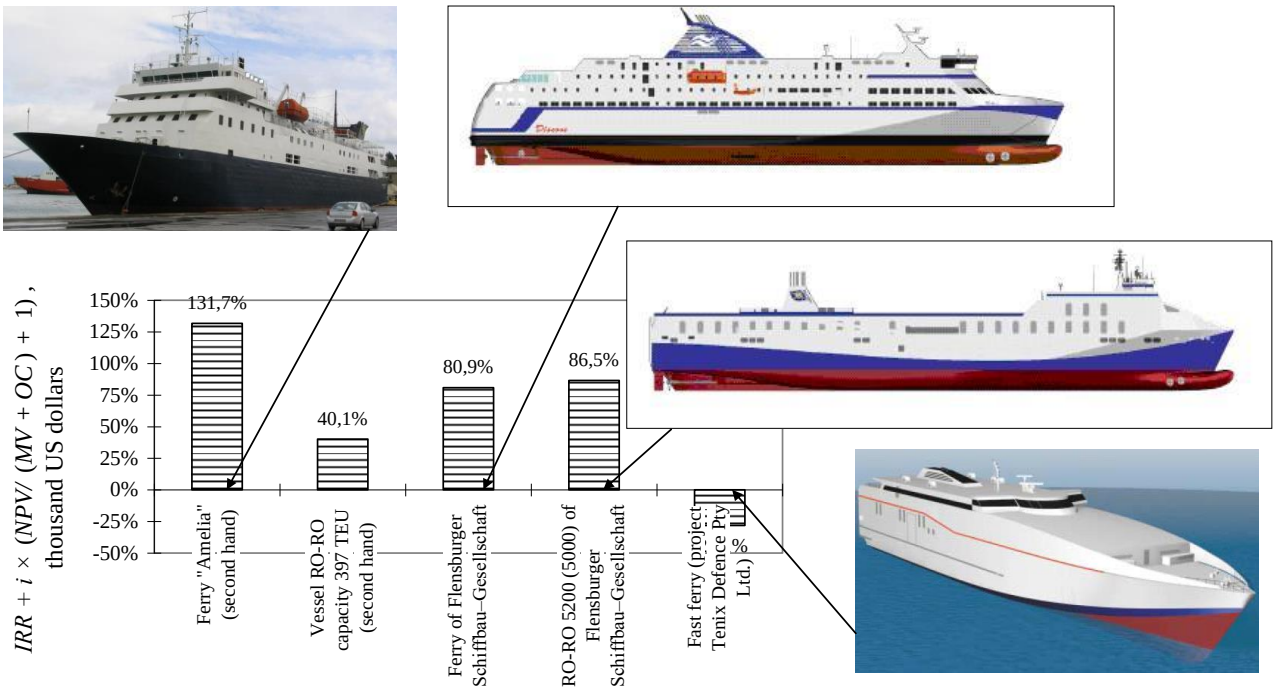
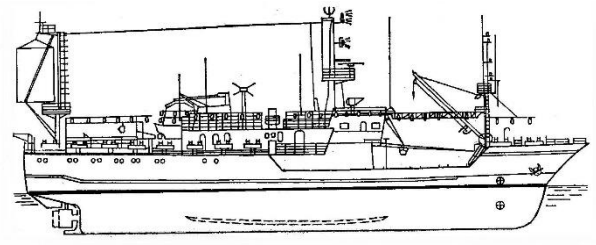



Fig. 19.8. The generalized criterion on the bases of indexes of the internal rate of return and the net present value $IRR + i \times (NPV/ (MV + OC) + 1)$

**Test questions**

1. Classes of the rolling cargo vessels and their advantages.
2. Rolling cargo vessels structural design features.
3. High–speed cargo vessels economic disadvantages.
4. Concepts of the systematic approach when determining commercial vessel options compared by economic criteria.
5. Economic criteria used for a comparative evaluation of commercial vessel options for the order.
6. Main tasks fulfilled to evaluate comparatively the variants of the commercial vessel choice for the commercial order.
7. Similar methodological basis used for evaluation of variants as a system requirement for comparison and choice.
8. Form of the generalized economic criterion on the basis of internal rate of return and net present value indexes.
9. Economic advantages and disadvantages of commercial vessel purchase at the pre–owned market.



# 20. Evaluation of ocean resources and unidentifiable intangible asset taking into account the risks of investment in marine industrial activity

Marine wealth in methodological sense is any useful properties of the marine environment for which development the investor aims his interests and activity. In applied tasks the ocean resources can be evaluated, for example, by estimating of fishery quotas for ocean biological resources development, or by evaluating of the advantages of access to marine cargo traffics, etc. And the concept of marine environment means not only the physical water environment, but the ocean as a reservoir having the characteristics of a geographical location, climatic conditions, biological resources, minerals of ocean bottom, industrial potential of coasts and other characteristics which corresponds to economic or other interests of the investor in marine environment, besides, it is characterized by the intensity of marine cargo transportations.

## 20.1. Evaluation of marine resources and unidentifiable intangible asset of a marine company with the account of total risks of innovative strategy

While estimating the marine company's property complex the estimation of the ocean resources means mostly the estimation of the goodwill – the grouped unidentifiable intangible asset which characterizes the advantages of investor's access to marine wealth and based on the concepts of the superfluous income and residual value. And, unlike widespread definition of goodwill as tendencies of clients to use again the same company, that is, as the evaluation of the demand for resources, at the basis for the estimation of the ocean resources value is the estimation of the supply from the point of demand in the marine industrial activity.

Not only in the field of marine activity, but also in other areas can the goodwill be a result of possible advantages of the investor's access to resources. In particular, when investing in the real estate the goodwill is closely connected with the investor's advantages in access to acquisition of the property or in using the sites for construction.

In order of the real estate rent for the investing or in case of the land plot rent for real estate constructing the goodwill can be the result of investor's access for the available advantages of economy of the rent charges.

The interrelation of the goodwill and the natural wealth can be explained by an example of real estate evaluation, considering, that in case of real estate construction the territory occupied for construction is natural resource, characterized by the location, the area, the form, the orientation etc. When the real estate is situated in a busy place the advantages can be estimated either as the goodwill of the company using real estate in a busy place and adherence of the clientele, or as advantages in the value of the real estate located at an expensive site of busy territory.

The definition of an asset as goodwill or as marine wealth to which development the investments into real assets are made and the property complex of the marine company is formed, depends on context.

In order to estimate the marine company's property complex value the unidentifiable intangible asset – goodwill should be determined. When evaluating of the isolated real asset (or commercial vessel) of the marine company's property complex there is a task to estimate the influence of the marine environment productivity on the asset value.

Unidentifiable intangible asset (goodwill) corresponds to a difference between the value property of the company's complex value and the total sum of values of real assets taken separately, including identified intangible assets as well as financial assets.

The goodwill value of the marine company can correspond to the residue of:

– Total sum of values of intangible assets after deducting it the values of all identified intangible assets;

– Total values of the marine company's property complex after deducting the values of the material assets, including financial and identified intangible;

– Present value of superfluous profit cash flow over the general profit of the marine company identified assets, including the profit of the identified intangible assets.

In respect of economic methodology the activity of investors and the managers serving interests of investors is directed to the increase of the marine company's property complex value by production the unidentifiable intangible asset.

The definition is fully fair for new enterprises at an innovative stage of their development when the profit is not alienated as a financial asset, but re–invested in real assets, including intangible ones, bought as the intellectual property or the equal rights.

The growth of the property complex by the value of unidentifiable intangible asset just encourages the investor to create of the marine company or enterprise division as combinations of the real assets paid while investing by financial assets.

At the same time investing in the financial assets can serve as a way of capitalization for the subsequent capital financing in real assets.

The goodwill is an unidentifiable intangible asset, that is the commercial advantages of the marine company which in real assets don't have it taken separately, including material assets for example marine commercial vessels and identified intangible assets.

In figurative definition the property rights underlying the unidentifiable intangible asset – goodwill, are equal to a difference between:

– Property rights (possession, use and disposal, under article 209 of the Civil code of Russian Federation) concerning the property complex (on article 132 of the Civil code, part 2), taken as a whole;

– And, the property rights concerning all isolated real assets, including identified intangible assets (intellectual property and equivalent rights under article 138 of the Civil code of Russian Federation), in the sum with financial assets.

Some difficulty in understanding can arise in connection with measurement of the amount of the ocean resources as, in particular, in case of real estate evaluation the natural resources – built–up land plots – are quite measurable and there is a system of property rights registration unlike in the field of the marine industrial activity.

Without going into details the measurement of the ocean resources by characteristics of those marine engineering and ocean technology, which are used for the

development of these resources, can be recommended as a general concept. For example, it is possible to measure marine cargo traffic in units of cargo vessel carrying capacity or in number of necessary cargo vessels with the account their carrying capacity. Also it is possible to measure ocean biological resources by the productivity of fishing vessels. The coastal ship–repair infrastructure can be characterized by the number of vessels, undergoing repair and maintenance service etc.

There is also the task of protection of the investor's interests in the sphere of marine industrial activity. This protection in real estate building industry would be done on the basis of marking of the territories.

One shouldn't think that the innovative strategy aimed at the growth of the value of the marine company's property complex by investing in real assets, by forming the property complex structure and providing of the access to marine wealth is not protected from an un–authorized use.

A certain restriction of access is the condition of financial sufficiency of means of investing in real assets, that is, the realization of innovative strategy of the investor should be unavailable without sufficient financing.

On the other hand, excessive financial capacity can be an obstacle for the realization of innovative strategy too, since they give the investor the opportunity for more expensive strategy.

From the system point of view to evaluate the unidentifiable intangible asset while estimating the property complex (or to evaluate of the ocean resources while estimating the isolated asset, for example a vessel) it is necessary to consider the sequence of investor actions during the period $t - t_0$ of investing in the formation of the structure of the real assets property complex:

– The acquisition of tangible and identified intangible assets with the total value $MV_\Sigma = \sum_n MV_n$ which in a certain structure and in the aggregate are the property complex of the marine company;

– Sale by the value $MV$ of tangible and identified intangible assets, which for the unidentifiable intangible asset *MW* are more expensive in aggregate than separately that the reason why the real assets had been bought separately to be sold in aggregate (namely in order of estimation of the isolated asset of the marine company the set is the asset and the marine wealth taken together);

– Cyclic repetition of the specified actions with period $\Delta t = t - t_0$.

And the difference of the same property value separately and in aggregate, allowing to use the set of property as a business based on the concepts of loyalty of clientele, the superfluous income and residual value, is unidentifiable intangible asset – goodwill – according to $MW = MV - MV_\Sigma = NPV_\Sigma$.

Unidentifiable intangible asset *MW* is equal to the net present value of the marine company's property complex $MW = NPV_\Sigma$ from the methodological point of view and means an evaluation of the ocean resources, that is an estimation of set of technological, legal and other possibilities of the ocean resources (marine wealth) development.

In correlation with the isolated real asset of the marine company, the index $MW_n$ means the estimation of the ocean resources contribution associated with this asset, by the

value of this asset and is equal to the net present value $MW_n = NPV_n$ of the marine company real asset, and in the sum with the value of asset $MV_n + MW_n$ methodologically means the investment value of the asset.

According to the discount formula of the present value the capitalization of the marine company's property complex assets is determined as

$$MV = MV_{\Sigma} \times (1+i)^{t-t_0}, \tag{20.1}$$

where $\Delta t = t - t_0$ – the duration of the period of structurization (regulation) of set of real assets when investing financial assets, in particular, the duration of creation of the marine company's property complex and the goodwill or the property complex in the structure of the enterprise, and also, the duration of manufacture of an asset, for example, the construction of the vessel; *i* is the index of additional net values as the discounting rate, corresponding also to the interest rate in a certain economic sector with the duration of assets structurization $\Delta t = t - t_0$.

From the system point of view the duration of the marine company's property complex creation or the constructing of the isolated real asset, is an indicator of recurrence (repeatability) and should be estimated from the point of view of financial capacity and economic feasibility.

The duration of the period of the property complex creation or period of the constructing of the isolated real asset of marine company $\Delta t = t - t_0$ is not related to the payback period or to the calendar periodicity.

From the investor's point of view the duration of the period $\Delta t = t - t_0$ corresponds to its financial capacity and an of the value $MV - MV_{\Sigma}$ to the investment $MV_{\Sigma}$, and also to total sum of the risks of innovative strategy *i*.

After mathematical transformations of the formula (20.1) the duration of the period of creation of the marine company's property complex (or manufacturing of the isolated real asset) from the point of view of the financial capacity of the investor characterized by his initial investments $MV_{\Sigma}$, can be estimated, as:

$$t - t_0 = \log_{1+i}((MV - MV_{\Sigma}) / MV_{\Sigma} + 1), \text{ or } t - t_0 = (\ln((MV - MV_{\Sigma}) / MV_{\Sigma} + 1)) / i. \tag{20.2}$$

For an economic environment the estimation of the duration of the period $t - t_0$ of the property complex creation or the period of the construction of the isolated real asset of the marine company is an object – matter of economic feasibility and there are alternatives. Depending on concentration of industrial capacity the duration of the period $\Delta t = t - t_0$ can be various and there is a redistribution of industrial capacity within an economic environment for increase of their cumulative efficiency.

Since the duration of the period $\Delta t = t - t_0$, which is required for generating the additional net value, is various in different sectors of economy, as well as an for progress of additional net values according to the discounting rate *i* it is possible to speak about the dependence between the duration of structurization of assets $t - t_0$ and the sum of risks *i* depending on industrial branch.

From the formal point the unidentifiable intangible asset – goodwill – corresponds to an increment of the present value of the marine company's property complex in relation to the total value of investments when arranging commercial ordering real assets in the set and characterizes the ability of the property complex to increase the present value during its formation. Therefore it is important to have an approach used in estimation of the period duration $\Delta t = t - t_0$, which is required for generating the additional net value that is considered in details in the following article 20.2.

The evaluation of unidentifiable intangible asset of the marine company *MW*, that is, the evaluation of the increment of the property complex value corresponds with mathematical derivative of the dependence of the marine company value on time $MV$ created while investing financial assets in real – tangible and identified intangible assets which total cost is equal $MV_{\Sigma}$, that is

$$MW = \Delta MV \approx MV' \times \Delta t = MV_{\Sigma} \times (1+i)^{t-t_0} \times \ln(1+i) \times (t - t_0), \tag{20.3}$$

where $\Delta MV$ – the increment of the value during the period $\Delta t = t - t_0$ of formation of the property complex.

As the marine company's property complex value capitalized in accordance with the formula (20.1) is equal $MV = MV_{\Sigma} \times (1+i)^{t-t_0}$ it is possible to transform the formula (20.3) as

$$MW = MV \times \ln(1+i) \times (t - t_0). \tag{20.4}$$

The dependence by the formula (20.3) of the ratio of the marine company unidentifiable intangible asset *MW* to the value of the invested real assets on the index of commercial risk as the discounting rate *i* and on the duration (period) of assets structurization in the property complex $\Delta t = t - t_0$ is shown on the graph (fig. 20.1).

Thus, by the relative value the unidentifiable intangible asset of the marine company essentially depends on the discounting rate and there is a relation between the factors of loyalty of clientele, the income superfluous and residual value, which mean also the efficiency of the ocean resources, and its positive influence on the value of the isolated asset of the marine company, on the one hand, and the indicators of the commercial risk on the other hand which at the same time is connected with predicted economic efficiency.

According the drawing (fig. 20.1) it is clear, that the more proportional share of unidentifiable intangible asset – goodwill – as a part of the marine company's property complex value (or the estimation of the ocean resources relative value, associable with the isolated asset), the more the index of commercial risk.

Since, on the other hand, the marine company's property complex value with certain assumptions can be calculated by the formula $MV = NOI / i$, the value of unidentifiable intangible asset *MW* (or marine wealth) is related to the estimation of the cash flow *NOI*, as:

$$MW = NOI \times \ln(1+i) / i \times (t - t_0), \tag{20.5}$$

or the use of discounting by the Euler' number exponential function by the factor $e^i \approx 1 + i$ for evaluation of unidentifiable intangible asset *MW* of the marine company depending on the net operating income leads to calculation by formula $MW = NOI \times i / (e^i - 1) \times (t - t_0)$, which can be recommended as a variant of the formula (20.5).

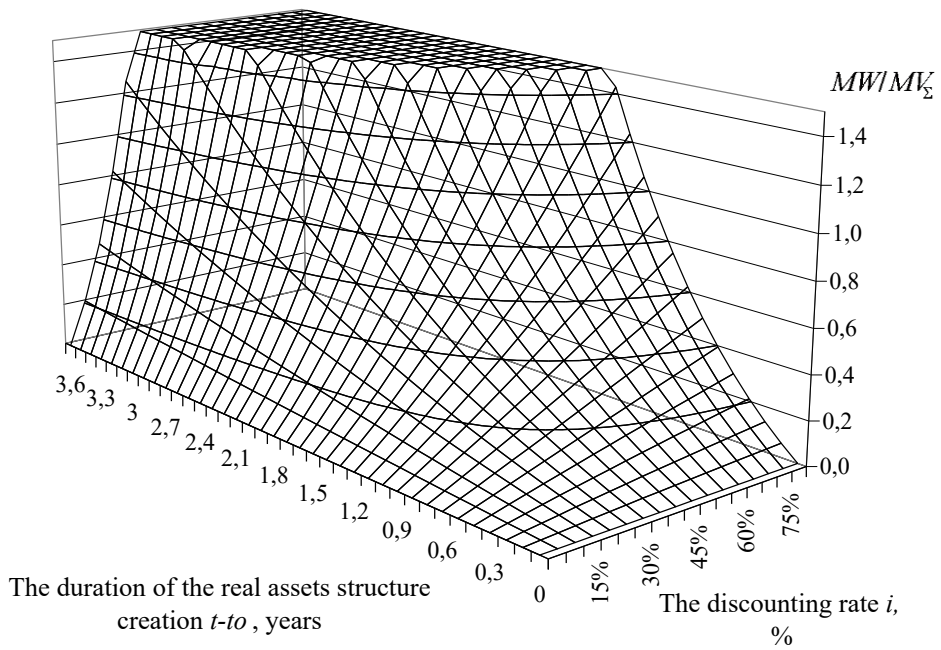



Fig. 20.1. The ratio of the non-identified intangible asset - goodwill to the total value of the invested assets in dependance on the discounting rate and on the duration of the real assets structure creation of the marine company property complex

Besides using the formulas (20.3, 20.4, 20.5) taking into account the time of completion of the formation and the time of input of the marine company's property complex (or the isolated real asset in its structure) with little commercial risks when $\ln(1+i) \approx (e^{i}-1) \approx i$, the additional approximate formulas for the estimation of unidentifiable intangible asset of the marine company, that is, for estimation of the ocean resources are the following:

$$MW \approx MV_{\Sigma} \times ((1+i)^{t-t_0}-1) \times i \times (t-t_0), \text{ or } MW \approx MV_{\Sigma} \times (e^{i \times (t-t_0)}-1) \times i \times (t-t_0), \quad (20.6)$$

and also $MW \approx MV \times i \times (t-t_0)$ and $MW \approx NOI \times (t-t_0)$. (20.6 and 20.7)

With rather short duration $t-t_0$ of the investment in creation of the marine company's property complex structure, that is, provided that

$$(1+i)^{t-t_0}-1 \approx (e^{i \times (t-t_0)}-1) \approx i \times (t-t_0),$$

the approximate value estimation of unidentifiable intangible asset *MW*, that is, the evaluation of the ocean resources, is equal

$$MW \approx MV_{\Sigma} \times (i \times (t-t_0))^2. \quad (20.8)$$

**Test questions**

1. Concept of group unidentifiable intangible asset – goodwill – as a part of the marine company's property complex.
2. Goodwill sources.
3. Concepts of goodwill definition.
4. Incentives of the investor to buy marine company's real assets.
5. Financial protection of the investor intellectual activity.
6. Methodological conformity of the property rights underlying unidentifiable intangible asset – goodwill.
7. Systematic approach in the basis of the sequence of the investor's actions to determine the unidentifiable intangible asset.
8. Value of the assets capitalization by the discount formula of present value.
9. Formal–logic sense of estimation of the unidentifiable intangible asset.
10. Dependence of the goodwill on the total value of invested real assets and the commercial risks index as the discounting rate (the formula derivation).
11. Main parties participating in intangible assets generation.
12. An evaluation of advantages of the access to marine wealth as unidentifiable intangible asset – goodwill – of the marine company and as a contribution of the ocean resources to the value of the isolated real asset.
13. Interrelation of the marine wealth evaluation, the unidentifiable intangible asset and the discounting rate index of the commercial risk.
14. Ocean resources evaluation with the account total investments into the real asset and the discounting rate index of the commercial risk.
15. Approximate estimation of the ocean resources taking into account methodological assumptions (the formula derivation).
16. Based on the conformity of discounting by the arithmetic discount financial functions and using the exponential functions of the Euler' number formal sign that the commercial risks are little.
17. Methodological conformity of the ocean resources estimation and the net present value.
18. Estimation of a reference point of the ocean resources value from the point of view of the investor who is consistently manufactures the assets and sells them, for example the marine company's property complex creation and sale, as a systematic activity.

## 20.2. Evaluation of ocean resources and goodwill with the account of balance of real assets structure of the marine company

The value of the ocean resources which makes sense only in a context of a set of technological, legal and other opportunities of their development should be correlated with the unidentifiable intangible asset – goodwill of the marine company with its net present value. Thus marine wealth in the methodological relation is any useful properties of the marine environment for which development the investor's activity is directed, among them we evaluate not only physical properties of the water environment, but also the sea, as a

reservoir with the account the size, geographical and climatic characteristics, activity developments in the ocean and at coasts, economic potential of marine cargo transportations, stocks of ocean biological resources, ocean–bottom minerals at shelf and behind its limits, resources of marine power, recreational possibilities etc.

On the one hand, the account of the invested assets and risks of innovative strategy (article 20.1) is the precondition for an estimation of the ocean resources – the evaluation of unidentifiable intangible asset of the marine company. On the other hand, the evaluation of unidentifiable intangible asset, which manufacture is the purpose of innovative strategy and investment of financial assets in formation of the real assets of the marine company's property complex structure, can be made on the basis of the analysis of both the balance of real assets and stability of balance structure.

Thus, the unidentifiable intangible asset corresponding to an evaluation of the ocean resources is the characteristic of stability of the balance assets in the structure of the marine company's property complex and the purpose of investing financial assets in formation of the structure of the property complex of its real assets.

The equation of the balance of the assets in the structure of the marine company's property complex looks like:

$$MV = MV_{\Sigma} + \sum_{N} NPV_n(NPV_{\Sigma}), \tag{20.9}$$

$$\text{or } NPV_{\Sigma} = \sum_{N} NPV_n(NPV_{\Sigma}), \tag{20.10}$$

where $NPV_{\Sigma} = MV - MV_{\Sigma}$ – the goodwill as the net present value of the marine company's property complex, corresponding to the evaluation of the ocean resources *MW*, $NPV_n$ – the net present value *n*– th asset as a part of its investment value $MV_n + NPV_n$, *MV* – the marine company's property complex value, $MV_n$ – the value of isolated *n*– th asset of the property complex, $MV_{\Sigma}$ – the total value of the tangible and identified intangible assets which in aggregate are the property complex of the marine company, the investment at formation of the property complex is $MV_{\Sigma} = \sum_{N} MV_n$.

Differentiating the formula (20.10) it is possible to obtain the assets structure balance equation of the marine company's property complex as increments:

$$\Delta NPV_{\Sigma} = \sum_{N} \Delta NPV_n + \sum_{N} \frac{\partial NPV_n}{\partial NPV_{\Sigma}} \times \Delta NPV_{\Sigma}, \text{ further}$$

$$\Delta NPV_{\Sigma} \times \left(1 - \sum_{N} \frac{\partial NPV_n}{\partial NPV_{\Sigma}}\right) = \sum_{N} \Delta NPV_n,$$

or after the mathematical transformations

$$\Delta NPV_{\Sigma} = f_{NPV} \times \sum_{N} \Delta NPV_n \text{ and } f_{NPV} = \frac{1}{1 - \sum_{N} \frac{\partial NPV_n}{\partial NPV_{\Sigma}}}, \tag{20.11}$$

where $f_{NPV}$ – the factor of the net present value characterizing the relation of an increment of the total sum of the net present value $\Delta NPV_{\Sigma}$ of the marine company's property

complex to a total increment of the invested value – the sums of the net present value of separate assets $\sum_N \Delta NPV_n$ .

In other words, the net present value factor $f_{NPV}$ is the proportional relation between an increment of the «whole» – the net present value of the marine company's property complex and a total increment of «parts» – the costs of separate assets.

If in case of combination of parts, real assets of the marine company, in a structure of the property complex the additional net value doesn't arise, for example because of a strategic error or excessive risks the net present value factor is equal to a one $f_{NPV}$ =1. Thus there are no economic reasons for stability, or, in other words, the reason for the balance of the structure of the property complex. Such reason could appear when in case of combination of the parts in an integral structure the arising additional net value is not equal to zero, and the net present value factor is larger than a one.

That is, the balance equation of the marine company's property complex structure of assets can be presented in a differential form depending on the total sum of increments $\sum_N \Delta MV_n$ of the invested value, as:

$$\Delta NPV_\Sigma = f_{NPV} \times \sum_N \Delta MV_n , \qquad (20.12)$$

and, the increments of the invested value $\Delta MV_n = \Delta NPV_n$ are formed of the profit or the savings distributed in profit.

The basis for use of the balance equation in the differential form (20.12) assets in the structure of the marine company's property complex is the following economic definition: an unidentifiable intangible asset corresponds to an increment of the net present value by an increment of the invested value.

The system concept of continuity is that the investments are not carried out from zero, and are a continuation of previous investments – capitalization for the initial capital. The continuity concept means the evaluation of the present solvency of the investor, since the further investments are considered as continuation.

It should be noted that the conclusion of formulas (20.1, 20.3 – 20.7, article 20.1) also is more correct in increments with the account the system concept of economic continuity. For this purpose it should be required to formulate the precondition of the formula (20.1) in increments $MV = MV_\Sigma \times (1+i)^{t-t_0}$ as: $MV - MV_\Sigma = \sum_N \Delta MV_n \times (1+i)^{t-t_0}$ , and also to transform the resulting formula (20.3 – 20.7).

However, in view of methodology the substantiation of the specified formulas in article 20.1 is made not in increments, but in final values, since there is a subject of the ocean resources evaluation and the unidentifiable intangible asset – goodwill of the marine company depending on the total commercial risks index for the set duration of the property complex formation, instead of on the basis of the assets structure stability balance analysis, including, the balance of the accumulated (capitalized) assets and increments that is done below.

A continuity concept can be illustrated additionally by determining the of economic criterion of investments profitability which is sometimes defined as a relation of the profit to the investments, but corresponds more precisely to the relation of the increment of the

profit to the increment of the investments causing this increase in profits, that in a limit (at a level of little increments) means mathematical derivative of the profit of investments.

The stability of assets structure balance in the property complex means the dependence of the summands of the net present value $NPV_n$, referred to the isolated assets, on the net present value of the marine company's property complex $NPV_\Sigma$, for example a proportional dependence $NPV_n = NPV_n(NPV_\Sigma^1)$.

The assets structure balance would be unstable, if the summands of the net present value $NPV_n$ were independent on the total net present value of the property complex $NPV_\Sigma$, that is, $NPV_n = \sum_N NPV_n(NPV_\Sigma^0)$.

Other dependence instead of proportional to one or another degree of total net present value $NPV_\Sigma$ is generally possible for each of addends of the net present value $NPV_n$, referred to the isolated assets.

If to remain within the limits of an assumption that the addends of the equation of balance (20.10) of marine company's property complex assets according to stability are included into one of two groups: either proportionally dependent on the total net present value of the property complex or independent on the total net present value this equation becomes:

$$NPV_\Sigma = \sum_{N1} NPV_n(NPV_\Sigma^1) + \sum_{N-N1} NPV_n(NPV_\Sigma^0), \qquad (20.13)$$

where $N1$ – the group of assets in proportional dependence $NPV_n(NPV_\Sigma^1)$ of the net present value referred to the isolated asset, on the net present value of complex $NPV_\Sigma$, $(N-N1)$ – the group of assets independent on the property complex according to the net present value $NPV_n(NPV_\Sigma^0)$.

The factor of balance $\alpha$ of assets structure of the property complex can be defined as a relation of a total sum of estimation of addends of the net present value $\sum_{N1} NPV_n(NPV_\Sigma^1)$ referred to the isolated assets, consisting in proportional dependence on one or another degree of the net present value of the marine company's property complex $NPV_\Sigma$ to the net present value of the property complex, as:

$$\alpha = \frac{\sum_{N1} NPV_n(NPV_\Sigma^1)}{NPV_\Sigma} = \frac{\sum_{N1} NPV_n(NPV_\Sigma^1)}{\sum_{N1} NPV_n(NPV_\Sigma^1) + \sum_{N-N1} NPV_n(NPV_\Sigma^0)}, \qquad (20.14)$$

Within the limits of a used assumption that the addends of equations (20.7) according to stability of the balance of the assets structure and the marine company structure enter into one of two groups: addends proportionally dependent on the net present value of the property complex and independent on the total net present value, the net present value factor $f_{NPV}$, determined by the formula (20.11), is equal

$$f_{NPV} = \frac{1}{1-\sum_N \frac{\partial NPV_n}{\partial NPV_\Sigma}} = \frac{1}{1-\alpha}, \text{ a } \Delta NPV_\Sigma = \frac{1}{1-\alpha} \times \sum_N \Delta NPV_n = \frac{1}{1-\alpha} \times \sum_N \Delta MV_n. \qquad (20.15)$$

On the other hand, with rather short duration $t - t_0$ of the period of investing in creation of the structure of the marine company's property complex (with the account assumptions, see article 20.1) the approximate value estimation of unidentifiable intangible asset *MW*, that is the evaluation of the ocean resources by the formula $MW \approx MV_{\Sigma} \times (i \times (t - t_0))^2$, and with the account the conformity of economic indexes at the level of increments and replacements of designations in the formula (20.8): $MW \sim \Delta NPV_{\Sigma}$ and $MV_{\Sigma} \sim \sum_N \Delta NPV_n = \sum_N \Delta MV_n$, the evaluation of the ocean resources depending on the duration of the period of investing and risks evaluation is:

$$\Delta NPV_{\Sigma} \approx (i \times (t - t_0))^2 \times \sum_N \Delta MV_n \,. \tag{20.16}$$

Equating the right parts of the formulas (20.15) and (20.16) and after mathematical transformations with the account the considered assumptions the period of duration of formation of the marine company's property complex $\Delta t = t - t_0$, with the account total commercial risks and also the factor $\alpha$ of the assets structure balance in the property complex, can be determined as:

$$t - t_0 \approx 1/(i \times \sqrt{1 - \alpha}) \,. \tag{20.17}$$

The duration of the marine company's property complex formation $\Delta t = t - t_0$, estimated by the approximate formula (20.17), corresponds to the joint account of the following preconditions:

– Dependences of unidentifiable intangible asset which means the evaluation of the ocean resources, on the estimation of the commercial risks with the account variable duration of marine company formation (article 20.1);

– Determination of the unidentifiable intangible asset of the marine company with the account the factor of the present value, characterizing the balance stability of the marine company in a proportion of its net present value, that is, unidentifiable intangible asset – estimation of the ocean resources to the total invested assets.

The dependence of the duration of the property complex formation $\Delta t = t - t_0$ on the basic influencing factors, is shown on the figure 20.2 which corresponds to the formula (20.17) with the account the used assumptions and preconditions.

Figure 20.2 shows, that the index of total commercial risks according to the discounting rate makes more substantial impact on the duration of the period of the marine company's property complex formation, than factor $\alpha$ of the assets structure balance in the property complex, and in the most general approach the duration of the marine company's property complex formation is proportional to the investments payback period, that is $\Delta t = t - t_0 \approx 1/(i \times \sqrt{1 - \alpha}) \sim 1/i \sim T_{\mathrm{R}} = 1/IRR$.

To the net present value factor $f_{NPV}$ used for the evaluation of unidentifiable intangible asset of the marine company, earlier there was the assumption is, that the addends of the balance equation enter into one of two groups: either proportionally dependent on the total net present value of the property complex or independent of the total net present value, and the factor of balance $\alpha$ of assets structure in the property complex is defined

as a relation of its total sum of estimations the net present value of the marine company's property complex $NPV_{\Sigma}$ in linear proportional dependence.

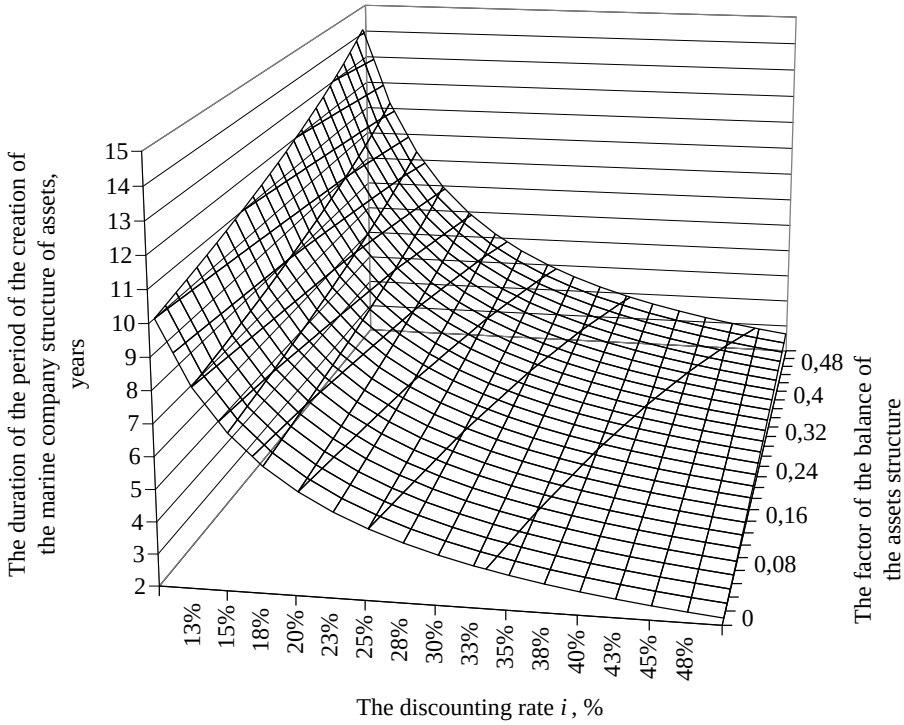



Fig. 20.2. The duration of the creation of the property complex of the marine company assets with the account of the commercial risks and assets structure balance

It should be noted that the determination of the net present value factor $f_{NPV}$ by the formula (20.11) is the common solution and is not necessarily connected with the specified assumption. To explain this fact it makes sense to consider the following example. If the general set of the marine company's property complex assets can be presented not by the formula (20.13), but as a part of the following groups where: $N1$ – the group of assets in linear proportional dependence on the total net present value $NPV_n(NPV_{\Sigma}^{1})$, $N2$ – the group of assets in a proportion of degree ¾ from total net present value $NPV_n(NPV_{\Sigma}^{3/4})$, $N3$ – the group of assets in a proportion of degree ⅔ from total net present value $NPV_n(NPV_{\Sigma}^{2/3})$, $N4$ – the group of assets in a proportion of degree ½ from the total net present value $NPV_n(NPV_{\Sigma}^{1/2})$ and $(N - N1 - N2 - N3 - N4)$ – the group of assets independent on the total net present value $NPV_n(NPV_{\Sigma}^{0})$, then the net present value factor is determined with the account a mathematical derivative by the formula (20.11) as:

$$f_{NPV} = \frac{1}{1 - \frac{\sum_{N1} NPV_n(NPV_{\Sigma}^{1})}{NPV_{\Sigma}} - \frac{3}{4} \times \frac{\sum_{N2} NPV_n(NPV_{\Sigma}^{3/4})}{NPV_{\Sigma}} - \frac{2}{3} \times \frac{\sum_{N3} NPV_n(NPV_{\Sigma}^{2/3})}{NPV_{\Sigma}} - \frac{1}{2} \times \frac{\sum_{N4} NPV_n(NPV_{\Sigma}^{1/2})}{NPV_{\Sigma}}},$$

and using symbols:

$$\alpha_1 = \frac{\sum_{N1} NPV_n (NPV_\Sigma^1)}{NPV_\Sigma}, \ \alpha_2 = \frac{\sum_{N2} NPV_n (NPV_\Sigma^{3/4})}{NPV_\Sigma}, \ \alpha_3 = \frac{\sum_{N3} NPV_n (NPV_\Sigma^{2/3})}{NPV_\Sigma}, \ \alpha_4 = \frac{\sum_{N4} NPV_n (NPV_\Sigma^{1/2})}{NPV_\Sigma},$$

the net present value factor $f_{NPV}$ can be determined, as:

$f_{NPV} = \dfrac{1}{1 - \alpha_1 - \frac{3}{4} \times \alpha_2 - \frac{2}{3} \times \alpha_3 - \frac{1}{2} \times \alpha_4}$, besides, for the considered example it is also possible, to determine the general factor $\alpha$ of the assets structure balance in the marine company's property complex by the formula

$$\alpha = \sum_N \frac{\partial NPV_n}{\partial NPV_\Sigma} = \alpha_1 + \frac{3}{4} \times \alpha_2 + \frac{2}{3} \times \alpha_3 + \frac{1}{2} \times \alpha_4, \qquad (20.18)$$

and, factors $\alpha_1$, $\alpha_2$, $\alpha_3$, $\alpha_4$ in the considered example show, what part of the total net present value $NPV_\Sigma$ of the marine company's property complex is the addends associable with the separate isolated assets and correlated with total net present value in a proportion of its certain degree serving in mathematical differentiation as a multiplier for determination of the net present value factor $f_{NPV}$, and this rule can be extended for the addends in another degree of proportional dependence on the total net present value $NPV_\Sigma$.

If to admit, also, that the net present value $NPV_\Sigma$ of the marine company's property complex is distributed between separate assets proportionally to their own market value, the factors $\alpha_1$, $\alpha_2$, $\alpha_3$, $\alpha_4$ can be determined in the proportion of the market value $MV_n$ by the groups of assets in the property complex, as:

$$\alpha_1 = \frac{\sum_{N1} MV_n}{MV_\Sigma}, \ \alpha_2 = \frac{\sum_{N2} MV_n}{MV_\Sigma}, \ \alpha_3 = \frac{\sum_{N3} MV_n}{MV_\Sigma}, \ \alpha_4 = \frac{\sum_{N4} MV_n}{MV_\Sigma}, \text{ that is, } \alpha = \sum_N \frac{\partial MV_n}{\partial MV},$$

and thus it is possible to use the data of the marine company, for example, by the tables of the accounting balance corrected for market prices.

When there is no other opportunities the factor $\alpha$ of assets structure balance of the marine company's property complex, apparently, should be evaluated expertly, probably on the basis of estimations of the balance, unidentifiable intangible asset and marine wealth by the data of the property complex of other marine enterprises similar to some extent with the account the analysis of similarity and comparability by the economic and the industrial indicators.

Coming back from evaluations of the economic indexes increments to the indexes in their final form and keeping in mind, that in any case the values are increments to previous values according to the system concept of continuity, the equation of assets structure balance (20.11) in the assumption about distribution of the net present value of the marine company between the isolated assets proportionally to their market evaluation becomes:

$$MW = NPV_\Sigma \approx f_{NPV} \times \sum_N MV_n \text{ and } f_{NPV} = \frac{1}{1 - \sum_N \frac{\partial MV_n}{\partial MV}}. \qquad (20.19)$$

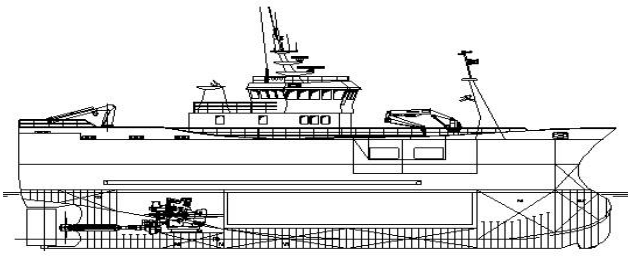
The formulas (20.11 and 20.12) of the ocean resources evaluation $MW$ – goodwill $NPV_\Sigma$ of the marine company show, that the goodwill evaluation to the invested assets is proportional to the net present value factor and, with the account of the stability of assets

structure balance as a part of the marine company's property complex, can be determined approximately, as:

$$MW = NPV_{\Sigma} \approx f_{NPV} \times MV_{\Sigma} \approx MV_{\Sigma} /(1-\alpha)\,. \qquad (20.20)$$

**Test questions**

1. Marine wealth as properties of the marine environment useful for the investor.
2. Interrelation of the economic concepts: the goodwill of the marine company, the net present value of its property complex and the ocean resources.
3. Bilateral preconditions for the ocean resources evaluation – definitions of the marine company unidentifiable intangible asset value.
4. Characteristic of stability of the marine company assets structure.
5. Equation of assets balance in the structure of the marine company's property complex (two forms).
6. Differential form of equation of the marine company assets balance structure.
7. Economic sense of the net present value factor as a stability characteristic – the balance of the property complex structure.
8. Intangible asset at an increment of the invested costs.
9. Systematic concept of investments continuity and the evaluation of the investor current solvency.
10. Stability of the assets structure balance in the property complex.
11. Equation of assets structure balance of the marine company's property complex in an assumption about proportionality of addends of one degree or another of the net present value.
12. The factor of assets structure balance of the marine company's property complex.
13. Estimation of the net present value factor depending on the factor of assets structure balance.
14. Estimation of the duration of the marine company's property complex formation, the approximate estimation of the duration of the property complex formation.
15. Estimation of the net present value factor with the account diverse character of the proportional dependences of addends of the balance equations.
16. General formula of the estimation of the factor of the marine company's property complex assets structure.
17. The assumption about distribution of the marine company net present value proportionally to the market evaluation of the isolated assets and the equation of assets structure balance in this assumption.



# 21. Evaluation of investor's contribution in joint marine industrial activity

In applied economics for the objects having complex structure, such as the marine companies, there are methodological issues of evaluation of the part, the whole, the isolated (special) and the general and with the account the definitions of the specified concepts there is a need for methodological ideas. The necessity of contribution evaluation can arise in certain expert tasks, such as: joint offshore wealth development on the basis of the contract on the production sharing, joint activity for service of the marine cargo transportations, division of the marine fishery company property, which possesses commercial fishing vessels and the quota rights for the development of ocean biological resources, etc.

