

**REPUBLIC OF AZERBAIJAN**

*Published as a manuscript*

**ABSTRACT**

of the dissertation for the degree of doctor of philosophy

**SCIENTIFIC BASES OF DESIGN OF SUBSEA  
CONSTRUCTION VESSEL IMPROVEMENT**

Specialty: 3319.03 – Shipbuilding and ship repair technology

Branch of science: of technical science

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**Baku – 2025**

The work was performed at Azerbaijan State Marine Academy

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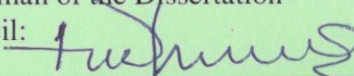
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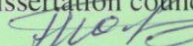
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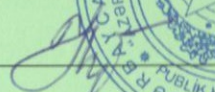
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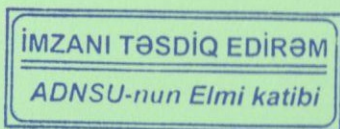


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## WORK GENERAL CHARACTERISTIC

**Timeliness of the topic.** Currently, the actively developing industry for the development of offshore oil fields poses new challenges for designers of ships and floating equipment. In the process of development of the sea shelf, the volume of subsea works is growing.

Therefore, the improvement of scientific bases and methods of the design of vessels, including subsea construction vessels (SCV) acquires special relevance. At the same time, an improvement in design methods promotes an increase in seaworthiness and increase in the service life of specialized vessels and floating facilities.

Improvement of the scientific bases of the design of SCV provides a systematization of the interrelation between the dimensions and design features, assessment of operating parameters, technology equipment installed, diving systems, and hardware with the main dimension of the designed vessel and also the comparative analysis of working characteristics of SCV and special Vessels.

Improvement of the design of SCV includes establishing the nature of the influence of the main dimension and weight load on the speed of the vessel, changes and assessment of the weight loading using the database of similar vessels.

The consistent patterns of change of the main dimensions, the relationship between the width of the SCV with the dimension of the propulsion plant, the parameters of cargo gears and davits, and also interrelation of the sizes of the vessel, taking into account the risk analysis and design restrictions have to be determined.

At the same time, it is necessary to systematize methods of formation of the standard shape of the vessel, structural elements, and the surfaces of the hull using zoning of compartments and determining the seaworthy characteristics of SCV.

Important tasks are also the formation of an algorithm for the process of the automated design taking into account the criteria of efficiency of optimization, in interrelation with the established technological complexes and hardware, and the development of the

nomogram for determining the main dimension in the early design stages of SCV.

The presented dissertation is also directed to the solution of these questions and therefore the subject is relevant and has great scientific and practical value.

**Degree of development of the research topic.** Certain issues of ship design, which mainly concern the assessment of technical compatibility and partial optimization of ship subsystems, have been considered throughout the modern history of shipbuilding. At the same time, the corresponding design tasks were relatively simple due to the relatively weak technical interconnection of the ship subsystems.

After the emergence of tools such as CAD, the systematic approach to the design of vessels significantly extended. A systematic approach to design ensures the optimization of the technical elements of ships as a single system vessel - technological equipment - technological operation, which requires the development of new and improvement of existing design methods.

One of the directions of the system approach to the design of vessels is the method of using the database of relative vessels. The method of using the database is applied generally in cases when inadmissibly the use of a close prototype is impossible and the vessels being designed are technically and technologically complex.

In ship-building, scientific and technical literature on the specified issues are covered relatively little and therefore this subject is little researched. The method of the database can reflect most precisely the construction opportunities of the vessel in the early stages of the design.

**Object and subject of research.** The object of the dissertation research is methods and means of improving the design of subsea construction vessel.

**Object of research** is to improve the methods of the design of subsea construction vessel with the use of the database of relative vessels.

**Purpose and objectives of the research.** The purpose of dissertation work is to improve the scientific bases of designing of

vessels for subsea operation, with the use of the database of relative vessels.

**The main objectives** of the dissertation are:

- establishing patterns of changes in the main dimensions of the vessel, taking into account the characteristics of technological equipment, diving systems and hardware providing subsea technology equipment;
- improvement of design methods of support vessels of subsea-technical operation on the basis of the database of similar vessels;
- defining the main dimension of the perspective vessel by the system optimized method of the automated design taking into account the estimated risk analysis and design limitations;
- formation of preliminary standard shape and dimensions of subsea construction vessel;
- development of an algorithm for improvement of the design of the subsea construction vessel
- development of scientifically based proposals and recommendations for presentation to the shipbuilding design organizations.

**Research methods.** In dissertation work modern theoretical and applied methods of scientific research are applied: analysis and synthesis, induction and deduction, measurement and calculation, numerical experiment, mathematical, physical and computer modeling, etc.