The task of the contribution evaluation arises, for example, if it is necessary to estimate shares of the investors' property. There are similar problems, in particular, in case of state–owned investment. The property share can be compensated in kind (physically) or in the monetary form.

It can be repeated, that the value for compelled sale, the resale discount, caused by the parties difficulties shifted to the seller, and external (economic) obsolescence are determined earlier (Chapter 9) by the condition of reasonable balance of seller $R1$ and buyer $R2$ interests, that is $R1 = R2$.

The similar concept of a reasonable balance of interests is taken also as a basis for the concept for determination of the value of contribution in case of co–production of the asset, for example, if one party invests resources – as the offshore wealth which are the federal property, or ocean biological resources as well as the territory or water area for conducting of marine industrial activity of other kinds, and other party invests the finance or other property as a real asset of the marine company. The method of contribution evaluation is considered below. It is necessary to estimate co–investing in creation of the marine company's property complex by two parties. The task is to evaluate the shares of investors. The offered concept of the contribution evaluation is based on the net present value $NPV$ division proportionally to investments if, for example, one investor, let us assume, the federal authorities, invested the right of the ocean resources development according to $MW$ (the development of offshore deposit, the quota for ocean biological resources development, etc.), and the second investor financed investments into the development of the ocean resources $MV_{\Sigma}$.

The marine company's property complex value which is generated by two participants with corresponding contributions, including the investment as a right of the ocean resources development according to $MW$ and total investments into their development $MV_{\Sigma}$, is $MV$, and the net present value is equal $NPV = MV - MW - MV_{\Sigma}$.

One can pay attention, that earlier (Chapter 20) there was pointed the formal conformity of the net present value $NPV$ and the ocean resources $MW$ value. At the same time under the previous formula the evaluation of the ocean resources $MW$ is used as data, and

the net present value $NPV$ is determined after the deduction of the resources value $MW$, and total investments $MV_\Sigma$ into the development of resources.

The explanation is in definition of the evaluated objects distinction, to which the net present value is related, where the difference is in a degree of object generalization.

The evaluation of the ocean resources corresponds to the investments into their development $MV_\Sigma$ and can be defined according to the concept of investments net present value. At the same time if to combine the right of the ocean resources development and the investment into their development, then there is another net present value that corresponds methodologically to the property complex of the specified structure and this net present value is defined below as a subject of evaluation of investors' shares.

According to the reasonable compromise of interests ($R1$ and $R2$) of each of investors, when $R1 = R2$, considering, that each of efficiency indexes is equal to the ratio of the net present value of the share ($NPV1$ or $NPV2$) per investments ($MW$ or $MV_\Sigma$):

$R1 = NPV1/ MW$ – the index of efficiency for the participant who invested in ocean resources (the right to wealth development) according to $MW$;

$R2 = NPV2/ MV_\Sigma$ – the index of efficiency for the investor who financed the real assets for the ocean resources development $MV_\Sigma$,

considering, that $NPV1 + NPV2 = NPV$, it is possible to receive the system of conditions:

$$NPV1 / MW = NPV2/ MV_\Sigma \text{ and } NPV1 + NPV2 = MV - MW - MV_\Sigma . \quad (21.1)$$

The unknown in this system are addends of the net present value $NPV1$ and $NPV2$. When solving of the equations system (21.1) it is possible to receive:

$$NPV1 = NPV2 \times MW / MV_\Sigma \text{ and } NPV2 \times (MW / MV_\Sigma + 1) = MV - MW - MV_\Sigma . \quad (21.2)$$

Further

$$NPV1 = (MV - MW - MV_\Sigma) \times MW /(MW + MV_\Sigma), \quad (21.3)$$

$$NPV2 = (MV - MW - MV_\Sigma) \times MV_\Sigma /(MW + MV_\Sigma).$$

In the resulting ratio the net present value of the marine company's property complex is derived between the two participants, one of which has invested the right of the ocean resources development, and the second – has financed expenses into the real assets. After distribution of the net present value between the parties the participant who invested the right of the ocean resources development according to $MW$ to reasonable economic interest applies for the right concerning the marine company's property complex according to $MW + NPV1$:

$$MW + NPV1 = MW + (MV - MW - MV_\Sigma) \times MW /(MW + MV_\Sigma), \quad (21.4)$$

that is the given participant applies as for the right concerning invested part $MW$ and the interest in additional part $NPV1$. And the second investor who financed the investments into the real assets for the development of the ocean resources $MV_\Sigma$, according to his reasonable economic interest, applies for the right concerning the marine company's property complex according to $MV_\Sigma + NPV2$:

$$MV_\Sigma + NPV2 = MV_\Sigma + (MV - MW - MV_\Sigma) \times MV_\Sigma /(MW + MV_\Sigma). \quad (21.5)$$

To evaluate the property rights of participants after the creation of the marine

company's property complex the following initial data are required: the value of the right of the ocean resources development *MW*, the total value of investments $MV_{\Sigma}$ into the ocean resources development and the resultant value *MV* of the marine company's property complex.

With other number of investors the value estimation of everyone participation in the common creation of the marine company's property complex depending on the value $MV_n$ invested by them is determined as

$$MV_n + NPV_n = MV_n + (MV - \sum_{n=1,N} MV_n) \times MV_n / \sum_{n=1,N} MV_n \,, \tag{21.6}$$

where *N* – the number of investors (participants); in case of consecutive participation of investors it corresponds to a number of predicted intervals of cash flow stability or stability of rates of cash flow capitalization by the operating marine company. And the sum $MV_n + NPV_n$ is equal to the investment value of the contribution $MV_n$, and each investor's share in the net present value accordingly is determined as

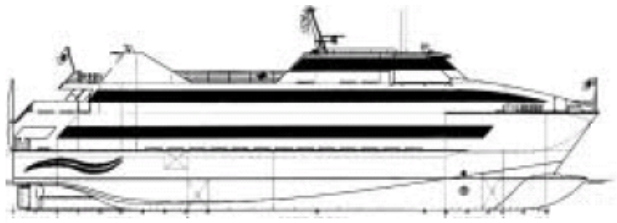
$$NPV_n = (MV - \sum_{n=1,N} MV_n) \times MV_n / \sum_{n=1,N} MV_n \,. \tag{21.7}$$

The formula (21.6) can be recommended for proportional division –the determination of the investment value of contribution $MV_n + NPV_n$, for example, to the manufacture of the marine company real asset, and also for evaluation of partner's or joint–stock's participation, the share holding, the property share in the company etc. before applying the adjustments to the value results determined by the independent methodological approaches: adjustment to the company property complex liquidity (or company share) and adjustment to controlling or non–controlling nature of share holding – for the joint–stock enterprise. To estimate the dividends $NPV_n$ it should be used the formula (21.7) with the account the specified adjustments to the values.

At first it is necessary to evaluate the marine company's property complex *MV* that is used as data in formulas (21.6 and 21.7), and also to determine the invested value of each contribution $MV_n$ separately.

### Test questions

1. Purposes to which there correspond the tasks of evaluation of the contribution in marine industrial activity (the examples).
2. Concept of the contribution evaluation in case of co–production of the asset.
3. Net present value in case of joint investment of shares.
4. Indexes of investment efficiency for the parties (investors).
5. Value of the marine company's property complex parts after division of the net present value besides the investors in proportion of investments (the formulas and the set of initial data).
6. Share of the investor in co–manufactured object (the general formula).
7. Division of the net present value to estimate dividends in joint business (the formula, adjustments).



# 22. Criterion functions for optimization of vessel's characteristics for commercial order, other asset or the property complex of the marine company, based on application of the economic criteria and value

The financial investment in the real assets of the marine companies from the economic point of view is innovative activity, and the economic model of the evaluation and the economic efficiency estimation among comparable variants of innovative strategy is the basis of the investments planning.

The investments planning for the marine industrial activity includes the optimum choice of characteristics of the marine company's real assets by the economic criteria and appropriate ones with view of financial or other limitations for optimum investment, in particular the determination of the optimum vessel characteristics by economic criteria for the contract commercial order.

The examples of the choice of the commercial vessel characteristics in the property complex the shipping company for the commercial order with the aim of replenishment and renovation of the commercial fleet are considered earlier (Chapter 19). The necessity to adhere to the systematic approach and concepts of comparability of evaluated variants of the vessel, that is very important in marine industrial activity, is explained, considering, that characteristics of the marine company assets are functionally interconnected substantially.

## 22.1. Systematic approach in elaboration of the criterion functions for optimization of a commercial vessel or property complex of the marine company characteristics

It should be noted that the property complex of the marine company functionally is a single whole, its elements are in many respects interconnected technologically and structurally, as well as the developed ocean resources.

When the investments are estimated in compliance with the systematic approach concepts the functional integrity is among the methodological features of the marine company's property complex in comparison with the investments estimation in other branches.

Object of the project optimization by economic criterion is the real asset (for example, a commercial vessel) which can be evaluated as the isolated property complex or the working company. And applicability of the project optimization methods by the economic criterion depends on how accurately the properties of optimized object can be correlated with the properties of the isolated property complex of working marine company. To put it otherwise it matters what properties of the optimized object are more important: economic, functional or technological.

Optimization of the project characteristics by economic criterion is the most effective approach for complex industrial objects for which, owing to the variety of properties

– physical, technological and functional one property cannot be a generalized criterion, and the quantity of properties is transformed to economic quality which is a criterion.

The economic criteria serve as index of efficiency and are determined by mathematical operations on the basic economical indexes: the annual income *I*, operation costs *C*, investments – market value *MV* or other value – with one definition or another, for example the value of a new asset of the marine company, the costs for manufacture of a real asset in market prices – reproduction cost *RC*.

Unlike the annual income *I* and operation costs *C* which characterize distributed in time *t* economic flows of incomes, and expenses, and in economy are determined and summarized usually per a year, investments *MV* or *RC* have one–time or discrete character in time or can be transformed to an estimation of the present value index.

The basic economical indexes and value (*I*, *C*, *MV* or *RC*) in them–selves do not reflect critical judgments, suitable for the choice of optimum decisions at a stage of designing, and are not criteria of a choice in optimization, but they serve to formulate the criteria which mathematically are determined by correlation of the basic indexes.

It is impossible to determine, for example, if it is required or not to choose optimal characteristics of the marine company real asset by the criterion of minimization of the operation costs *C* taken separately from the indexes of: incomes *I* and investments *MV* or *RC*. With varied optimized characteristics it is required to analyze joint change of the basic economical indexes of the marine company asset.

Mathematical operations on the basic indexes in formalizing of the criterion functions reflect critical judgments which are necessary to provide the compromise of advantages and disadvantages when optimizing project characteristics of the marine company's property complex asset.

The correlation between the applied economics and mathematics goes deep with the complexity of expert tasks. For wide consumption the estimation of serial objects can be carried out by the expert methods under the simplified adapted instructions.

The applied economics and some sections of mathematics, such as theory of numbers and sequences, theory of the differential equations, probability theory etc., practically merge in case of estimation of complex objects which include: the functional property complexes of the industrial enterprises with the account the system analysis in time and prospects forecasting; the investment projects, including evaluation of strategy and intangible asset which estimation requires preliminary working out of corresponding economic model of the separate assets, durable and proportional to the enterprise as a whole, for example, marine commercial vessels or batches of vessels for the commercial order, where investments into their manufacture are elements of innovative strategy, etc.

In process of globalization in the industry the convergence of mathematical and economic bases in an expert estimation will proceed.

Formation of global economy should be correlated with the development of the technological pattern of the world, considering, that the core of the pattern is digital technologies. According to the given criterion the formation of the global economy will come by the end by the moment of change of the pattern, that is, when possibilities of the core development will be exhausted, and the basic direction of development will be changed.

As digital technologies are aimed at the artificial intelligence modeling, probably the resource of the development directions will be exhausted and it is necessary to expect

the change of the technological way when the intelligence will be technically sufficiently reproduced.

By this time it will be possible to consider the formation of global economy finished which will be carried out through a digital model of public intelligence. And, possibly, this process will not take a long time, as dynamical processes of formation change can be observed.

The greatest convergence of economy with mathematics will be implemented, when the control of digital processes in networks allows raising globally integration, and economic interaction will be carried out not pair wise, but integrally, that is, each enterprise will cooperate with all global set. The economy thus will become a mathematical model of global strategy, and monetary concepts will be displaced to consumption sphere.

In modern market conditions, typical for the developed states and prior to globalization, investors are separated. At the same time in investment activity it is required to use criteria which are mathematical transformations on the basic economical indexes and allow operating investments with global orientation which is in the fact that that the general concept of efficiency and optimality for all investors are introduced by mathematical transformations on the basic indexes.

Criteria of the optimality, allowing to separate the optimal project characteristics (or the range of the optimum solutions) from not optimum, are a way to use the economic criteria of efficiency which allow to arrange all compared project options in order of preference, that is, in other words the criterion of economic efficiency is a more general economic concept than the criterion of optimality, since it is not required to narrative all options by preference if there is a need to separate only optimum options. The criterion of optimality is a way to use of efficiency criterion.

On the other hand, if to arrange the options by the criterion, then, in case of a limited quantity of options or in case of a limited range of definition of variables the optimum variants will be found as well.

The criterion in the form of a criterion function $f$ is defined depending on varied unknown characteristics of the marine company asset: variables $X$ (that is a vector or a set of variables), params $Y$ and data $Z$ (constants).

The set of variants of the resulted project characteristics investigated for the optimality, means a set of values of variables $X$ (namely, values of vector), and each option is characterized by a certain value of this vector.

The set of variables $X$ is defined as a part of those independent values (that is, independent on each other, on params and constants) which substantially influence the criterion of the marine company's property complex asset optimality.

For example, to optimize economically the commercial vessel project characteristics, a certain value of the vector of variables $X$ corresponds to each option among the compared, and the structure of the vector can include vessel characteristics varied by optimization (in particular, the displacement of commercial vessel, the deadweight, the load–carrying capacity, the tonnage and the power of main engine or the velocity).

Working out of criterion function is inseparably linked and also is accompanied by classification of mathematical values in sets: variables $X$, params $Y$ and data $Z$.

While working out the criterion function $f$ it is supposed, that the metrics is defined, for example, in the form of algorithm according to the influence of an independent values ($X$, $Y$ or $Z$) on the criterion, and it is taken into account, that the structure of the criterion

function which is based on classification of entering values, is developed by successive approximations. The estimation of influence of any entering value on the economic criterion can be made at each step, and working out of criterion function structure comes to end concurrently with performance of optimizing subject and, as a matter of fact, it is solution of this task.

The set of params *Y* is introduced as a part of those independent values, where each of them separately does not influence substantially by the specified metrics on the optimality criterion in the form of criterion function *f*.

For example, the unlimited quantity of economically insignificant for optimization of a commercial vessel design characteristics can be included into set of params, except those which are concern to variables *X*.

For practical purposes the params can be taken structurally, let us assume, according to a technological prototype and can be considered invariable when making project optimization of variables by the economic criterion.

According to system–based principles of project optimization by economic criteria the real asset as part of the marine company's property complex methodologically should be defined as a single whole consisting of the parts. And when connecting the parts in the whole the dialectic principle of «quantity transition into quality» is carried out and the object as a single whole acquires new properties which were absent in parts. For example, if at stage of choice for the commercial order the cargo vessel optimized by economic criterion to consider as a set of two parts – a hull characterized by cargo capacity and a main engine (more exactly, a propulsive complex – a vessel's «running gear») characterized by power, then, when connecting these two parts there appears a new property of the cargo vessel, in particular, carrying capacity which was absent in separate parts.

It is an additional property arising in process of connection of parts of the real asset or the marine company's property complex in a single whole that is a subject of the project optimization by economic criterion, instead of a set of the properties which are in the parts of the asset taken separately.

It should be added, that determination of a complete object as a complex of parts in case of project optimization by economic criterion has a methodological rather the mechanical sense.

Continuing an example concerning cargo vessel, the parts in methodological sense it should be defined more exactly as not a hull and an engine (and so on, with the account inexhaustibility of division), and not separate parts of the hull – a fore, an aft, sides, decks, bottom, bulkheads, details etc., but in each case as all the vessel as a whole, considered from the point of view of one part of methodology or another, that is, from the point of view of separate seaworthy properties and operational characteristics.

In particular, with due account of design methodology the following characteristics can be considered as parts of commercial vessel: buoyancy, that is a commercial vessel as a whole from the point of view of useful physical property of buoyancy (seaworthy property), stability – all vessel from the point of view of physical property of stability, and further: unsinkability, controllability, marine propulsion, life time, manufacturability, etc.

In other words, with due consideration of the systematic approach for the project optimization by economic criterion, the separate functional or technological properties referred for the asset as a whole should be considered as parts of real asset or marine company's property complex.

Since the optimized object is defined as a single whole of parts and its divisibility into parts is inexhaustible, there is a concept of a more general object, part of which is optimized object, and also there is a concept of inexhaustibility of induction, that is, methodological generalizations of optimized objects, by analogy to inexhaustibility of deduction – methodological divisions of objects into parts.

For example, the shipping, the shipbuilding industry, the marine engineering, the marine industrial fishery etc. would be a more general object in project optimization by economic criterion, than a commercial vessel, in methodological sense.

It should be noted that representation of the marine company real asset optimized by economic criterion, as a whole of parts for dialectic definition of the objects properties absent in separate parts and appeared when connecting the parts, leads to definition of hierarchy of the economic models used for project optimization.

Except the economic model of optimized object there supposed to be the models with more general objects, that is, the models of «top levels», as well as economic models of separate parts of the optimized object, more exactly – the separate properties referred to an object as a whole, – the models of the «bottom levels». And as a result of the decision of more general, so–called external subjects of optimization of «top levels» are defined the data set *Z* (constants) which in subjects of «top levels» were optimized variables *X* are defined.

It allows us to formulate the concept of options comparability in process of optimization of the project by the economic criterion, in other words, the concept of similarity of options compared when optimizing the real asset or the property complex of the marine company, that differ by characteristics *X*, and are similar by other characteristics.

The concept of options comparability, which is the options similarity, means, that at the variables *X* range – the combinations of optimized object characteristics compared by the economic criterion – the data *Z*, which are determined as variables *X* in a more general subject of optimization remain unchanged and similar.

It should be added, that in process of detailed elaboration of marine company's property complex into parts and optimization of separate parts, that is in each case of the whole object considered from the point of view of a part of design methodology (the separate functional properties related to the object as a whole), variables *X*, which are determined in optimization of the whole object, become data *Z* in subjects of project optimization of «the bottom levels» for object's parts.

And the structure of variables *X* in subsystems (that is for a commercial vessel or another asset, estimated from the point of view of separate functional property) for subjects of «the bottom levels» is defined among the set of independent characteristics which in optimization of the whole object were params *Y* and were taken expertly, for example, according to a prototype.

Thus, the criterion function *f* in project optimization of the marine company real asset by the economic criterion is defined depending on variables *X*, params *Y* and data *Z*. Thus the comparability of options compared by economic criterion that differ by the values of varied variables *X* is provided.

The criterion function is formalized as an economic model of optimized object which is a sequence of dependences between variables *X*, params *Y* and data *Z*, on the one hand, and the basic economical indexes: the income *I*, the operation costs *C* and investments *MV* or *RC*, on the other hand.

And any of the economic criteria used in optimization in the form of the criterion function *f*, is based on the correlation of the basic economical indexes – the income *I*, the operation costs *C* with the investments *MV* or *RC*.

It's worth mentioning, that the criterion function *f* is a mathematical generalization over the income *I*, the operation costs *C* and investments *MV* or *RC* and is defined depending on variables *X*, params *Y* and data *Z* of optimized object, since the basic economical indexes are defined depending on variables, params and data.

It is necessary to add, that besides the specified economic indexes: *I*, *C* and *MV* or *RC* by which the economic criterion *f* depending on the values of vectors is defined: *X*, *Y* and *Z*, there are also generalized variables (intermediate values), dependent on *X*, *Y* and *Z* that are used in the structure of economic model during optimization.

For example, if in case of vessel optimization the displacement empty *DP* and deadweight *DW* are referred to a number of independent variables *X*, the cargo displacement, which is the sum of deadweight and displacement empty $D = DP + DW$, does not enter in the structure of independent variables and is a generalized variable.

It should be added, that for the applied purposes choose the set of independent variables *X* (vessel characteristics, other real asset or property complex of the marine company), varied in process of optimization by the economic criterion, it is reasonable to use practical recommendations in the form of the following properties of independent variable:

– It substantially influences on the economic criterion of optimality;

– It is not determined unequivocally by other characteristics which are independent variables;

– It is ranged changeable, that is, it differs for comparable variants;

– It has numerical measurement – it is expressed by a real number (that is, the discrete characteristics and non–numerical, as for example vessel class, shouldn't be included in a set of the independent variables varied by optimization).

Usually, when the specified practical recommendations are observed, the criterion function is continuous in the range of definition, smooth in mathematical sense and convex.

The economic criterion functions which can be applied in optimization of vessel project characteristic, other real assets or marine company's property complex are reviewed below without going into details. Besides, the examples of criterion functions practical use are shown in the form of graphs.

**Test questions**

1. Economic definition of the innovative marine industrial activity.
2. Subject of the investments planning when choosing of optimal characteristics the marine company real asset.
3. Object of optimization by the economic criterion.
4. Basic economic indexes.
5. Criteria of efficiency and the criterion of optimality.
6. Ways of economic criteria transformation to the value.

7. The criterion of an economic optimality as a way of general and comparative efficiency indicators application.

8. Criterion function and the economic model.

9. Definition of the structure (set) of variables for optimization.

10. Signs of the set of params.

11. Systematic approach and comparability of options in case of optimization by the economic criterion.

12. Definition of the data set (external data).

13. Practical recommendations for definition of the independent variables set.

## 22.2. Economic criteria of characteristics optimization of vessel or property complex of the marine company for the commercial order, based on costs minimization

**The criterion of the discounted costs** (the specific costs as discounting of operation costs and investments by the discounting rate *i*) with the assumption of set life time *T* of the marine company real asset in the form of criterion function is defined as

$$f(X,Y,Z) = (1+i)^{1/2} \times \sum_{t=1}^{T} C_t(X,Y,Z)/(1+i)^t + MV(X,Y,Z) + OC(X,Y,Z) \times (1\text{-}1/(1+i)^T).$$

In other mathematical equations in definition of the criterion functions the symbols of variables *X*, params *Y* and data *Z* are omitted for brevity. Despite the fact that in symbols of indications of the arguments are omitted, all used indexes and economic criteria are functions of arguments *X*, *Y* and *Z*.

The discounted costs is a minimized criterion of comparative efficiency, that is among the comparable variants of vessel characteristics for the commercial order or other marine company real asset from the set *X* the best is the option to which there corresponds the minimum value of the discounted costs.

The economic criterion of the discounted costs means the present value of investments into the construction *RC* of a commercial vessel or an other real asset or the marine company's property complex, which optimal characteristics are determined by this criterion, into the equipment of commercial vessel or replenishment of working assets of the marine company at a rate of *OC* and in productive operation of an asset – at a rate of cash flow of annual operation costs *C*. And in case of investing in manufacture of a new vessel or other asset of the marine company the discounted costs are defined in the form of criterion function as

$$f = (1+i)^{1/2} \times \sum_{t=1}^{T} C_t/(1+i)^t + RC + OC \times (1\text{-}1/(1+i)^T). \qquad (22.1)$$

The minimized criterion of the discounted costs can be named as a criterion of the present worth (value) also. But in view of terminology of economic methodology the «costs», instead of «worth (value)» is more correct, since the economic value index is a characteristic of investments into assets which in this case are in the commercial turnover– are on sale, transferred in rent, invested, pledged etc

The asset in turnover should be evaluated, as a rule, by two parties, and one of the investors has a concern in expenses, in one form or another connected with an asset, and

the second one has a concern in incomes and profit. Therefore from the various points of view – both standard and methodological – it is not quite correct to call an index «the value» which is account only the expenses, as, for example, the criterion of the discounted costs.

Besides application of the partial sums (22.1) from the formal–logic point the economic criteria and indexes of the present value can be defined by integrated summation. For example, the criterion of the discounted costs can be defined by integrated summation as

$$f = \int_0^T \frac{C(t)dt}{(1+i)^t} + RC + OC \times (1\text{-}1/(1+i)^T),$$

where $C(t)$ – the distributed in time intensity of operation costs cash flow.

However, as in applied economics cash flows are usually summarized annually, it is preferable to determine the criteria by discrete summation of the discounted cash flows, instead of integration, in particular, because for integrated summation there will be difficulties when defining data – the distributed intensities of cash flows.

With an assumption at a stage of project optimization by the economic criterion for the commercial order of a new vessel with the account the assumption of enough big life time $T$ when $1/(1+i)^T \approx 0$, and also with the account the assumption that in the present prices the operation costs $C$ do not vary in time the criterion function in the form of the present worth is defined as $f = C/i + RC + OC$ and in the specified form usually is called the criterion of the discounted costs.

When the system concepts of options comparability are observed, the criterion function can be applied for the project optimization of commercial vessel or other marine company asset in the form of the specific discounted costs – per unit of effect $Q$, that is as $f = (C + (RC + OC) \times i)/Q$.

For example, in case when the deadweight $DW$ and the power of the main engine $Ne$ are chosen as variables at a project optimization stage of a marine fishing vessel by economic criterion characteristics, the costs into manufacturing $RC$ considerably exceed the expenses in equipment and supply – working assets (that is, if we neglect working assets $OC$ as a part of optimality criterion), and the volume of annual catch as effect $Q$ is defined, the criterion of the specific discounted costs transformed with the account listed assumptions on the basis of the economic criterion of discounted costs can be expressed as the criterion function :

$$f = (C(DW, Ne) + RC(DW, Ne) \times i)/Q(DW, Ne),$$

and generally with the account the possibility of the commercial vessel order at the pre–owned market

$$f = (C(DW, Ne) + MV(DW, Ne, t) \times i)/Q(DW, Ne).$$

In the general subject of effective investments planning in the marine industrial activity, considering, that the commercial order for manufacturing of the vessel (that is, the purchase of commercial vessel from the manufacturer under the condition of branch transfer between shipbuilding and shipping) is a special case of the commercial order at the pre–owned market when investments are estimated by the parties by the market value, the criterion component is not a reproduction cost $RC$ of the commercial vessel or other

real asset of the marine company, and the market value *MV*, irrespectively of age, even for a new vessel, differs from reproduction cost *RC* by the adjustment value by the economic obsolescence $D_5$ (see paragraph 9) external influence taking into account the cause of the external influence wear explained as the parties difficulties to sell a newly manufactured vessel from a batch, shifted to the seller, and on the basis of the specific risks analysis (paragraph 18.2) for the option of purchase of the vessel at the pre–owned market which is not a batch vessel with optimal characteristics.

There is a dialectic interrelation between indexes: on the one hand, an estimation of difficulties in case of the purchase of a new vessel from a modern batches, on the other hand, clearing from certain risks which would arise in case of the purchase of the vessel at the pre–owned market.

As an example it is possible to present the criterion function in expanded form in order to determine the fishing vessel's optimum characteristics by the economic criterion.

The formula presented below for an illustrative example with use of the certain data and macro–economical indexes is the basic economic model of fishing vessel corresponding to a general form of the economic criterion of discounted costs (22.1), that is, the simplest model, suitable for the further detailed elaboration which, nevertheless, is formalized on the basis of systematic approach concepts application and reflects the influence of data, vessel characteristics, particulars and params for economical indexes and criterion:

$$f \approx 4{,}33\times(0{,}048\times DW+0{,}0036\times Ne+17{,}5\times(10+Q)+0{,}443\times Ne\times(2\times L_R/(24\times$$
$$\times(17{,}8\times Ne/DW^{0{,}54})^{0{,}403})+0{,}063\times DW/q_{G2}+0{,}429\times DW/Q)/(0{,}571\times DW/Q+$$
$$+2\times L_R/(24\times(17{,}8\times Ne/DW^{0{,}54})^{0{,}403}+0{,}629\times DW/q_{G2}))+4{,}83\times DW+0{,}36\times Ne+$$
$$+[0{,}048\times DW+0{,}0036\times Ne+17{,}5\times(10+Q)]\times(0{,}571\times DW/Q+2\times L_R/(24\times$$
$$\times(17{,}8\times Ne/DW^{0{,}54})^{0{,}403})+0{,}629\times DW/q_{G2})/335+0{,}443\times Ne\times(2\times L_R/(24\times$$
$$\times(17{,}8\times Ne/DW^{0{,}54})^{0{,}403})+0{,}063\times DW/q_{G2}+0{,}429\times DW/Q)/335$$

thousand US dollars / t.

Other criteria of economic efficiency and criterion functions considered below in the form of basic models in view of optimization by economic criteria of marine vessel characteristics for the commercial order have the similar expanded form.

The form of criterion function of the specific discounted costs for an example of optimization of fishing vessel project characteristics, cargo vessel and for a choice of cargo vessel at the pre–owned market is shown on charts (fig. 22.1–22.3).

It should be explained, that the dependences of the basic indexes on variables are not considered in the given text though they are rather difficult when formalizing and data substantiation.

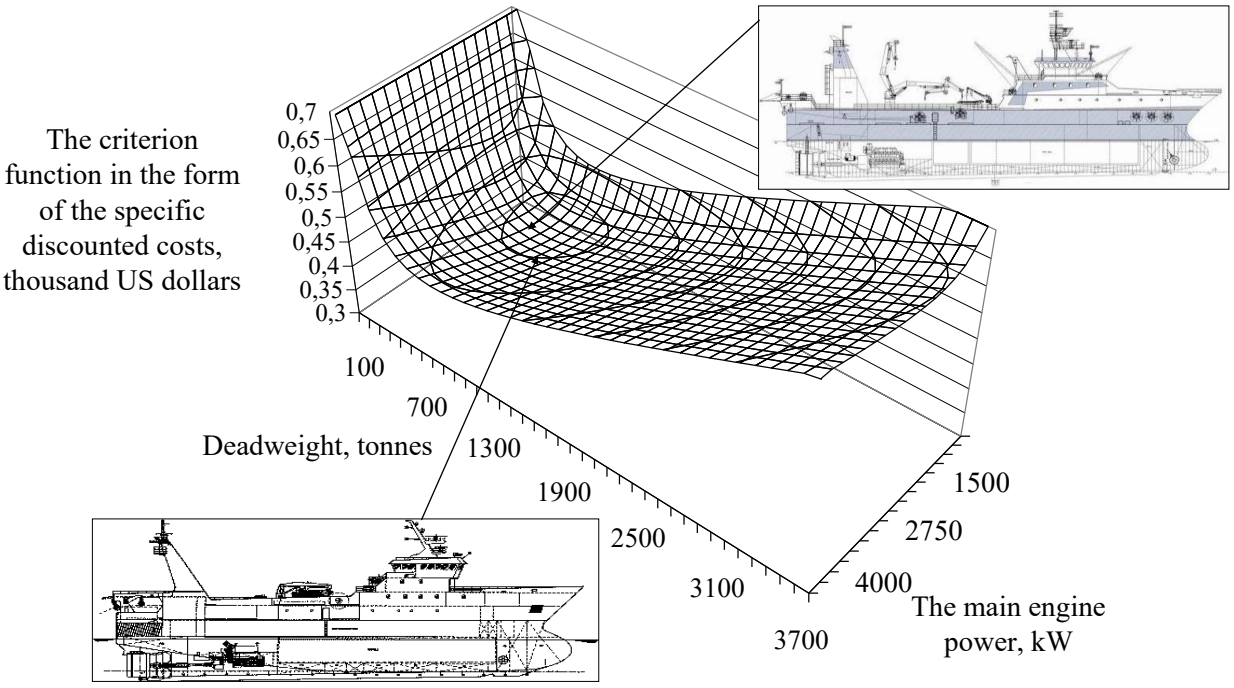



Fig. 22.1. The criterion function in the form of the specific discounted costs for the fishing vessel (the data: the distance to a fishery district 1500 nautic miles; the fishing vessel productivity 50 tonne/day)

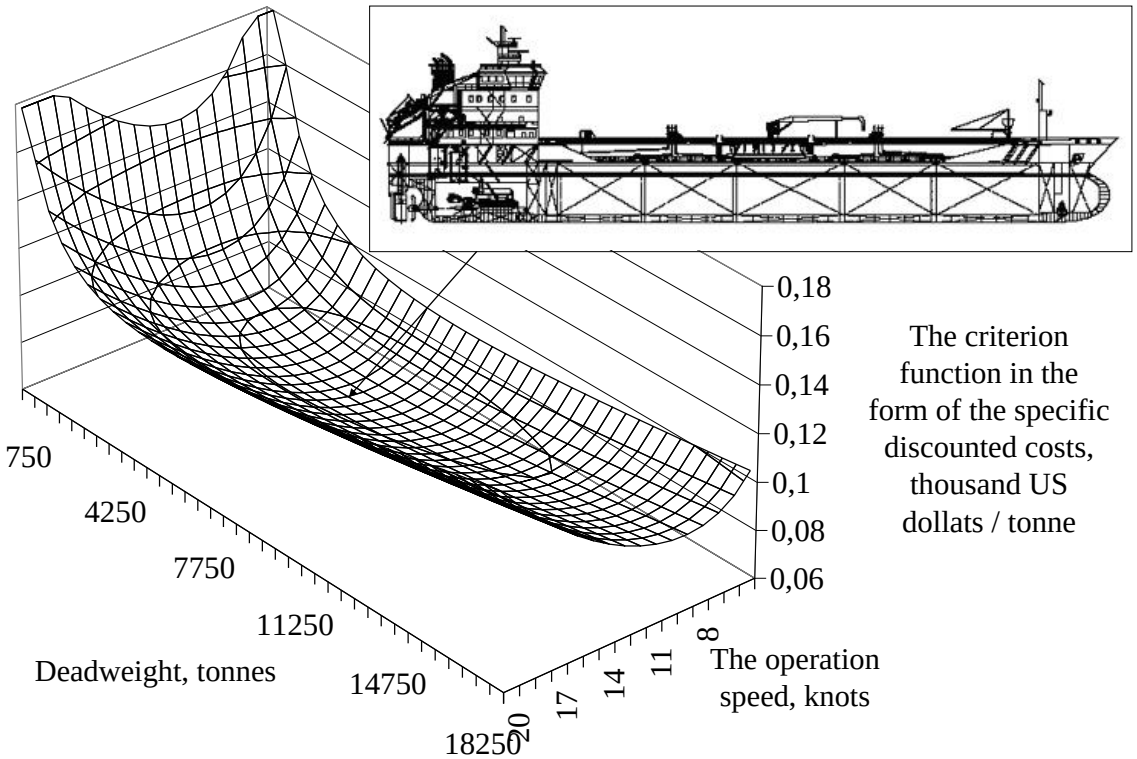



Fig. 22.2. The criterion function in the form of the specific discounted costs for commercial cargo vessel

In details the formalization of the dependences of the basic indexes on vessel characteristics is stated in the specialized literature on the economic optimization subject of marine commercial vessels characteristics [12].

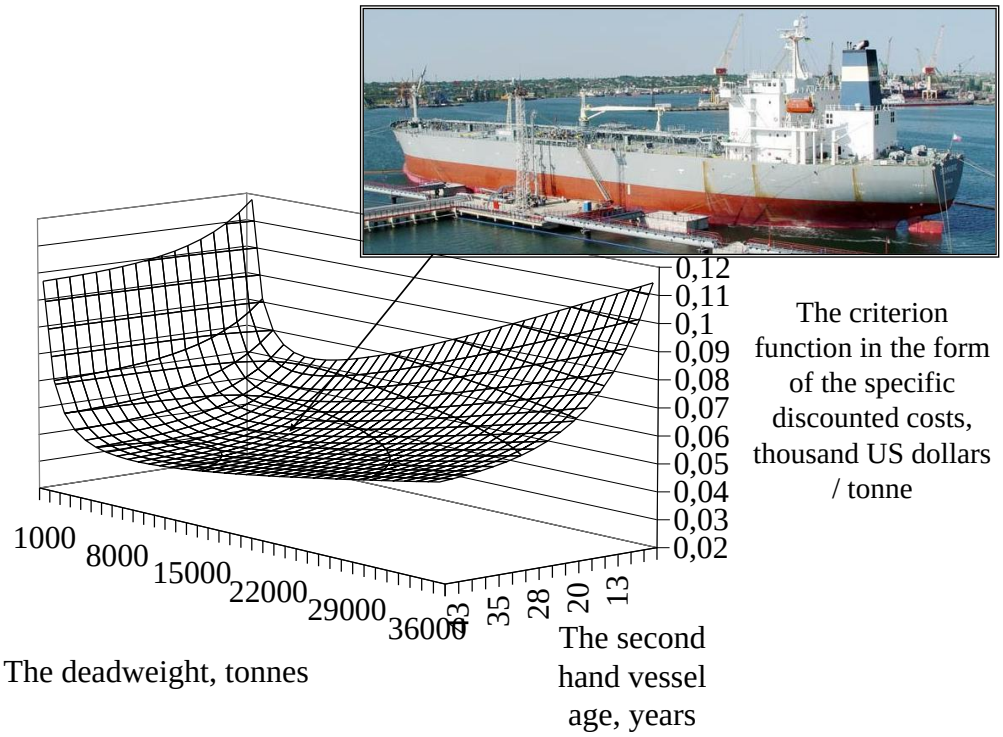



Fig. 22.3. The criterion function in the form of the specific discounted costs of second hand commercial cargo vessel

And the economic model used in project optimization of the marine company real asset consists of dependences for determination of the basic indexes: $I(X,Y,Z)$, $C(X,Y,Z)$, $RC(X,Y,Z)$, and also effect $Q(X,Y,Z)$ and from the dependence of one criterion or another in the form of the criterion function on the basic indexes.

The basic indexes in themselves: the income *I*, the operation costs *C* and investments *MV* (or *RC*), – do not reflect critical judgments, suitable for a choice of optimum results in investment planning. For example, it is impossible to determine, whether it is necessary to reduce the operation costs *C* or not, since much depends on how the index of the income *I* thus will change.

The concepts of efficiency, expediency and utility are introduced by mathematical operations on the basic indexes when formalizing of one economic criterion or another in the form of the criterion function, and judgments about economic efficiency depend on mathematical operations.

For effective expert activity in applied economics good knowledge of mathematical analysis, including theory of numbers, exponential functions and their properties, differential and integral calculus, probability theory, and also mathematical statistics and computer science in the program of a university course for economists is required. It does not mean that the expert in the field of economy carries out mathematical derivations directly in his expert work, but it is required, that mathematical generalizations were competently

used in the economic calculations and the expert was capable to reproduce the derivation of the used formulas.

Besides the basic indexes the mathematical equations of criteria also include macroeconomic index of the discounting rate *i* which is an economic indicator of commercial risk and is usually estimated per year (in this sense the symbol *i* does not mean the mathematical imaginary unit).

For innovative economy in the countries that mostly carry out the construction of new vessels and marine engineering, instead of the assets operation bought at the pre–owned market, the limited values of risks according to the discounting rate *i* in a range from 0.05 to 0.25 (from 5 to 25 %) are characteristic.

The criterion of the discounted costs exponential function of The Euler' number (*e* = 2.71828283 ...) it is defined as

$$f = e^{i/2} \times \sum_{t=1}^{T} C_t \times e^{-i \times t} + MV + OC \times (1\text{-}e^{-i \times T}) .$$

Assuming at a stage of commercial vessel project optimization or other asset of the marine company, that in the present prices the operation costs do not vary by years – *C* = const, the criterion function of the discounted costs can be presented as:

$$f = C \times (1+i) \times (1\text{-}1/(1+i)^T)/i + RC + OC \times (1\text{-}1/(1+i)^T , \qquad (22.2)$$

or $f = C \times e^i \times (1\text{-}e^{-i \times T})/i + RC + OC \times (1\text{-}e^{-i \times T})$ – on condition of discounting by exponential function of The Euler' number.

When formalizing the criterion function for the analysis of expediency of commercial vessel purchase at the pre–owned market, in view of the fact that the reproduction cost *RC* of commercial vessel is not used as a part of specific discounted costs criterion, the market value *MV* is used with the account depreciation (see paragraph 8.1) by the formula

$$(1 - D_2) \times (1 - D_4) = 0.0086 \times ((1 + 0.09)^{53-t} - 1)^{1.044} .$$

The economic advantages of not a new vessels operation, which value is less than the value of newly constructed vessels, are accompanied by the additional risks, and the expert decision concerning the comparative evaluation of economic advantages and additional risks is required.

**The minimized criterion of the required freight rate** characterizes the income *I* per unit of effect *Q*, necessary for investments compensation for manufacture of the commercial vessel or other asset of the marine company or purchase at the pre–owned market *MV*, for equipment *OC* (replenishment of the working assets), compensation of the operation costs *C* during the period of productive operation and the net operating income (or profit) for the rate corresponding to interests of the investor and equal, in particular, to the macroeconomic index of total risks according the discounting rate *i*.

The criterion of the required freight rate in the form of the criterion function is defined as

$$f = (1+i)^{1/2} \times i \times (\sum_{t=1}^{T} C_t /(1+i)^{t-1} \times (1 - 1/(1+i)^T) + (MV + OC \times (1 - 1/(1+i)^T))) / Q , \qquad (22.3)$$

or for the discounting by the exponential function of The Euler' number

$$f = e^{i/2} \times i \times (\sum_{t=1}^{T} C_t \times e^{-i\times(t-1)} / (1 - e^{-i\times T}) + (MV + OC \times (1 - e^{-i\times T}))) / Q.$$

Assuming for the commercial vessel or other real asset of the marine company, that in present prices the operating costs are constants – $C_t = C = const$, it is possible to represent the criterion of the required freight rate in the form of the criterion function as $f = (C + (MV + OC) \times i) / Q$, that corresponds to the economic criterion considered above in the form of the specific discounted costs.

**Test questions**

1. Practical recommendations for determination of the set of independent variables definition.
2. Criterion of the discounted costs (the formula derivation).
3. Advantages of cash flows discrete summation.
4. Transformation of the discounted costs criterion to the criterion of the resulted costs (the formula derivation).
5. Application of discounting by exponential function of the Euler' number in economic criteria (the formula derivation).
6. Methodological assumptions in case of use the economic criteria for optimization of the vessel characteristics or other asset of the marine company.
7. Criterion of internal rate of return (the formula derivation).
8. Macroeconomic index of total risks according to the discounting rate and the real interest rate.
9. Relative property of commercial vessel economic life time or other asset of the marine company with the account payback and the macroeconomic index of commercial risks.

## 22.3. Optimality criteria of commercial vessel project characteristics, assets or property complex of the marine company, based on an estimation of profitability indexes

**The criterion function of the internal rate of return** *IRR* is defined as

$$f = ((1+i)^{1/2} \times \sum_{t=1}^{T} (I_t - C_t) / (1+i)^t + Rv / (1+i)^T) / (MV + OC \times (1\text{-}1/(1+i)^T)) - 1, \quad (22.4)$$

or for the discounting by the exponential function of The Euler' number

$$f = (e^{1/2} \times \sum_{t=1}^{T} (I_t - C_t) \times e^{-i\times t} + Rv \times e^{-i\times T}) / (MV + OC \times (1\text{-}e^{-i\times T})) - 1,$$

where *Rv* is a reversion – the additional income from resale of the commercial vessel, other real asset or the property complex of the marine company at the pre–owned market or for scrap at the end of productive operation.

Assuming for commercial vessel, other asset or property complex of the marine company, that the net operating income in the present prices is constants –

$I_t - C_t = I - C = const$, it is possible to present the criterion of the internal rate of return in the form of criterion function as

$$f = ((I - C) \times (1 + i) \times (1\text{-}1/(1 + i)^T)/i + Rv/(1 + i)^T)/(RC + OC \times (1\text{-}1/(1 + i)^T)) - 1, \qquad (22.5)$$

or $f = ((I - C) \times e^i \times (1\text{-}e^{-i \times T})/i + Rv \times e^{-i \times T})/(RC + OC \times (1\text{-}e^{-i \times T})) - 1$ – for the discounting by the exponential function of The Euler' number.

If to assume that at a design stage the life time *T* is rather large, when $1/(1 + i)^T \approx 0$, the influence *Rv* of the reversion on the economic criterion can be neglected.

The index of the internal rate of return *IRR* which for new asset corresponds to the relation of the net operating income *NOI* of the productive operation of commercial vessel, other real asset or property complex of the marine company to the present value of investments $MV + OC$, for project optimization is compared with the «real» interest rate.

The relation of the rate of discounting *i* to the factor of discounting $(1 + i)$, is used as a real interest rate, that is, the real interest rate means, figuratively speaking, «depreciated» for a year, that is, «discounted» rate of discounting $i/(1 + i)$.

The economic criterion of the internal rate of return is a maximized index of general efficiency of the commercial vessel or other real asset.

For new vessel, other real asset or the property complex of the marine company in case of sufficient life time with the account neglected of reversion *Rv* and with the account assumptions, that in present indexes the net operating income is constant – $I_t - C_t = I - C = const$, the criterion function in the form of criterion of internal rate of return is defined as

$$f = (I - C) \times (1 + i)/(i \times (RC + OC)) - 1, \qquad (22.6)$$

or $f = (I - C) \times e^i/(i \times (RC + OC)) - 1$ – for the discounting by the exponential function of The Euler' number.

The form of the criterion function for an example of characteristics optimization for the commercial order of a new fishing vessel by the criterion of internal rate of return is shown at the charts: (fig. 22.4), for crude cargo vessel (fig. 22.5), for cargo vessel at the pre–owned market (fig. 22.6).

For estimations when investing in the purchase at the pre–owned market there is an expert problem of correlation of additional risks with planned indexes of efficiency, which for the pre–owned market are substantially higher.

And efficiency of investments at the pre–owned market increases (fig. 22.6) in the relative value owing to the depreciation of the vessels or other assets over the time, and risks of investing thus grow.

The estimation of growing risks balance and estimated indexes of efficiency is required. Apparently, in some cases it should be recommended to limit the efficiency with a view of decrease of investment risks.

At the same time, there are companies which bought not new vessels on regular basis, and this activity with the account the ability of their managers to strategic planning, generally gave the positive results.

It should be specified, that strategic planning usually is aimed at the reduction of risks in conditions when the basic branch activity involves commercial risks.

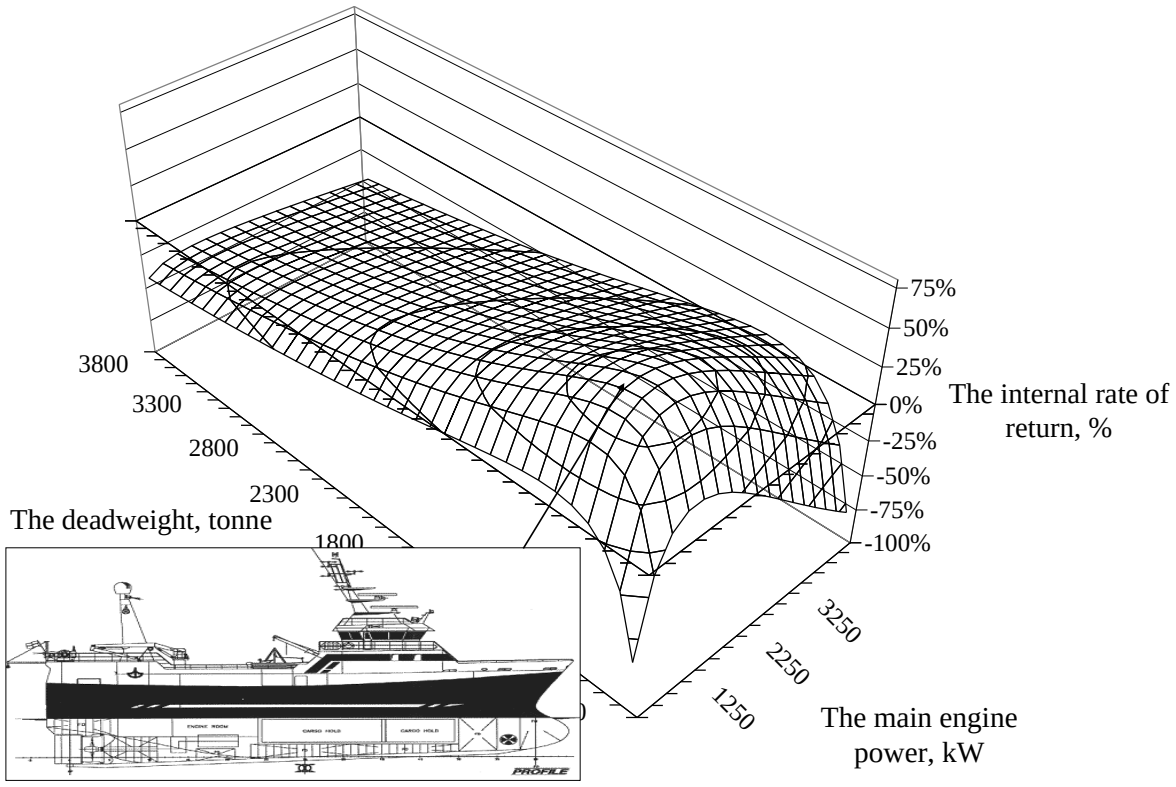



Fig. 22.4. The criterion function as the internal rate of return for fishing vessel

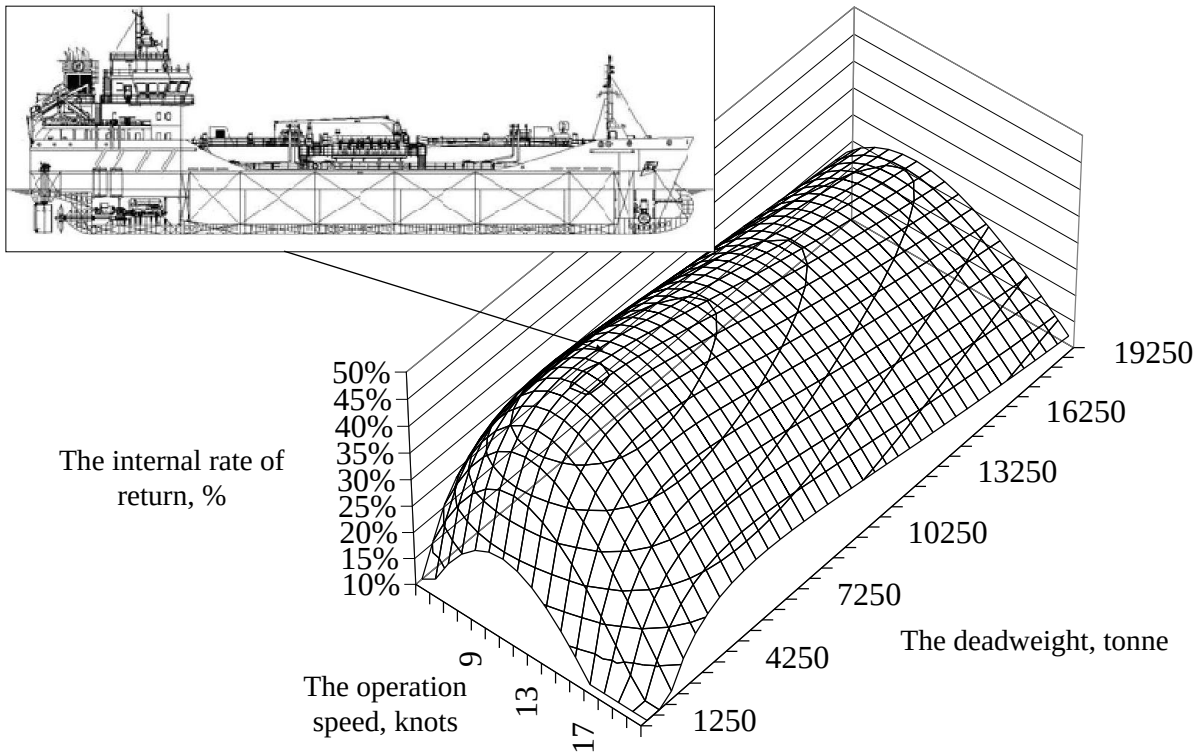



Fig. 22.5. The criterion function as the internal rate of return for commercial cargo vessel

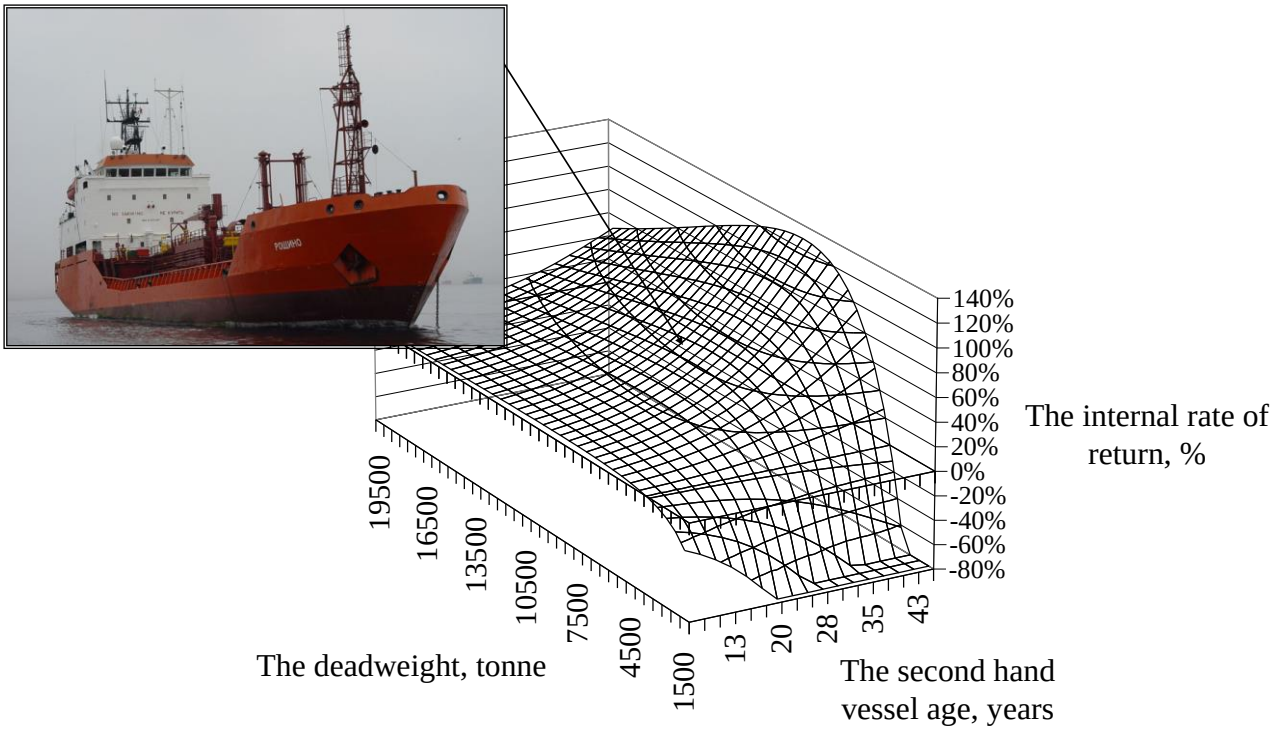



Fig. 22.6. The criterion function as the internal rate of return for the second hand commercial cargo vessel

For example, if the source of income and profit is the purchase and use of not a new vessels before the decommission in the productive operation, the recommended object of innovative investment can be the development of shipbuilding, that, by the way, corresponds to the above mentioned example of Onassis' activity, that is, the preferable object of investment is usually located in adjacent economic and branch space in relation to the basic industrial profile activity, to be exact, the preferable object of investment is an economic reflexion of branch activity.

On the other hand, the strategic planning and investments management in other part of the activity is more difficult professional work than only determination of the general direction of investment.

In particular, there is a need for estimation of proportions between investment and branch (industrial profile) activity, to be exact, planning of these proportions in the long term, up to a choice of characteristics and particulars, and also sequence of vessels planned to be constructed etc. if to continue the example.

It should be noted that economic life time $T$ of assets is a relative concept and it depends on total commercial risks *i*. It is possible to define, for example, the life time in relation to a payback period of investments $T_R$, which, in turn, is defined by the index of internal rate of return, that is $T_R = 1/IRR$, which correlated with macroeconomic index of risks – with the discounting rate *i*.

In each task of estimation of the value and efficiency of investments the question of life time determination requires rather detailed studying. In case of the limited life time of the marine company real asset if assumption $1/(1+i)^{T_R} \approx 0$ is unacceptable, let us assume, if owing to economic stability the sum of commercial risks *i* is small, or the index of life time *T* is related to the expenditure of the limited resource, for example quotas of

ocean biological resources, stocks of a deposit or fuel stocks in a single–use energy source etc., and for the specified reason the index of life time *T* is included into number of optimized variables *X*, then when determining the internal rate of return the relation of the present value of the profit cash flow $p = NOI - f_m$ to the value of investments is taken as a maximized index of comparative efficiency, rather than the relation of the net operating income *NOI* to present value of investments $MV + OC$.

Keeping in mind the infinite sequence of the cycle – the manufacture of the marine company asset through the investments *MV*, the equipment by means of working assets *OC*, the productive operation with extraction of the cash flow of net operating income $NOI_t = I_t - C_t$, recycling or resale at the pre–owned market at the value corresponding to the reversion *Rv*, and multiply repetition of the specified cycle due to deductions from the net operating income for the replenishment of spent investments, then while determining the profit present values of cash flow it is required to subtract the value of so–called «the capitalized costs» $(MV + OC - Rv/(1+i)^T)/c(T,i)$, where $c(T,i)$ – the factor of investments capitalization as a part of the criterion on the basis of a sequence estimation: vessel construction (or other real asset of the marine company) or purchase at the pre–owned market, productive operation, recycling, reinvestment, remanufacturing and multiply repetition of the specified cycle, – is defined as $c(T,i) = (1+i)^T/((1+i)^T - 1)$, or $c(T,i) = e^{i\times T}/(e^{i\times T} - 1)$ – for the discounting by the exponential function of The Euler' number from the present value of cash flow of the net operating income

$$(1+i)^{1/2} \times \sum_{t=1}^{n\times T, n\in N=1,2,\ldots,\infty} (I_t - C_t)/(1+i)^t .$$

The criterion of the internal rate of return determined with the account limited life time of the commercial vessel or other asset of the marine company on the basis of modeling of the profit cash flow, can be presented in the form of thecriterion function as

$$f = \frac{(1+i)^{1/2} \times \sum_{t=1}^{n\times T, n\in N=1,2,\ldots,\infty} (I_t - C_t)/(1+i)^t - (MV - Rv/(1+i)^T)/c(T,i) - OC}{MV + OC}, \tag{22.7}$$

or for the discounting by the exponential function of The Euler' number

$$f = \frac{e^{i/2} \times \sum_{t=1}^{n\times T, n\in N=1,2,\ldots,\infty} (I_t - C_t)\times e^{-i\times t} - (MV - Rv\times e^{-i\times T})/c(T,i) - OC}{MV + OC}.$$

Assuming for the commercial vessel or other real asset of the marine company, that in the present prices the net operating income is constant – $I_t - C_t = I - C = const$, the criterion of the internal rate of return introduced with the account limited life time on the basis of modeling of the profit cash flowcan be transformed as:

$$f = ((I - C)\times(1+i)/i - (MV - Rv/(1+i)^T)/c(T,i) - OC)/(MV + OC), \tag{22.8}$$

or for the discounting by the exponential function of The Euler' number

$$f = ((I - C)\times e^i/i - (MV - Rv\times e^{-i\times T})/c(T,i) - OC)/(MV + OC).$$

**The criterion of the net present value** *NPV* is a maximized index of efficiency.

For commercial vessel, other real asset or property complex of the marine company at the manufacture stage, including designing and economic optimization of characteristics, the criterion of the net present value is determined in the form of the criterion function as

$$f = (1+i)^{1/2} \times \sum_{t=1}^{T} (I_t - C_t)/(1+i)^t + Rv/(1+i)^T - MV - OC \times (1 - 1/(1+i)^T), \qquad (22.9)$$

or for the discounting by the exponential function of The Euler' number

$$f = (1+i)^{1/2} \times \sum_{t=1}^{T} (I_t - C_t) \times e^{-i \times t} + Rv \times e^{-i \times T} - MV - OC \times (1 - e^{-i \times T}).$$

In the assumption, that – $I_t - C_t = I - C = const$, the criterion of the net present value can be transformed to:

$$f = (I - C) \times (1+i) \times (1 - 1/(1+i)^T)/i + Rv/(1+i)^T - MV - OC \times (1 - 1/(1+i)^T), \qquad (22.10)$$

or for the discounting by the exponential function of The Euler' number

$$f = (I - C) \times e^{i} \times (1 - e^{-i \times T})/i + Rv \times e^{-i \times T} - MV - OC \times (1 - e^{-i \times T}).$$

The form of the criterion function for an example of fishing vessel optimization by the criterion of net present value is shown on the chart (fig. 22.7).

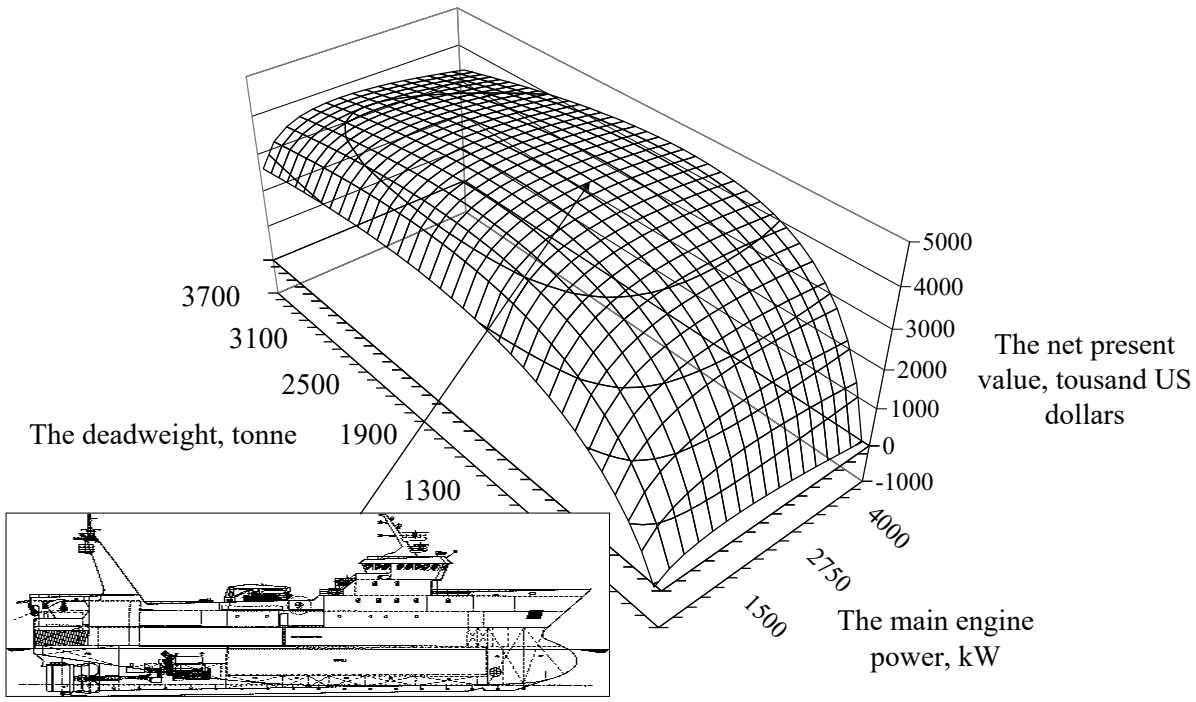



Fig. 22.7. The criterion function as the net present value for fishing vessel (data: the extent to fishery grounds1500 nautic miles, the fishing vessel productivity 50 tonne/day)

The criterion of the net present value defined with the account the limited life time of commercial vessel or other asset of the marine company on the basis of modeling of profit cash flow, it is possible to present in the form of the criterion function as:

$$f = c(T,i)\times(1+i)^{1/2}\times \sum_{t=1}^{n\times T, n\in N=1,2,\ldots,\infty}(I_t - C_t)/(1+i)^t + Rv/(1+i)^T - MV - c(T,i)\times OC, \quad (22.11)$$

or for the discounting by the exponential function of The Euler' number

$$f = c(T,i)\times(1+i)^{1/2}\times \sum_{t=1}^{n\times T, n\in N=1,2,\ldots,\infty}(I_t - C_t)\times e^{-i\times t} + Rv\times e^{-i\times T} - MV - c(T,i)\times OC.$$

Assuming for commercial vessel or for other real asset of the marine company, that in the present prices the net operating income is constant – $I_t - C_t = I - C = const$, the criterion of the net present value introduced with the account of limited life time of real asset of the marine company on the basis of modeling of profit cash flow, can be transformed:

$$f = c(T,i)\times(I-C)\times(1+i)/i + Rv/(1+i)^T - MV - c(T,i)\times OC, \quad (22.12)$$

or for the discounting by the exponential function of The Euler' number

$$f = c(T,i)\times(I-C)\times e^{-i}/i + Rv\times e^{-i\times T} - MV - c(T,i)\times OC.$$

As for the possibility of use of the criteria which have been not expressed by economical indexes for optimization of characteristics, for the commercial order of vessel or other real asset of the marine company or when optimizing the investments into property complex, for example, the criteria of the minimized weight of commercial vessel structures or the minimized displacement, maximized cargo capacity or tonnage, operational speed, propulsive factor, carrying capacity, etc., it should be noted that applicability of these or similar criteria should be estimated from positions of conformity of the results of characteristics optimization by these criteria which have not been expressed by the economical indexes, and results of optimization by a certain economic criterion.

From the system point of view it is impossible to choose, for example, vessel characteristics only from the point of view of the minimum weight of the hull (let us suppose, in relation to cargo capacity). It is important at what price the weight of the hull is minimal. After all the unacceptable recommendation can appear result to make the hull of the excessively expensive material, though easy and strong (the titan, the carbon fiber–plastic, etc.).

As for the application of optimality criterion, which is not an economic index, there supposed to be a general economic criterion in relation to which it is possible to judge about applicability of the «not economic» criterion then the specified general economic criterion is valid. Thus there is a question, why there is a need for the second criterion which has been not expressed economically.

At the same time the criteria which have not been expressed by economic indexes can be applied to optimization of characteristics for the commercial order of marine engineering objects of separate kinds if the applicability of these criteria and their conformity to the general economic criterion is a settled result of the usual experience.

**Test questions**

1. Criterion of the internal rate of return for optimization of the commercial vessel

or other asset of the marine company for the commercial order (the formula derivation).

2. Criterion based on indexes of profit and capitalized costs with the account the limited life time of the commercial vessel.

3. Economic criterion of the net present value (the formula derivation).

4. Criterion of the net present value determined with the account the limited life time of the commercial vessel (the formula derivation).

5. Possibility of application of the criteria which is not expressed by economic indexes for estimation of efficiency and for comparison of variants of investment in marine industrial activity.

## 23. Marine company economic optimality in case of uncertainty of the investment objective or data

The economic efficiency and optimality of the characteristics for the commercial order of the commercial vessel or other real asset as a part of the property complex of the marine company when working out the investment project and in case of comparative estimation of the options is connected with the concept of economic multicriteriality when there is indeterminate of the purpose or data.

So the generalized (complex) criteria of optimality which unite particular criteria should be formulated and used. And each of particular criteria, in turn, is put in conformity of one of the possible purposes of the investor under condition of objective uncertainty.

The same applies to the data certainty – to a so–called situational uncertainty: the criterion is put in conformity to each combination of external conditions (data).

Uncertainty is considered as formally irremovable factor, and formalization of the generalized criteria requires participation of the expert. And uncertainty, as an ineradicable factor, also appears in process of coordinating the results of evaluation of the commercial vessel, other asset or the property complex of the marine company by independent approaches.

In spite of the fact that there is a set of expert recommendations how to generalize independent approaches results of value estimation, at the same time there is no and cannot be any materialistically strict demonstrative formal methods of coordination results, and difference of results is a consequence of difference of the purposes and data sets for each of independent approaches for value estimation.

### 23.1. Causes of the objective and situational uncertainty resulting in the economic multicriteriality

The cause of the purpose or situational uncertainty which usually leads to multicriteriality is considered to be a breakdown of connections between economic models of various levels within the limits of the systematic approach. In applied tasks the broken connections usually are replaced with expert opinions.

To apply the generalized criteria of optimality it is required, in particular, that the generalized particular economic criteria should have methodologically similar sense

coinciding with the resultant generalized criterion, for example the general time scale, similar dimension and so on.

Besides, all local economic efficiency criteria as a part of the generalized criteria should have a conterminous order of preference; they should be simultaneously maximized or minimized.

At the same time when there is an uncertainty of data there is no need to transform local economic criteria to a similar form for use as a part of the generalized criterion, since particular criteria are homogeneous in itself, and difference of their values is connected with ambiguity of data.

Conformity of the methodological sense of local economic criteria as a part of the generalized criterion in case of objective uncertainty certainly is fulfilled, if particular criteria are presented in the form of investments (value) as a part of the generalized criterion expressed as value.

It is necessary to pay attention that all economic criteria which can be applied to optimization of characteristics for the commercial vessel order, other asset or property complex of the marine company, contain in the structure the index of investments *MV* (or *RC*) which therefore can mathematically be derived on the basis of any economic criterion.

As the basic economical indexes: the income *I*, operation costs *C* and investments *MV* (or *RC*), – do not reflect critical judgments, suitable for choosing optimum solutions, and are not the criteria of choice in optimization, but serve to formulate the criteria which mathematically are determined by correlation of the basic indexes, it should be noted that concepts of efficiency, expediency and utility are introduced by mathematical operations on the basic indexes for formalization of one criterion or another in the form of criterion function. And if mathematically to derive investments *MV* (or *RC*) from any criterion the unequivocal conformity of mathematical actions which in one case leads to generalization of the basic indexes to criterion of efficiency will remain, and in other case – to generalization of the basic indexes and criterion to the value index (investments), thus the criterion is derived into restriction.

On the other hand, as critical judgments about efficiency of commercial vessel, other asset or property complex of the marine company are formed by mathematical operations on the basic indexes (*I*, *C* and *MV* or *RC*), the determination of investments (value index) depending on other indexes and criterion by the same mathematical operations contains not less data about mathematical structure of economic criterion, appropriate to fine a compromise in process of optimization.

For the multiobjective optimization and formulation of the generalized criteria of efficiency of marine company real asset the preliminary mathematical transformation of each of particular criteria to the form of value (investments) eliminates possible subject discrepancies of generalized particular criteria, in particular possible discrepancies of dimension, time scale and order of preference.

Besides uncertainty of data or purpose, the reasons of two–criterial property of optimality of the commercial vessel, other asset or property complex of the marine company can be in the methodological duality of optimality criterion from the economic point of view, since there should be a preference to optimize the choice and comparison of options with both an economic environment, and with comparable options.

For example, in case of indeterminate of investor's motives to maximize of internal rate of return, which is the criterion of general efficiency of commercial vessel, other asset or property complex of the marine company in relation to a macroeconomic environment,

or to minimize the costs (resulted or discounted) which characterize the comparative efficiency, the specified criteria should be generalized in a compound criterion.

But first, it is required to transform the particular criteria to a homogeneous kind, let us assume, to express the value (investments) on the basis of particular criteria of the internal rate of return and the discounted costs, and then to combine these particular criteria expressed in the value, as parts of the generalized complex criterion which also will be expressed as value.

For the subsequent generalization as a part of the complex criterion the economic criterion of the discounted (resulted) costs determined with the account the introduced assumptions should be transformed $f_1 = C/i + MV_1 + OC$,
to the form of the value (investments) as $MV_1 = f_1 - C/i - OC$.

Economic determination of the value index by transformation of the criterion of the discounted costs means the evaluation of investments which are justified in relation to average market discounted costs $f_1$ for comparable investments into the commercial vessel, other asset or the property complex of the marine company on condition that the efficiency and the risks level of investment correspond to the rate of discounting *i*.

Transformation of the efficiency criterion in the form of the internal rate of return

$$f_2 = (I - C) \times (1 + i) / (i \times (MV_2 + OC)) - 1$$

to the value index of investments looks like:

$$MV_2 = (I - C) \times (1 + i) / (i \times (1 + f_2)) - OC,$$

or $MV_2 = (I - C) \times e^{i - f_2} / i - OC$ for the discounting by the exponential function of The Euler' number.

The evaluation by transformation of the criterion in the form of the internal rate of return means the estimation of investments which are justified under condition that the level of profitableness of the commercial vessel (other asset or the property complex of the marine company), estimated by the indexes of net operating income $(I - C)$ and the risks of investment correspond to the rate of discounting *i*, in relation to the average market value of internal rate of return $f_2$ for comparable investments.

When local generalized criteria in the form of the investments value $MV_1$ and $MV_2$ are substituted in complex criterion *f*, the initial criteria $f_1$ and $f_2$ are derived in restrictions.

### Test questions

1. Uncertainty of the investor's purpose or data and multicriteriality of characteristics optimization of the commercial vessel or other asset of the marine company for the commercial order.

2. Transformation of local economic criteria to a similar form, for example to the form of value, for use as a part of the optimality generalized criterion.

3. Methodological duality of economic criterion as a cause of the two–criterial property of optimality.

4. Transformation of the resulted costs criteria and the internal rate of return to the form of value (investments).

## 23.2. Generalized investments efficiency criteria based on value indexes

The method of compound criteria can be applied for generalization of several local efficiency criteria into single complex criterion.

**The compound criterion** is formulated as

$$f = \sum_{j=1}^{J} (\alpha_j \times f_j), \tag{23.13}$$

where $\alpha_j$ – the expert weight factor which is characterizes the methodological importance of the particular criterion $f_j$ and simultaneously is a scale multiplier (in case when the particular criteria in the formula are non–uniform and have different scale); $J$ – the total of the particular criteria in compound criterion.

Strictly speaking, any criteria of efficiency are compound, since they represent the sum of two or several indexes, for example, they represent the sum of investments $MV$ and the flow of the operation costs $C$, divided by the factor $i$, as a part of discounted (resulted) costs criterion of $f_1 = C/i + MV_1 + OC$ or other criterion.

The compound criterion in the form of the criterion function for the optimization of the marine company real asset, constructed on the basis of the discounted (resulted) costs criterion in the form of the value $MV_1$ and internal rate of return in the form of the value $MV_2$ provided that the «weight» of the discounted costs criterion is equal to $\alpha$ in the compound criterion and it is formulated as

$$f = \alpha \times MV_1 + (1-\alpha) \times MV_2. \tag{23.14}$$

The compound economic criterion defined by the transformation of the value indexes of the commercial vessel, other asset or the property complex of the marine company on the basis of the criteria of the discounted costs and the internal rate of return, with share weight $\alpha$, means the estimation of investments which are justified in relation to the average market discounted costs $f_1$ upon condition that the level of risks of the investment corresponds to the rate of discounting $i$, and with share weight $(1-\alpha)$ it means the estimation of investments which are justified upon condition that the level of profitableness estimated according to an index of net operating income $(I-C)$ in relation to the average market value of the internal rate of return $f_2$ for comparable investments.

After the substitution of the particular criterion of the discounted costs in the form of the value $MV_1$ and particular criterion of the internal rate of return in the form of the value $MV_2$ the compound criterion looks like:

$$f = \alpha \times (f_1 - C/i) + (1-\alpha) \times (I-C) \times (1+i)/(i \times (1+f_2)) - OC, \tag{23.15}$$

or for the discounting by the exponential function of the Euler' number

$$f = \alpha \times (f_1 - C/i) + (1-\alpha) \times ((I-C) \times e^{i-f_2}/i) - OC.$$

It's worth mentioning, that if in case of objective uncertainty the generalized criterion (the compound criterion considered above or the generalized criterion of other type) is formalized on the basis of methodologically similar particular criteria preliminary transformed to the form of the value (investments), then the generalized criterion also is the

value of the marine company real asset with the account that combination of conditions which expertly or mathematically are taken as a principle of particular criteria generalizations.

And mathematical and expert principles of the particular criteria generalization as a part of the complex criteria also are a source of judgments about efficiency, optimality and utility as well as mathematical operations on the basic indexes: the income *I*, the prime cost *C* and investments *MV* (or *RC*), – when formalizing particular criteria.

The Laplas' criterion, which is defined formally almost the same as the compound criterion can be used as a form of the compound criterion for economic optimization of the characteristics of the vessel or other real asset of the marine company.

The difference is that in the structure of the Laplas' criterion the weight factor $\alpha_j$ characterizes the probability of *j*–th situation (a combination of data) in case of the situational uncertainty or the probability of *j*–th objective of the investor in case of the objective uncertainty.

Thus the sum of probabilities of all *J* situations is equal to one, that is, the sum of the expert weight factors as a part of generalized Laplas' criterion is equal to $\sum_{j=1}^{J} \alpha_j = 1$.

**The Wilde's criterion, or the principle of «the greatest care»** concerning judgments about efficiency and optimality of the commercial vessel, other asset or property complex of the marine company is formulated as follows: if the particular criteria $f_j$, as a part of the complex Wilde's criterion, are minimized the complex criterion is minimized too and is defined as $f = \max_j f_j$.

If the particular criteria $f_j$ as a part of the complex Wilde's criterion are maximized, the criterion formulated as

$$f = \min_j f_j, \tag{23.16}$$

is maximized.

The preference order by the particular criteria which are a parts of Wilde's criterion and by the generalized Wilde's criterion coincides.

The methodological sense of the generalized Wilde's criterion as a principle of «the greatest care» of investor to the judgments about the efficiency and optimality of the commercial vessel, other asset or the property complex of the marine company can be explained as follows: the best combination of characteristics of the object by the Wilde's criterion is the combination of characteristics of the object for which the criterion has the best value in the worst circumstances.

Figuratively speaking, by Wilde's criterion the best is the combination of the marine company real asset characteristics for which the maximum losses are minimum. And losses are considered not in terms applied in accounting, but from the methodological point of view, that is, as estimations of deviations from optimality by each of particular criteria.

For generalization of particular criteria of the discounted costs and internal rate of return the maximized Wilde's criterion is defined as

$$f = \min(f_1 - C/i, (I - C) \times (1 + i)/(i \times (1 + f_2))) - OC, \tag{23.17}$$

or for the discounting by the exponential function of the Euler' number

$$f = \min(f_1 - C/i, (I - C) \times e^{i - f_2}/i) - OC.$$

Wilde's criterion estimated by transformation of value indexes on the basis of the criteria of discounted costs and internal rate of return means the least value of the evaluation which in any case is justified as in relation to average market discounted costs $f_1$ upon condition that the investment risks level corresponds to the rate of discounting *i*, and in relation to profitableness of the commercial vessel, other asset or the property complex of the marine company, the internal rate of return $f_2$ estimated in relation to the average market value and to the index of net operating income $(I-C)$ for comparable investments.

**By Horvitz' criterion** (unlike Wilde's criterion) for judgments about vessel characteristics optimality, other asset or property complex of the marine company there are considered not only the worst situations (a combination of data) with share weight $(1-\gamma)$ but also the best with share weight $\gamma$.

The preference order by Horvitz' criterion corresponds to the preference order by the particular criteria which are a part Horvitz' of generalized criterion.

If the particular criteria $f_j$ are minimized the Horvitz' criterion is formulated as $f=\gamma\times\min_j f_j+(1-\gamma)\times\max_j f_j$, where $\gamma$ – the expert factor of «optimism» when determining the criterion of Horvitz.

Accordingly if the particular criteria $f_j$ are maximized the Horvitz' criterion for use as a part of an optimality concept of the commercial vessel, other asset or the property complex of the marine company is defined as

$$f=\gamma\times\max_j f_j+(1-\gamma)\times\min_j f_j. \tag{23.18}$$

For generalization of the particular criteria: the discounted costs and the internal rate of return, transformed to the value, Horvitz' complex maximized criterion is defined in the form of the criterion function as

$$\begin{aligned} f=\gamma\times\max(f_1-C/i,(I-C)\times(1+i)/(i\times(1+f_2)))+\\ +(1-\gamma)\times\min(f_1-C/i,(I-C)\times(1+i)/(i\times(1+f_2)))-OC, \end{aligned} \tag{23.19}$$

or for the discounting by the exponential function of The Euler' number

$$f=\gamma\times\max(f_1-C/i,(I-C)\times e^{i-f_2}/i)+(1-\gamma)\times\min(f_1-C/i,(I-C)\times e^{i-f_2}/i)-OC.$$

Horvitz' criterion defined by the transformation of value indexes on the basis of criteria of discounted costs and internal rate of return, with share weight $(1-\gamma)$ means the least value which in any case is justified as in relation to average market discounted costs $f_1$ by the requirement of the investment risks level corresponding to the rate of discounting *i*, and in relation to profitableness of the commercial vessel (or other asset of the marine company), internal rate of return $f_2$ estimated by the index of the net operating income $(I-C)$ for comparable investments, and with share weight $\gamma$ – the greatest the market value which can be justified by one of entering particular criteria upon condition that the successful circumstances are reflected by this criterion.

**According to Savage's method** for generalization of the particular criteria as a part of the complex efficiency criterion of commercial vessel, other asset or the property complex of the marine company it is supposed that one of combinations of external conditions (or one of the purposes of the investor) for each of the comparable by optimization options

is the best. In comparison with the best combination of the data other combinations are «unprofitable» in sense of deviation from optimality.

Savage's criterion in the considered formulation is minimized irrespectively of the order of preference of the particular criteria entered into it, as it is based on minimization of «losses». Certainly, concepts «losses» and «advantages» as a part of Savage's criterion are applied in methodological sense, instead of in terms, applied in accounting.

The best, by Savage's criterion, is the combination of characteristics of the vessel, other asset or the property complex of the marine company for which the greatest possible «losses» are the least.

For the minimized particular criteria Savage's complex criterion (minimized) is formulated as $f = \max_j(f_j - \min_k f_k)$, accordingly, for maximized particular criteria Savage's complex criterion is formulated as $f = \max_j(\max_k f_k - f_j)$.

To generalize the local efficiency criteria of the discounted costs and the internal rate of return the minimized Savage's complex criterion in the form of the criterion function is determined as

$$f = \max(\max MV_1 - (f_1 - C/i), \max MV_2 - (I - C) \times (1+i)/(i \times (1+f_2))) + OC, \qquad (23.20)$$

or for the discounting by the exponential function of The Euler' number as

$$f = \max(\max MV_1 - (f_1 - C/i), \max MV_2 - (I - C) \times e^{i - f_2}/i) + OC.$$

To use Savage's criterion the algorithm should contain determination of optimum combinations of characteristics by each of particular criteria, and also values of particular criteria corresponding to them in the form of the investments value ($\max MV_1$ and $\max MV_2$).

The criterion function for an example of fishing vessel optimization by minimized Savage's criterion is shown on the chart (fig. 23.1).

The maximized Savage's criterion (or the principle of «maximization of the minimum advantages») unlike minimized Savage's criterion (that is the principle of «minimization of the maximum losses») can be formulated as follows.

One of the external combinations of the conditions (one of the investor's purposes) for each of the compared options of characteristics of the commercial vessel, other asset or the property complex of the marine company for the commercial order is the worst. In comparison with this combination other combinations are favorable. The best combination of characteristics by maximized Savage's criterion, for which the least possible advantages will be the greatest, is the best one.

For minimized particular criteria the maximized generalized Savage's criterion is defined as $f = \min_j(\max_k f_k - f_j)$; for maximized particular criteria the maximized Savage's criterion is formulated $f = \min_j(f_j - \min_k f_k)$ as well.

For maximized Savage's criterion as a principle of «maximization of the minimum advantages», this order of preference remains irrespective of entering into it particular criteria order of preference.

**The criterion representing convolution in the form of functions Kobb–Douglas,** is formulated as $f = \prod_j f_j^{\beta_j}$, where $\prod$ – is a symbol of particular criteria

multiplication. A special example of the similar generalized criterion is multiplicative convolution $f = \prod_j f_j$ .