The values of parameters of similar vessels close to the research vessels are presented in the graphs prepared in MS Excel software. The approximation of graphical results is performed by method of the regression analysis.

Development of standard shape, formation of the surface and calculation of seaworthiness characteristics of subsea construction vessel are carried out using the Delfship software.

### **Basic provisions submitted for the defense:**

1. Systematization of the interrelation between the dimensions and operating parameters of the technology equipment and apparatus with the main dimension of the designed vessel.
2. Results of comparative analysis of subsea construction vessels with specialized diving vessels and vessels carrying apparatus equipment.
3. Patterns of changes of weight loading and main dimension, the interrelations between the width of the vessel and the dimension of the propulsion plant, parameters of cargo gears and davits and as well as the characteristics of diving system and apparatus equipment.
4. Systematization of design features of subsea construction vessel with the use of the database of similar vessels. The developed algorithm of design and a problem of optimization of subsea construction vessel.
5. Implementation of the principles of system approach to design and new classification of subsea construction vessel.
6. Method of selecting the main dimension taking into account the estimate risks and design limitations of subsea construction vessel at early design stages.

**Scientific novelty.** The scientific novelty of the work in a **concept plan** lies in improvement of a system optimized method of design with the use of the database of similar vessels, taking into account the estimated technical characteristics of apparatus equipment, technology and diving equipment for subsea operation.

#### **Have scientific novelty:**

- development of an algorithm for the automated design of vessels for subsea operation;
- the selection of criteria of efficiency for the solution of the problem of optimization of the process of design of subsea construction vessel;
- establishment of interrelation between the characteristics of a technology equipment, diving equipment and apparatus

equipment with the main dimensions of subsea construction vessel;

- development of the nomogram for selection of the main dimensions of vessels at the early design stages, taking into account the estimated design features of the vessel and parameters of technology equipment.

**Practical significance of the work.** The practical value of the research is determined by the applied orientation and relevance of the development. The complex and many-sided task of designing of vessels for subsea operation is solved by systematic approach that helps in improvement of the quality of design and ensures the competitiveness of vessels. Results of the research are used in the development of technical specifications for the design of new types of vessels for subsea operation.

**Degree of reliability of work results.** The reliability of the obtained results from the algorithm is confirmed by comparison of values of the database of similar vessels.

**Approbation of work.** The results of work on its main sections were reported at scientific seminars of department and also at regional and international conferences. Practical developments are introduced in the companies which are involved in design of the similar vessels and operations of their equipment.

Materials of the thesis were reported, discussed and approved at the following international conferences:

- Конференция по строительной механике корабля, посвященная памяти профессора В.А.Постнова и 90-летию со дня его рождения, - Санкт-Петербург: - 13 – 14 декабря 2017.
- XVII International scientific-technical conference on “Water Transport Problems”, - Баку: - 05 – 06 май, 2022.
- XIV international scientific-technical conference “Innovation in Shipbuilding & Ocean technical”, - Nikolayev: - 20-21.09.2023.
- 2<sup>nd</sup> international scientific-practical conference “Machine Building and Energy: New Concepts and Technologies”, -Баку: АЗТУ, 23-24 ноябрь, 2023.

- XIX International scientific-technical conference on “Water Transport Problems”, - Баку: - 02 – 03 май – 2024.
- 2<sup>nd</sup> international scientific and technical conference “Infocommunication Systems and Artificial Intelligence Technologies” (ICSAIT 2024), - Baku 2024.
- XX International scientific-technical conference on “Water Transport Problems”, - Баку: - 01 – 02 may – 2025.

**The name of the organization where dissertation work was performed.** Dissertation work was performed at the Azerbaijan State Marine Academy at the department of "Shipbuilding and ship repair".

**Personal contribution of the Degree candidate in the conducted researches.** In the dissertation work on justification of relevance, the selection of methods of the research, theoretical and experimental research, generalizations and systematization of results were directly executed by the Degree candidate.

**Structure and volume of work.** Dissertation work consists of an introduction, five chapters, the conclusion, the list of the used literature including 125 chapters and four appendices.

Work is presented on 174 pages of the computer text, contains 38 drawings, 56 graphs and 11 tables. Chapter 1 consists of 37603, Chapter 2 consists of 18501, Chapter 3 consists of 20406, Chapter 4 consists of 31194, Chapter 5 consists of 18384 characters. The total amount of work consists of 161452 characters.

**Publications.** The main results of the thesis were received by the author and rather fully published in 13 articles, 5 materials of conferences and 3 theses.