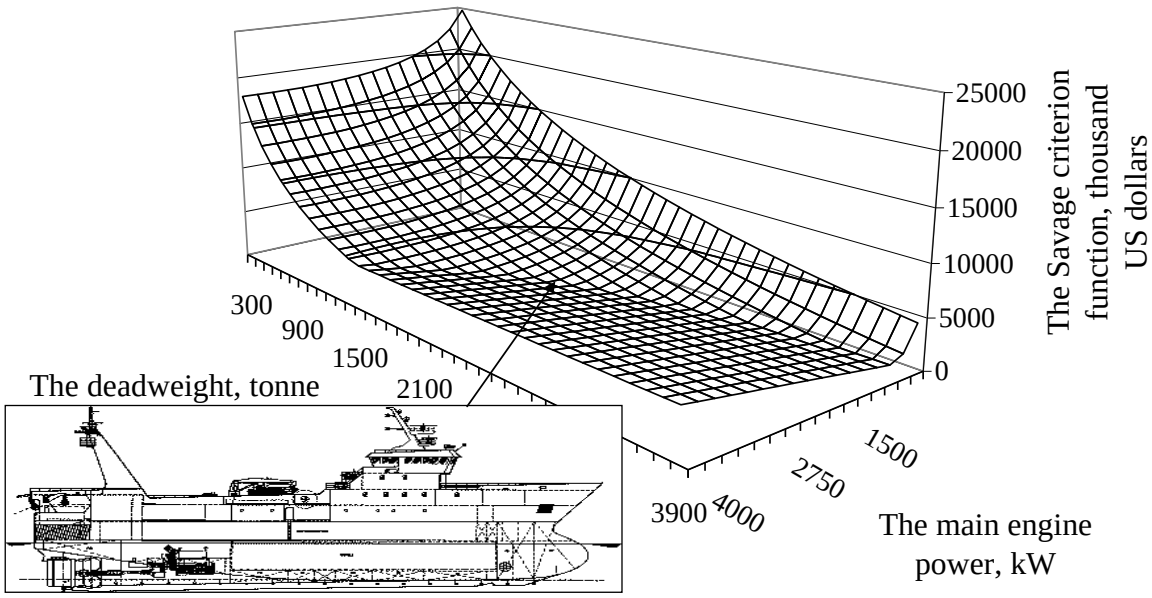



Fig. 23.1. The function of the minimized Savage criterion expressed as the estimation of the "losses" when deviating from the fishing vessel optimality

Assuming, that the particular criteria have similar dimension or are methodologically similar, for example, when they are expressed in the form of the investments (value), the generalized criterion representing convolution, can be improved:

$$f = \sqrt[\left(\sum_j \beta_j\right)]{\prod_j f_j^{\beta_j}} ,$$

for example, it is possible to represent the multiplicative convolution as $f = \sqrt[j]{\prod_j f_j}$ .

For particular criteria: the discounted costs and the internal rate of return, expressed in the form of investments (value), the criterion in the form of multiplicative convolution is determined as

$$f = \sqrt{(f_1 - C/i - OC) \times ((I - C) \times (1+i)/(i \times (1+f_2)) - OC)} , \qquad (23.21)$$

or for the discounting by the exponential function of The Euler' number

$$f = \sqrt{(f_1 - C/i - OC) \times ((I - C) \times e^{i - f_2} / i - OC)} .$$

The multiplicative convolution of local economic criteria means the average quadratic evaluation of investments into commercial vessel, other asset or the property complex of the marine company which are justified in relation to the average market discounted costs $f_1$ upon the condition that the investment risks level corresponds to the rate of discounting *i*, and investments which are justified providing the profitableness level estimated by index of net operating income $(I - C)$ in relation to the average market value of internal rate of return $f_2$ for comparable investments.

**The expert way of particular criteria generalization is the method of concessions**, and the sequence of concessions application can be considered as the criterion function of characteristics optimization for the commercial order of the commercial vessel, other asset or the property complex of the marine company.

To use the concessions method for multiobjective optimality determination of particular criteria should be arranged according to their importance for the optimization of characteristics of the commercial vessel or other asset of the marine company for commercial order.

The sequence of the multiobjective optimization by concessions method is as follows. The combinations of the marine company real asset characteristics compared by criteria are estimated by that particular criterion which is considered the most important, for example $f_1$.

The permissible deviation from the optimality by the first (most important) criterion $f_1$ is set and among the set of compared combinations of characteristics there should be chosen the optimum one by the criterion $f_1$, as well as those combinations which differ from the optimum characteristics by the value not exceeding the value of the permissible deviation from the optimality by the criterion $f_1$.

Operations are repeated among the set of the chosen combinations of characteristics by the second criterion $f_2$ (the next in order of importance) etc. The use of concessions method supposes that the sequence of such operations leads to an optimum option.

If particular criteria are maximized the concessions method is formulated as

$$\max f_j(\max f_{j-1}(...(\max f_1))) \ , \qquad (23.22)$$

where 1, 2, …, $j$–1, $j$ – the sequence of particular criteria ranged according to the order of importance decrease.

The criterion function by concessions method is presented for the example of fishing vessel optimization in the chart (fig. 23.2).

The concession in the form of border on the graphic surface corresponds to the transition to the second criterion within permissible deviation from the optimality by the first criterion.

The opening of the multiobjective assumptions of optimality of the commercial vessel, other asset or property complex of the marine company can be fulfilled not only by the introduction of the criterion function in the form of the generalized criterion on the basis of expert parities of particular criteria.

The approaches under condition of uncertainty and multicriteriality can be classified in general as expert and formal. The ways of the local economic criteria generalization considered above as a part of complex optimality criteria concern the set of expert approaches.

For formalistic approaches the necessity of subjective expert's participation is excluded usually by means of introduction of methodological concessions, for example by redefinition of concept of the purpose of characteristics optimization of commercial vessel or other real asset of the marine company for the commercial order from the search of an optimum combination of characteristics to determination of optimum combinations area.

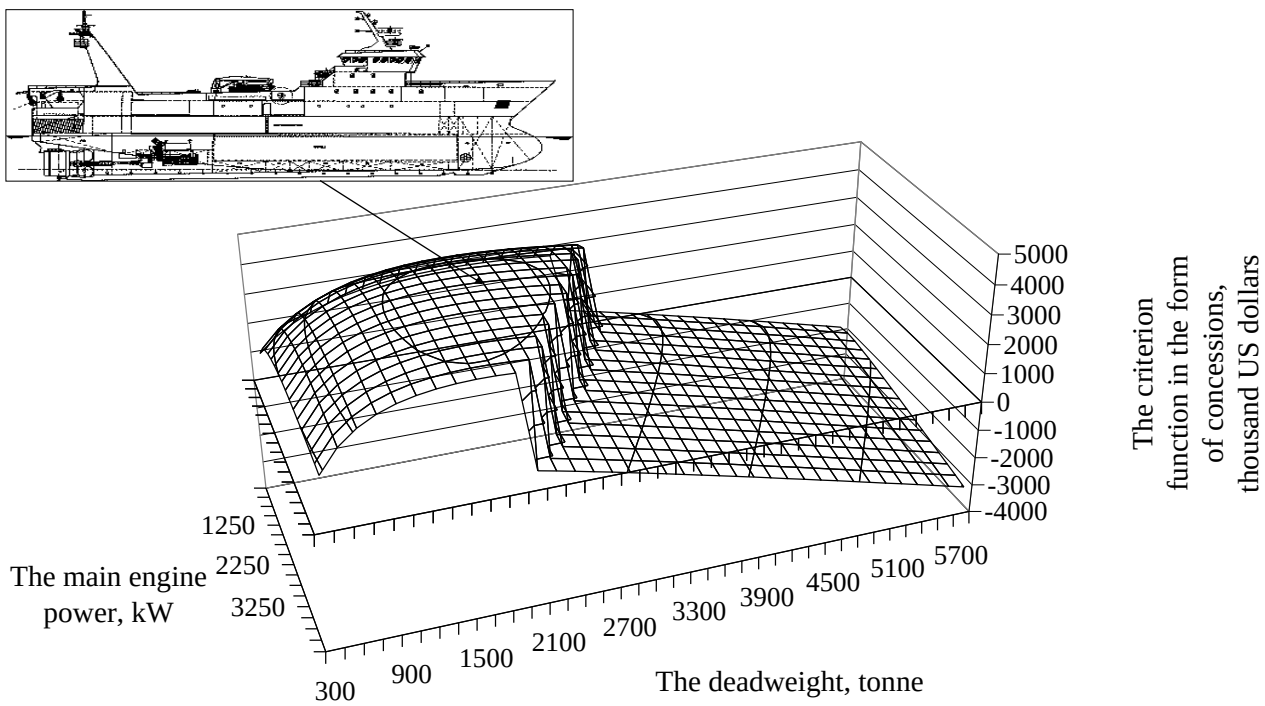



Fig. 23.2. The criterion function in the form of concessions estimated for the fishing vessel by the value

**The methodological principles of compromises in the economic optimization of characteristics** of commercial vessel or other real asset of the marine company for the commercial order in the presented definition need to be referred to a number of the formal approaches directed to determination of area of optimum solutions.

Following the formal principles of compromises, the area of optimum combinations of vessel characteristics or other marine company asset is in so–called Pareto's area $\{X^*\}$, outside of which all local economic criteria simultaneously worsen, and Pareto's area $\{X^*\}$ is defined in space of variables *X*.

The optimization method is to minimize the Pareto's area $\{X^*\}$ which is «shrinked» to the optimum combination $X^*$ of characteristics as the combination is located in Pareto's area $\{X^*\}$.

If particular criteria $f_1, f_2, ..., f_j$ are maximized the definition of Pareto's area $\{X^*\}$ is formulated as

$$\{X^*\} = X - (X - X_1^*) \vee (X - X_2^*) \vee ... \vee (X - X_j^*),$$
$$f_1(X_1^*) \geq f_1(X),\ f_2(X_2^*) \geq f_2(X), ...,\ f_j(X_j^*) \geq f_j(X). \quad (23.23)$$

For economic optimization of the fishing vessel intended for the autonomous use of project characteristics the test calculations of the criterion function and the Pareto's area are presented in the figure (fig. 23.3).

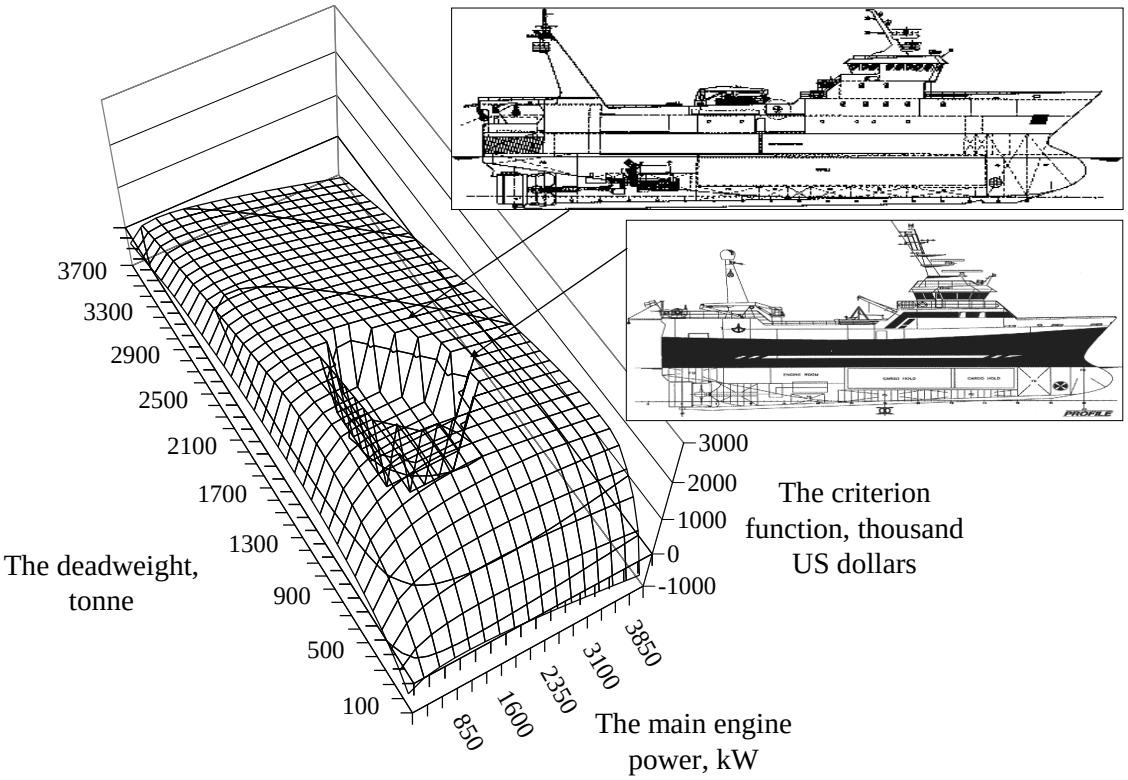



Fig. 23.3. The criterion function anf the Pereto's area for fishing vessel

And the criterion function is defined as a particular criteria combination of the discounted costs and the internal rate of return transformed to the form of the investments, and the Pareto's area is shown by boundaries.

The minimization of Pareto's area $\{X^*\}$ (that is «shrinking» to an optimum combination of characteristics $X^*$ of the vessel or other real asset of the marine company) is made generally by one of two or by two methods: the expert participation and, hence, by increasing of subjectivity of the result or by increasing the number of used particular criteria which are algorithmically used to determine the Pareto's area, where the criterion function is defined as well.

At the same time the possibilities to increase the number of particular economic criteria used to determine Pareto's area are limited, since the set of particular criteria depends on the structure of the optimized object presented as a whole of the parts when formulizing the comparability concepts from the point of view of the systematic approach.

The advantage of the Pareto method in comparison with other ways of multiobjective optimization is that the necessity of the expert's participation is minimal, though the result is presented not by the optimum combination of the characteristics of the vessel or other real asset of the marine company, but by the area of the optimum characteristics combinations.

Therefore the process of determination of the optimal characteristics determination in the Pareto's area requires the additional expert's participation.

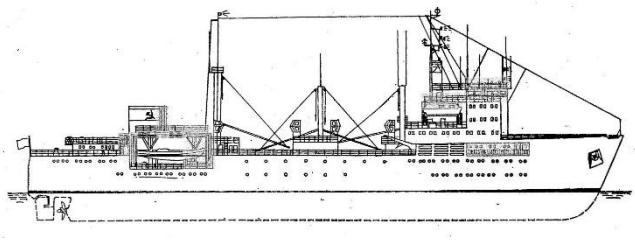
The similar formal methods of the multiobjective economic optimization do not give the answer what combinations of characteristics of the commercial vessel or other real asset of the marine company for the commercial order are optimum, and show, what values cannot be the optimum.

Since other criteria and criterion functions from among considered can be used to exclude not optimum variants too, these possibilities shouldn't be attributed only to formal approaches, the theory of compromises and the Pareto method.

For the option of transformation of the economic criterion representing the formalization of the Pareto's method to the value of the commercial vessel or other asset of the marine company, the resultant index does not characterize the value, and shows the boundary of values which cannot be the value that means – the boundary of values which can be the value.

**Test questions**

1. Generalization by the compound criteria method (the formula derivation).
2. The use of the Laplas' criterion and the weight factors reflecting probabilities of the purpose or data (the formula derivation).
3. Wilde's criterion, or a concept of «the greatest care» concerning judgments about efficiency and about optimality of characteristics of the commercial vessel or other asset of the marine company for the commercial order (the formula derivation).
4. Horvitz' criterion, or a concept of «reasonable optimism» in the structure of optimality concept (the formula derivation).
5. Savage's criterion – «minimization of the greatest losses» or «maximization of the least advantages» by the economic criteria optimization (the formula derivation).
6. Generalization of particular economic criteria using multiplicative convolutions (the formula derivation).
7. Generalization of local economic criteria by concessions method.
8. Methodological concepts of compromises, used for optimization of the characteristics of the vessel or other asset of the marine company for the commercial order and the concept of the «Pareto's area».
9. Optimality redirection when using the Pareto method and replacement of commercial vessel optimal characteristics concept by the area of optimal characteristics.



# 24. Recommendations concerning the choice of criteria for design optimization and investments evaluation in marine industrial activity

The ways of the criteria transformation to the value of the commercial vessel or other real asset of marine company, differing by the type of the initial indexes ( $MV_1 = f_1 - C / i - OC$ and $MV_2 = (I - C) \times (1 + i) / (i \times (1 + f_2)) - OC$, Chapter 23) should be considered as a form of the economic law characterizing proportionality of the profit and investments. And while transforming the value the initial criterion is deduced in limitation.

The value of the commercial vessel, other real asset or the property complex of marine company, used as the optimality criterion, characterizes in common both comparative and general efficiency that is required by economic optimization, since the variant of investment chosen for the commercial order should be more preferable on the one hand than other comparable variants (available for the construction or acquisition at the pre–owned market), and on the other hand it should be better than the generalized estimation of investments efficiency in the macroeconomic environment.

Economic criteria in the initial form, unlike the value to which criteria can be transformed, correspond only to one of the specified conditions depending on the fact of the criterion concerns either the number of indexes of the comparative or the general efficiency.

The investments estimation in the form of the value used as the optimality criterion partially don't have the methodological contradictions of the criteria in the initial form, and the value at the same time characterizes both the general and the comparative efficiency, since, in any form of transformation the value is a ratio of the comparative efficiency index (profit or the net operating income) to the general efficiency index – the internal rate of return (the capitalization rate or other).

## 24.1. Methodological contradictions of the economic criteria applied for optimization of vessel characteristics, other real assets or marine companies complexes for the commercial order

Not all methodological contradictions of initial criteria from the point of view of their applicability as a part of optimality concept of the commercial vessel, other asset or the property complex of the marine company are eliminated by means of transformation of the criteria to value.

In particular, for the criteria based on the costs accounting, in case of the transformation of the criteria to the value the following contradiction remains: the minimization of expenses in interests of one investor corresponds to minimization of incomes of the other investor that contradicts the interests of the second investor.

In other words, the motivations to minimize the costs in case of systematic reproduction of these motivations can lead to the oppression of an economic environment. In

essence, it contradicts the interests of each investor as well as co–investors to develop an economic environment.

For the criteria based on the prevailing influence of incomes indexes, for example for the criteria in the form of profits, internal rate of return, profitability, etc., during their transformation to the value of the commercial vessel, other real asset or the property complex of the marine company the following contradiction characteristic as for each of these criteria in the initial form as well as for the criteria transformed to the value remains: the income maximization (or corresponding operations on the other criteria or the value, depending on the income) comes into conflict with motives to preserve and reasonable use the ocean resources which in a wide methodological sense is meant not only the water environment considered physically, but also the ocean as a reservoir in aggregate properties, including characteristics of a geographical location, climatic conditions, biological resources, minerals of ocean bottom, industrial potential of coasts, including demand for marine cargo transportations, and other characteristics which corresponds with economic or other interests of the investor in the marine environment.

For the specified reason the purpose of maximization of incomes or corresponding operations on the indexes depending on incomes, in case of regular reproduction can lead to intensive expenditure and exhaustion of the ocean resources, that in essence contradicts the interests of the investor which motives, at first sight, is maximization of incomes, but in not to a lesser degree is interested in preservation of the ocean resources as a necessary condition of the marine company's property complex efficiency which he owns. The methodological contradiction of the criteria based on maximization of the income, is predetermined, thus, by limitation of the ocean resources.

If to designate the contradiction of the economic criteria based on minimization of expenses, as social and economic which is connected with oppression of the economic environment the contradiction of the criteria corresponding to maximization of the income and profit, and also dependent economic indexes can be defined as ecological, that is connected with the over–expenditure of resources, in wide understanding of the ocean resources.

It should be noted that the friendly attitude to marine wealth has the direct relation to economic efficiency estimation.

In narrow definition the ecology usually means the research, measurement and preservation of natural resources. On the other hand, the listed subjects usually concern other scientific subjects (to physics, chemistry etc.) as well. And subjects of the natural resources preservation, are disconnected from an estimation of the extent of the resources use, usually have no solution as it is not quite clear, for whom the resources are saved.

Apparently, for an ecological conclusions and recommendations there is a need for the systemic estimation of resources with the account their variety without reducing resources only to natural substances, and estimating the total needs of the investor in the marine industrial activity.

It is possible to see the connection of economy with ecology, besides, they have related terms on the basis of the general root of the words – «eco», meaning the house, house–habitant.

The example which has been discussed at the conference on the lake Baikal ecology is pertinent. To protect the lake Baikal wild life besides the ban of its industrial use the realization of environmental protection measures and financial investment are of great importance.

The investment means the development of resources outside certain boundaries of the lake Baikal zone. All work and use of natural resources should be shifted outside the lake, in particular to make building materials, energy, to build communications, networks and the real estate, to develop the alternative manufacture and to move the population.

Thus, preservation of natural resources of Baikal lake means an expenditure of other resources and it is necessary to define a parity of value of the wild life of the lake and other natural resources and to estimate, if a reasonable use of Baikal lake could be admitted and to what extent.

It is clear, that the task of wildlife management of the lake Baikal obviously contains under itself an economic basis. The ecology issues in broad sense of preservation of the ocean wealth should be paid more attention when working out investment projects by the economic criteria.

No doubts, that productive operation of the commercial vessel, other real asset or the property complex of the marine company and any economic activities in the ocean involve expenditure of the ocean resources in proportion to received incomes.

Minimization of expenses, at first sight, corresponds to the ecology purposes in sense of preservation of the marine environment and resources, unlike the estimation of the criteria based on maximization of the income and profit. But actually the minimization of expenses does not have conditions and possibilities of the compromise of the investor's needs with the account ecology requirements, since the motives of the ocean resources preservation without other motives formally lead to the curtailment of the marine industrial activity.

In real estate economy it is known a solution concerning the compromise of the investor's interests with the account ecology requirements. If the built up site value contribution to the total value of the real estate (as s part of building and the site) is estimated as the criterion of the real estate efficiency, the maximization of such a criterion, for example, when comparing the variants at the design stage, corresponds to reasonable use of resources – built up site.

Certainly, it is true when the building site has to be redeemed, that is, the site estimation corresponds to the net present value of the investments consisting of expenses both for the building, and for the site acquisition. And the site value depends on all set of natural and climatic factors, as well as infrastructural and environmental factors, and on characteristics of the erected building.

The rules of building based on a reasonable market payment for used natural resources, encourage investors to use sites rationally and to improve them.

And in case of regular repetition of such approach the built up territories and used resources as a whole are favorable according to the ecological estimation in a broad sense, both as nature preservations and creation of conveniences encouraged by the motivation of investors to maximize the of natural resources value (in particular, the contribution of territory site value to the structure of the real estate value).

This approach is widely accepted and used for the construction at the territories of the majority of the countries of Europe, economically developed East Asia and North America.

It makes sense to define the methodological analogy in approaches to investments efficiency evaluation into the real estate where the balance with the account compatibility of estimations of economy and ecology of built up territories has been found to a certain extent, as well as in approaches to the estimation of investments efficiency into marine industrial activity to eliminate whenever possible methodological contradictions of the

criteria based on minimization of expenses, leading to oppression of the economic environment, and on maximization of incomes and the profit, leading to the over–expenditure of the marine wealth.

The recommendation to use the evaluation of the ocean wealth contribution into the total value of the complex including marine wealth and assets of the marine company at determination of the vessel characteristics (or other asset) can be a methodological analogy to evaluation of the investment efficiency into real estate.

Such economic criterion will correspond to the net present value estimation of total investments provided that the access to the marine wealth is supervised and given for a reasonable market payment, for example as the tax or by the production sharing contract.

**Test questions**

1. Joint characteristic of the comparative and the general efficiency of commercial vessel when using the value as an optimality criterion or the economic criteria transformed to value.
2. Methodological contradiction of the criteria based on expenses minimization (negative influence on the economic environment).
3. Contradiction of the economic criteria based on maximization of the income and profit (the over–expenditure of resources).
4. Economic motives in the environmental issues and protection of the marine environment.
5. Preservation of the ocean resources with the account the investor's motives for it reasonable use and increase of the marine wealth contribution into the marine company value.

## 24.2. Estimation of investments efficiency by the criterion of the ocean resources contribution into the structure of the vessel's value or the value of the marine company complex of assets

To determine the optimum combination of the characteristics of the vessel, other asset or the property complex of the marine company from the investor's point of view there is an initial statement, that the object in process of optimization can be evaluated only in a complex with the marine wealth which development is its function.

The object of optimization by the economic criterion has a comprehensive complex character, that is includes interacting elements: investor, marine wealth, asset or the property complex studies to estimate the value or efficiency.

The marine engineering complex value in the definition used in case of optimization from the investor's point of view is influenced by utility of both components evaluated in common as a part of a complex, – the engineering and the marine wealth.

The measure of utility of the contribution of the marine wealth to the complex object can be evaluated as an optimality criterion of the commercial vessel, other real asset or the property complex of the marine company.

The evaluation of the contribution which is made by the marine wealth to the value of commercial vessel, other real asset or the property complex of the marine company, is called further «the ocean resources contribution».

The ocean resources contribution represents a difference of the value $MV_I$, evaluated by the factor of the annual income $I$ (16.12 – 16.14), in the assumption, that the income corresponds to the functional characteristics of the commercial vessel (or other asset), on the one hand, and the value $MV_C$, on the other hand, evaluated by the factor of expenses (16.7 – 16.9) provided that expenses $C$ correspond to the functional characteristics.

The methodological basis for the estimation of the ocean resources contribution is the rights of the investor. Property rights concerning marine wealth are received or accepted according to the rights for commercial vessel (other asset or the property complex of the marine company).

The financial constrain and condition of the commercial vessel economic optimality (for the commercial order for manufacturing or purchase), other real asset or the property complex of the marine company by the criterion of the ocean resources contribution also are formulated as:

$$MV \leq [MV], \quad MV_I - MV_C \to \max, \tag{24.1}$$

where $MV$ – the value of the vessel (other real asset or the property complex of the marine company); $MV_I$, $MV_C$ – the values as a measure of utility by the factors of the annual income $I$ and the operating costs $C$; $MV_I - MV_C$ – the ocean resources contribution to the value as a measure of utility of the commercial vessel, other real asset or the property complex of the marine company; $[MV]$ – the boundary value – the financial constrain of the investor.

The values which characterize the investments and a part of optimality concept (24.1) are their present values on the date of estimation. The given explanation is important, since the investments can be done not at a time, but according to a certain plan or a contract.

As a part of the criterion function of the ocean resources contribution $MV_I - MV_C$ (24.1) and limitations $MV \leq [MV]$, the components ($MV$, $MV_I$ and $MV_C$) are functions of optimized variable characteristics, of params and external data – $X$, $Y$ and $Z$.

Apparently, for the estimation of economic efficiency of the commercial vessel, other real asset or the property complex of the marine company at an innovative stage of the project from among the considered conditions the limitations of financial assets for the manufacture of marine engineering are more important, and for the sufficient level of marine industrial activity development more important condition is limitation of the ocean resources.

Between innovative and financial stages of the investment project, when the degree of intensity of the ocean resources development corresponds to functional characteristics of the marine company assets, conditions of optimality, when there is no limitations, can correspond to a transitive stage.

In the expanded form the condition of economic optimality (24.1) of vessel, other real asset or the property complex of the marine company is formulated as:

$$MV + OC \times i / R \leq [MV], \; I/R_I - C/R_C - MV \times R/R_C - OC \times i \times (1/R_I + 1/R_C) \to \max. \tag{24.2}$$

Limitations of the investments as a part of optimality concept depend on ways of manufacture financing.

Concerning unlimited possibilities of financing, for example the use of the extra capital, are more characteristic for large enterprises and for steady economy when the basis

for loan granting are cash flows in an company's turnover rather then earlier saved up money resources or property,. Nevertheless, cash flows are, in their turn, the sign of the assets capitalized before.

In the circumstances of the insufficient stability of economy or the enterprise the assets accumulated before as a rule are used as a pledge. Thus, the earlier accumulated capital, anyhow, is the financial constrain when investing. Use of the extra capital does not mean cancellation of financial constrain when determining the characteristics of the commercial vessel or other asset of the marine company for the commercial order, and financial constrain usually is referred to integral preconditions.

When formulating an optimality in many cases the limitation is carried out in the form of equality $MV = [MV]$. Due to the reason, that the increase of the investments $MV$ in the maximum limits $[MV]$ leads to improvement of economic indexes, usually investments are equal to limiting values and limitation is carried out as equality.

The financial limitation for the investor $MV \leq [MV]$ in case of conformity of a supply and demand can be carried out in the form of equality for the following reasons.

From the buyer point of view the net present value $NPV$ of the commercial vessel or other real asset of the marine company is equal to $NPV_1 = MV - [MV]$, and from the point of view of the seller – $NPV_2 = [MV] - MV$.

The necessary compromise between the buyer and the seller interests is reached by the requirement of $NPV_1 = NPV_2$ (= 0.0), thus $MV = [MV]$, that is a financial constrain is carried out in the form of equality.

The supply of physically and technologically realizable variants of commercial vessel or other marine company real asset can be considered unlimited when the demand is satisfied with the economic possibilities of the investor.

To illustrate the financial limitation and its influence on the characteristics of the vessel construction there is the model of reproduction cost (articles 5, 5.1, 6) used for the formulation of the function, that is, a surface where the financial limitation can be plotted and then the range of definition of the vessel characteristics within the financial limitation can be determined.

The example of the function of reproduction cost, characterizing the need for investments, with financial constrain and its projection to characteristics of a fishing vessel planned to be constructed is presented on the figure (fig. 24.1).

The limitation of the ocean resources by estimated maximal annual income $[I]$ proportional to the capacity of the ocean resources available for development, in case of determination of characteristics of the commercial vessel or other asset of the marine company for the commercial order is formulated as $I/R_I \leq [MV_I]$ or $I \leq [I]$, since $[MV_I] = [I]/R_I$.

In case of limitation $[I]$ of available marine wealth the condition of optimality of characteristics of commercial vessel or other asset of the marine company for the commercial order looks like:

$$I \leq [I], \quad I/R_I - C/R_C - MV \times R/R_C - OC \times i \times (1/R_I + 1/R_C) \square \max. \tag{24.3}$$

The concept of optimality of commercial vessel characteristics or another asset of the marine company for the commercial order (24.1–24.3) reflects the investor's preferences.

To estimate the financial (or functional) limitations and their influences on the characteristics of an asset of the marine company's property complex, for example, the vessel characteristics, there should be an economic model (concerning the fishing vessel see

article 15) used for the formulation of the function – a surface where the functional limitation is plotted in order to receive the range of definition of characteristics.

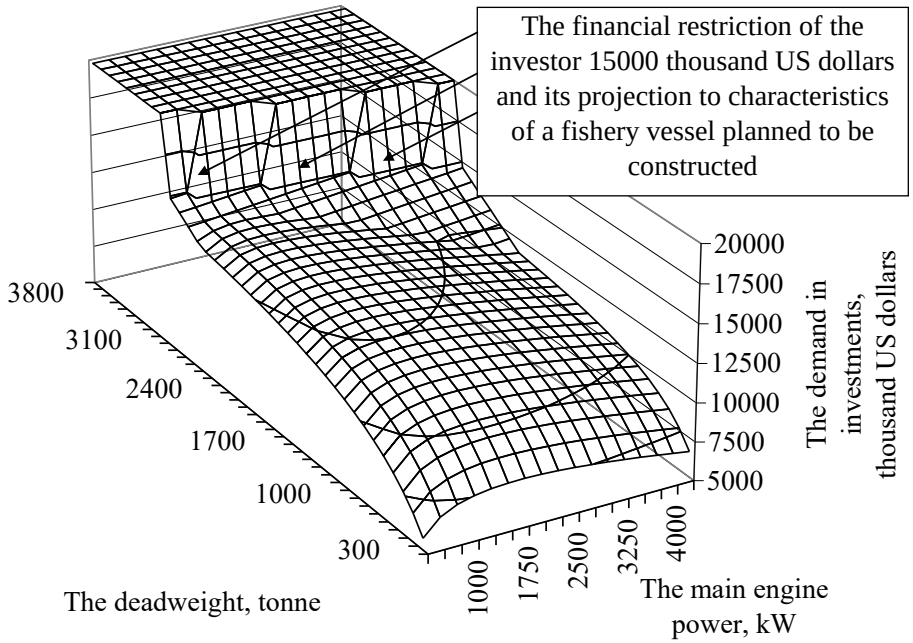



Fig. 24.1. The demand in investments (thousand US dollars) and the restrictions of the field of definition the fishery vessel characteristics

The example of the functional limitation and its projection to characteristics of a fishing vessel planned to be constructed is presented on the graph (fig. 24.2).

The methodological limitations, such as those that are shown in illustrative examples, form a field of definition of the cargo vessel optimal characteristics.

At the same time, since in case of available innovative strategy and sufficient resources (ocean biological, cargo traffics and other marine wealth) the value of the strategy exceeds the values of financial assets, the financial credit is reasonable for investor, and the financial markets become open. The investor's structure thus becomes complicated (articles 18, 18.2), and there are partnership of the marine companies with creditors and other parties.

The financial and the resource constrains thus lose their urgency, and the economic optimality becomes an own internal property of the marine company asset, in particular a vessel planned to be purchased or to serial manufacturing which characteristics are optimized when there are no limitations in the assumption, that there are enough financial resources, and functional needs (for trade productivity or for carrying capacity a vessel) are not limited.

The example of the criterion function of the ocean resources contribution to the value of the cargo vessel, when there are no limitations, is presented on the graph (fig. 24.3). The surface of the criterion function in the form of dependence of the ocean resources contribution on fishing vessel characteristics for the autonomous operation, determined by test calculations for the accepted values of initial data, is presented graphically (fig. 24.4).

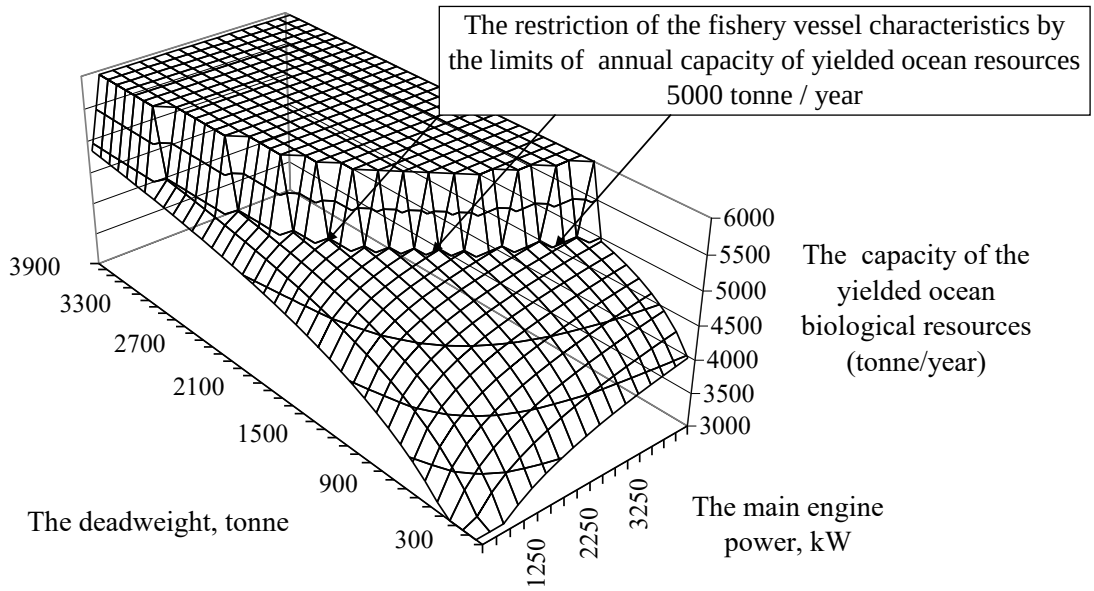



Fig. 24.2. The limits of the yielded ocean biological resources (tonne/year) and the restriction of the fishery vessel characteristics (data: fishery vessel productivity 20 tonne/day; annual capacity of yielded ocean resources5000 tonne/year)

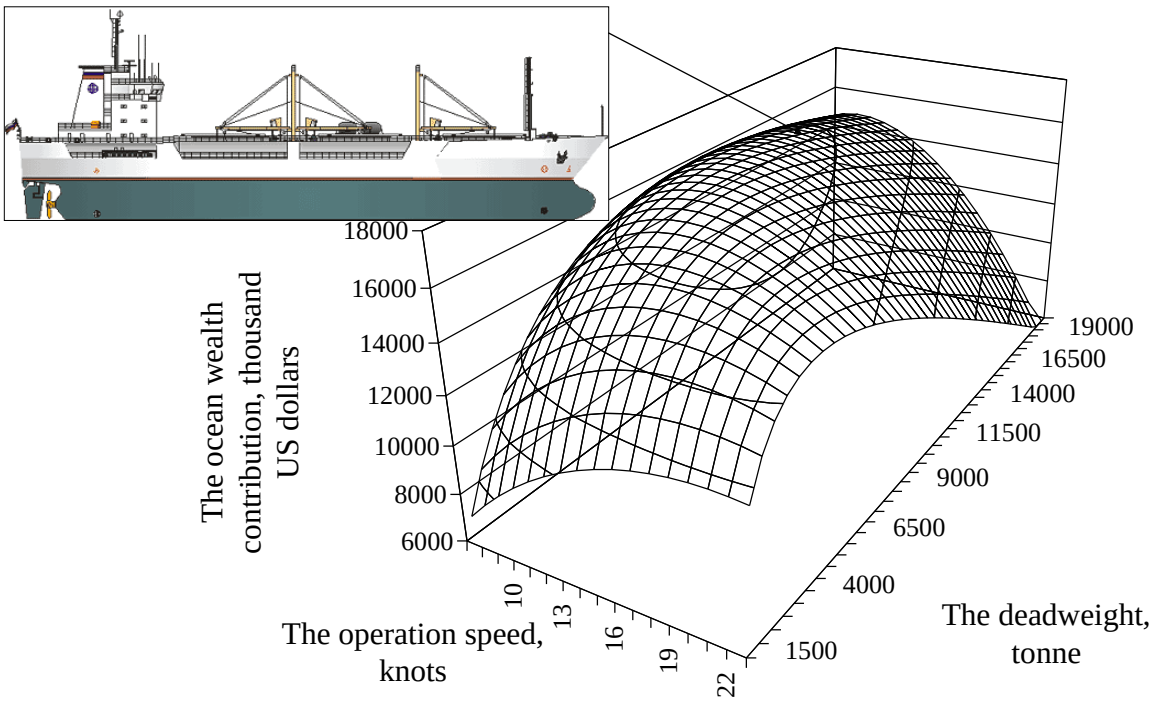



Fig. 24.3. The criterion function in the form of the ocean wealth contribution to the cargo commercial vessel value (data: the line extent 1000 nautic miles, the cargo loading productivity 1000 tonne/day)

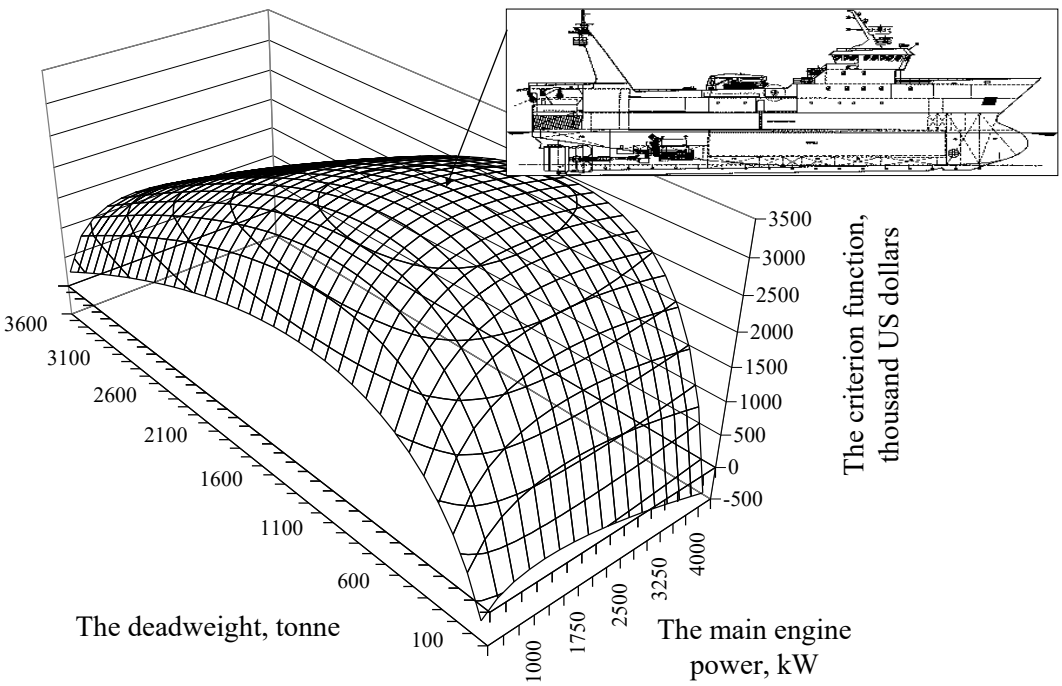



Fig. 24.4. The criterion function in the form of the ocean wealth contribution to the value of the fishery vessel for the autonomous operation (data: the distance to the fishery grounds 1500 nautic miles, the vessel productivity 50 tonne/day)

## Test questions

1. Complex property of the object of an estimation of efficiency – the vessel (or other asset of the marine company) – and the ocean resources contribution to the value and efficiency.

2. Concept of an economic optimality on criterion of the ocean resources contribution (the formula derivation).

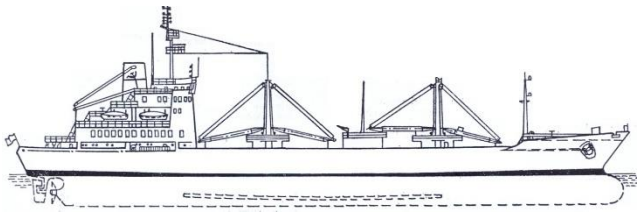
3. Financial constrain at an innovative stage of the project of investments into the marine company.

4. Limitation of the ocean resources by the estimation of the maximal annual income as a part of an optimality concept.

5. Financial constrain of the investor, carried out as the equality.

6. Partnership of the marine company with the creditor as the factor of the strategy value of the marine company, exceeding the value of the extra financing.

7. Optimality as internal property of the asset planned for the commercial order, for example, of the commercial vessel, in case of when estimation of strategy of the company exceeding the value of the loan.



# 25. Guidelines for determination of economically efficient vessel characteristics and particulars for the commercial order for construction or purchase at the pre–owned market

It should be explained, that the methods of characteristics optimization by economic criteria are applicable for vessels (or other real assets as a part of marine company's property complex) to an extent to which the object of optimization can be evaluated as the company's property complex.