## **MAIN CONTENT OF WORK**

**In introduction,** the relevance of the thesis is proved. The degree of development of the topic is outlined and the relatively little knowledge of the scientific foundations and methods of design of vessels are stated. Subsea construction vessels were selected as the object of research.

The purpose and objectives of the thesis are created: the main objective is to the improvement of the design of the subsea construction vessel with use of the database of similar vessels.

**In chapter 1** The features of the existing vessels performing subsea operation are considered. All types of vessel ensuring subsea operation are analyzed such as: diving vessels, remote operated vehicle (ROV) support vessel and autonomous underwater vehicles (AUV) support vessel, also manned submersibles (MS) support vessel. The performance characteristics and technological capabilities of the indicated types of vessels are outlined.

The stationary and mobile technological equipment, apparatus facility and complexes applied on vessels which supports the subsea and technical works are considered. Characteristics of mobile technology equipment, including the deep-water diving systems installed on the open deck, diving systems and apparatus facility of container execution, mobile drilling, pipe laying and cable laying systems are stated [1, 2]<sup>1, 2</sup>.

The option of arrangement of a stationary deep-water diving system on the vessel has been considered. Apparatus facility are characterized and its classification are given, the alternative scheme of joint arrangement of a stationary deep-water diving system and

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1. Баширов Р.Д. Системный анализ и критерии оптимизации технологического оборудования многоцелевого судна с краном грузоподъемностью 300т / О.М.Абдуллаев // Морской вестник, - Санкт Петербург: - 2015. №2, - с. 20.
  2. Баширов Р.Д. Системный анализ и обобщенные критерии оптимизации многоцелевого кранового судна грузоподъемностью крана 300т / О.М.Абдуллаев, Р.А.Керимли // Proceedings of Azerbaijan State Marine Academy, - Баку: - 2015. №2, - с.13 – 16.

apparatus facility on subsea construction vessel is submitted [4, 5]<sup>4,5</sup>.

The existing approaches to design of subsea construction vessel are considered and the review of publications on the studied subject is executed. The development of methods and stages of ship design is analyzed. The development direction of design methods of vessels with the use of information technologies are stated in detail. It is indicated that the application of systems analysis methods leads to the development of modern CAD systems in the design of vessels [11]<sup>11</sup>.

As a result of carried out in the 1st chapter of researches the block diagram of an object of a research and preliminary mathematic model (formulas 1 - 3) expressed by the function (4) is created [3, 6]<sup>3,6</sup>:

$$A = A (W, M, R, P), \quad (1)$$

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4. Егоров Г.В., Мустафаев В.О., Абдуллаев О.М. Особенности проектирования водолазных судов для Каспийского моря // Конференция по строительной механике корабля, посвященная памяти профессора В.А.Постнова и 90-летию со дня его рождения, - Санкт-Петербург: - 13 – 14 декабря 2017. – с.168.
  5. Егоров Г.В., Абдуллаев О.М. Принципы проектирования малых судов обеспечения для Каспийского моря // Конференция по строительной механике корабля, посвященная памяти профессора В.А.Постнова и 90-летию со дня его рождения, - Санкт-Петербург: - 13 – 14 декабря 2017. – с.169.
  3. Абдуллаев О.М. Оптимизация характеристик технологического оборудования многоцелевого кранового судна грузоподъемностью крана 300т // - Астрахань: Вестник Астраханского Государственного Технического Университета. Серия: Морская Техника и технология, - 2016. №1, - с. 7 – 11.
  6. Абдуллаев О.М., Садыгов В.Б. Перспективы совершенствования научных основ проектирования судов обеспечения подводно-технических работ // XVII International scientific-technical conferece on “Water Transport Problems”, - Баку: - 05 – 06 май – 2022. – с.10 – 12.
  11. Egorov A.G., Abdullayev O.M. About design of subsea construction vessels of new generation // XIV international scientific-technical conference “Innovation in Shipbuilding & Ocean technical”, - Nikolayev: - 20-21.09.2023. – с.10 – 11.

here W – set which elements and also their associations are the factors of the external environment operating on the projected system;  
M – the set including the components and (or) their associations forming a system;  
R – set which represents the relation (compliance) between components of the projected system and also between a system with its components and the external environment;  
P – the set including the property of a system determined by properties of elements of sets W, M, R. This set can also be characterized as "Design features of the designed vessel" and to consider as a set of transfer functions as properties appear in a system as result of association of its components.

$$P = f(C_{div.}, C_{ROV}, C_{AUV}, C_{MS}, C_{T.E.}), \quad (2)$$

here P – design features of the designed vessel;