Usually it can be referred to the marine commercial vessel if the difference of the vessel's properties from the property complex are taken into account by the adjustment, for example, in addition to commercial vessel estimation to determine the working assets and to consider them in the general algorithm and if the number of variable of the vessel's characteristics optimized by the economic criterion is not too great.

When working out the model in details and increasing the number of varied characteristics, it becomes clear that many of characteristics are in functional interrelation, other, than the conformity of the optimality by the economic criterion.

At preliminary stages of the investment planning after the estimation of the vessel main characteristics which are optimum from the economic point of view and correspond to the best values of the criterion (the left half of the scheme, fig. 25), as a first approximation it is required to determine a number of dependent characteristics and particulars to generate technical requirements for the vessel order for constructing or purchase.

Dependent vessel characteristics, as well as particulars can be determined on the basis of naval architecture calculations (the right half of the scheme, fig. 25) on the basis of the analysis of physical properties of the commercial vessel's interaction with the marine environment (seaworthy properties), and also taking account of the internal properties of the commercial vessel design that is usually made after the investments are received at stages of the structural and technological design and it is not quite acceptable for the process of working out the investment project.

In other words, the left part of the scheme on fig. 25 shows the determination of vessel characteristics by the economic criterion and this optimization method is called «an external subject», that at the same time the right party of the scheme shows – the determination of the commercial vessel particulars from the physical point of view that is «an internal subject».

Since the external subject (the left part of the scheme) usually is solved by the investor – the shipping company which in the national relation gravitates to the ocean resources, and an internal subject (the right part of the scheme) is solved at the shipyard which most probably is located in the global industrial centre of East Asia, then, the condition of vessel characteristics optimality by the economic criterion which is structurally shown on the scheme, has an international sense.

At preliminary design stages to determine the dependent characteristics and particulars when formulating the technical requirements for the vessel of the commercial order it is possible to use statistical dependences which approximately reflect developed parities

between characteristics and particulars of an efficient, seaworthy and reliable vessel, safe in operation, strong and durable.

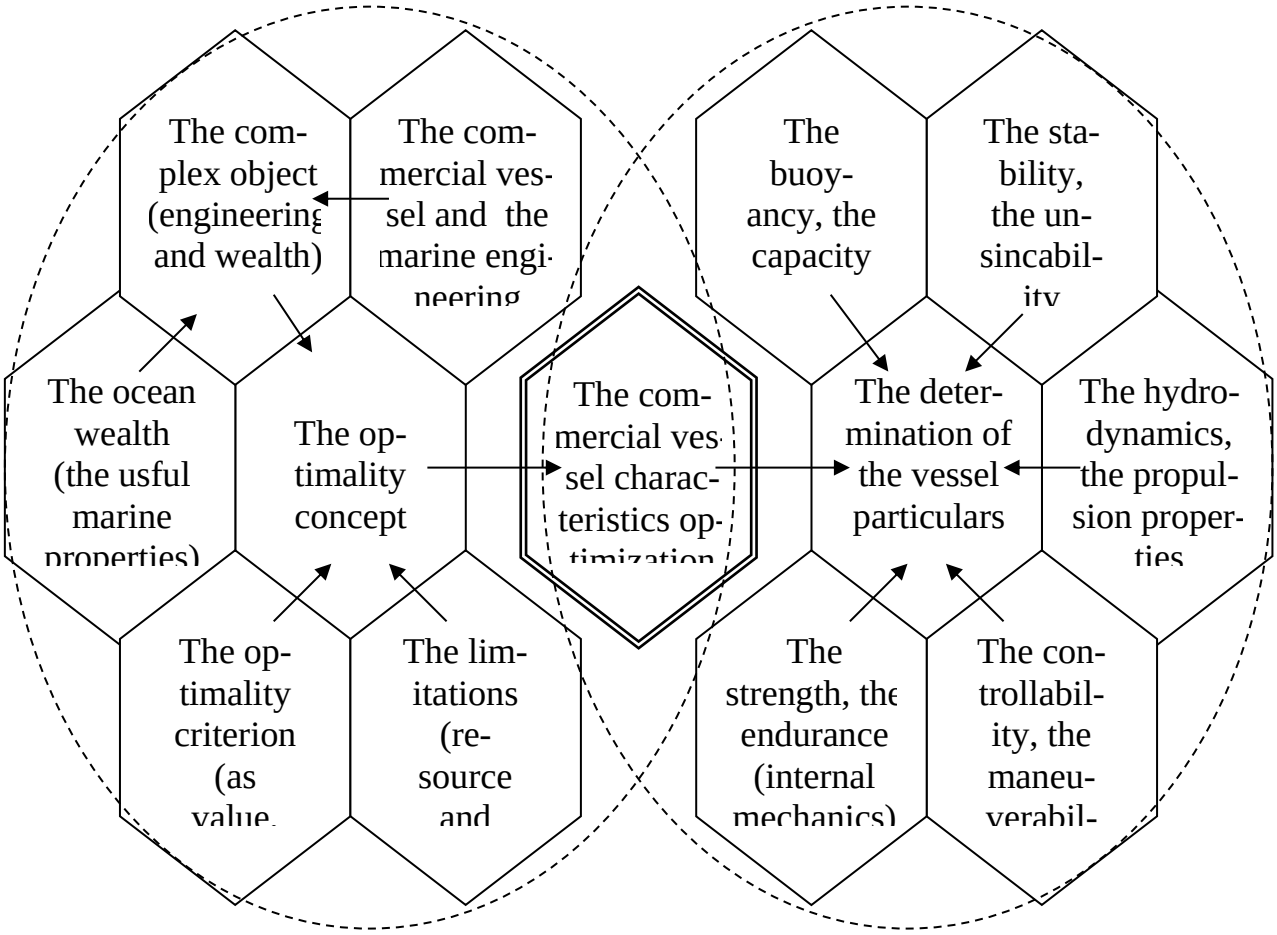



Fig. 25. The economical optimality of the commercial vessel project characteristics and particulars in the naval architecture and marine engineering systematic concept

According to system principles the independent characteristics of the vessel defined on the basis of optimization by the economic criterion, usually are chosen from the get out of number of the following ones: displacement *D*, displacement empty *DP*, cargo capacity *PG* and deadweight *DW* (considering, that from the listed four vessel characteristics usually two or three are dependent according to a certain degree of subject generalization), volume of vessel cargo holds *W*, total register tonnage *GRT* and net register tonnage *NRT*, power of main engine *Ne*, operational speed $\upsilon_S$, etc.

Usually at the phase of commercial vessel project optimization by the economic criterion from one to three or four characteristics vary, and depending on them other vessel characteristics and particulars are determined on the basis of design shipbuilding calculations or under empirical (statistical) formulas, and also on the basis of data of analogues use.

Besides the independent characteristics determined by optimization by the economic criteria, in order to work out technical requirements for the vessel order it is necessary to determine also dependent characteristics and particulars such as: the commercial vessel dimensions, including waterline length *LW*, length over all *L* (or *LOA*); breadth *B*, draught *TW* at cargo waterline and depth *H* to the main deck (that is decks of impenetrable

transverse bulkheads), and also, the factor of the general volume displacement $\delta$ – the ratio of commercial vessel volume displacement to multiplication of waterline length, breadth and draught at cargo waterline.

The general recommendations concerning the characteristics and particulars in the order for vessels of widespread classes depending on the main characteristics which are preliminary determined by optimization by the economic criteria with the account the financial constrains of the investor or functional limitations are presented below.

Besides, formulas which are presented in Chapter 25 for commercial vessel of corresponding class at a stage of data processing can be applied to check the compatibility of commercial vessel data or to additional determination of absent data, and also for the educational purposes when doing practical exercises – for vessel characteristics determination in learning tasks.

The results of the given Chapter were studied with the participation of M.B. Bezuglova and M.V. Kovalenko under the author's guidance.

**Test questions**

1. Applicability of methods of optimization by the economic criterion for determining the characteristics of the vessel (or other marine company asset).
2. Dependent characteristics and particulars of vessel.
3. Formation of technical requirements for the commercial order for vessel (or other marine company asset).

## 25.1. Correlation between of cargo vessel characteristics and particulars

The dependences between characteristics of marine cargo vessels (for example of a universal dry–cargo motor vessel and a commercial vessel for transportation of crude cargoes), between particulars, and also between characteristics, on the one hand, and particulars, on the other hand, are formalized on the basis of statistical generalizations and reflect developed parities between characteristics and particulars of an efficient, seaworthy and reliable vessel, safe in operation, strong and durable to an extent in which these properties are inherent in the used data of analogues.

To determine the parities between characteristics for the commercial order of the universal dry–cargo vessel with displacement $D$ (ts), cargo capacity $PG$ (ts), deadweight $DW$ (ts) and specification fuel stock $P_{FL}$ (ts) the results of statistical generalizations the following dependences can be recommended:

$$DW = 0.409 \times D^{1.063}, \text{ t}; \tag{25.1}$$

$$PG = 0.232 \times D^{1.051}, \text{ t}; \tag{25.2}$$

$$P_{FL} = 0.0015 \times D^{1.368}, \text{ t}. \tag{25.3}$$

The parities between the vessel characteristics for transportation of crude cargoes can be determined as

$$DW = 0.477 \times D^{1.043}, \text{ t}; \tag{25.4}$$

$$PG = 0.874 \times D^{0.919}, \text{ t}; \quad (25.5)$$

$$P_{FL} = 0.0015 \times D^{1.338}, \text{ t}; \quad (25.6)$$

$$W = 0.493 \times D^{1.05}, \text{ cubic ms}. \quad (25.7)$$

The regression dependences of characteristics on the design particular of the dry–cargo vessel – the waterline lengths $LW$ (m) look like:

$$D = 0.583 \times LW^{1.945}, \text{ t}; \quad (25.8)$$

$$DP = 1.333 \times LW^{1.501}, \text{ t}; \quad (25.9)$$

$$DW = 0.159 \times LW^{2.149}, \text{ t}; \quad (25.10)$$

$$PG = 0.387 \times LW^{1.81}, \text{ t}; \quad (25.11)$$

$$W = 0.031 \times LW^{2.542}, \text{ cubic ms}; \quad (25.12)$$

$$GRT = 0.192 \times LW^{2.058}; \quad (25.13)$$

$$NRT = 0.0505 \times LW^{2.152}. \quad (25.14)$$

The dependences of vessel crude cargoes transportation characteristics on the waterline lengths $LW$ (m), received on the basis of statistical generalizations, look like:

$$D = 0.181 \times LW^{2.255}, \text{ t}; \quad (25.15)$$

$$DP = 0.11 \times LW^{2.1}, \text{ t}; \quad (25.16)$$

$$DW = 0.087 \times LW^{2.334}, \text{ t}; \quad (25.17)$$

$$PG = 0.322 \times LW^{1.946}, \text{ t}; \quad (25.18)$$

$$W = 0.076 \times LW^{2.385}, \text{ cubic ms}; \quad (25.19)$$

$$GRT = 0.038 \times LW^{2.445}; \quad (25.20)$$

$$NRT = 0.023 \times LW^{2.362}. \quad (25.21)$$

To determine the design particulars and dimensions of the universal dry–cargo vessel for the commercial order it is possible to recommend the following statistical dependences:

$$LW / B = 2.814 \times \ln(LW) - 5.712; \quad (25.22)$$

$$B / TW = 0.0086 \times LW + 2.535; \quad (25.23)$$

$$H / TW = 0.151 \times LW^{0.468}; \quad (25.24)$$

$$LW / H = 8.812 \times LW^{0.16}; \quad (25.25)$$

$$\delta = 0.0016 \times LW + 0.504. \quad (25.26)$$

It should be noted that parities of commercial vessel dimensions and the factor of the general volume displacement also allow to use the equation of buoyancy $LW \times B \times TW \times \delta \times 1.025 = D$ (Archimedes' law), to determine the displacement and further other characteristics according to formulas (25.1–25.7) at early design stages – before obtaining the investments into the project basic part – for the commercial order of the vessel.

The recommended parities of dimensions and particulars of commercial vessel for transportation of crude cargoes for the commercial order:

$$LW / B = 2.013 \times ln(LW) - 2.527; \quad (25.27)$$

$$B / TW = 0.469 - 0.0007 \times LW; \quad (25.28)$$

$$H / TW = 0.59 \times LW^{0.174}; \quad (25.29)$$

$$LW / H = 2.938 \times LW^{0.348}; \quad (25.30)$$

$$\delta = 0.0008 \times LW + 0.689. \quad (25.31)$$

To determine ship main engine power *Ne* depending on displacement *D* (ts) the following regression formulas can be recommended:

– For universal dry–cargo vessel $Ne = 0.418 \times D^{0.957}$, kW; (25.32)

– For crude cargoes tanker $Ne = 0.591 \times D^{0.909}$, kW. (25.33)

The determination of ship main engine power *Ne* according to formulas (25.32, 25.33) is based on the account of parametrical property of operational speed $\upsilon_S$ under the project of the cargo vessel that is specification speed, that can be explained as follows.

In case of varying of vessel displacement *D* in the range from 100 to 100000 t the specification speed $\upsilon_S$ varies within a substantially smaller interval by relative estimation, let us assume, from 14 to 20 knots, so it can be seen, that specification speed $\upsilon_S$ is rather steady and invariable in comparison with an interval of variation of the design characteristic of vessel displacement *D* that is a parametrical property of the specification speed.

The parities of the vessel design particulars determined by the formulas (25.22–25.31) possess the same parametrical property of stability with a rather narrow interval in case of variation of other characteristics, params and data.

As the specification speed $\upsilon_S$ varies within a substantially smaller interval than the displacement of vessel *D* at early stages of the vessel characteristics determination for the order there is a possibility to derive the speed out of data frameworks when determining the ship main engine power *Ne* and to determine power only depending on the vessel displacement *D*, considering thus, that speed $\upsilon_S$ is steadier, than displacement, and is also in dependence on displacement (that is speed is taken into account in formulas indirectly 25.32, 25.33).

The reduction of factorial dimension of calculations using parametrical properties of some characteristics of the vessel and parities of particulars is of great importance at early stages of determination of vessel design characteristics for the commercial order, since it is possible to find characteristics and vessel particulars by means of consequently detailed calculation.

The operational speed of the vessel $\upsilon_S$ according to the project (specification), in its turn, can be determined depending on waterline length *LW* which is connected with displacement *D* by the formulas (25.8, 25.15).

The regression dependences of commercial vessel operational speed $\upsilon_S$ on waterline length *LW* (m) look like:

– For the universal dry–cargo vessel

$\upsilon_S = 5.795 \times LW^{0.142}$, knots; (25.34)

– For crude cargoes tanker $\upsilon_S = 2.33 \times LW^{0.344}$, knots. (25.35)

The formulas of the «Admiralty factors» $Ne = \upsilon_S^{2,5} \times D^{0,5} / [c_{ADM}]$ for the determining of the commercial vessel main engine power *Ne* depending on displacement *D* (ts) and specification speeds $\upsilon_S$ (knots) when determining of factors $[c_{ADM}]$ according to the statistic data look like:

– For the universal dry–cargo vessel

$$Ne = \upsilon_S^{2.5} \times D^{0.5} / 21.6 \text{, kW;} \tag{25.36}$$

– For crude cargoes tanker $Ne = \upsilon_S^{2.5} \times D^{0.5} / 21.9$, kW. (25.37)

**Test questions**

1. Parametrical properties of the commercial vessel dependent characteristics.
2. Estimation for the commercial order of the commercial vessel displacement by the equation of the balance of loading depending on deadweight.

## 25.2. Dependences between characteristics and particulars of fishing vessel

After the phase of determination of independent characteristics according to the concepts of the systematic approach by optimization methods by the economic criterion it is required to estimate other characteristics – dependent, and also design particulars of the marine steel fishing vessel for the commercial order since usually there is only one independent characteristic from among the main ones such as: vessel displacement *D*, cargo capacity *PG* and deadweight *DW* in case of economic optimization at early stages of fishing vessel designing – before obtaining the basic investments.

The other characteristics should be estimated by naval architecture methods of shipbuilding design calculation or according to statistical generalizations.

If one characteristic of a fishing vessel from among specified above is determined by optimization methods by the economic criterion, other two characteristics can be calculated using of the equations of weight loading balance which are formalized by the statistical generalizations for vessels of the given class.

The following equations of weight loading balance should be applied in order to determine the fishing vessel dependent characteristics from among number: vessel displacement *D* (ts), cargo capacity *PG* (ts) and deadweight *DW* (ts):

$$0.37 \times D - 1.37 \times D^{1/2} - DW = 0; \tag{25.38}$$

$$0.40 \times D - 0.68 \times D^{2/3} - DW = 0; \tag{25.39}$$

$$0.21 \times D - 1.09 \times D^{1/2} - PG = 0. \tag{25.40}$$

The multipliers in the equations (25.38–6.40) concerning the characteristics of marine steel fishing vessels are the results of statistical generalizations and selection.

Also the parity between displacement *D* (ts) and project (specification) deadweight *DW* (ts) of the fishing vessel for the commercial order (if one of these characteristics is determined by optimization methods by the economic criterion, and the second

characteristic is in dependence on the first one) can be found by solving the equation of weight loading balance which is not only the result of statistical generalization, but also includes the use of the weight factor $0.0 < a < 1.0$, which characterizes expert preference of the entering balance equation in the form of (25.38) in relation to the equation (25.39):

$$(0.37 \div 0.40) \times D - a \times 1.37 \times D^{1/2} - (1-a) \times 0.68 \times D^{2/3} - DW = 0\,. \qquad (25.41)$$

The regression dependences of other characteristics and particulars on displacement $D$ (ts) and waterline lengths $LW$ (m) of the fishing vessel look like:

$$W / PG = 6.03 \times D^{-0.122}\text{, cubic m / t – specific tonnage;} \qquad (25.42)$$

$$GRT = 0.385 \times D^{1.074}; \qquad (25.43)$$

$$NRT = 0.127 \times D^{1.071}; \qquad (25.44)$$

$$W = 0.42 \times D^{1.003}\text{, cubic ms;} \qquad (25.45)$$

$$D = 0.113 \times LW^{2.394}\text{, t;} \qquad (25.46)$$

$$DW = 0.0228 \times LW^{2.515}\text{, t;} \qquad (25.47)$$

$$PG = 0.0066 \times LW^{2.67}\text{, t;} \qquad (25.48)$$

$$W = 0.0514 \times LW^{2.407}\text{, cubic ms;} \qquad (25.49)$$

$$GRT = 0.035 \times LW^{2.60}; \qquad (25.50)$$

$$NRT = 0.0126 \times LW^{2.569}\,. \qquad (25.51)$$

The recommended parities of fishing vessel dimensions depending on waterline length $LW$ (m) for the commercial order are:

– The relative length of a fishing vessel in dependence on waterline length $LW$ (m) $LW / B = 1.93 \times \ln(LW) - 2.93$; (25.52)

– The relative breadth of fishing vessel $B / TW = 0.0039 \times LW + 2.38$; (25.53)

– The height of fishing vessel board $H$ to the main deck $H = 0.40 \times LW^{0.68}$, m; (25.54)

– The height of fishing vessel board $HD$ to main deck $HD = 1.24 \times LW^{0.50}$, m; (25.55)

– The relation of fishing vessel length $LW$ to height $H$ of the board to main deck $LW / H = 2.50 \times LW^{0.32}$; (25.56)

– The relation of fishing vessel length $LW$ to height $HD$ of the board to upper deck $LW / HD = 0.81 \times LW^{0.50}$; (25.57)

– The relation of height $H$ of the board to the fishing vessel main deck to draught $TW$ in cargo $H / TW = 0.92 \times LW^{0.10}$; (25.58)

– The relation of height $HD$ of the board to fishing vessel upper deck to draught $TW$ in cargo $HD / TW = 1.18 \times LW^{0.09}$; (25.59)

– The factor of the general volume displacement $\delta = 0.0016 \times LW + 0.504$. (25.60)

The recommended statistical dependences to calculate the main engine power on displacement $D$ (ts) for fishing vessel commercial order are follows:

– The power of fishing vessel's main engine $Ne$

$$Ne = 3.57 \times D^{0.81}, \text{ kW}; \tag{25.61}$$

– The total power of fishing vessel auxiliary engines $Nu$

$$Nu = 3.98 \times D^{0.66}, \text{ kW}; \tag{25.62}$$

– The formula of the «Admiralty factors» by the results of statistical data generalizations $Ne = v_S^{2.5} \times D^{1/2} / 15.5$, kW. (25.63)

To estimate the daily running fuel expenditure depending on main engine power $Ne$ (kW) the following empirical dependence can be recommended:

$$q_1 = 0.008 \times Ne^{0.946}, \text{ t / day}. \tag{25.64}$$

The statistical dependence of fishing vessel operational speed $\upsilon_S$ on waterline length $LW$ (m)

$$v_S = 3.17 \times LW^{0.346}, \text{ knots}. \tag{25.65}$$

Concerning vessels of other classes, except considered above: the universal dry–cargo vessel, the tanker for crude cargoes transportation and the marine steel fishing vessel, that is for vessels with other set of classification attributes (see paragraph 1.1), for example, for rolling cargo vessels, ferries, container cargo vessels, bulk cargo vessels, vessels for transportation of wood cargoes, towing vessels, icebreakers, not self–propelled (barges) etc., – it can be recommended to apply statistics accumulation, working out and use of the analogues regression formulas for project characteristics and particulars estimation – the dimensions and their parities.

When constructing a new vessel, including the project stage, the estimation of her characteristics, dimensions and their parities under statistical formulas (25.1–25.65 or similar according to vessel class) can be a source of data for the further specification of characteristics and dimensions by the methods of naval architecture and shipbuilding design calculations for the initial approximation.

Also the determination of characteristics and dimensions of a commercial vessel can be a method of quality supervision of constructing from the part of the investor. For this purpose, the investor should estimate optimal characteristics and dimensions as the basis to make the decision on vessel construction, and the probable deviations revealed at a stage of acceptance of the constructed vessel from the set of predetermined characteristics should be defined for the commercial order for construction as the basis for preliminary stipulated concessions of purchase price (reproduction cost).

When planning the commercial vessel purchase at the pre–owned market, and also in a value estimation the essential difference of her characteristics, dimensions and their parities from the statistical values defined by the formulas (25.1–25.65) can be a sign of functional depreciation – surplus or a lack of one particular or property or another and the basis for purchase price concession.

**Test questions**

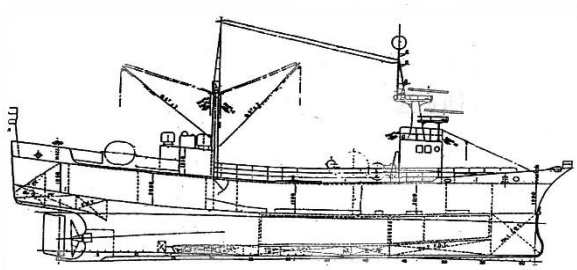
1. Independence of variable for optimization by the economic criterion and interrelation between the fishing vessel main characteristics: displacement, cargo capacity and deadweight.

2. Additional determination of fishing vessel dependent characteristics by the balance equation, the variants of fishing vessel balance equation.

3. General recommendations concerning determination of dependent characteristics of commercial vessels of various classes with accumulation and use of statistical data.

4. Estimation of characteristics and particulars for the control of the quality of construction from the part of investor.

5. Application of the values of dependent characteristics and the particulars of commercial vessel, determined statistically, for estimation of functional depreciation and purchase price concessions.



## 26. The steps in evaluation process and quality of the economic estimation of investments in the marine industrial activity

The evaluation and the economic efficiency estimation of investments quality can be evaluated by the reliability and accuracy criteria. For maintenance of appraisal quality it is more important to have available and effective system of a quality inspection rather than its activity. And bureaucratization of the system of the quality inspection survey strongly harms the purposes of inspection and appraisal, as that.

When there is bureaucratization of the system of the quality inspection survey of economic estimations the methodology and professional survey, critical and at the same time unbiased and joint is usually superseded, becomes impracticable.

The same usually occurs, if the inspection is done by the unauthorized person or if there are any procedural infringements, for example, if the documents to be inspected come from a doubtful source if the documents are not filed completely if there is a pressure on the surveyor or inspected expert, etc.

The advisory counts in the self–regulatory organizations as a rule control the quality of the economical expertise, conformity to ethics standards and resolve of probable contradictions arising between experts.

Besides the research of the formal conformity in checked expert works, the inspection of their quality is carried out to measure (characterize) the methodological and ethical concepts in the judgments of the professional economical expertise with the concepts of the self–regulatory organization.

Leaving outside specifications, the aim of advisory councils is to protect the professional environment where assets can be evaluated on the basis of substantiation of calculations and external data. The purpose of substantiation of calculations is the estimation of investments: the value (and its types) and the separate indexes of market value determined by independent approaches, the indexes of efficiency, the depreciation and obsolescence, the income, the operation costs, the net operating income, the commercial risks,

and also the indexes which all in aggregate are determined depending on identification signs of the evaluated vessel or other asset of the marine company and on data.

Used external data, for example some price (monetary) indexes which cannot be experimentally measured, are evaluated by the expert approaches. The source of data for an expert economic estimation is to the full materialistic only regarding measured physical characteristics.

Since it is impossible to construct any substantiation of a value index without expert monetary data, the monetary data cannot be a result of substantiation of calculations. Therefore any economic evaluation contains the expert monetary initial data accepted without substantiation of calculations also in the case when the expert uses the network information and this way he shifts the responsibility for the expert data reliability to the other person.

Even if monetary data are based on preceding bookkeeping entries (records), it is necessary to consider, that the preliminary decision about the monetary transactions was made by the authorized person expertly.

The reference to the source of monetary initial data, for example, determined from the Internet network or from publications, is not a negation of expert sense of these initial data. It is a question only about shifting of responsibility for initial data to the other person who has published them, but also had no possibility to measure the monetary initial data objectively and only assume their values by the expert opinion.

Application of the initial data in expert economic value estimation is necessary and in itself does not serve as critical judgment about reliability of an expert evaluation. Much depends on a methodological correctness of operations on expert data and on detailed development of data.

The level of detailed development of data would correspond to economic model of an evaluated vessel, other asset or the property complex of the marine company. The detailed elaboration of the model to the extent at which the influence of the asset (vessel) characteristics, data and params on the value is defined, leads to formation of the sets of these values and dependences between them.

Resultant value itself or the basic economic indexes (that is resultants indicators) can not be the initial data for estimation since from the system point of view it is required to reflect the influence of the basic identification characteristics of asset or the property complex on the value and other economic indexes.

The general guidance of detailed elaboration of expert initial monetary data for the economic evaluation of the commercial vessel, other real asset or the property complex of the marine company can be the following:

– Detailed elaboration of economic model of evaluated object (or object detailed elaboration) to the extent when there will be a possibility to neglect the influence of accuracy of separate monetary initial data on the general result of economic evaluation;

– Integration of economic model, more correctly, the object integration when evaluating by a uniform model.

The integration of economic model, in particular, leads to its detailed elaboration if, for example, in case of evaluation of the marine company's property complex the uniform model covers also the evaluation of its assets, instead of applying the data concerning assets which are evaluated by the expert opinion separately.

Probably, it is possible to manage without detailed elaboration of economic model, if there is a task to evaluate some batch objects for which applied instructions are available, and economic methodology itself is not applied. But such simplification is hardly applicable concerning marine commercial vessels, other assets or the marine companies' property complexes.

Detailed elaboration of the economic model of the commercial vessel, other real asset or the property complex of the marine company, which helps to reduce subjectivity of the evaluation, considering, that there is no possibility to do without using the expert initial data of monetary indexes and without them it is impossible to find monetary result, leads to the fact the evaluation of similar objects should be fulfilled by the methods of mathematical programming.

When the expert study is carried out by the methods of mathematical programming, the function of the expert are not calculations, but working out of an algorithm and a program. Used data, intermediate calculations and results further should be transferred into a narrative part of the expertise.

The expert economic evaluation itself by the methods of mathematical programming is carried out in one step after the algorithm finishing.

The estimation of both value result, and monetary initial data determined expertly (which cannot be determined by physical measurements) by the methods of mathematical programming is made simultaneously, and there is a possibility to estimate the influence of each of monetary data on the general result in order to research the relevance of assumptions in case where the data estimated expertly and to study if the degree of model detailed elaboration is quite acceptable or not.

Apparently, monetary initial data determined expertly can not be estimated most strictly and systematically with the account the analysis of their influence on the general result if the evaluation is not made based on methods of mathematical programming, that is if calculations of the general result of the value or other economic indexes are made manually in the narrative part of the expertise.

Thus, the methods of mathematical programming for expert economic evaluation of rather complex (single or not batch – made) objects, such as commercial vessels, other assets or the marine companies' complexes of the assets, one should understand as a modern systematic approach allowing to estimate as correctly as possible monetary initial data, expert economic results and to research about adequacy of used methods and algorithms rather than a possible alternative, along with other possibility – «the manual calculations». There are no such possibilities if mathematical programming is not used.

On the other hand, the algorithm and used methods should be reported in depth in a narrative part of the appraisal and of there should be enough transferred from mathematical algorithm in a narrative part data and results to carry out the evaluation and if it is required, to reproduce the algorithm.

At the same time the narrative part of the expertise is not equal to the available mathematical algorithm. On the one hand, the narrative part contains the analysis, explanatory and comments that the working algorithm can not contain, and other hand – the narrative part does not possess the functions of the working algorithm allowing reproduce an expert economic evaluation and possible variants in one step.

The applied expert evaluation in the algorithmic form with the account methodological and algorithmic compatibility will be done based on methods of mathematical programming in the long view in a global network.

In spite of the fact that the general prospects are rather clear, it should be noted that practical possibilities to change the expert work substantially and to direct it to a general analysis of the evaluated object, that, of course, will affect the structure and the form of the expert work, are far from widespread application, since there is a need for working out of corresponding methodology and, probably, the software product.

The economic evaluation based on methods of mathematical programming opens a possibility of the electronic reporting in appraisal that promotes improvement of the quality of the economic expertise.

There should be confusion that the electronic report means that the expert can avoid making a narrative appraisal. The narrative part of the electronic report is not an expert evaluation, but its description. The evaluation itself is thus carried out based on methods of mathematical programming in the algorithmic form and is a part of expert work along with the narrative description.

It worth repeating, that the basic advantage of evaluation by mathematical programming methods is not that they make the expert's work easy, but it is an additional possibility to carry out the work in one step after finishing the algorithm that allows to estimate simultaneously the economic result and monetary initial data which cannot be estimated differently but by the expert opinion. This estimation should be made within the operating algorithm general for all expert work and the algorithm should be estimated if it is correct and in its turn elaborated sufficiently.

It allows rather objectively determining the value or indexes of efficiency of complex objects, such as vessels, other assets and the marine companies' complexes for which there are no batch analogues and which can not be evaluated differently than by methods of mathematical programming using the rough assumptions that influence the result of expert evaluation.

The detailed elaboration of the economic model should not be too excessive when with a small set of data in the model the capacious files of the information are generated, and when the result usually presented by single index of value or economic index is determined the information files vanish.

In case of excessive detailed elaboration the economic model which thus is not researchable in essence becomes as though «inflated» by lot of the internal information. And the information (initial data) that come into the model from the outside is not great, also as well as the information that goes out of the model (the value result of an estimation which is single index).

At first sight, there can be an incorrect impression, that excessively detailed economic model is more exact. Actually it can be considered as uncertain. The excessive detailed elaboration of economic model can be defined when correlating the initial data files and the results, on the one hand; with a file of intermediate calculations, on the other hand.

If the model is rational, harmonious and researchable and corresponds to the complexity of evaluated object the specified files should be proportional.

Excessive detailed elaboration as a drawback of the economic model structure corresponds to the excess of intermediate calculations file in comparison with data and results.

It should be noted that in estimations of economic indexes above mentioned drawback of excessive detailed elaboration of calculation models is rather widespread and can worsen the quality of expert evaluation and reduce the trust to it.

For example, when estimating the investments efficiency indicators for business plans with use of some packages offered for experts, from three to ten values are used as data (the income, the operation cost, rates of taxes, the currency exchange rate, some other), the result is the evaluation of the internal rate of return (or payback period), and intermediate calculations are kept within tens multi–digit tables, which cannot be checked up even if to put them in a narrative part of expert's report.

To avoid the excessive detailed model elaboration, even a rather complicated one, such as economic model in case of the system evaluation of the commercial vessel, other real asset or the property complex of the marine company, when working out the economic model an expert should adhere to the concepts when the files of initial data and results, on the one hand, and the files of intermediate calculations, on the other hand, correspond with each other as proportional.

When using the Internet network to determine the data on prices of vessels or marine engineering and ocean technology one should to understand the symbols and to be familiar with the professional terms.

Besides, it is necessary to know the symbols of various monetary units and dimensions, and also to understand the rules of conventions at record of numerals, etc. In other words, to use the information databases for the evaluation of the vessel and other assets of the marine companies' one should have a certain erudition.

Conformity of the data presented in a graphic form in expert's report with the data received from the Internet on the computer screen in the form of the Internet pages can not characterize the data as reliable ones, and even there can be a doubt concerning excessive efforts of the expert to reproduce the external conformity of his report with the data presentation form of the Internet. The similar possible requirements – to issue in expert work data according to the design of the Internet page – some times can arise in case of superficial checking that doesn't concern the essence of the expert's report. Such requirements are not quite serious.

The data should be transformed to a general uniform format of the expertise narrative part, which is the structured document, considering, that in process of transformation the data become a part of expert's work of estimation of the value and economic efficiency of investments in the marine industrial activity.

Anyway, if the data from the Internet network are presented in a format of expert's report instead of the Internet page, there is a confidence, that when transforming the data and editing the text the expert has at least read them, that is not always obvious, if the data are enclosed to the expert's report from the computer screen.

Unlike the spent efforts of the expert to transform the data to a format of appraisal (with preservation of electronic addresses and possibilities to research the information in essence), it is the negligence and data presentation in the row form copied in the Internet format, without sufficient processing of format, without studying and the analysis of data, that can be a substantial drawback of the appraisal report.

It is necessary to consider that the possibility of the checking of the data, received from the information network, has a probabilistic nature and depends on the duration of checking. It is not quite logical verify all the data used in expert's report in the Internet network. It is necessary to check the basic part of the data which should be enough, for verification of the general tendencies essential to the evaluation.

Eventually the possibility of data checking is lost, and the information in the network varies. If data are doubled by the different analogues or sources also there is an address for a feedback the probability of verification of the data basic part is better, and check is a verification of the majority of the data (not all ones).

In some cases the advantage of the expert work on appraising of a vessel, asset or the property complex of the marine company is a simplicity and brevity of a statement. Really, the laconicism is a positive characteristic.

At the same time excessive simplification of expert work is a drawback since the object is rather complex and its evaluation should contain certain sections, at least:

– Definition of object and an estimation subject, proceeding from the purpose by the contract;

– Description of limitations and assumptions;

– Characteristic of evaluated property rights;

– Description of the vessel's characteristics and particulars (or other asset of the marine company), allowing to identify her unequivocally;

– Description of used calculation models which should allow estimating the basic economic indexes and the value on the basis of identification signs used as initial data;

– Data of marketing researches and statistical generalizations;

– Calculations which could be reproduced, using a narrative part of checked expert work or can be check up by other available way;

– Data, allowing to establish the person, authorship, qualification and the relation of the expert to subject of estimation (estimation under the contract, under the duty regulations according to employment, under the court decision, other) and to object of an estimation (who is the proprietor and in what relations he is with the expert).

Usually excessively short expert reports of «the simplified content» on the value or efficiency estimation of a commercial vessel, an asset or a property complex of the marine company met in practice do not contain even a correct statement of the task, leaving aside the solving of the task.

When checking the expert's report the basic subject is the correctness and system based character of economic indicators and value estimation in dependence on variables, params and data.

The typical methodological errors, except arithmetic errors and orthographic ones occurred in expert's reports on estimation of commercial vessel, other real asset or the property complex of the marine company are usually as follows:

1. Object of evaluation is defined incorrectly methodologically and inaccurately in respect of physical or time borders, as well as in the set of property rights.

2. Subject of evaluation – the value standard that is a purpose for which the value is determined, which choice is subordinated to the evaluation purposes, is defined incorrectly.

3. Independence of methodological approaches is broken – the independence of the data in the basis of standard approaches of the value estimation, applied also in a corresponding part of expertise when estimating efficiency.

4. There is a discrepancy of approaches – the discrepancy of assumptions in approaches.

5. Results of estimation of the value or efficiency do not depend on identification signs, that is the causal relationship is broken, and the essential characteristics of evaluated vessel, other asset or property complex of the marine company are not used or not completely used in the evaluation.

6. If the value that is evaluated not a market, but other one, an error can be the deviation from concept of the market value as a basis of evaluation, that is, the definition of other types of the value not through the market value in the methodological or algorithmic sense is erroneous.

7. Errors of the double accounting of data are.

The list of the specified widespread methodological errors does not include arithmetic errors. To except the arithmetic errors in expert's reports on the value and economic efficiency estimation the following ways can be recommended:

– To carry out the expert work so that the calculations can be reproduced, to duplicate calculations (to repeat);

– To simplify calculations and to represent calculations in completed form – the formula with symbols, the formula with substitution of values, the result;

– To avoid unreasonable complication of calculations and excessive detailed elaboration of economic models;

– To detail the algorithms of the estimation of the value and economic efficiency according to degree of object's complexity;

– To fulfill the expert estimation of the value and efficiency based on methods of mathematical programming;

– Not to carry out calculations with intermediate rounding off «in a manual mode» when typing the text document.

Typing errors, which do not lead to distortion of the results of the estimation of the value or economic efficiency, and do not lead to distortion of identification signs of evaluated asset or to distortion of methodological concepts of evaluation, for example, the value concept, and so on, are not considered to be errors.

While estimating the economic indexes of efficiency or the value under some circumstances it is necessary to determine the error of the results. The error is not an error, but is a natural property of the results of estimation which have a probabilistic nature.

The system reasons of estimation error of economic efficiency indexes and the value are the following:

– The error of data which in the evaluation of commercial vessel, other real asset or property complex of the marine company characterize the methodological connections with a more general system than the evaluated object which is a part of this system;

– Error of assumptions, in particular, the values of params accepted by the expert opinion, which characterize methodological connections with local subsystems of the commercial vessel or other asset of the marine company concerning which the error of economic indexes is evaluated;

– The discrepancy (that is an expert or subjective nature) of methodological connections between the factors which influence the basic economic indexes, that is the approximate character of interrelation of factors of conformity of economic model with the laws described by it.

To estimate the influence of an inaccuracy of data or params the alternative calculations of value or economic efficiency indexes for various values of data or the params varied within error limits are required.

To estimate the accuracy of methodological connections between the factors it is required to use independent approaches of estimation of the value and the basic economic indexes.

The error of estimation of economic indexes or value is determined by the absolute size (in monetary units) by alternative calculations or on the basis application of independent methodological approaches.

The error should be estimated by the relative value or on the basis of relation with a base indicator. The dimension of the error is thus eliminated or the error is compared to the index of the same dimension.

The base of error estimation should be defined from the point of view of the systematic approach. For example, the base of error estimation can be the value of a growing business of the working marine company or the constant value of business of the company–bankrupt, equal to the sum of assets values.

If the durability of the object is limited, as, for example, the life time of a commercial vessel (or other isolated asset), unlike life time of the property complex – sets of assets, in some cases the base of error estimation from the point of view of the systematic approach can be the sum of the vessel value and depreciation at the present value, for example, the reproduction cost (or replacement cost) rather than the vessel value (or other asset).

It should be considered, that the market value of the commercial vessel with the limited life time decreases from the reproduction cost to zero. Thus the error of the value estimation in the relative value will go to infinity if the value decreasing to zero within vessel life time is accepted as a base of error comparison.

On the other hand, it should be taken into consideration that over the time a vessel (or other isolated asset) in relation to the reproduction cost collects the depreciation, which in economic sense is an index of the market value decrease. Therefore, if to assume, that the estimation error by the relative value not should grow boundless by with the vessel years when the market value decreases to zero, hence, the error of evaluation should decrease to zero by the absolute measure (monetary) – to proportionally to be depreciation of the vessel value applied as a base for the estimation of the relative error.

But thus there is a system contradiction which is in the fact that by the monetary measure the error of the value estimation is also an error of determination of the depreciation collecting over the time of commercial vessel within the life time, and the error of estimation of depreciation cannot be equal zero by relative and absolute size.

Hence, the market value of the commercial vessel (or other isolated asset of the marine company), becoming cheaper to a zero within life time, cannot be a base of comparison for determination of a relative error of its estimation. The same is true concerning the error estimation of other general economic indexes of the commercial vessel or other isolated asset of the marine company.

Thus, as a base for determination of the error of value estimation of the commercial

vessel (or other isolated asset) by the relative value it is reasonable to accept any economic index which is not connected with life time and does not essentially vary over the time. As a base it is possible to accept:

– Reproduction cost;

– Operation costs or the annual income, and also some other indexes which are formalized by the operation costs and the income, for example, the value estimated based on income approach in the assumption of the big residual life time of the commercial vessel (or other asset);

– Criteria of efficiency used to express one economic index or another which error of determination is estimated by the relative value, considering that criteria are usually evaluated for a constructed or relatively new vessel and depended on life time insignificantly.

It can be illustrated by an example. Let us admit that by the cost approach the value of not a new vessel is estimated 100 thousand US dollars, based on income approach – 250 thousand US dollars, based on comparable sales approach – 550 thousand US dollars, and reproduction cost (the cost of a new vessel structural analogue manufacturing in present market prices on the date of the estimation) is 15 million US dollars.

Despite the apparent spread of values (100, 250, 550 thousand US dollars, on the average 300 thousand US dollars) the vessel value estimation by the independent approaches in comparison with the reproduction cost of the commercial vessel (15 million US dollars) or in comparison with the accumulated depreciation which is almost equal to the reproduction cost, is quite a satisfactory approximation of zero estimation, and the spread of values is acceptable and is a prompt that the estimation corresponds to the residual liquidation value of the commercial vessel.

For the conditions of a similar example concerning the checking of the accuracy the evaluation of not a new vessel can cause much more doubts if spread of the results of evaluation by the independent approaches is: 290, 300, 310 thousand US dollars that means an incredibly high accuracy of the evaluation in comparison with the commercial vessel reproduction cost (15 million US dollars) or in comparison with the accumulated depreciation and leads to an incorrect general conclusion, that the vessel value is equal to 300 thousand US dollars whereas actually the value corresponds to zero or residual liquidation value, and the sum of 300 thousand US dollars is an error of the estimation, that is visible according to the initial example.

Thus, to determine the error of the value estimation of the commercial vessel (or other asset of the marine company) one should the correctly determine the base of the relative error from the point of view of the systematic approach when the vessel is evaluated not in itself, but in a context of all cycle (manufacturing, equipment, productive operation and utilization) and in structure of all connections – in the property complex, as a batch production output, as a result of investment and as an object of an efficiency evaluation within the limits of the corresponding innovative project, as an object in classification of the commercial vessels and assets etc.

The important factor of reliability and quality of the estimation of commercial vessel, other real asset or the property complex of the marine company is the independence of the expert from the parties concerned in evaluated objects.

The expert participation in a self–regulatory professional organization opens the possibility of his independence from the parties and the customer of evaluation service that is problematic under other circumstances.

The independence of expert estimation of the value or efficiency of investments follows from the mutual obligations of participants of the self–regulatory professional organization, only one of which in each separate case fulfills the estimation by the contract with the customer, but in approaches he is guided by the general rules and other participants of the self–regulatory organization who in this case do not make the evaluation and are independent.

If the expert does not participate in the self–regulatory organization he is dependent on the customer or other party, since the independence of the expert is a relative concept.

The parties and the customer should not influence the independence of the expert (concerning the conditions of payment or otherwise), therefore the following condition are considered to be inappropriate and are not quite lawful:

– Conditions in contracts for estimation, establishing the influence of the customer on the expert concerning evaluation methodology;

– Participation of other party in expertise of value or efficiency, except the expert which by the contract can influence the expert or the estimation;

– Instruction to the expert to use the methodological conditions and assumptions or the rules of evaluation differing from professional specifications and standards of the self–regulatory organizations;

– Evaluation of the commercial vessel, other real asset or the property complex of the marine company by the «internal» expert who is the employee of one of the concerned parties.

Estimating the independence of the expert as a factor of quality of estimation of the value or efficiency of investments, it is necessary to consider the rationality of approaches to accreditation of the appraisal and consulting companies with corporate customers of expert services.

According to the accepted practice for accreditation the expert organization usually should correspond to a certain set of requirements (the value of assets, the company's staff, the insurance of the professional responsibility and so on). The question is in rationality of corporate customer requirements for accreditation of the expert or the company.

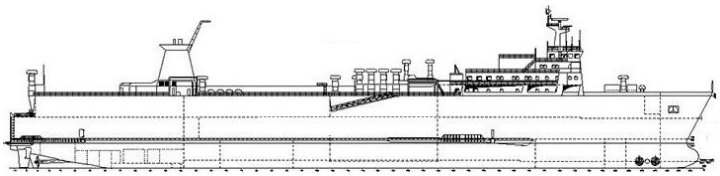
Apparently, the most proved criteria for accreditation can be the signs of the expert's (or the company) compliance with the strategy of the self–regulatory professional noncommercial organization, defined as a form of the expert participation in the self–regulatory professional organization or as the most effective organizational form of the expert company.

Thus, the accreditation of the expert (or the company) with the corporate customer in case of the rational approach of the customer to a choice of the expert is, actually, the partnership or the associated participation of the corporate customer in the self–regulatory professional noncommercial organization.

On the other hand, in case of the customer's partnership with the self–regulatory professional organization the independence of experts is not broken otherwise it can be doubt if the expert is directly accredited at the corporate customer, that also essentially influences the quality of the evaluation and the economic efficiency estimation of vessels, other real assets or the marine companies' complexes of the assets.

**Test questions**

1. Quality of the evaluation and the economic efficiency estimation of investments by the reliability and accuracy factors.
2. Data accepted by the expert opinion for the evaluation.
3. Probabilistic nature of data verification in the information network.
4. Basic subject of verification of expert report of estimation of the value or economic efficiency.
5. Widespread general methodological errors made in process of evaluation of the commercial vessel, other real asset or the property complex the marine company.
6. Recommendations how to avoid arithmetic errors in the estimation of value or efficiency.
7. System causes of an error of estimation of the value and basic economic indexes.
8. The base of the estimation of the error and spread when estimating the value or when determining the economic efficiency index.
9. Independence of the expert as a factor of economic evaluation quality.
10. The relative nature of the expert independence and the importance of his participation in the self–regulatory professional organization.



# Conclusions

The estimation of the value and economic efficiency of vessels, marine engineering, other assets and the marine companies' complexes is methodologically isolated by the complex structure of the object which is based on the investor's motivation to development the ocean resources through the vessels construction or the other marine engineering, by means of the creation of the marine engineering complex and productive operation of the specified objects.

Professional experts in the field of the enterprise (business) value estimation, economy, management and crisis management should be familiar with the methods of the solution of the economic expert tasks in order to promote the advancement of financial investments into the real economic sector and to increase the efficiency of the marine companies' complexes of the assets.

To solve the expert tasks of the estimation of the value and economic efficiency an expert should have the understanding of features of estimation of the real assets of the marine companies' complexes, in particular vessels, and also the experience and vision of prospects of marine industrial activity, technique and technology economic development.

The textbook contains the methodological material explaining theoretical concepts and developing practical skills in solving the applied expert tasks of evaluation of the vessels, the marine engineering, other assets and the marine companies' complexes.

The choice of methodological approaches used in estimation of the value and economic efficiency of vessels and other real assets of the marine companies' complexes is influenced by the following features of characteristic assets:

– Characteristic asset of the marine company should be evaluated as a property complex, that is as economically isolated unit applying the methods of the evaluation of the operating company and necessary adjustments;

– Value of the commercial vessel or other isolated asset of the marine company is proportional to the total value of the marine company as a whole;

– Vessel or other isolated asset of the marine company in the technological and functional relation is not a stereotypic one, and even a large batch usually does not exceed several units with noticeable differences, and its properties substantially depend on marine resources for the development of which it is used;

– Unlike the property complex and real estate the value of characteristic assets of the marine company considerably decreases over the time as the value transfers to the value of the production or services;

– Characteristic asset of the marine company is constructed and operated to provide the investor's access to the marine wealth that is the basic system precondition for estimation of the value and economic efficiency.

The terms and the general concepts used in the field of shipbuilding, fleet technical operation and maintenance, which are necessary for the expert, including the concepts of the commercial vessels classification, the set of the vessels structural elements, the devices, the systems and the power–plants, the basic concepts in the field of the vessel repair service and maintenance are presented in Chapter 1.

The Chapter 2 of the textbook contains the recommendations on the initial data processing and on the scheduling of the work of the vessel evaluation. The features of standard approaches application for commercial vessel evaluation are presented in the 3–rd Chapter.

The concepts of the comparable sales approach to commercial vessel evaluation, including recommendations concerning a choice of units of comparison and a substantiation of the of statistical regressions formalization for the vessel evaluation based on Chapter 4.

The Chapter 5 of the textbook covers the methodical features and recommendations concerning the vessel estimation by the cost approach, models of commercial vessel reproduction cost as well as concept of the integrated infrastructural part of reproduction cost. The comparable sales approach and marketing researches can be applied for the estimation of the vessel reproduction cost in a specific case in the form of statistical regressions that is stated in Chapter 6. The concepts of the estimation of depreciations in case of the evaluation based on cost approach are stated in Chapter 7, and characteristic examples of the estimation of the commercial vessel depreciations are considered in Chapter 8.

The external economic obsolescence is considered among the general set of the components, and the approach to the estimation of the external economic obsolescence based on the account of economic difficulties of the seller and the buyer shifted to the seller, is presented in Chapter 9.

Concept of the external economic obsolescence closely corresponds to the determination of the resale discount to the value since the basis for discount determination usually is either the limited duration of the exposure period of the commercial vessel for sale or difficulties of the parties participating in the sale, – the seller and the buyer, – shifted to the seller.

Concepts of the resale discount estimation in case of vessel sale in the period substantially shorter than the typical marketing period are considered in Chapter 10.

The features of evaluation of the commercial vessel, other real asset or the property complex of the marine company based on income approach are a subject of Chapters 11–16 of the textbook. The interval method of capitalization which is based on the relation of the time periods of capitalization of the discounted cash flow to the investment periods under the planned schedule is considered within the limits of the income approach application for the property complex evaluation (Chapter 12).

In practice of the assets evaluation based on income approach discounting by the factor (1+*i*) on the basis of the discounting rate *i*, which has developed as the formalization of hypothec investment charges is usually applied.

On the other hand, the analysis of formal properties of economic risks (Chapter 13) leads to determination of discount by using the exponential functions $e^i$ of the Euler' number, *e* = 2.71828283... And $e^i \approx (1+i)$ with small values of the discounting rate *i*, when $i \approx \ln(1+i)$, that is with rather small values of the rate $i \leq (0.15 \div 0.20)$, the results of the arithmetic discounting application and exponential functions of the Euler' number for estimation of the value and efficiency of real asset are rather close.

At the same time the discounting by the exponential functions of the Euler' number $e^i$ can be considered preferable for the vessel evaluation or other asset, and also the property complex of the marine company in which structure there is the isolated real asset proportional by its value to the value of property complex as a whole and applied by the investor get an access to the marine wealth.

Unlike the discounting by the factor (1+*i*), the use of the exponential functions of the Euler' number $e^i$ in the basis does not contain any conditions and is not a mathematical model of interest on the loan or the deposit that is more objectively.

The discounting by the factor (1+*i*) is a reasonable mathematical approximation in case of rather small risks $i \leq (0{,}15 \div 0{,}20)$.

Application of the income approach methods for the estimation of the commercial vessel, other real asset or the real assets property complex of the marine company is based on the economic models which are the sequences of methodological dependences between vessel characteristics, data and the params usually evaluated by expert opinion, on the one hand, and by the basic economic indexes, on the other hand.

The annual income, the annual operating costs and investments into the shipbuilding or the marine engineering manufacturing (or purchase at the pre–owned market) and in equipment – in replenishment of a stock of working assets are referred to a number of the basic economic indexes of the commercial vessel, other real asset or the property complex of the marine company concern.

The basic economic models (that is most the general models suitable for detailed elaboration and use in an applied estimation) are presented in Chapter 14 – for a cargo vessel, Chapter 15 – for a fishing vessel.

The methodical bases and recommendations used to determine the factors applied to value estimation with use of indicators of operation costs (article 16.1) and the annual income (article 16.2) are stated in Chapter 16 within the limits of variations of the income approach methods used for the vessels in which relation according to their concept of the

highest and the best use the income indicator is not provided (for the support vessels as, for example, for a tug vessel, an icebreaker or an emergency vessel, that is intended for increase of efficiency of others vessels and fleet).

And evaluation based on income approach using a factor of the annual income concerns the estimation of the commercial vessel or other real asset for which operation costs are in dependence on intensity of operation, that is if operation costs depend on the annual income, as, for example, for the variant of the industrial fishery within the limits of the quotas for the ocean biological resources, when the annual income is limited, and the value is determined using the annual income factor.

Thus the value characterizes a complex object – a vessel and the ocean resources which are subject to development, and the vessel value (or other asset of the marine company) substantially depends on their efficiency.

The estimation of the value of the right–of–use according to the usual terms of lease concerning marine commercial vessels and the estimation of the value of the charter rate are carried out in Chapter 17 on the basis of the standard concept of the market value as a basis of the evaluation, correlating the market value with the set of property rights – possession, disposal and use.

The value of the right–of–use is defined as a difference between the present values of the vessel for the specific time interval at the beginning and at the end of use. And the charter market rate with the account various possible periodicity of the rent charges is determined by the equations, based on the equality of value of the right–of–use and the present value of the rent cash flow.

When determining the adjustments besides of the periodicity of the rent charges the following factors are taken into consideration: predicted change of the vessel value by the end of the period of use (article 17.3); specific obligations of the owner for the commercial vessel maintenance, which is used by the tenant, for example, under the time–charter (article 17.4); the conditions of the vessel repayment at the end of the period of use (article 17.5).

The general structure of the marine company's real assets property complex is considered in Chapter 18. Modern shipbuilding and shipping develop in the conditions of the international specialization that is considered in article 18.1. The factor of global international specialization has the systematic character influencing the structure of the investor (article 18.2) as a part of the isolated object of the evaluation and the economic efficiency estimation of investments in shipbuilding and shipping (article 18.3).

The estimation of the efficiency in the marine industrial activity and estimation of the value are the integral adjacent subject matters in the applied economics (Chapter 19), of the financial investments aimed at the advancement into the real sector. The concepts of efficiency and value are redefined in interrelation to each other.

The annual income, operation costs and investments (article 19.1) are referred to a number of the basic economic indexes which within the limits of the systematic approach are evaluated with application of the economic models of commercial vessels, other real asset or the property complex of the marine company economic models in correspondence with the data, characteristics and params.

The basic indicators do not reflect critical judgments about the efficiency of variants necessary for the comparison and the choice of characteristics combination of the vessel for the commercial order (or another asset of the marine company). There is a need

for correlations of «pluses» and «minuses», and these correlations, logical from the point of view of the systematic approach, determined by mathematical operations on the basic indicators, are economic criteria.

The following indicators such as: net present value (reproduced value) and internal rate of return which can be transformed to index of investments recovery term are most widespread among the criteria of efficiency estimation of the commercial vessel or the property complex of real assets.

The ocean resources defined as properties of the marine environment which are of investor's concern, and which are an element of the real assets complex of the marine enterprise or the factor of the value and efficiency of the commercial vessel, are evaluated formally by their net present values (Chapter 20), that at the methodological level corresponds to the concept of unidentifiable intangible asset – goodwill – as a part of the real assets property complex of the marine company (article 20.2).

Among the applied expert tasks in the sphere of joint marine industrial activity there can be a task to estimate the contribution of separate investors (Chapter 21), for example, in case of joint offshore development on the basis of the production sharing contract, in case of joint activity in marine cargo traffic transportation, in case of the partition of property of the marine fishery company which possesses the vessels and the rights for quotas for fishing of the ocean biological resources, etc.

The dependences of the basic economic indexes of the annual income, the operation costs and the investments on varied characteristics of the commercial vessel when keeping to a systematic approach of the variants comparability for the known and specified params and data and dependence of economic criteria on the basic indicators make the criterial functions for economic optimization of the vessel characteristics for the commercial order (Chapter 22), that in case of indeterminate of the marine company asset purpose or data (Chapter 23) leads to multiobjective sense and to use of the generalized criteria, corresponding some determinations or other of the value, with the account the methodological conditions.

The determination of the optimal vessel characteristics (or another asset of the marine company's property complex) by the economic criteria according to the concepts of the systematic approach is made with the account the limitations. It is possible to refer the financial constrain of the investor and the resource constrain to a number of the basic limitations (Chapter 24).

When the marine company has its own innovative strategy which access of the investor to the development of the ocean resources, the financial constrain is not so important, since on the one hand the efficiency of the strategy provides access to the financial markets and on the other hand the strategy means rather a sufficient amount of the ocean resources for the overcoming of resource constrain (functional).

In other words, when there is an innovative strategy of the investor, the optimality is the internal property of the commercial vessel characteristics (or the other asset of the marine company), and optimization of the project characteristics is carried out using the criterial function without imposing financial or functional limitations.

In order to work out the initial technical requirements of the contract (or of the choice at the pre–owned market) it is required to determine the combination of the set of characteristics and particulars which are interconnected and have a complex influence on

the vessel efficiency and the properties: seaworthiness, reliability, life time, long–lasting, safety, etc.

The subject of project economic optimization is the main characteristics, but the particulars can be approximately determined using the proportional statistical equations and the regression dependences (Chapter 25).

The methodical recommendations concerning the methods of the determination of marine commercial vessels' value (cargo and fishery) are included in the appendix to the textbook as a model of a term paper and the recommendations can be used to develop practical skills in the field of vessel evaluation as an asset of the property complex of the marine company.

The applied economics approaches suitable for determining the marine technology design characteristics, particularly the commercial vessels, and optimization by the systematic approach extend the methodological systematization, since the systematic approach is an interdisciplinary

The statement requires clarification. The concept of the design object, such as a commercial vessel of a certain class, can be introduced the methodological approach allow the uniformity of approaches for all vessels of this class, for example, the similar methods of the ship theory (the seaworthy properties evaluation) and structural mechanics (the provision of the vessel life time) are applied to all commercial vessels.

But it can be difficult to define the concepts of: the marine engineering, the ocean technology, the marine technical complex, etc., which are broader than the concept of vessel of a certain class. That is, the vessel can be attributed to marine engineering (ocean technology, marine technical complex), but these objects are not confined to a vessel, since they include other classes of objects.

The question is if it is possible whether to formulate general design methodology for marine engineering (ocean technology) if it covers commercial vessels of different classes, offshore rigs, underwater technology for industrial use, coastal infrastructure of marine enterprises, industrial shipbuilding and ship repair facilities, parts of hydraulic structures, etc., that is, whether it is possible to provide general design methods of such diverse objects, and this way justify in terms of project methodology the concepts of: the marine engineering, the ocean technology, the marine technical complex, etc.

Since the above mentioned subjects of ship theory and structural mechanics, as well as other technical subjects, are usually attributed to objects in the narrow definition, for example, to the commercial vessels, then, it is possible to justify a broader concept of the object in terms of design methodology, such as marine technology, including commercial vessels of various classes and other objects of marine engineering (ocean technology), by introducing a common systematic approach for optimization of project characteristics by the economic criterion of maximized marine resources (ocean resources) contribution to the value of the marine engineering object.

It is the optimization by the economical criterion and by the systematic approach that is a common methodological basis for the design of marine engineering (ocean technology, marine technical complex), as well as the commercial vessels of all classes, and offshore rigs, coastal infrastructure of marine enterprises, facilities of shipyards and dockyards, parts of hydraulic structures, etc. The optimization by the criterion of contribution of the marine resources (ocean wealth) to the value of the marine engineering object is a systematic approach for the design to be applied to any object from the specified list. Other

objects that not reefer to the marine engineering (ocean technology), are not subject for the design optimization by the criterion of the marine resources contribution for object value.

The understanding of the marine engineering as objects of designing, production and investment is the basis for improvement of design methodology based on optimization and systematic approach and allows solving the applied tasks.

And it should be noted that the systematic approach for designing is a unifying approach in various aspects and allows not only to combine structurally different marine objects in the general concept of marine technology on the basis of a uniform methodology for project optimization, but also facilitate mutual understanding between the shipyards which should produce vessels, that are in demand, and shipping companies which are investors – the customers for the shipbuilding industry, and with due regard of the global industrial specialization in shipbuilding, shipping and other fields of ocean development on the basis of international cooperation.

This way the extra features opened by the systematic approach and methods of the design optimization of the marine technological facilities and property complexes of marine companies based on the approach are as follows:

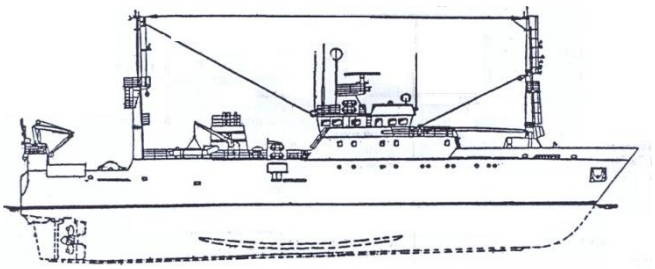
1. Inclusion of applied economics methods in a number of the concepts of Naval Architecture and theory of ship design, along with the mechanics (structural mechanics, hydromechanics) and other subjects of the applied physics, the development of ship designing theory on the basis of the systematic approach.

2. Methodological ordering of the subject–matter – the definition of the sets of independent variables: initial data (external, i.e. constants), variables to be optimized – the main characteristics and the params of optimization – particulars of the designed ship.

3. «Marine Technology» can be defined from the standpoint of the design theory, taking into account that this term includes technical facilities for the ocean development along with the commercial vessels, and the general designing methods of a broad class of marine engineering that differ in design and in respect of mechanic are the optimization by the economic criteria based on a systematic approach.

4. Promotion of the financial investments in the real assets and improvement of economic indexes of marine industries by the application of a project economic evaluation from the standpoint of the investor, who develops the marine resources.

5. Promotion of the international cooperation in shipbuilding and ocean development, in view of the fact that the batch commercial shipbuilding in recent years is located mainly in the industrialized countries of East Asia, while investors are located everywhere – with reference to the geographical location of the ocean resources.



## Symbols, dimensions and abbreviations

For the use of data and for the evaluation of marine commercial vessels it is necessary to understand the widespread specific symbols, abbreviations and professional terms.

It is possible to refere the following ones to a number of widespread abbreviations: *GRT*, *NRT* – gross and net register tonnage (the characteristics of the conventional volume defined by the rules of the International Convention on Tonnage Measurement of Ships, 1969); *DW* – deadweight; *EPS* – effective power of vessel's main engine; *LOA* – the vessel length over all (Length over all), etc.

It should be noted that indicators of gross and net register tonnage in information databases are specified in units corresponding to so–called English ton (usually is called – gross ton).

In the English language and in information databases – metric ton ([t] = 1000 kg or «metric ton») the mass unit writing differs from traditional English ton ([ton] = 1016,047 kg or «long ton», that is 2240 trading pounds), and differs from register tonnage unit ([gross ton] = 2.832 cubic m, that is 100 cubic feet, earlier the term «register ton» was applied).

It is required to consider a context correctly to obtain the dimension. Usually unit «ton» or «gross ton» means conventional volume unit equals 2.832 cubic m.

Besides, it is necessary to define symbols of various monetary units and dimension, and also one should know, that the fractional part of numerals in the English language separates a point, instead of a comma that is accepted in Russian, and decimal categories of numbers can be separated by commas, and know a number of other conventions.

In other words, for the use of information databases for the vessels evaluation and effectivity estimation, and also for reading and professional understanding of the expert report on an estimation of commercial vessel or other asset of the marine company, including the analysis of sources of data and their use, knowledge, experience and certain erudition are necessary.

The dimensions of the economic indexes, characteristics of a commercial vessel or the other asset of the marine company, the external data, the particulars and params, and also the operational characteristics can be various. The coordination and transformation of dimensions concerns professional competence of the expert and is him responsibility.

There atre no dimensions of the units in the presented methodological material, except for the following instructions:

– Numerical data with dimensions, and also the numerical values counted by the formulas;

– Dimensions of formulas which are generalizations of numerical data, for example statistical regressions;

– Dimensions in the graphs and in the tables which are representation of numerical data;

– Symbols containing instructions on dimension.

The instructions on dimension contains the following symbols:

– Operational speed $\upsilon_S$, in knots;

– Register tonnage (*GRT*, *NRT*), in units of Register tonnage by the rules of the International Convention on Tonnage Measurement of Ships, 1969;

– Economic time ($t$, $t_N$, $t_1$, $t_2$, $t_3$, $t_4$, $T$, $T_{MV}$, $t_{MV}$, $T_R$, $T_1$, $T_2$, …, $T_N$), the long–lasting or the periodicity, in years, not only the units, but also the fractional values and zero are applied;

– Vessel operational time ($T_{EXP}$, $T_{RF}$, $t_R$, $t_{R1}$, $t_{R2}$, $t_{G1}$, $t_{G2}$, $t_M$, $t_{FS}$, $\Delta t$, $t_{AR}$), in days;

– Indicators of the annual income $I$ and the operation costs $C$ determined counting annually.

The values of rates, risks, factors, multipliers, expert coefficients and the indicators of the irremovable depreciation are determined on relative value or in percentage.

The determination of the value and the basic economic indexes where if was necessary to use a dimension is made in US dollars as the market of the commercial vessels, marine transportations, and also the marine business generally have an international structure and generally calculations are made in US dollars. The data in the marine broker companies' bases and in the Internet are almost everywhere presented in the same monetary unit.

The explanatory to applied symbols for vessel evaluation or other asset of the marine company's property complex are shown below. The explanatory to symbols are accompanied by short definitions and in these cases also they bear auxiliary function of glossary.

At the statement of the methodical subject the following symbols are accepted.

$MV$ – symbol used for following economic indexes:

a) Market value of vessel, other real asset or market value of the marine company's property complex, including full set of tangible and intangible assets, – depending on the context;

b) Present value of a cash flow of the net operating income (or profit);

c) Value as a result of the estimation by one of independent standard approaches.

$MV_C$, $MV_I$ – values evaluated by the factors of the operation costs $C$ and the annual income $I$;

$MV_0$ – initial value (invested) $MV_0 = MV(t = 0{,}0)$;

$MV_1$, $MV_2$ – depending on the context: the value at the beginning and at the end of the period of use of the vessel or the other asset of the marine company by the contract of rent; the value estimated on a basis cost and comparable sales retrospective approaches at the determination of indicators of efficiency, if $MV_3$ – the value as the result of the prospective income approach; the value (investments) indexes defined as the economic efficiency criteria transformation: the value $MV_1$, estimated on the basis of transformation of an discounted costs indicator $f_1$, the value $MV_2$, estimated on the basis of an internal rate of return indicator $f_2$.

$\Delta MV$ – depreciation of the vessel value or the other real asset by the end of the period of use or the appreciation of property complex value during the creation of the marine company.

$\Delta MV_1$ – additional income meaning the estimation of the seller's of a real asset (vessel) clearing from difficulties – an estimation of the right of released assets use and an estimation of expenses savings for the asset maintenance in a suitable condition after the end of its manufacture.

$\Delta MV_2$ – additional investments for the real asset (vessel) imputing into operation, that is an estimation of economic difficulties of the buyer shifted to the seller.

*dMV/dt* – value derivative on time – the mathematical potential of present value (the value expenditure for a time unit, in particular, for a year).

$MV_\Sigma$ – total value of the tangible and identified intangible assets which in aggregate are the property complex of the marine company, the investment during the property complex creation $MV_\Sigma = \sum_n MV_n$.

$MV_n$ – investment value of the *n*–th partner (contribution) during co–production or creation of the property complex, the value of the isolated *n*–th asset of the property complex, – depending on the context.

$MV_n + NPV_n$ – investment value of the *n*–th contribution, the investment value of the *n*–th asset, – depending on context.

$MV_P$, $MV_D$ – private and the debt financial parts with the account a total investments $MV_\Sigma = MV_P + MV_D$.

*MW* – an estimation of the ocean resources (marine resources) contribution to the value of the isolated real asset of the marine company, associated with this asset, that is an estimation of set of technological, legal and other opportunities of the ocean resources development; an estimation of unidentifiable intangible asset (goodwill) as a part of the marine company's property complex, – depending on the context.

*RC* – reproduction cost – the sum of the investments for the structural analogue construction in modern market prices on the day of estimation, or the replacement cost, that is the sum of the investments for functional analogue construction.

$RC_n$, $RC_{n,m}$ – investments components of the reproduction cost – infrastructural parts of investments.

$D_1$, $D_2$, $D_3$, $D_4$, $D_5$ – set of the depreciation components: the physical depreciation eradicable $D_1$, the physical depreciation irremovable $D_2$, the functional depreciation eradicable $D_3$, the functional depreciation irremovable $D_4$, the external economic obsolescence $D_5$.

$D_{1–4}$ – internal depreciation in the sum of the physical and the functional.

*MVF* – vessel value (or the other asset) with the requirement of the compelled or forced sale (Market value forced), differently – the liquidating value.

*El* – factor of elasticity of the supply in relation to demand (the marketing indicator) – the module of relative appreciation of the mathematical derivative of the supply in relation to the demand.

*DF* – resale discount at the compelled or forced sale (Discount forced), – a difference of the market value and the liquidation value *DF = MV – MVF*.

*SV* – residual liquidation value (Scrap value) – the value of the compelled sale of materials as a vessel scrap without an estimation of functional suitability of separate parts.

*Rv* – reversion that is the additional income of vessel or other real asset sale at the end of the period of productive operation or the period of the prognosis at the estimation of the present value cash flow, depending on context, the value of scrap sale (residual liquidating value).

*I* – annual income index in annual account (Income), depending on the subject requirements it can be applied to the designation of the potential or effective income.

*m* – tariff rate, the cost for the delivery to destination of the cargo unit (one ton, a piece, unit of volume, etc.), that is the transport tariff rate, for a fishing vessel – the income per the mass unit or seafood conventional.

*C* – index of annual operation costs (total) steady within a year and constant annually cash flow of operation costs.

$C_t$ – cash flow of operation costs which are evaluated on the beginning of each year, but are distributed within a year.

*C*(*t*) – terminal intensity of operation costs cash flow distributed within year.

$C_n$ – components of the annual operation costs, including:

$C_{CR}$ – expenses for crew salary;

$C_{FED}$ – spending on food for the crew;

$C_{EXP}$ – expenses for crew delivery (to onboard and from);

$C_{SOC}$ – specific payments to the social insurance funds of the crew salary;

$C_{FL}$ – annual expenses for fuel;

$C_{SUP}$ – annual expenses for supply;

$C_{RM}$ – average annual expenses for maintenance and repair;

$C_G$ – running costs;

$C_{MM}$ – administrative expenses for management;

$C_{DS}$ – marketing expenses;

$C_{RES}$ – expenses for the quota purchase – a payment for use of ocean biological resources under the rates provided by the tax Code;

$C_{INST}$ – expenses for the compensation of deterioration and for the replenishment of the fishery tools;

$C_{MS}$ – expenses for the purchase of tare materials, separation and technological materials.

$\sum C_{NC}$ – sum of the vessel annual operation costs components related to the added value as a part of production or services turnover (except services of the partner organizations, financial expenses etc.).

*OC* – working assets for vessel or other real asset of the marine company equipment.

$C_U$ – consumption costs that are the minimum income $I_{MIN}$, when vessel or other asset operates without losses, provided that the profit and the losses equal to zero, and the net operating income *NOI* corresponds to the charges for the compensation of real assets restoration $f_m \times MV$ **.**

[*MV*], [*I*] and [*C*] – external limitations for value and efficiency estimation: the limitation of investments [*MV*] (for example, according to accumulation of the investor's assets and thir value), the income [*I*] (in particular, by the quotas for the ocean biological resources use) and the operation costs [*C*] (for one external reason or another).

$c_{FL}^{*}$ – cost of one t of the diesel fuel used on board of the vessel.

$c_{\mathrm{CR}}$ – average annual expenses for one crew member support.

*NOI* – indicator of the net operating income (*NOI* = *I* – *C*).

$NOI_1$, $NOI_2$, …, $NOI_N$ – sequence of the cash flow values for the stability intervals which correspond to intervals of planning marine company's property complex $T_0$, $T_1$, $T_2$, …, $T_N$.

*p* – profit, the index applied when the evaluation based on income approach usually in calculation indexes before the taxation – the economic index correlated with the net operating income and differs for the size of deductions for real assets restoration $f_m \times MV$ (when we determine profit the deduction are subtracted from the net operating income, $p = NOI - f_m \times MV$ ).

$RN_t$ – charge (payment) under the rent contract for vessel or other asset use.

*RN* – charter market rate – the equal rent charge of the uniform periodicity, which present value corresponds to the right–of–use value of commercial vessel (or other asset of the marine company).

$\Delta RN(\Delta MV)$, $\Delta RN(C)$, $\Delta RN(L)$ – adjustments to charter market rate estimation *RN* with the account the requirements: the reduction $\Delta MV$ of asset value by the end of the period of use, the owner's obligations *C* of the asset servicing, correlated with the operation costs, with the account the requirement of leasing–rent contract with the repayment by the end of the period of use and obligations *L* of the asset repayment by the tenant.

*DCF* – discounted cash flow, the present value of the net operating income cash flow.

*NPV* – net present value (reproduced value), corresponding to the difference of the value and the investments.

$NPV_{\Sigma}$ – value of goodwill as the net present value of the marine company's property complex, corresponding to an estimation of the ocean resources *MW*.

*NPV*1, *NPV*2 or $NPV_n$ – components of the net present value divided between two or another number of *N* participants (investors of the marine company); the net present value of *n*–th asset as a part of investment value, – depending on the context.

*IRR* – internal rate of return, as the relation of profit to investments, more precisely, the profit gain to the gain of the investments causing this gain of the profit, minus rate of the gain of consumer price index that is an inflation indicator.

$T_{\mathrm{R}}$ – investments recovery term – an economic index is reverse in ratio to index of internal rate of return *IRR*, $T_{\mathrm{R}} = 1/IRR$.

*t* – age of the vessel or the real asset of marine company; an indicator of present time in annual account; the term from the time of account to an estimation of the economic index, – depending on context, evaluated in years.

*N* – number of the predicted intervals of cash flow stability or stability of accumulation of the cash flow grades, corresponding to a number of investments planning periods; the number of investors (partners, participants) at their joint participation in the marine company's property complex creation or in asset manufacture; the number of assets (groups of assets) of the marine company's property complex, – depending on the context.

$N1$ – assets group in linear proportional dependence of the net present value related to the isolated asset, on the net present value of the property complex of marine company assets $NPV_n(NPV_\Sigma^1)$.

$(N - N1)$ – group of the assets independent on the net present value of property complex $NPV_n(NPV_\Sigma^0)$.

$t_N$ – present time – the discrete variable at summation of the discounted cash flow.

$T$ – life time of the vessel or the other real asset; the term of the forecast period of planning before the reversion $Rv$ is expected, for example at the end of vessel (or other asset of the marine company) productive operation, – depending on the context.

$(T - t)$ – term of operation before the utilization with the account the life time and the age $t$ of a vessel or another asset of the marine company, that is residual life time.

$t_1$, $t_2$ – the beginning and the end of the usage period of the vessel (or the another real asset) by the rental contract.

$t_3$, $t_4$ – the beginning and the end of rent charges payment term.

$T_{MV}$ – exposure period of the typical marketing period for vessel sale at market value.

$t_{MV}$ – duration of the vessel productive operation after purchase before the compelled sale – term of an exposure at the compelled sale.

$t_{MV}$ / $T_{MV}$ – vessel or other real asset of marine company terminal position during the marketing period.

$t - t_0$ – duration of the investment in the creation of the property complex of real assets structure or in the manufacture of the isolated real asset.

$T_0$, $T_1$, $T_2$, …, $T_N$ – planning intervals under the plan of investments.

$[t]$ – term between payments under the rent contract.

$T_{EXP}$ – term of vessel annual operational period.

$T_{RF}$ – term of the commercial vessel round trip (for the fishing vessel the term of the operation at the fishing ground between fuel fillings–up).

$t_R$ – running time of a commercial vessel for the round trip.

$t_{R1}$, $t_{R2}$ – running time in the transitions to destination and to harbor accordingly.

$t_{G1}$, $t_{G2}$ – time of cargo operations in harbors of departure and destination accordingly.

$t_M$ – term of cargo vessel maneuvering during the round trip, the general duration of fishing vessel maneuvering to search fish concentration.

$t_{FS}$ – actual term of duration of the fish products reception before hold filling, duration of the cargo vessel positioning in the point of destination.

$\Delta t$ – term of fish transfer to the cargo vessel and supply reception to the fishing vessel.

$t_{AR}$ – term of vessel mooring in the harbor between the trips.

$Q$ – annual transportation capacity of the cargo vessel, annual productivity of fishing vessel processed product.

$n_R$ – average number of the commercial vessel round trips within a year.

$i$ – discounting rate, correlated with the rate of efficiency or with a macroeconomic index of risks and evaluated by the methods applied in the business estimation, for

example, by the market extraction according to analogues, by the next models: the cumulative risks set, the arbitration pricing, the average weighed value of the capital, the model of an evaluation of capital assets, etc.

$i_0$ – risk–free rate evaluated according to the data of the emission centers or to the other available data.

$i_1$ – adjustment with the account systematic (external) economic risk.

$i_2$ – adjustment with the account non–systematic risk, or $i_2$ – the total risks index under the given investment project in relation to the macroeconomic risks estimation *i*, that is $i_2$ can mean the estimation of innovative strategy risks.

$i_3$ – indicator of the rate of a consumer price index gain (an inflation index).

$i_P$ – efficiency of private finances evaluated, for example, by the internal rate of return *IRR*.

$i_D$ – value of the debt funds evaluated as the loan rate.

$i_n$ – risk, that is probability of the individual *n*–th action negative result.

$(1-i_1)\times(1-i_2)\times...\times(1-i_n)$ – probability of the successful innovative strategy consisting of *n* consecutive actions.

$\eta_{MV}$ – rate of the property tax.

$\eta_{INS}$ – rate of insurance coverage.

*f* – economic efficiency criterion function depending on determined optimal vessel (or other real asset of the marine company) project characteristics *X* for the commercial order, on the params *Y* and the data *Z*.

*X*, *Y*, Z – variables (that is a vector or a set of variables – the optimized project characteristics), the params and data (constants), the symbols of the criterial function argument.

$f_m$ – factor of fund of compensation of a depreciated part of the investments for restoration, denoted also by *PMT/FVA*, in the applied economics is evaluated as one of discount financial functions with the account the real asset residual life time (*T* – *t*) and the macroeconomic index of total commercial risks in the form of the discounting rate *i*, by the book keeping rules $f_m$ is associated with the standard of the amortization (restoration) charges in dependence on the asset assignment and in correspondence with the real assets classification.

$f_{MV}$ – factor of present value potential, considering vessel depreciation (or other asset of the marine company) in the process of value transformation into the financial form.

$f_{NOI}$ – factor of the net operating income evaluated with the account the factor of present value potential $f_{MV}$.

*R* – rate of the net operating income capitalization, including addends: the discounting rate in the sum of risks $\Sigma i_n$ and the factor of the fund of compensation of depreciated part of investments $f_m$, used at an evaluation based on income approach in the sum with rates: the property tax $\eta_{MV}$, the insurance coverage $\eta_{INS}$.

$R_{MV}$ – rate of the net operating income capitalization with the account the factor of the net operating income defined by the factor of present value potential.

$R_C$ – factor of operation costs $C$, which is proportionality factor between the asset value and the operation costs.

$R_I$ – factor of the annual income $I$, which is proportionality factor between the asset value and the annual income.

$c(T,i)$ – factor of investments capitalization as a part of economic criterion of the capitalized costs on the basis of sequent estimation of the: the vessel construction (or the other real asset of the marine company), productive operation, recycling, the reinvestment, the reproduction and repetition of the specified cycle.

$R1$, $R2$ – of investments efficiency indexes of the seller and the buyer or joint investors – as a part of the balance of their interests $R1 = R2$.

$R_0$ – index of risks of innovative strategy which is set by the planned investment schedule, the capitalization rate of the initial capital.

$e$ = 2.71828283... – Euler's number – a mathematical constant which can be applied in calculations of present values of economic indexes under discount financial functions.

*FV*, *FVA*, *PMT/FVA*, *PV*, *PVA*, *PMT/PVA* – symbols of the discount financial functions:

*FV* – indicator of the future value of the individual investment;

*FVA* – indicator of unit capitalization – future value at the end of the definite period $T$ of an unit cash flow annuity, uniform on periodicity;

*PMT/FVA* – factor fund of compensation of the depreciated part of investments (the constant periodic payment in accumulation of the definite unit sum at the end of the period within life time or the forecast period $T$), in formulas is designated as $f_m$;

*PV* – present value of unit (discounting), that is the present value of the future unit investment, through time $t$;

*PVA* – present value of the unit cash flow annuity, uniform on periodicity by the end of the definite period $T$;

*PMT/PVA* – payment for the unit amortization (repayment of the unit credit by equal payments, uniform on periodicity by the end of the definite period $T$).

$a$, $a_1$, $a_2$, $a_3$ – symbols of factors, particularly, the statistical approximation factors of the marketing researches, the expert factors of preference of the separate results of evaluation by the independent methodological approaches or so called «weightings» of the factors of economic criteria components.

$\alpha$ – confidential probability (balance factor) of the net operating income in structure of a capitalized index at estimation of the present value based on income approach; the factor of the structure balance of the property complex assets, – depending on the context.

$\alpha_1$, $\alpha_2$, $\alpha_3$, $\alpha_4$ – factors showing what part of the total net present value $NPV_\Sigma$ of the marine company's property complex its composed, associated with the separate isolated assets and correlated with the total net present value in a proportion with its certain degree.

$\alpha_j$ – expert weight factor which is characterizing methodological importance of certain economic criterion $f_j$ and simultaneously is a scale multiplier.

$\gamma$ – expert factor of «optimism» when defining Horvitz criterion.

$J$ – total sum of the private criteria generalized in compound criterion.

$D$ – vessel cargo displacement (total) when full cargo and with the draught at the cargo waterline.

$DP$ – vessel displacement empty (the displacement in dry dock).

$DW$ – deadweight, the sum of all variables load components of commercial vessel: cargo, fuel, supply, tools, tara (container), crew with luggage, ballast, stocks etc., or, on the other hand, a difference of cargo displacement of vessel and displacement empty $DW = D - DP$.

$PG$ – cargo capacity of commercial vessel.

$W$ – capacity of commercial vessel cargo premises – the hold volume (it can be measured in cubic m, for some vessels' classes the volume of refrigerator hold can be measured in cubic feet, 1 foot corresponds 0.305 m, 1 cubic foot is 0.02832 cubic m).

$GRT$, $NRT$ – gross and the net register tonnage – conditional volume, – counted depending on commercial vessel characteristics and dimensions by rules of the International Convention on Tonnage Measurement of Ships, 1969, measured in units of Register tonnage – 1 unit of capacity corresponds 2.832 cubic m, that is 100 cubic feet.

$Ne$ – power of the vessel's main engine (also designated as $EPS$ that is effective power the main engine, i.e. the power corresponded to the movement).

$\upsilon_S$ – operational speed under the project of commercial vessel, that is the specification speed in knots (nautical miles per hour, 1852 ms per hour), the specification speed of a fishing vessel.

$\upsilon_{S1}$ and $\upsilon_{S2}$ – speed of commercial vessel accordingly during the trip to destination and return trip.

$n_{\mathrm{CR}}$ – number of crew, including the personnel onboard the processing fishing vessel.

$L$ – length of vessel over all (also it is designated as $LOA$).

$WL$ – cargo waterline.

$LW$, $B$ – commercial vessel length at the cargo waterline, the breadth.

$TW$ – draught at vessel cargo waterline.

$H$ – height of the board to the main deck (that is deck covers the hermetic transverse bulkheads).

$HD$ – height of the board to the apper cargo deck (including the spaces ahead the deck of hermetic transverse bulkhead).

$\delta$ – factor of the general volume displacement, the relation of commercial vessel displacement of volume units to the parallelepiped volume which sizes are equal to the length of cargo at the waterline, breadth and a vessel draught of cargo waterline.

$PG_{\mathrm{PR}}$ – specification cargo of the conventional fish products (or seafood), processed by fishing vessel annually.

$P_{\mathrm{F}}$ – amount of the fresh ocean bioresources (fish or other), catches during the round trip of fishing vessel between the fillings–up of fuel.

$r$ – weight ratio of the conventional fish products (or seafood) output to the processed amount of fresh ocean bioresources, ranged from 0.0 to 1.0.

$[c_{\mathrm{ADM}}]$ – the Admiralty factor determined with use of the commercial vessel–prototype data or accounting of the statistical data and used for an estimation of the

commercial vessel's main engine effective power according to a prototype (note: the Admiralty factor is the characteristic of a prototype and, as well as other applied data of a prototype, in symbols it is accepted in square brackets).

£ – extent of ocean rout (a distance to the area of harvesting – for fishing vessel).

$P_{FL}$ – specification fuel stock onboard, $P_{FL}$ also can designate the fuel consumption for a trip depending on its use in calculation, considering, that, when designed rationally the vessel's specification fuel stock is according to the fuel expenditure during the trip between the fuel fillings–up (not so much extra stocks).

$P_{FR}$ – fuel consumption for fish search, maneuvering and trawling (catching) during the period between transfers of fresh fish to the processing ship or the fish production to a consumer or a cargo vessel.

$P_{FM}$ – fishing vessel's fuel consumption for maneuvering.

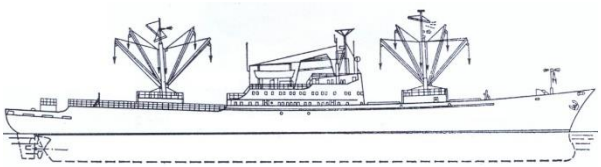
$P_{FPR}$ – fishing vessel's fuel expense in an operating time at trawling (catching).

$q_1$ – daily fuel consumption for running.

$q_2$ – daily fuel consumption for trawling (catching).

$q_{G1}$, $q_{G2}$ – average daily productivity of cargo operations in the departure (arrival) harbor and the destination point.

$\eta_{Gi}$, $\eta_{G1}$, $\eta_{G2}$ – operating factors of use of vessel cargo capacity during the trip to destination and return trip.



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Shipyard commercial order weekly report
Shipping Statistics and Economics
Motor Ship Special Survey
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Morsroy Zhournal (Russia)
Shipbuilding (Sudostroyenie, Russia)
Shipping (Sudokhodstvo, Ukraine)

# Appendix.

## Methodological manual guidelines for value estimation of different classes of the marine commercial vessels (fishery and cargo)

Practical training in the field of the economical expertise of assetsusually involves solving universal fragmentary tasks of evaluation, for example, the calculation of present values of cash flows or the calculation of other discount financial functions.

Practical training in the sphere of value estimation of the marine commercial vessels have an integral structure and based on the study of sequences of steps of standard approaches application to vessel value estimation with account of professional specific of this type of the economic expertise.

The manual for practical tasks contain the tabular forms for calculations to be filled. To carry out tasks one should copy the manual in order to fill in the forms when doing calculations on the copies.

## Initial data

The data are processed in the tabular form (tab. A1).

Table A1

| The index name | The symbol, unit of measure | | Data |
|---|---|---|---|
| **Data of the fishing vessel** | | | |
| Total cargo displacement | $D$ | t | |
| Cargo capacity | $PG$ | t | |
| Fuel stock onboard (specification) | $P_{\mathrm{FL}}$ | t | |
| Volume of refrigerator hold | $W$ | cubic m | |
| Operational speed | $\upsilon_S$ | knot | |
| Crew, including the fish processing personnel | $n_{\mathrm{CR}}$ | man | |
| Average annual expenses one member of crew charge (for the practical work it is set by the instructor) | $c_{\mathrm{CR}}$ | thousand dollar US a year | |
| Year of manufacture | – | year | |
| The remained term before the expiration of the Certificate of seaworthiness | – | year | |
| Daily productivity of the processed fish output at the sea | – | t / day | |
| Distance to the ocean fishing ground | £ | nautical mile | |
| The duration of inter–voyage mooring in harbor | $t_{\mathrm{AR}}$ | day | |
| Price of processed fish product (for the condition of transfer of the catch to the harbor) | $m$ | thousand US dollars / t | |
| Cost of the consumed fuel for fishing vessel (for the practical training it is set by the instructor) | $c^*_{FL}$ | thousand US dollars / t | |
| Discounting rate | $i$ | % | |

The termination of table A1

| The index name | The symbol, unit of measure | | Data |
|---|---|---|---|
| **Data of the cargo vessel** | | | |
| Total cargo displacement | $D$ | t | |
| Cargo capacity | $PG$ | t | |
| Operational speed | $\upsilon_S$ | knot | |
| Crew | $n_{CR}$ | man | |
| Year of manufacture | – | year | |
| The remained term before the expiration of the Certificate of seaworthiness | – | year | |
| Distance to destination from the home harbor | $£_1$ | nautical mile | |
| Distance to destination from the foreign port of departure | $£_2$ | nautical mile | |
| General mileage of the marine route from the home harbor to the ocean fishing ground, from district to foreign ports, from foreign ports to the home harbor (for practical training it is recommended to accept the mileage more than $£_1+£_2$ ) | $\Sigma£$ | nautical mile | |
| Daily productivity of cargo operations in the point of destination | $q_{G1}$ | t / day | |
| Daily productivity of cargo operations in the port of departure | $q_{G2}$ | t / day | |
| Daily bare boat charter rate | | US dollar / day | |
| Cost of the consumed fuel for the cargo vessel (it is set by the instructor) | $c^*_{FL}$ | thousand US dollars / t | |
| Operating factor of cargo vessel capacity use in the return trip (ranged from 0.0 to 1.0) | $\eta_{G2}$ | | |
| Tariff rate of transportation of cargoes from foreign ports to ocean fishing ground | $m$ | thousand US dollars / t | |
| Tariff rate of transportation of cargoes from the home harbor to the ocean fishing ground | $m_1$ | thousand US dollars / t | |
| Tariff rate on transportation of cargoes between the home harbor and the foreign port | $m_2$ | thousand US dollars / t | |

The recommended initial data are presented in tab. A2 and A3.

Table A2

# Recommended initial data for the practical work on fishing vessel evaluation

| Total cargo displacement $D$, t | Cargo capacity $PG$, t | Stock of fuel specification $P_{FL}$, t | Volume of the refrigerator's holds $W$, cubic m | Operational speed $\upsilon_S$, knots | Crew, including the fish processing personnel $n_{CR}$, man | Year of manufacture | Remained term before the expiration of the Certificate of seaworthiness, year | Daily productivity of the processed fish output reception at the sea, t / day | Distance to the ocean fishing ground £, nautical mile | Price of processed fish product $m$ as the transfer to harbor, thousand US dollars / t | Discounting rate $i$, % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 100 | 50 | 215 | 9.5 | 15 | 1987 | 5 | 10 | 450 | 0.7 | 25 |
| 600 | 136 | 68 | 293 | 9.7 | 18 | 1988 | 4 | 14 | 500 | 0.73 | 24 |
| 700 | 160 | 80 | 343 | 9.9 | 21 | 1989 | 3 | 18 | 550 | 0.76 | 23 |
| 800 | 183 | 91 | 393 | 10.1 | 24 | 1990 | 2 | 22 | 600 | 0.79 | 22 |
| 900 | 206 | 103 | 443 | 10.3 | 27 | 1991 | 1 | 26 | 650 | 0.82 | 21 |
| 1000 | 230 | 115 | 494 | 10.5 | 30 | 1992 | 5 | 30 | 700 | 0.85 | 20 |
| 1100 | 253 | 127 | 544 | 10.7 | 33 | 1993 | 4 | 34 | 750 | 0.88 | 19 |
| 1200 | 277 | 138 | 595 | 10.9 | 36 | 1994 | 3 | 38 | 800 | 0.91 | 18 |
| 1300 | 300 | 150 | 645 | 11.1 | 39 | 1995 | 2 | 42 | 850 | 0.94 | 17 |
| 1400 | 324 | 162 | 696 | 11.3 | 42 | 1996 | 1 | 46 | 900 | 0.97 | 25 |
| 1500 | 347 | 174 | 747 | 11.5 | 45 | 1997 | 5 | 50 | 950 | 1 | 24 |
| 1600 | 371 | 185 | 797 | 11.7 | 48 | 1998 | 4 | 54 | 1000 | 1.03 | 23 |
| 1700 | 395 | 197 | 848 | 11.9 | 51 | 1999 | 3 | 58 | 1050 | 1.06 | 22 |
| 1800 | 418 | 209 | 899 | 12.1 | 54 | 2000 | 2 | 62 | 1100 | 1.09 | 21 |
| 1900 | 442 | 221 | 950 | 12.3 | 57 | 2001 | 1 | 66 | 1150 | 1.12 | 20 |
| 2000 | 466 | 233 | 1001 | 12.5 | 60 | 2002 | 5 | 70 | 1200 | 1.15 | 19 |
| 2100 | 489 | 245 | 1052 | 12.7 | 63 | 2003 | 4 | 74 | 1250 | 1.18 | 18 |
| 2200 | 513 | 257 | 1103 | 12.9 | 66 | 2004 | 3 | 78 | 1300 | 1.21 | 17 |
| 2300 | 537 | 269 | 1155 | 13.1 | 69 | 1986 | 2 | 82 | 1350 | 1.24 | 25 |
| 2400 | 561 | 280 | 1206 | 13.3 | 72 | 1987 | 1 | 86 | 1400 | 1.27 | 24 |
| 2500 | 585 | 292 | 1257 | 13.5 | 75 | 1988 | 5 | 90 | 1450 | 1.3 | 23 |
| 2600 | 609 | 304 | 1308 | 13.7 | 78 | 1989 | 4 | 94 | 1500 | 1.33 | 22 |
| 2700 | 632 | 316 | 1360 | 13.9 | 81 | 1990 | 3 | 98 | 1550 | 1.36 | 21 |

Table A3

## Recommended initial data for the practical work on cargo vessel evaluation

| Total cargo displacement *D*, t | Cargo capacity *PG*, t | Operational speed $\upsilon_S$, knot | Crew $n_{CR}$, man | Year of manufacture | Remained term before the expiration of the Certificate of seaworthiness, year | Distance to destination from the home harbor £$_1$, nautical mile | Distance to destination from foreign port of departure £$_2$, nautical mile | Daily productivity of cargo operations in point of destination $q_{G1}$, t / day | Daily productivity of cargo operations in port of departure $q_{G2}$, t / day | Daily bare boat charter rate, US dollar / day |
|---|---|---|---|---|---|---|---|---|---|---|
| 10000 | 6463 | 12.5 | 19 | 1986 | 1 | 2000 | 1500 | 1400 | 2000 | 5500 |
| 12000 | 7956 | 12.7 | 20 | 1987 | 2 | 2100 | 1580 | 1600 | 2190 | 5800 |
| 14000 | 9484 | 12.9 | 21 | 1988 | 3 | 2200 | 1660 | 1800 | 2380 | 6100 |
| 16000 | 11044 | 13.1 | 22 | 1989 | 4 | 2300 | 1740 | 2000 | 2570 | 6400 |
| 18000 | 12631 | 13.3 | 23 | 1990 | 5 | 2400 | 1820 | 2200 | 2760 | 6700 |
| 20000 | 14243 | 13.5 | 24 | 1986 | 1 | 2500 | 1900 | 2400 | 2950 | 7000 |
| 22000 | 15877 | 13.7 | 25 | 1987 | 2 | 2600 | 1980 | 2600 | 3140 | 7300 |
| 24000 | 17533 | 13.9 | 26 | 1988 | 3 | 2700 | 2060 | 2800 | 3330 | 7600 |
| 26000 | 19208 | 14.1 | 27 | 1989 | 4 | 2800 | 2140 | 3000 | 3520 | 7900 |
| 28000 | 20902 | 14.3 | 28 | 1990 | 5 | 2900 | 2220 | 3200 | 3710 | 8200 |
| 30000 | 22612 | 14.5 | 29 | 1991 | 1 | 3000 | 2300 | 3400 | 3900 | 8500 |
| 32000 | 24338 | 14.7 | 30 | 1992 | 2 | 3100 | 2380 | 3600 | 4090 | 8800 |
| 34000 | 26080 | 14.9 | 31 | 1993 | 3 | 3200 | 2460 | 3800 | 4280 | 9100 |
| 36000 | 27836 | 15.1 | 32 | 1994 | 4 | 3300 | 2540 | 4000 | 4470 | 9400 |
| 38000 | 29606 | 15.3 | 33 | 1995 | 5 | 3400 | 2620 | 4200 | 4660 | 9700 |
| 40000 | 31388 | 15.5 | 34 | 1996 | 1 | 3500 | 2700 | 4400 | 4850 | 10000 |
| 42000 | 33184 | 15.7 | 35 | 1997 | 2 | 3600 | 2780 | 4600 | 5040 | 10300 |
| 44000 | 34991 | 15.9 | 36 | 1998 | 3 | 3700 | 2860 | 4800 | 5230 | 10600 |
| 46000 | 36810 | 16.1 | 37 | 1999 | 4 | 3800 | 2940 | 5000 | 5420 | 10900 |
| 48000 | 38640 | 16.3 | 38 | 2000 | 5 | 3900 | 3020 | 5200 | 5610 | 11200 |
| 50000 | 40480 | 16.5 | 39 | 2001 | 1 | 4000 | 3100 | 5400 | 5800 | 11500 |
| 52000 | 42332 | 16.7 | 40 | 2002 | 2 | 4100 | 3180 | 5600 | 5990 | 11800 |
| 54000 | 44193 | 16.9 | 41 | 2003 | 3 | 4200 | 3260 | 5800 | 6180 | 12100 |

## Data processing for fishing vessel evaluation

The task of the given practical work of fishing vessel evaluation is to determine the set of characteristics as well as the deadweight *DW*, the displacement empty *DP*, the main engine power *Ne*, the daily fuel consumption for running $q_1$ and for trawling (catching) $q_2$, the length at the cargo waterline *LW* and the breadth *B*, using initial data and the prototype characteristics.

The deadweight is $DW \approx PG + P_{FL}$ =…….+…….=…… t .

The displacement empty is equal

$$DP = D - DW = \ldots\ldots\ldots\ldots\ldots - \ldots\ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ t.}$$

The vessel–prototype characteristics are presented in tab. A4.

Table A4

| Cargo displacement total [*D*], t | Length at the cargo waterline [*LW*], m | Breadth [*B*], m | Operational speed [$\upsilon_S$], knot | Power of the main engine [*Ne*], kW | Daily fuel consumption for running [$q_1$], t / day | Daily fuel consumption for trawling (catching) [$q_2$], t / day |
|---|---|---|---|---|---|---|
| 1150 | 50.5 | 10.2 | 12 | 820 | 4.4 | 2.8 |

Symbols of the prototype data are accepted in square brackets.

The length vessel of the cargo waterline of the evaluated fishing is determined as:

$$LW = [LW] \times \sqrt[3]{D/[D]} = 50.5 \times \sqrt[3]{\ldots\ldots\ldots\ldots\ldots/1150} = \ldots\ldots\ldots\ldots\ldots \text{ m.}$$

The breadth of the evaluated vessel is determined as:

$$B = [B] \times \sqrt[3]{D/[D]} = 10.2 \times \sqrt[3]{\ldots\ldots\ldots\ldots\ldots/1150} = \ldots\ldots\ldots\ldots\ldots \text{ m.}$$

The main engine power of the evaluated vessel is determined by the formula of «the Admiralty factors». The Admiralty factor [$c_{ADM}$] for the fishing vessel is calculated with use of vessel–prototype data and makes

$$[c_{ADM}] = [D]^{0.5} \times [v_S]^{2.5} / [Ne] = 1150^{0.5} \times 12^{2.5} / 820 = 20.6$$

The main engine power *Ne* of the evaluated fishing vessel is

$$Ne = D^{0.5} \times v_S^{\ 2.5} / [c_{ADM}] = \ldots\ldots\ldots\ldots^{0.5} \times \ldots\ldots\ldots\ldots^{2.5} / 20.6 = \ldots\ldots\ldots\ldots\ldots \text{ kW.}$$

The daily fuel consumption for running of the evaluated fishing vessel is

$$q_1 = [q_1] \times Ne / [Ne] = 4.4 \times \ldots\ldots\ldots\ldots / 820 = \ldots\ldots\ldots\ldots\ldots \text{ t / day.}$$

The daily fuel consumption for trawling (catching) is

$$q_2 = [q_2] \times Ne / [Ne] = 2.8 \times \ldots\ldots\ldots\ldots / 820 = \ldots\ldots\ldots\ldots\ldots \text{ t / day.}$$

The net register tonnage of a fishing vessel for the given practical work should be determined by the formula

$$NRT = 0.127 \times D^{1.071} = 0.127 \times \ldots\ldots\ldots\ldots\ldots\ldots^{1.071} = \ldots\ldots\ldots\ldots\ldots\ldots$$

units of register tonnage.

The determination of the value and the basic economic indexes in the given practical work is carried out in US dollars since the market commercial vessels has the international structure and calculations mostly are made in US dollars.

The data of vessel prices of the majority of marine broker companies and the data in advertisements in the Internet usually are presented in the same monetary units.

## Estimation of fishing vessel replacement cost based on comparable sales approach

The vessel value based on comparable sales approach can be estimated by use of the analogues in accordance with its methodological definition under the Federal Standard # 2 «The purpose of evaluation assignment and types of value (FSA # 2)», approved by the order # 255 of Ministry of Economical Development of Russia July 20, 2007: the market value is the «most probable price …». The specified definition can be provided with the statistical calculations and the regressions formalization.

The fishing vessel replacement cost *RC* is estimated according the marketing research.

The calculations provided in accordance with the requirements of Standards and are based on marketing researches and on the account of the following factors:

– Characteristics of the economic environment – the indexes which characterize the vessels market and the marine services, considered by statistical researches in the process of regressions formalization;

– Conditions of the prospective sale – mainly of the transferred set of rights and time of sale – for analogues and for the evaluated vessel; and the transferred property rights are defined according to the Article 209 of the Civil code of the Russian Federation; for estimation of replacement cost the vessel years is equal to zero since replacement cost corresponds to the cost of a new vessel analogue with reference to economic conditions on the date of estimation;

– Characteristics of the commercial vessel and analogues – when estimating the replacement cost corresponding, units of comparison are used.

Data about the replacement cost of a new steel fishing vessels are taken into account by statistical researches in process of regressions formalization.

The used units of comparison are as follows:

– Deadweight *DW*;

– Displacement empty *DP*;

– Length of the cargo waterline *LW* of the fishing vessel;

– Main engine power *Ne*;

– Volume of cargo holds *W*.

The deadweight of the evaluated fishing vessel is equal to *DW* = …… t.

The replacement cost when using the marketing researches data of prices of the new steel fishing vessels and deadweight *DW* as a unit of comparison is equal

$$RC = 87.7 \times DW^{0.678} = 87.7 \times .....^{0.678} = \ldots\ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The displacement empty of the evaluated fishing vessel is equal to
*DP* = ……. t.

The replacement cost when using the marketing researches data of the prices of new steel fishing vessels and deadweight *DP* as a unit of comparison is equal

$$RC = 33.1 \times DP^{0.75} = 33.1 \times \ldots\ldots\ldots\ldots\ldots\ldots^{0.75} = \ldots\ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The length of the cargo waterline of the evaluated fishing vessel is
*LW* =…..… m.

The replacement cost when using the marketing researches data of the prices of new steel fishing vessels and the length of the cargo waterline of an evaluated fishing vessel *LW* is used as a unit of comparison is

$$RC = 5.20 \times LW^{1.77} = 5.20 \times \ldots\ldots\ldots\ldots\ldots\ldots^{1.77} = \ldots\ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The main engine power of the evaluated fishing vessel is equal to
*Ne* = …… kW.

The replacement cost when using the marketing researches data of the prices of new steel fishing vessels and main engine power *Ne* is used as a unit of comparison is equal

$$RC = 4.23 \times Ne^{0.98} = 4.23 \times \ldots\ldots\ldots\ldots\ldots\ldots^{0.98} = \ldots\ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The holds capacity of the evaluated fishing vessel is equal
*W* = …….. cubic m.

The replacement cost when using the marketing researches data of the prices of new steel fishing vessels and capacity of holds *W* is used as a unit of comparison is equal

$$RC = 57.95 \times W^{0.704} = 57.95 \times \ldots\ldots\ldots\ldots\ldots\ldots^{0.704} = \ldots\ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The average value of the replacement cost of the fishing vessel when using the marketing researches data and various characteristics as units of comparison: deadweight *DW*, displacement empty *DP*, lengths of the vessel of the cargo waterline *LW*, power of main engine *Ne*, holds capacity *W* _____ _____, 20___, – equals

$$RC = (\ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots) / 5 =$$

$$= \ldots\ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

In the given estimation the replacement cost of the fishing vessel when using the marketing researches and statistical regressions is not the average weighed characteristic as in case of the value estimation by standard independent approaches, and is the calculation by the uniform database with the assumption about the equal influence of applied units of comparison to the replacement cost of the vessel.

## Fishing vessel value estimation based on cost approach

The eradicable physical depreciation of the vessel is estimated in cash, corresponds to needs for expenses for repair and on _____ _____, 20___ is

$D_1 = C_{RM} \approx 0.025 \times RC = 0.025 \times$……. = ……. thousand US dollars.

In case of the evaluation by the «life time» method the ineradicable physical depreciation $D_2$ should be correlated with the vessel years $t$ and its prospective life time $T$.

In a proportion of the statistical regression of the value dependence on vessel years $t$ = …… years for the variant when the vessel tonnage is used as a unit of comparison the ineradicable physical depreciation of the fishing vessel on _____ _____, 20___ is

$$D_2 = 100\% \times (1 - ((1+0.02)^{55-t} - 1)^{1,01} / ((1+0.02)^{55} - 1)^{1,01}) =$$
$$= 100\% \times (1 - 0.504 \times ((1+0.02)^{55-\ldots\ldots\ldots\ldots} - 1)^{1,01}) = \ldots\ldots\ldots\ldots\ldots\ldots\%.$$

In a proportion of the statistical regression of the value dependence on vessel years $t$ = …… years for the variant when the vessel's main engine power is used as a unit of comparison the ineradicable physical depreciation of the fishing vessel on _____ _____, 20___ is

$$D_2 = 100\% \times (1 - ((1+0.01)^{50-t} - 1)^{1.005} / ((1+0.01)^{50} - 1)^{1.005}) =$$
$$= 100\% \times (1 - 1.55 \times ((1+0.01)^{50-\ldots\ldots\ldots\ldots} - 1)^{1.005}) = \ldots\ldots\ldots\ldots\ldots\ldots\%.$$

In a proportion of the statistical regression of the value dependence on vessel years $t$ = …… years for the variant when the index of area as the unit of comparison equal to the product of the vessel length over all by the breadth, ineradicable physical depreciation of a fishing vessel on _____ _____, 20___ makes

$$D_2 = 100\% \times (1 - ((1+0.023)^{53.5-t} - 1)^{1,01} / ((1+0.023)^{53.5} - 1)^{1.01}) =$$
$$= 100\% \times (1 - 0.417 \times ((1+0.023)^{53.5-\ldots\ldots\ldots\ldots} - 1)^{1.01}) = \ldots\ldots\ldots\ldots\ldots\ldots\%.$$

The following recommendations should be applied to the approximate determination of vessel life time $T$ to an estimate the ineradicable physical depreciation in a linear proportion to age $t$ :

a) To define the age of vessel $t$ and remained term before the expiration of the Certificate of seaworthiness;

b) To accept vessel structural durability equal 25 years if the sum of vessel years $t$ and the period before the expiration of the Certificate of seaworthiness is less than 25 years;

c) If the sum of vessel years $t$ and the term before the expiration of the Certificate of seaworthiness is more than 25 years, vessel structural durability $T$ should be equal to the sum of vessel years $t$ and the term before the expiration of the Certificate of seaworthiness $T$ = ……+……..=…….. years.

It should be noted, that the recommended value of the «critical age» (25 years) is offered only for use in practical training work.

The vessel structural durability with the account the stated recommendations is equal to $T$ = …….. years.

The ineradicable physical depreciation in a linear proportion by the fishing vessel years $t$ and structural durability $T$ on _____ _____, 20___ is

$$D_2 = 100\ \% \times t\ /\ \mathrm{t} - 100\ \% \times SV\ /\ RC =$$

$$= 100\ \% \times \ldots\ldots\ldots\ /\ \ldots\ldots\ldots - 100\ \% \times \ldots\ldots\ldots\ /\ \ldots\ldots\ldots \approx \ldots\ldots\ldots\ \%,$$

where $t$ = …… years – the age on the day of the fishing vessel evaluation;

$T$ = …… years – the structural durability of the fishing vessel;

$SV$ = ……. thousand US dollars – the scrap value, i.e. the residual liquidation value – the value of the compelled sale of materials as a vessel scrap without an estimation of functional suitability of separate parts, for the practical work recommended for estimation with the cost of a scrap 50 US dollars for t of the vessel displacement empty;

$RC$ = ……. thousand US dollars – the vessel replacement cost.

The average weighed value of ineradicable physical depreciation $D_2$ of the fishing vessel, determined depending on age $t$ and life time $T$ from the set of values received above: …… %, …… %, …… % and …… %, is equal

$$D_2 = ¼ \times \ldots\ldots\ldots\ \% + ¼ \times \ldots\ldots\ldots\ \% + ¼ \times \ldots\ldots\ldots\ \% + ¼ \times \ldots\ldots\ldots\ \% =$$

$$= \ldots\ldots\ldots\ldots\ \%.$$

The functional depreciation ($D_3$, $D_4$) in the considered example does not influence the vessel market value, since a base index in case of the evaluation by the cost approach is not the reproduction cost, but the replacement cost $RC$, that is the cost of construction of the evaluated vessel functional analogue at market prices, possessing the same elements of a functional inefficiency.

The evaluation of external obsolescence (economical) $D_5$ in the given practical work should be neglected or considered by the expert adjustment – from 5 to 15 %.

Also the formula (9.17) or the similar formula depending on assumptions concerning the estimations of difficulties of the parties and external limitations ($\Delta MV_1, \Delta MV_2$ and $[I]$ can be recommended to evaluate the external economic obsolescence, see Chapter 9). And in order to estimate the vessel's external economic obsolescence $D_5$ by the formula (9.17) it is necessary to estimate preliminary the annual operation costs $C$ and working assets $OC$, that is shown below in case of the estimation based on income approach.

The market value of a fishing vessel estimation based on cost approach on _____ _____, 20___, corresponds to a difference between the replacement cost $RC$ and depreciation

$$MV = RC \times (100\ \% - D_2)/100\ \% - D_1 =$$

$$= \ldots\ldots\ldots \times (100\ \% - \ldots\ldots\ldots)/100\ \% - \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

## Fishing vessel evaluation based on method of the net operating income capitalization

The structure of annual operation costs $C$ for a fishing vessel correspond to the summation

$$C = C_{CR} + C_{FED} + C_{EXP} + C_{SOC} + C_{RES} + C_{INST} + C_{MS} + \\ + C_{FL} + C_{SUP} + C_{RM} + C_{G} + C_{MM} + C_{DS},$$

where, the labor costs of the crew $C_{CR}$ (with the service personnel), expenses for crew's food supply $C_{FED}$, the specific payments to the social insurance funds from the crew salary $C_{SOC}$, the expenses for crew delivery $C_{EXP}$ (to onboard and out of), the expenses for the quota purchase $C_{RES}$ (a payment for ocean biological resources use under the rates provided by the tax Code), the expenses for the compensation of deterioration and for the replenishment of the fishery tools $C_{INST}$, the expenses for the purchase of tare materials, separation and technological materials $C_{MS}$, the annual expenses for fuel $C_{FL}$, the annual expenses for supply $C_{SUP}$, the average annual expenses for maintenance and repair $C_{RM}$, the general service expenses, the administrative expenses for management and marketing $C_G + C_{MM} + C_{DS}$ .

The average annual expenses for repair are roughly 2.5 % of the reproduction cost of commercial vessel and are determined above

$$C_{RM} \approx \text{…… thousand US dollars.}$$

The annual expenses for crew salary $C_{CR}$ (with the service personnel), expenses for crew's food supply $C_{FED}$, the specific payments to the social insurance funds from the crew salary $C_{SOC}$, the expenses for crew delivery $C_{EXP}$ (to onboard and out of) with the account the developed proportion of these terms is equal

$$C_{CR} + C_{FED} + C_{EXP} + C_{SOC} \approx 1.48 \times n_{CR} \times c_{CR} = 1.48 \times \text{……} \times \text{……..} = \\ = \text{…….. thousand US dollars,}$$

where $n_{CR}$ = …… man – the crew of a fishing vessel, including the fish processsing personnel, $c_{CR} \approx$ …… thousand US dollars a year – the average annual expenses for the support of one crew member.

For the analysis and the choice of the highest and the best variant of use it is reasonable to consider different variants of fishing vessel operation, including the autonomous (A), the expedition operation (B), as well as the processing refrigeration vessel (C).

### A. Autonomous fishing vessel operation

There is a variant of fishery operation when the vessel makes the trawling (catching), processing and produces as the average …… t / day of frozen production daily and independently delivers processed fish products to the harbor.

The average duration of trip in case of the autonomous operation is calculated as $T_{RF} = t_R + t_M + t_{FS} + t_{AR}$, where $t_M + t_{FS}$ = 1 + …… = …… days – the duration of commercial vessel operation at the fishing grounds before the hold is filled; $t_M \approx 1$ day (the recommended data for the practical training work) – the general duration of vessel maneuvering around fishing grounds for the trip; $t_{FS} \approx$ …… days – fish catching before

the hold is filled (the cargo capacity of fishing vessel $PG$ = …… t and the average daily rate of production – …… t / day are taken into consideration); $t_{AR}$ – the duration of harbor mooring between trips, $t_{AR} \approx$ …… days (for the practical training work it is recommended to accept the duration of mooring $t_{AR}$ in the range from 3 to 10 days, smaller values – for small fishing vessels).

The duration of vessel running to ocean fishing grounds (for example, in the sea of Okhotsk with the average remoteness from the port about …… miles) is determined as:

$$t_R = 2 \times £ / (24 \times \upsilon_S) = 2 \times \ldots\ldots / (24 \times \ldots\ldots) = \ldots\ldots \text{ days},$$

where £ =…… nautical miles – the distance to the fishing grounds from home harbor; $\upsilon_S$ =…… knots – the vessel operational speed.

The average duration of a trip in case of autonomous operation of a fishing vessel makes

$$T_{RF} = t_R + t_M + t_{FS} + t_{AR} = \ldots\ldots + \ldots\ldots + \ldots\ldots = \ldots\ldots \text{ days}.$$

The total of the vessel's round trips during the annual operational cycle is $n_R = T_{EXP} / T_{RF} = 330 / \ldots\ldots \approx \ldots\ldots$, where $T_{EXP} \approx 330$ days – the general duration of the annual operational period.

The annual average productivity of the processed products makes

$$Q_1 = n_R \times PG = \ldots\ldots \times \ldots\ldots = \ldots\ldots\ldots\ldots \text{ t},$$

where $PG$ = …… t – the amount of the processed fish products, during the trip, corresponding to the cargo capacity $PG$ for the variant of fishing vessel autonomous operation.

The expenses for quota purchase $C_{RES}$ (payment for ocean biological resourses), as well as the other components of operation costs related to the annual volume of fishery $Q_1/r$, namely: the compensation of deterioration and replenishment of fishery tools $C_{INST}$, the expenses for purchase of tare materials and separation $C_{MS}$, the general service expenses, the expenses for management and marketing $C_G + C_{MM} + C_{DS}$ with the account the developed relation of the components of the sum, – are equal to:

$$C_{RES} + C_{INST} + C_{MS} + C_G + C_{MM} + C_{DS} \approx 0.14 \times Q_1 / r =$$

$$= 0.14 \times \ldots\ldots / 1.0 = \ldots\ldots \text{ thousand US dollars},$$

where $r$ – the weight ratio of processed fish products for t of fresh fish, $r$ = 1.0 – the recommended value to be used in practical training work when $PG_{PR} = P_F/1.0 = P_F$, that is the weight of processed fish products in given should be accepted equal to the fresh fish weight.

The annual operational expenses for fuel in case of the autonomous operation of fishing vessel

$$C_{FL} = (q_1 \times t_R + q_2 \times (t_M + t_{FS})) \times n_R \times c^*_{FL} =$$

$$= (\ldots\ldots \times \ldots\ldots + \ldots\ldots \times \ldots\ldots) \times \ldots\ldots \times \ldots\ldots =$$

$$= \ldots\ldots \text{ thousand US dollars},$$

where, $q_1$ = …… t / day – the daily fuel consumption for running; $q_2$ = …… t / day – the average daily fuel consumption in the course of maneuvering and production reception at the fishing grounds; $c^*_{FL}$ = …… US dollar / t – the cost of one t of the applied diesel fuel.

Cost of supplies make

$C_{SUP} \approx 0.07 \times C_{FL} \approx 0.07 \times$ …….. = …… thousand US dollars.

The general value of annual operation costs $C_1$ for the fishing vessel without including depreciation charges is determined by summation of the components with the account the recommendations concerning grouping of components and is

$C_1 = (C_{CR}+C_{FED}+C_{EXP}+C_{SOC}) + (C_{RES}+C_{INST}+C_{MS}+C_G+C_{MM}+C_{DS}) + C_{FL} + C_{SUP} + C_{RM} =$

= ……..+ ……..+ ……..+ ……..+ ……..= …….. thousand US dollars.

The average price of prevailing kinds of the fish products processed by the vessel in an autonomous fishing and delivered to the port, that is the income per a unit of mass of the processed fish products (or seafood), includes delivery expenses (from 80 to 120 thousand US dollars / t, on the average 0.10 thousand US dollars / t) and equals

$m$ = …… + 0.10 = …….. thousand US dollars / t.

The annual income is

$I_1 = Q_1 \times m$ = …… × …… = …… thousand US dollars.

The rate of the net operating income capitalization is determined by the sum of:

– Discounting rate which is preset and equals $i$ = ……. %, and

– Factor of fund of compensation of investments, with the account the life time $T$, vessel years $t$ and the operation time which remains before the vessel utilization for scrap

$T - t$ = ……..…–……...…=…… years.

The factor of fund of compensation of the depreciated part of the investments $f_m$ equals

$$f_m = \frac{i}{(1+i)^{T-t}-1} = \frac{.....}{(1+.....)^{.....}-1} = ..... \approx .....\% .$$

The rate of the net operating income capitalization is

$R = i + f_m$ = …… % + ……. % = ……. %.

By the method of the net operating income capitalization the value of the technically valid for marine operation and equipped fishing vessel for the autonomous operation, determined on _____ _____, 20___, is

$$MV_1 = (I_1 - C_1)/(R + \eta_{MV} + \eta_{INS}) =$$

= (……. – …….) / (……. + 0.02 + 0.015) = ……. thousand US dollars.

The value of the annual net operating income for the given variant of vessel operation makes

$NOI_1 = I_1 - C_1$= ……. – ……. = ……. thousand US dollars.

For the operation of the fishing vessel technically valid for marine operation and equipped there is a requirement for the stock of working assets $OC_1$ for the advance payments of operation costs.

The requirement for the replenishment of the working assets equals

$OC_1 \approx C_1 \times T_{RF} / T_{EXP}$ = ……. × ……. / 330 = ……. thousand US dollars.

The vessel value estimated based on income approach, minus required adjustment for the replenishment of the working assets ($OC_1$ = ……. thousand US dollars) and after the deduction of the eradicable physical depreciation ($D_1 \approx$ ……. thousand US dollars) on _____ _____, 20___ make

$MV_1 - OC_1 - D_1$ = …… – …… – ……= ……. thousand US dollars.

**B. Vessel operation at the fishing ground**

The variant of operation when the vessel carries out the trawling (catching), processing and production of frozen processed fish with average daily productivity ……..…. t and also transfers fish products to processing mother ship (or on a cargo vessel for the delivery to the port).

The fuel consumption for the search of fish, maneuvering and fishery during the period between the transfers of the fish on processing mother ship is

$$P_{FPR} = P_{FM}(t_M) + P_{FR}(t_{FS}, \Delta t),$$

where $P_{FM} = q_1 \times t_M$ – the fuel consumption on maneuvering when searching a congestion of fish, $q_1$ – the daily fuel consumption for running, $P_{FR} = q_2 \times (t_{FS}+\Delta t)$ – the fuel consumption during the operating time at the fishing grounds, including fishery and transfer of the processed fish products $q_2$ – the daily fuel consumption for trawling (catching); $t_M \approx 1$ days; $\Delta t$ =1 day (offered values for a training task);

$$P_{FM} = q_1 \times t_M = \ldots\ldots\ldots \times 1 = \ldots\ldots\ldots \text{ t};$$

$$P_{FR} = q_2 \times (t_{FS} + \Delta t) = \ldots\ldots\ldots \times (\ldots\ldots\ldots + 1) = \ldots\ldots\ldots \text{ t};$$

$$P_{FPR} = P_{FM} + P_{FR} = \ldots\ldots\ldots + \ldots\ldots\ldots = \ldots\ldots\ldots \text{ t}.$$

The duration of round trip $T_P$ of the vessel in fishing ground (an interval of the fuel fillings–up) is

$$T_{RF} = (t_M + t_{FS} + \Delta t) \times P_{FL} / P_{FPR} =$$

$$= (1 + \ldots\ldots\ldots + 1) \times \ldots\ldots\ldots / \ldots\ldots\ldots = \ldots\ldots\ldots \text{ days},$$

where $P_{FL}$ = ……. t – the specification (maximal) stock of fuel onboard a vessel.

The amount of the processed fish products, trawled (catched) during the round trip, is equal

$$PG_{PR} = P_F/r = PG \times r \times P_{FL} / P_{FPR} = \ldots\ldots\ldots \times 1.0 \times \ldots\ldots\ldots / \ldots\ldots\ldots = \ldots\ldots\ldots \text{ t},$$

where $PG$ = ……. t – the cargo capacity of a fishing vessel.

The total of round trips of a fishing vessel during an annual operational cycle is

$$n_R = (T_{EXP} - t_R - t_{AR}) / T_{RF} = (330 - \ldots\ldots\ldots - \ldots\ldots\ldots) / \ldots\ldots\ldots = \ldots\ldots\ldots$$

The annual productivity at the fishing ground is at the average

$$Q_2 = n_R \times PG_{PR} = \ldots\ldots\ldots \times \ldots\ldots\ldots = \ldots\ldots\ldots \text{ t}.$$

The expenses for quota purchase $C_{RES}$ (payment for ocean biological resources), as well as the other components of operation costs related to the annual volume of fishery $Q_2/r$, namely: compensation of deterioration and replenishment of tools $C_{INST}$, expenses for purchase of tare materials and separation $C_{MS}$, the general service expenses, the expenses for management and marketing $C_G + C_{MM} + C_{DS}$ are equal

$$C_{RES} + C_{INST} + C_{MS} + C_G + C_{MM} + C_{DS} \approx 0.14 \times Q_2 / r =$$

$$= 0.14 \times \text{…….} /1.0 = \text{…….} \text{ thousand US dollars.}$$

The annual expenses for fuel in case of the vessel operation at the fishing ground make $C_{FL} = (P_{FL} \times n_R + q_1 \times t_R) \times c^*_{FL} =$

= (……. × ……. + ……. × …….) × ……. = …… thousand US dollars.

The annual expenses for supply are equal to

$$C_{SUP} \approx 0.07 \times C_{FL} \approx 0.07 \times \text{……..} = \text{……} \text{ thousand US dollars.}$$

The general value of annual operation costs $C_2$ is determined by the summation of the components with the account recommendations concerning grouping terms and is equal

$$C_2 = (C_{CR}+C_{FED}+C_{EXP}+C_{SOC}) + (C_{RES}+C_{INST}+C_{MS}+C_G+C_{MM}+C_{DS})+C_{FL}+C_{SUP}+C_{RM} =$$

= ……..+ ……..+ ……..+ ……..+ ……..= …….. thousand US dollars.

The average price of the fish products of prevailing kinds processed by the vessel at the fishing ground and transferred to a cargo vessel for delivery (or to processing mother ship), that is the income per a unit of mass of the processed fish products (or seafood), is $m$ = ……. thousand US dollars / t and does not include expenses for the delivery to the port.

The annual income is determined as:

$$I_2 = Q_2 \times m = \text{…….} \times \text{…….} = \text{……} \text{ thousand US dollars.}$$

The capitalization rate is equal to $R$ = …….. %.

By the net operating income capitalization method the value of the vessel technically valid for marine operation and equipped, for the variant of the vessel operation at the fishing ground, determined on _____ _____, 20___, is

$$MV_2 = (I_2 - C_2)/(R + \eta_{MV} + \eta_{INS}) =$$

= (…… – ……) / (……. + 0.02 + 0.015) = ……. thousand US dollars.

The annual net operating income in the given variant of vessel operation is

$$NOI_2 = I_2 - C_2 = \text{…….} - \text{…….} = \text{……} \text{ thousand US dollars.}$$

For operation of the fishing vessel technically valid for marine operation and equipped, the stock of working assets $OC_2$ for the advance payments of operation costs is required.

The requirement for the replenishment of the working assets is equal

$$OC_2 \approx C_2 \times T_{RF} / T_{EXP} = \text{…….} \times \text{…….} / 330 = \text{…….} \text{ thousand US dollars.}$$

The vessel value estimated based on income approach, minus required adjustment for the replenishment of the working assets ($OC_2$ = ……. thousand US dollars) and after the deduction of eradicable physical depreciation ($D_1 \approx$ ……. thousand US dollars) on _____ _____, 20___ is

$$MV_2 - OC_2 - D_1 = \text{……} - \text{……..…} - \text{…….} = \text{……} \text{ thousand US dollars.}$$

### C. Vessel operation as the processing refrigeration vessel

There is a variant when the processing fishing vessel, for example the refrigerating processor, receives fresh fish from the trawling (catching) vessels, processes and produces of the fish products with the average daily productivity …….. t (in the given task it is offered to accept daily productivity twice more than the productivity of the trawling vessel) and transfers the production to the cargo vessels for the delivery to the port.

The processed products output in case of the vessel operation as the processing refrigerator is more than in operation variants of autonomous marine fishery expedition. The productivity increase is possible, if the autonomous fishing is not carried out, and the fresh fish is received from others vessels.

Since in a considered variant the vessel accepts the fresh fish from the trawling (catching) vessels and processes it, then one part of the income concerns the operation of the evaluated fishing vessel, and the other part – to the trawling (catching) vessels.

The fuel consumption for maneuvering and fish receiving during the period between the transfers of the production to the a cargo vessel is determined according to the terms

$$P_{FM} = q_1 \times t_M = \ldots\ldots\ldots \times 1 = \ldots\ldots\ldots \text{ t};$$

$$P_{FR} = q_2 \times (t_{FS} + \Delta t) = \ldots\ldots\ldots \times (\ldots\ldots\ldots + 1) = \ldots\ldots\ldots \text{ t};$$

where $t_{FS} \approx$ …… days – the duration of the fish products reception before the hold is filled (it is considered that cargo capacity of fishing vessel $PG$ = …… t and average daily productivity of the processed products – …… t offered for the given task is twice more than the set productivity for the fishing vessel).

The fuel consumption for maneuvering and reception of fish during the period between the transfers of the production to a cargo vessel is equal to

$$P_{FPR} = P_{FM} + P_{FR} = \ldots\ldots\ldots + \ldots\ldots\ldots = \ldots\ldots\ldots \text{ t}.$$

The duration of round trip $T_P$ of the vessel in fishing ground (an interval between the fuel fillings–up) is equal to

$$T_{RF} = (t_M + t_{FS} + \Delta t) \times P_{FL} / P_{FPR} =$$

$$= (1 + \ldots\ldots\ldots + 1) \times \ldots\ldots\ldots / \ldots\ldots\ldots = \ldots\ldots\ldots \text{ days}$$

The amount of the processed fish products, produced during the round trip, is equal to

$$PG_{PR} = P_F / r = PG \times r \times P_{FL} / P_{FPR} = \ldots\ldots\ldots \times 1.0 \times \ldots\ldots\ldots / \ldots\ldots\ldots = \ldots\ldots\ldots \text{ t}.$$

The total sum of round trips of the fishing vessel during the annual operational cycle is

$$n_R = (T_{EXP} - t_R - t_{AR}) / T_{RF} = (330 - \ldots\ldots\ldots - \ldots\ldots\ldots) / \ldots\ldots\ldots = \ldots\ldots\ldots \ .$$

The average annual productivity by the output amount of the processed fish products with the requirement of fish reception from others vessels at the fishing ground is

$$Q_3 = n_R \times PG_{PR} = \ldots\ldots\ldots \times \ldots\ldots\ldots = \ldots\ldots\ldots \text{ t}.$$

The correlated with the annual amount of the fish products output $Q_3$ components of the operation costs, namely: expenses for purchase of tare materials and separation $C_{MS}$, the general service expenses, the expenses for management and marketing $C_G + C_{MM} + C_{DS}$ with the account the developed parity terms are equal

$$C_{MS} + C_G + C_{MM} + C_{DS} \approx 0.04 \times Q_3 / r =$$

$$= 0.04 \times \ldots\ldots\ldots\ / \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The annual expenses for fuel in case of vessel operation at the fishing ground are equal to

$$C_{FL} = (P_{FL} \times n_R + q_1 \times t_R) \times c_{FL}^* =$$

$$= (\ldots\ldots\ldots \times \ldots\ldots\ldots + \ldots\ldots\ldots \times \ldots\ldots\ldots) \times \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The annual expenses for supply are equal to

$$C_{SUP} \approx 0.07 \times C_{FL} \approx 0.07 \times \ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The general value of operation expenses $C_3$ for the fishing vessel used as a processing refrigerator without including depreciation charges is determined by the summation of the components with the account recommendations concerning grouping of components and is equal

$$C_3 = (C_{CR}+C_{FED}+C_{EXP}+C_{SOC}) + (C_{MS}+C_G+C_{MM}+C_{DS}) + C_{FL}+C_{SUP}+C_{RM} =$$

$$= \ldots\ldots\ldots + \ldots\ldots\ldots + \ldots\ldots\ldots + \ldots\ldots\ldots + \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

For a considered variant of vessel operation when the fresh fish is not trawled (catched) by a vessel but is only processed and transferred to cargo vessels, and the fresh fish is received from the trawling (catching) vessels, the average price of the fish products of prevailing kinds $m$, related to the income of the evaluated vessel, is roughly equal to $m$ = ……. thousand US dollars / t (that is approximately 50 % of the production price of the frozen processed fish in case of autonomous marine fishing ground as it is offered to accept in given task) which in case of production transfer in the sea for transportation to the port is set ……. thousand US dollars / t, see article (B).

The other part of the income per a unit of mass of processed fish products is redistributed to the fishing vessels delivering fresh fish.

The annual income is determined as:

$$I_3 = Q_3 \times m = \ldots\ldots\ldots \times \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The capitalization rate is equal to $R$ = ……. %.

By the net operating income capitalization method the value of technically valid for marine operation and equipped vessel for a variant of use as a processing refrigerator at the fishing ground, determined on _____ _____, 20___, is

$$MV_3 = (I_3 - C_3)/(R + \eta_{MV} + \eta_{INS}) =$$

$$= (\ldots\ldots\ldots\ldots - \ldots\ldots\ldots\ldots) / (\ldots\ldots\ldots + 0.02 + 0.015) = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The net operating income for the given variant of vessel operation is equal to

$$NOI_3 = I_3 - C_3 = \ldots\ldots\ldots - \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

For the operation of technically valid for marine operation and equipped fishing vessel, the stock of working assets $OC_3$ for the advance payments of operation costs is required.

The requirement for the replenishment of the working assets is equal

$OC_3 \approx C_3 \times T_{RF} / T_{EXP}$ = ……. × ……. / 330 = ……. thousand US dollars.

The market value of the evaluated vessel based on income approach, minus the required adjustment for the replenishment of the working assets ($OC_3$ = ……. thousand US dollars) and after the deduction of eradicable physical depreciation ($D_1 \approx$ ……. thousand US dollars) on _____ _____, 20___ is

$MV_3 - OC_3 - D_1$ = …… – ……..…. – ……. = ……. thousand US dollars.

The conclusion of fishing vessel evaluation based on income approach: the highest and the best use of the vessel with the given assumptions of calculation corresponds to the variant of vessel operation (to choose A, B or C)

……

The maximal value of the vessel, estimated by the method of the net operating income capitalization is accepted in correspondence with the highest and the best use concept.

The value of the fishing vessel, corresponding to a prospective variant of the highest and the best use, estimated based on income approach on _____ _____, 20___, is equal ……..…. thousand US dollars.

## Evaluation of fishing vessel based on comparable sales approach

The results of the marketing researches for the value estimation of the fishing vessel based on comparable sales approach are used in the form of statistical regressions of the fishing vessels at the pre–owned market.

The net register tonnage is equal to $NRT$ = …… .

According to the formula of statistical regression, the fishing vessel value with the account the vessel years $t$ = …… years on date of estimation when using the marketing researches data and the net register tonnage as the unit of comparison on _____ _____, 20___ is equal

$$MV = 0.6724 \times NRT^{1.25} \times e^{-0.00035 \times NRT} \times ((1+0.02)^{55-t} - 1)^{1.01} =$$

$$= 0.6724 \times .....^{1.25} \times e^{-0.00035 \times .....} \times ((1+0.02)^{55-.....} - 1)^{1.01} = .....$$ thousand US dollars.

The main engine power of fishing vessel is equal to $Ne$ = …… kW.

According to the formula of statistical regression, the fishing vessel value with the account the vessel years $t$ = …… years on date of estimation when using the marketing researches data and the main engine power as the unit of comparison on _____ _____, 20___ is equal

$$MV = 0.342 \times Ne^{1.23} \times ((1+0.01)^{50-t} - 1)^{1.005} =$$

$$= 0.342 \times .....^{1.23} \times ((1+0.01)^{50-.....} - 1)^{1.005} = .....$$ thousand US dollars.

The index of area equal to the product of the vessel length over all by the breadth is equal to

$$L \times B = \ldots\ldots\ldots\ldots \times \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots\ldots \text{ square m.}$$

By the formula of statistical regression, the fishing vessel value with the account the vessel years $t$=…… years on the date of estimation when using the marketing researches data and the index of area equal to the product of the vessel length over all by the breadth as the unit of comparison on _____ _____, 20___ is equal to

$$MV = 0.455 \times (L \times B)^{1.25} \times e^{-0.00026 \times (L \times B)} \times ((1 + 0.023)^{53.5 - t} - 1)^{1.01} =$$

$$= 0.455 \times \ldots\ldots\ldots\ldots^{1.25} \times e^{-0.00026 \times \ldots\ldots\ldots\ldots} \times ((1 + 0{,}023)^{53.5 - \ldots\ldots\ldots\ldots} - 1)^{1.01} = \ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The average value of technically valid for marine operation fishing vessel when using the comparable sales approach and the marketing researches data on _____ _____, 20___ is equal to

$$MV = \ldots\ldots\ldots \times ⅓ + \ldots\ldots\ldots \times ⅓ + \ldots\ldots\ldots \times ⅓ = \ldots\ldots\ldots \text{ thousand US dollars.}$$

When estimating based on comparable sales approach and using the marketing researches and statistical regressions the fishing vessel value is the calculation by the uniform database with the assumption about the equal importance influence of applied units on the vessel value.

The vessel value based on comparable sales approach can be estimated by using of the analogues in accordance with its methodological definition under the Federal Standard # 2 «The purpose of evaluation assignment and types of value (FSA # 2)», approved by the order # 255 of Ministry of Economical Development of Russia July 20, 2007: the market value is the «most probable price …». The specified definition can be provided with the statistical calculations and the regressions formalization.

At the same time the use of one or several isolated analogues for vessel evaluation based on comparable sales approach and introduction of adjustments to the value of each analogues' does not precisely correspond to the evaluation under the Standard since there should be done statistical research and formalization of the regressions for the estimation of probabilistic nature of analogues' values. It to the full extent concerns the estimation based on comparable sales approach of the vessels or other real assets of the marine company which are stereotype like the serial equipment in which relation the probabilistic nature of the separate analogues prices is proved by their stereotype feature.

## Data processing for cargo vessel evaluation (dry–cargo refrigeration vessel)

For dry–cargo refrigeration vessel evaluation in the given practical work it is required to determine the set characteristics as well as the deadweight *DW*, the displacement empty *DP*, the main engine power *Ne*, the daily fuel consumption for running $q_1$, the length at the cargo waterline *LW* and the breadth *B*, using initial data and the prototype characteristics.

The deadweight is $DW \approx PG + P_{FL}$ =…….+…….=…… t.

The displacement is equal to

$$DP = D - DW = \ldots\ldots\ldots\ldots\ldots - \ldots\ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ t.}$$

Vessel–prototype characteristics are presented in the tab. A5.

Table A5

| Cargo displacement total [*D*], t | Operational speed [$\upsilon_S$], knot | Power of the main engine [*Ne*], kW | Daily fuel consumption for running [$q_1$], t / day (all types, averaged) | Daily fuel consumption in the harbor [$q_2$], t / day (all types, averaged) |
|---|---|---|---|---|
| 8500 | 14 | 4050 | 15.1 | 2.5 |

Symbols of the prototype data are accepted in square brackets.

The main engine power of an evaluated vessel is determined by the formula of «the Admiralty factors».

The Admiralty factor [$c_{ADM}$] for cargo vessel is calculated using the vessel–prototype data and equals

$$[c_{ADM}] = [D]^{0.5} \times [v_S]^{2.5} / [Ne] = 8500^{0.5} \times 14^{2.5} / 4050 = 16.7 .$$

The main engine power *Ne* of the evaluated vessel equals

$$Ne = D^{0.5} \times v_S^{2.5} / [c_{ADM}] = \ldots\ldots\ldots\ldots^{0.5} \times \ldots\ldots\ldots\ldots^{2.5} / 16.7 = \ldots\ldots\ldots\ldots \text{ kW.}$$

The Daily fuel consumption for running of the evaluated vessel (all types, averaged) is equal

$$q_1 = [q_1] \times Ne / [Ne] = 15.1 \times \ldots\ldots\ldots\ldots / 4050 = \ldots\ldots\ldots\ldots \text{ t.}$$

Daily fuel consumption in the harbor (all types, averaged) makes

$$q_2 = [q_2] \times Ne / [Ne] = 2.5 \times \ldots\ldots\ldots\ldots / 4050 = \ldots\ldots\ldots\ldots \text{ t.}$$

## Estimation of the cargo vessel replacement cost based on comparable sales approach

The vessel evaluation in correspondence with the Standards as the most probable price is provided by the processing and use of the marketing research and the statistical generalizations for the appraisal.

The value estimation is made according to the methodological conditions and assumptions and with due account of the following factors:

– Characteristics of the economic environment;

– Requirements of prospective sale;

– Characteristics of the commercial vessel and analogues.

The deadweight *DW* and hold volume *W* can be used as comparison units of the dry–cargo refrigeration vessel.

The deadweight *DW* of the dry–cargo refrigeration vessel is equal to

*DW* = …… t.

By the formula of statistical regression the replacement cost of the dry–cargo refrigeration vessel when using the deadweight *DW* as a unit of comparison on _____ _____, 20___ is equal

$$RC = 1.585 \times DW^{1.255} \times e^{-0.0001 \times DW} =$$

$$= 1.585 \times \ldots\ldots\ldots^{1.255} \times e^{-0.0001 \times \ldots\ldots\ldots\ldots} = \ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The hold volume *W* of the dry–cargo refrigeration vessel equals

*W* = …… cubic ms.

By the formula of statistical regression the replacement cost of the dry–cargo refrigeration vessel when using the cargo hold volume *W* as a unit on _____ _____, 20___ equals

$$RC = 1.500 \times W^{1.255} \times e^{-0.00011 \times W} = 1.500 \times \ldots\ldots\ldots\ldots^{1.255} \times e^{-0.00011 \times \ldots\ldots\ldots\ldots} = \ldots\ldots\ldots\ldots$$

thousand US dollars.

The average replacement cost of dry–cargo refrigeration vessel when using the comparable sales approach and the marketing researches data on _____ _____, 20___ is equal to

*RC* = ……. × ½ + ……. × ½ = ……. thousand US dollars.

When estimating based on comparable sales approach, the replacement cost of dry–cargo refrigeration vessel when using the marketing researches and statistical regressions is not the average weighed characteristic, as in case of the value estimation by standard independent approaches, but the calculation according to a uniform database with the assumption about the equal importance of applied units of comparison for vessel replacement cost.

## Estimation of the cargo vessel based on cost approach

The eradicable physical depreciation of dry–cargo refrigeration vessel is estimated in cash and corresponds to expenses requirement for repair (the condition accepted in the given practical work) and on _____ _____, 20___ equals

$D_1 = C_{RM} \approx 0.025 \times RC = 0.025 \times$ …….. = …….. thousand US dollars.

In proportion of statistical regression dependences of the value on the age of the dry–cargo refrigeration vessel *t* = …… years the eradicable physical depreciation of vessel on _____ _____, 20___ equals

$$D_2 = 100\% \times (1 - 0.0113 \times ((1 + 0.09)^{50-t} - 1)^{1.044}) =$$

$$= 100\% \times (1 - 0.0113 \times ((1 + 0.09)^{50-\ldots\ldots\ldots\ldots} - 1)^{1.044}) = \ldots\ldots\ldots\ldots\%.$$

When estimating by the «life time» method ineradicable physical depreciation $D_2$ should be related with the age of the vessel $t$ and its prospective life time.

The structural durability of dry–cargo refrigeration vessel is evaluated with the account stated above recommendations and is equal to $T$ = …….. years (as well as in recommendations according to life time and depreciation of a fishing vessel estimation).

In a linear proportion of structural durability $T$ and years $t$ of dry–cargo refrigeration vessel the eradicable physical depreciation on _____ _____, 20___ equals

$$D_2 = 100\ \% \times t\ /\ \mathrm{t} - 100\ \% \times SV\ /\ RC =$$

$$= 100\ \% \times \ldots\ldots\ldots\ldots\ /\ \ldots\ldots\ldots\ldots - 100\ \% \times \ldots\ldots\ldots\ldots\ /\ \ldots\ldots\ldots\ldots \approx \ldots\ldots\ldots\ldots\ \%,$$

where $t$ = …… years – the age at the moment of an estimation of dry–cargo refrigeration vessel; $SV$ = ……. thousand US dollars – the scrap value – the residual liquidation value in case of the compelled sale of materials as the vessel scrap without the estimation of functional suitability of separate parts, for the practical work offered to be estimated with conventional scrap price 50 US dollars for one t of vessel displacement empty; $RC$ = ……. thousand US dollars – the vessel replacement cost.

The average weighed value of ineradicable physical depreciation $D_2$ of dry–cargo refrigeration vessel, determined in dependence on years $t$ and life time $T$ of the set of values estimated above: …… % and …… %, is equal to

$$D_2 = \ldots\ldots\ldots\ldots \times ½ + \ldots\ldots\ldots\ldots \times ½ = \ldots\ldots\ldots\ldots\ \%.$$

The functional depreciation ($D_3$, $D_4$) in a considered example does not influence the vessel market value as a base index when in case of the evaluation by the cost approach we apply the cost of replacement $RC$ (instead of the reproduction cost), that is the manufacturing in market prices of functional analogue of the evaluated vessel possessing the same elements of a functional inefficiency.

The evaluation of external obsolescence (economical) $D_5$ in the given practical work should be neglected or taken into consideration by the expert adjustment – from 5 to 15 %.

Also for the evaluation of external obsolescence (economical) one should use the formula (9.17) or the similar formula depending on assumptions according to estimations of economical difficulties and external limitations ($\Delta MV_1, \Delta MV_2$ and $[I]$, see Chapter 9). And for the estimation of vessel external economic obsolescence $D_5$ by the formula (9.17) it is necessary to estimate preliminary annual operation costs $C$ and working assets $OC$ that is presented below when estimating the vessel value by the income approach.

The market value of dry–cargo refrigeration vessel, estimated by the cost approach on _____ _____, 20___, corresponds to the difference between the replacement cost $RC$ and deterioration and is equal to

$$MV = RC \times (100\% - D_2)/100\ \% - D_1 =$$

$$= \ldots\ldots\ldots \times (100\ \% - \ldots\ldots\ldots..)/100\ \% - \ldots\ldots\ldots = \ldots\ldots\ldots..\ \text{thousand US dollars.}$$

## Cargo vessel evaluation based on method of the net operating income capitalization

The annual cost $C$ of the cargo vessel operation (operation costs) is determined as:

$$C = C_{CR} + C_{FED} + C_{EXP} + C_{SOC} + C_{FL} + C_{SUP} + C_{RM} + C_{G} + C_{MM} + C_{DS}.$$

The annual expenses for repair are roughly 2.5 % of vessel reproduction cost and are determined above – $C_{RM} \approx$ ……. thousand US dollars.

The operating expenses for crew support, including the specific payments $C_{SOC}$ to the social insurance funds from the crew salary, with the account the developed proportion between the components $C_{CR}$, $C_{FED}$, $C_{EXP}$ and $C_{SOC}$ are equal

$$C_{CR} + C_{FED} + C_{EXP} + C_{SOC} \approx 1.48 \times n_{CR} \times c_{CR} =$$

$$= 1.48 \times \ldots\ldots\ldots\ldots \times \ldots\ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ thousand US dollars,}$$

where $n_{CR}$ = …… man – the crew of the dry–cargo refrigeration vessel;
$c_{CR} \approx$ …… thousand US dollars annually – the average annual expenses for the support of one member of the crew.

In order to find the prospective variant of the highest and the best use of commercial vessel for the evaluation based on income approach the next variants of vessel operation (cyclically repeating) are considered:

(A) The delivery of supplies from the south coast of Primorski Krai to the fishing grounds in sea of Okhotsk (or to the coastal fish factories) and the delivery of the processed fish products to the ports of the southern coast of Primorski Krai;

(B) The delivery of supplies from East Asian harbors to the fishing grounds near to Indonesia or the Mariana Islands and the delivery of processed fish products, for example, the tuna to the Pacific Rim countries;

(C) The delivery of supplies from home harbor (at the southern coast of Primorski Krai) to the fishing grounds in sea of Okhotsk (or to the coastal fish factories), the delivery of processed fish products from the fishing grounds to ports of the Pacific Rim countries, the goods delivery from the Pacific Rim ports to the southern coast of Primorski Krai.

### A. Cargo vessel operation for delivery of supplies from southern coast of Primorski Krai to the fishing grounds in the sea of Okhotsk (or to the coastal fish factories) and delivery of the processed fish products to the ports of southern coast of Primorski Krai

The delivery of supplies from the southern coast of Primorski Krai to the fishing grounds in sea of Okhotsk (or to the coastal fish factories) and delivery of the processed fish products to the ports of the southern coast of Primorski Krai is considered in the following example.

The running time for trip – duration of vessel running to the point (point) of destination and returning to the port of arrival is determined as:

$$t_R = 2 \times £ / (24 \times \upsilon_S) = 2 \times \ldots\ldots\ldots\ldots / (24 \times \ldots\ldots\ldots) = \ldots\ldots\ldots\ldots \text{ days,}$$

where £ = …….. nautical miles – the distance to destination from the home harbor; $\upsilon_S$ =…… knots – the vessel operational speed.

The duration of cargo handling operations $t_G$ during the round trip is determined taking into account cargo capacity of the vessel *PG*, operating ratios of vessel cargo capacity during the trip to destination and return trip $\eta_{G1}$ and $\eta_{G2}$ and daily productivity of cargo operations $q_{G2}$ around the fishing grounds, that is in the destination point, and is equal

$$t_G = PG \times (\eta_{G1} + \eta_{G2}) / q_{G2} = \ldots\ldots\ldots \times (1.0 + \ldots\ldots\ldots) / \ldots\ldots\ldots \approx \ldots\ldots\ldots \text{ days},$$

*PG* = …….. t – the cargo capacity of the vessel; $\eta_{G1}$ = 1.0 – the operating factor of vessel cargo capacity use in the trip do destination; $\eta_{G2}$ = …….. – the operating factor of vessel cargo capacity in the return trip (mostly the supply); $q_{G2}$ = …… t / day – the daily productivity of cargo operations at the point of destination.

The time of operation of the vessel in the point of destination before the total transfer of the cargo $t_{FS} = t_G + t_M$ = …….. + 1 = ……. days, where $t_M \approx 1$ day – the general duration of vessel maneuvering for the trip (offered 1 day in given practical work).

The duration of vessel mooring in the harbor for trip $t_{AR}$ is determined taking into account the cargo capacity of the vessel *PG*, the operating factors of vessel cargo capacity during the trip to destination and in return trip (departure) $\eta_{G1}$ and $\eta_{G2}$ and the daily productivity of cargo operations $q_{G1}$ in the harbor (i.e. in the point of arrival / departure)

$$t_{AR} = PG \times (\eta_{G1} + \eta_{G2}) / q_{G1} = \ldots\ldots\ldots \times (1.0 + \ldots\ldots\ldots) / \ldots\ldots\ldots \approx \ldots\ldots\ldots \text{ days},$$

$q_{G1}$ = …….. t / day – the daily rate of the loading–unloading operations in the harbor (i.e. in the point of arrival / departure).

The average duration of the trip is equal to

$$T_{RF} = t_R + t_{FS} + t_{AR} = \ldots\ldots\ldots + \ldots\ldots\ldots + \ldots\ldots\ldots = \ldots\ldots\ldots \text{ days}$$

The total of vessel's round trips during the annual operational cycle equals

$$n_R = T_{EXP} / T_{RF} \approx 330 / \ldots\ldots\ldots = \ldots\ldots\ldots .$$

The annual operational expenses for fuel and lubricants for the considered variant of vessel operation equal

$$C_{FL} = n_R \times ((t_R + t_M) \times q_1 + (t_{AR} + t_G) \times q_2) \times c^*_{FL} =$$

$$= \ldots\ldots\ldots \times ((\ldots\ldots\ldots + 1) \times \ldots\ldots\ldots + (\ldots\ldots\ldots + \ldots\ldots\ldots) \times \ldots\ldots\ldots) \times \ldots\ldots\ldots =$$

$$= \ldots\ldots\ldots \text{ thousand US dollars},$$

where, $q_1$ = …… t / day – the daily fuel consumption for running; $q_2$ = …… t / day – the average daily fuel consumption in the course of maneuvering and cargo reception at the destination point; $c^*_{FL}$ = …… thousand US dollars / t – the average cost of one t of the applied diesel fuel.

The annual expenses for supply are equal

$$C_{SUP} \approx 0.07 \times C_{FL} \approx 0.07 \times \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The average annual cargo traffic of vessel makes

$$Q_1 = n_R \times PG \times (\eta_{G1} + \eta_{G2}) = \ldots\ldots\ldots \times \ldots\ldots\ldots \times (1.0 + \ldots\ldots\ldots) = \ldots\ldots\ldots \text{ t.}$$

The correlated with the annual cargo traffic $Q_1$ components of operation costs, namely: the general service expenses, the expenses for management and marketing $C_G + C_{MM} + C_{DS}$ with the account the developed parity of components of the sum, – are equal

$$C_G + C_{MM} + C_{DS} \approx 0.02 \times Q_1 = 0.02 \times \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The general value of annual operation costs $C_1$ for the given variant of the dry–cargo refrigeration vessel operation, determined by summation the components with the account the recommendations concerning grouping of terms without including depreciation charges equals

$$C_1 = (C_{CR} + C_{FED} + C_{EXP} + C_{SOC}) + C_{FL} + C_{SUP} + C_{RM} + (C_G + C_{MM} + C_{DS}) =$$

$$= \ldots\ldots\ldots + \ldots\ldots\ldots + \ldots\ldots\ldots + \ldots\ldots\ldots + \ldots\ldots\ldots =$$

$$= \ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The tariff rate of cargo transportation to the ports of Primorski Krai and supply from Primorski Krai for fishing vessels in the marine expeditions, or supply for coastal points is equal to $m$ = …… thousand US dollars / t.

The annual income is determined as:

$$I_1 = Q_1 \times m = \ldots\ldots \times \ldots\ldots = \ldots\ldots \text{ thousand US dollars.}$$

The rate of the net operating income capitalization is determined as the sum of:

– Discounting rate, which is set and is equal $i$ = …… % and

– Factor of fund of compensation of investments,

with the account of the vessel life time $T$, years $t$ and the term remained before the vessel utilization for scrap $T - t$ = ……–……=…… years.

The factor $f_m$ of the fund of compensation of depreciated part of investments is

$$f_m = \frac{i}{(1+i)^{T-t} - 1} = \frac{\ldots\ldots\ldots\ldots}{(1+\ldots\ldots\ldots)^{\ldots\ldots} - 1} = \ldots\ldots\ldots \approx \ldots\ldots\ldots\%.$$

The rate of the net operating income capitalization equal

$$R = i + f_m = \ldots\ldots\ldots\ \% + \ldots\ldots\ldots\ \% = \ldots\ldots\ldots\ \%.$$

By the method of the net operating income capitalization the value of the technically valid for marine operation and equipped dry–cargo refrigeration vessel, determined for considered variant of vessel operation on _____ _____, 20___, is equal to

$$MV_1 = (I_1 - C_1)/(R + \eta_{MV} + \eta_{INS}) =$$

$$= (\ldots\ldots\ldots - \ldots\ldots\ldots) / (\ldots\ldots\ldots + 0.02 + 0.015) = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The annual net operating income of given variant of vessel operation equals

$$NOI_1 = I_1 - C_1 = \ldots\ldots\ldots - \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

For a considered variant of operation of dry–cargo refrigeration vessel there is requirement for the stock of working assets $OC_1$ for the advance payments of operation costs.

The working assets $OC_1$ are equal

$$OC_1 \approx C_1 \times T_{RF} / T_{EXP} = \ldots\ldots\ldots \times \ldots\ldots\ldots / 330 = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The value of the dry–cargo refrigeration vessel estimated based on income approach, minus the requirement for the replenishment of the working assets ($OC_1$ = …… thousand US dollars) and after the deduction of eradicable physical depreciation ($D_1 \approx$ …… thousand US dollars), on _____ _____, 20___ equals

$$MV_1 - OC_1 - D_1 = \ldots\ldots\ldots - \ldots\ldots\ldots - \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

**B. Delivery of supplies from the East Asia harbors to the fishing grounds and the processed fish products to the Pacific Rim countries**

The delivery of supplies from East Asian harbors to the fishing grounds near Indonesia or Mariana Islands and delivery of processed fish products for example the tuna to the harbors of East Asia is considered in the following example.

The running time for trip (the duration of vessel voyage to the in destination and the return trip to the harbor) is determined as:

$$t_R = 2 \times £ / (24 \times \upsilon_S) = 2 \times \ldots\ldots\ldots\ldots / (24 \times \ldots\ldots\ldots\ldots) = \ldots\ldots\ldots\ldots\ldots \text{ days,}$$

where £ = …….. nautical miles – the distance to destination from the port of departure; $\upsilon_S$ =…… knots – the vessel operational speed.

The duration of cargo handling operations during the trip is equal to

$t_G$ = ……. days (see article A).

The operation time of vessel in destination before the total transfer of the cargo

$$t_{FS} = t_G + t_M = \ldots\ldots\ldots + 1 = \ldots\ldots\ldots\ldots\ldots \text{ days}$$

The duration of harbor mooring for the round trip $t_{AR}$ = ……. days (see article A).

The average duration of the trip is calculated as:

$$T_{RF} = t_R + t_{FS} + t_{AR} = \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ days}$$

The total of vessel round trips during the annual operational cycle equals

$$n_R = T_{EXP} / T_{RF} \approx 330 / \ldots\ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots\ldots$$

The annual operational expenses for fuel and lubricants for a considered variant of vessel operation are

$$C_{FL} = n_R \times ((t_R + t_M) \times q_1 + (t_{AR} + t_G) \times q_2) \times c^*_{FL} =$$

$$= \ldots\ldots\ldots\ldots \times ((\ldots\ldots\ldots\ldots + 1) \times \ldots\ldots\ldots\ldots + (\ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots) \times \ldots\ldots\ldots\ldots) \times \ldots\ldots\ldots\ldots =$$

$$= \ldots\ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The annual expenses for supply are equal to

$$C_{SUP} \approx 0.07 \times C_{FL} \approx 0.07 \times \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The average annual cargo traffic of vessel is

$$Q_2 = n_R \times PG \times (\eta_{G1} + \eta_{G2}) = \ldots\ldots\ldots\ldots \times \ldots\ldots\ldots\ldots \times (1.0 + \ldots\ldots\ldots\ldots) = \ldots\ldots\ldots\ldots \text{ t.}$$

The correlated with the annual cargo traffic $Q_2$ components of operation costs, namely: the general service expenses, the expenses for management and marketing $C_G + C_{MM} + C_{DS}$ with the account the developed parity of the components of the sum, – are equal to

$$C_G + C_{MM} + C_{DS} \approx 0.02 \times Q_2 = 0.02 \times \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The total annual operation costs $C_2$ for the given variant of the dry–cargo refrigeration vessel operation, determined by summation the components with the account recommendations concerning grouping of components without including depreciation charges equal

$$C_2 = (C_{CR} + C_{FED} + C_{EXP} + C_{SOC}) + C_{FL} + C_{SUP} + C_{RM} + (C_G + C_{MM} + C_{DS}) =$$

= ……..…. + ……..…… + ……..…… + ……..…… + ……..… =

= …….. thousand US dollars.

The annual income is determined as:

$I_2 = Q_2 \times m$ = …… × ……. = …….. thousand US dollars,

$m$ = …… thousand US dollars / t – the tariff rate of transportation of cargoes on a line from East Asian harbors to the fishing grounds near Indonesia or the Mariana Islands and the rates of the delivery frozen processed fish products, for example the tuna, to the harbors of East Asia.

The capitalization rate is equal $R$ = ……%.

By the method of the net operating income capitalization the value of the technically valid for marine operation and equipped dry–cargo refrigeration vessel, determined for considered variant of vessel operation on _____ _____, 20___, is equal to

$$MV_2 = (I_2 - C_2)/(R + \eta_{MV} + \eta_{INS}) =$$

= (…..…… – …..……) / (…..…… + 0.02 + 0.015) = …… thousand US dollars.

The annual net operating income of the given variant of vessel operation makes

$NOI_2 = I_2 - C_2$ = ……. – ……. = ……. thousand US dollars.

For a considered variant of operation of dry–cargo refrigeration vessel there is a requirement forthe stock of working assets $OC_2$ for the advance payments of operation costs.

The working assets are equal

$OC_2 \approx C_2 \times T_{RF} / T_{EXP}$ = …….. × …….. / 330 = …….. thousand US dollars.

The value of the dry–cargo refrigeration vessel estimated based on income approach, minus the requirement for the replenishment of the working assets ($OC_2$ = ……. thousand US dollars) and after the deduction of eradicable physical depreciation ($D_1 \approx$ ……. thousand US dollars) on _____ _____, 20___ equals

$MV_2 - OC_2 - D_1$ = …… – ……..…. – ……. = ……. thousand US dollars.

### C. Delivery of the processed fish products to ports of the Pacific Rim countries and the cargoes to Russia

The scheme of the vessel operation is the following. The delivery of the supplies is carried out from home harbor at the southern coast of Primorski Krai to the fishing grounds in the sea of Okhotsk (or to the coastal fish factories). The delivery of fresh fish from the fishing grounds to ports of the Pacific Rim. Delivery of the goods is carried out from ports of the Pacific Rim to the southern coast of Primorski Krai. Repetition of the specified cycle.

The running time for the trip is determined as:

$t_R = \Sigma £ / (24 \times \upsilon_S)$ = …… / (24 × ……..) = …….. days,

where Σ£ =……. nautical miles – the general range of the marine route,
$\upsilon_S$ =…… knots – the vessel operational speed.

The duration of cargo handling operations during the round trip is $t_G$ = ……. days – the duration of cargo handling operations in two ports twice more than $t_{ГР}$ (see articles A, B).

The operation time of commercial vessel in both destinations before the total transportation of the cargo

$$t_{FS} = t_G + t_M = \ldots\ldots + 1 = \ldots\ldots\ldots\ldots \text{ days.}$$

The duration of mooring in the harbor for the trip $t_{AR}$ = …..…. days (see articles A, B).

The average duration of the trip is calculated as:

$$T_{RF} = t_R + t_{FS} + t_{AR} = \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots + \ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ days.}$$

The total of vessel round trips during the annual operational cycle makes

$$n_R = T_{EXP} / T_{RF} \approx 330 / \ldots\ldots\ldots\ldots = \ldots\ldots\ldots\ldots .$$

The annual operational expenses for fuel and lubricants for the considered variant of vessel operation makes

$$C_{FL} = n_R \times ((t_R + t_M) \times q_1 + (t_{AR} + t_G) \times q_2) \times c^*_{FL} =$$

$$= \ldots\ldots\ldots \times ((\ldots\ldots\ldots + 1) \times \ldots\ldots\ldots + (\ldots\ldots\ldots + \ldots\ldots\ldots) \times \ldots\ldots\ldots) \times \ldots\ldots\ldots =$$

$$= \ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The annual expenses for supply are equal

$$C_{SUP} \approx 0.07 \times C_{FL} \approx 0.07 \times \ldots\ldots\ldots = \ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The cargo traffic in case of the vessel operation for supply delivery is accepted at a rate of 25 % (the data offered for the practical work) of a cargo traffic of the processed fish products from the fishing grounds, and the cargo traffic of the goods from abroad to Russia is equal to a cargo traffic of the processed fish products (100 %).

The average annual cargo traffic of vessel equals

$$Q_3 = n_R \times PG \times (100\ \% + 100\ \% + 25\ \%)/100\ \% =$$

$$= \ldots\ldots\ldots\ldots \times \ldots\ldots\ldots\ldots \times (100\ \% + 100\ \% + 25\ \%)/100\ \% = \ldots\ldots\ldots\ldots\ldots \text{ t.}$$

The correlated with the annual cargo traffic $Q_3$ components of operation costs, namely: the general service expenses, the expenses for management and marketing $C_G + C_{MM} + C_{DS}$ with the account the developed parity of the components of the sum, – are equal to

$$C_G + C_{MM} + C_{DS} \approx 0.02 \times Q_3 = 0.02 \times \ldots\ldots\ldots = \ldots\ldots\ldots \text{ thousand US dollars.}$$

The total annual operation costs $C_3$ for the given variant of the dry–cargo refrigeration vessel operation, determined by summation of the components with the account recommendations concerning grouping of the components without including depreciation charges are equal to

$$C_3 = (C_{CR} + C_{FED} + C_{EXP} + C_{SOC}) + C_{FL} + C_{SUP} + C_{RM} + (C_G + C_{MM} + C_{DS}) =$$

$$= \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots =$$

$$= \ldots\ldots\ldots\ldots\ldots \text{ thousand US dollars.}$$

The annual income is thus determined as

$$I_3 = \sum(Q_3 \times m) = Q_3 \times (100\ \% + 25\ \%) / (100\ \% + 100\ \% + 25\ \%) \times m_1 +$$

$+ Q_3 \times 100\ \% / (100\ \% + 100\ \% + 25\ \%) \times m_2 =$…… × (100 % + 25 %):

:(100 %+100 %+25 %) × …… + ….. × 100 % / (100 % + 100 % + 25 %) × …… =

= …… thousand US dollars,

where $m_1$ = ……. thousand US dollars / t – the tariff rate for cargoes transportation to fishing ground and out of; $m_2$ = …… thousand US dollars / t – the tariff rate for cargoes transportation between the harbor in East Asia (for example, in Japan or the Republic of Korea) and Russia.

The capitalization rate is equal to $R$ = …… %.

By the method of the net operating income capitalization the value of the technically valid for marine operation and equipped dry–cargo refrigeration vessel, determined for the considered variant of vessel operation on _____ _____, 20___, is equal to

$$MV_3 = (I_3 - C_3)/(R + \eta_{MV} + \eta_{INS}) =$$

= (…..…… – …..……) / (…..…… + 0.02 + 0.015) = …… thousand US dollars.

The annual net operating income of the given variant of vessel operation is equal

$NOI_3 = I_3 - C_3 =$ ……. – ……. = ……. thousand US dollars.

The considered variant of operation of the dry–cargo refrigeration vessel requires the stock of working assets $OC_3$ for the advance payments of operation costs.

The working assets are equal

$OC_3 \approx C_3 \times T_{RF} / T_{EXP} =$ …….. × …….. / 330 = …….. thousand US dollars.

The value of the dry–cargo refrigeration vessel estimated based on income approach, minus required adjustment for the replenishment of the working assets ($OC_3$ = ……. thousand US dollars) and after the deduction of eradicable physical depreciation ($D_1 \approx$ ……. thousand US dollars) on _____ _____, 20___ equal

$MV_3 - OC_3 - D_1 =$ …… – ……..…– ……. = ……. thousand US dollars.

The conclusion (to choose A, B or C): with the given assumptions of calculation the highest and the best use of dry–cargo refrigeration vessel corresponds to the variant

…….

The value of the vessel on _____ _____, 20___ corresponding to a prospective variant of the highest and the best use, estimated based on income approach is

…..…….. thousand US dollars.

## Value estimation of the cargo vessel based on comparable sales approach

The value of the dry–cargo refrigeration vessel based on comparable sales approach can be estimated using of the analogues in accordance with its methodological definition under the Federal Standard # 2 «The purpose of evaluation assignment and types of value (FSA # 2)», approved by the order # 255 of Ministry of Economical Development of

Russia July 20, 2007: the market value is the «most probable price …». The specified definition can be provided with the statistical calculations and the regressions formalization.

The value estimation as the most probable price is carried out by means of formalization and use of statistical regressions. On the other hand, the use of one or several isolated analogues for the estimation based on comparable sales approach and introduction of adjustments to the prices of analogues doesn't precisely correspond to the vessel evaluation under the Standards, since the probabilistic analysis of statistics should be done and the given definition: whether there corresponds prices of analogues to their most probable price.

For an estimation of the dry–cargo refrigeration vessel the comparable sales approach the marketing research of prices uses in the form of statistical regressions.

As the units of comparison of dry–cargo refrigeration vessel the deadweight *DW* and the holds volumes *W* are used.

The deadweight *DW* of dry–cargo refrigeration vessel is set *DW* = ……. t.

By the formula of statistical regression the value of the dry–cargo refrigeration vessel with the account the vessel age *t* =….. years for date of estimation when using the deadweight *DW* as the unit of comparison on _____ _____, 20___ is equal

$$MV = 0.01788 \times DW^{1.255} \times e^{-0.0001 \times DW} \times ((1+0.09)^{50-t} - 1)^{1.044} =$$

$$= 0.01788 \times .....^{1.255} \times e^{-0.0001 \times .....} \times ((1+0.09)^{50-.....} - 1)^{1.044} = .....$$

thousand US dollars.

The hold volume *W* of dry–cargo refrigeration vessel is equal *W* = …… cubic ms.

The note: the capacity of cargo hold of the dry–cargo refrigeration vessel in some cases is presented in cubic feet and correct transformation of dimensions is required from calculation of 1 cubic foot, which corresponds to 0.02832 cubic ms.

By the formula of statistical regression the value of the dry–cargo refrigeration vessel with the account the vessel age *t* =……. years when using the holds volumes *W*, occupied with cargo, as the unit of comparison on _____ _____, 20___ is equal

$$MV = 0.01694 \times W^{1.255} \times e^{-0.00011 \times W} \times ((1+0.09)^{50-t} - 1)^{1.044} =$$

$$= 0.01694 \times .....^{1.255} \times e^{-0.00011 \times .....} \times ((1+0.09)^{50-.....} - 1)^{1.044} = .....$$

thousand US dollars.

The average value of the dry–cargo refrigeration vessel when using the comparable sales approach and the marketing researches data on _____ _____, 20___ is equal

*MV* = …… × ½ + …… × ½ = …… thousand US dollars.

An estimation of the dry–cargo refrigeration vessel based on comparable sales approach and use of marketing researches and statistical regressions is calculation by the uniform database with the assumption about the equal importance of applied units influence for the vessel value.

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Michael V.Voyloshnikov

# EVALUATION OF THE COMMERCIAL VESSELS, THE MARINE COMPANY'S ASSETS AND THE OCEAN RESOURCES

The textbook