$C_{div.}$  – function of the diving complex installed on the vessel;

$C_{ROV}$  – function of the remotely operation vehicle installed on the vessel;

$C_{AUV}$  – function of the autonomous underwater vehicle installed on the vessel;

$C_{MS}$  – function of the manned submersible installed on the vessel;

$C_{T.E.}$  – function of the mobile technology equipment installed on the vessel.

$$A = f(P). \quad (3)$$

$$U_{T.O.} = f(U_{T.Y.}, U_{K.Y.}, U_{B.K.}, U_{A.C.}, ), \quad (4)$$

here  $U_{T.Y.}$  – conditional characteristics of the pipe-laying equipment;

$U_{K.Y.}$  – conditional characteristics of the cable-laying equipment;

$U_{B.K.}$  – conditional characteristics of the diving complex;

$U_{A.C.}$  – conditional characteristics of the apparatus facility (ROV/AUV).

**Chapter 2** is devoted to the analysis of functions of support vessels of subsea operations taking into account the parameters of technological equipment and assessment of their influence on the sizes and technical characteristics of the vessel. Influences of the lifting equipment are considered, values of the database of similar vessels are compared to calculate values, the dependence of crane loading capacity on width of the vessel and depth of the hook's immersion on the vessel width [7, 19]<sup>7, 19</sup>.

Influences of the diving equipment are considered, values of the database of similar vessels and estimated results are compared. The dependences of the divers' immersion depth on the width of the vessel, the crane's lifting capacity and the divers' immersion depth were stated.

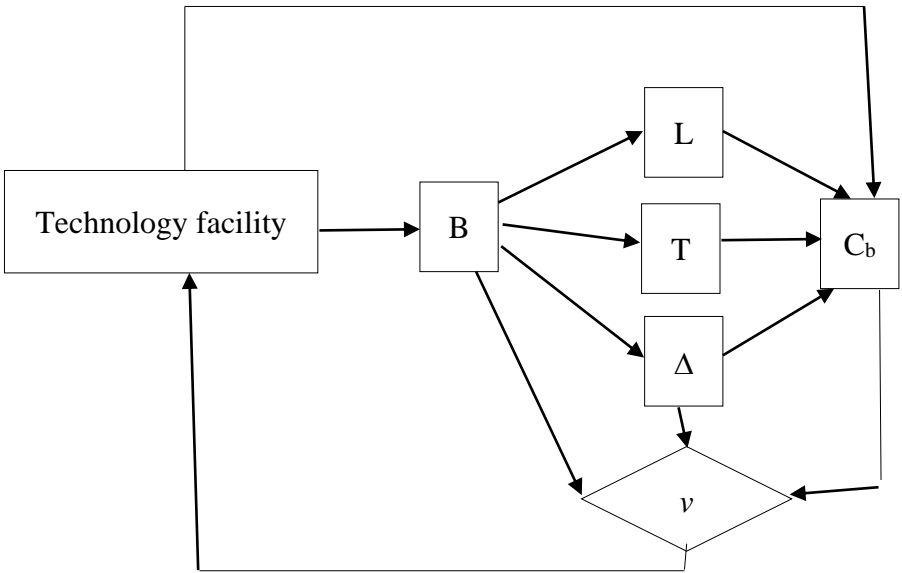
Dependences of depth of immersion of apparatus facility and width of the vessel, depth of immersion of apparatus facility with a loading capacity of the crane and depth of immersion MS are similarly received from width of the vessel and MS support vessel displacement from vessel width. Values of the database of similar vessels and the calculated results of the dependence of the cargo deck area on the width and length of the vessel on the cargo deck area are compared [7]<sup>7</sup>.

Settlement models of dependence of width of the vessel on the sizes of technology equipment, apparatus facility and diving complex were received. The dependences of the main dimensions on the technological means installed on the vessel have been constructed, which is represented by the block diagram fig. 1.

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7. Абдуллаев О.М. Анализ функций судна обеспечения подводно-технических работ с учетом технологического оборудования и оценка влияния на размеры и технические характеристики судна // - Баку: Proceedings of Azerbaijan State Marine Academy, - 2023. №1(37), - с.11 – 21.

19. Bashirov R.D., Abdullayev O.M., Abdullayev R.O. The System Analysis and Mathematical Model of the Subsea Construction Vessels // Baku: Herald of the Azerbaijan Engineering Academy, - 2025. #17(2), pp. 73 – 82.



**Fig. 1. The block diagram of dependence of the main dimensions on the technological means established on the vessel**

In fig. 1 designated:

L – vessel length (it is formed of L/B ratio);

B – vessel width;

T – draft (it is formed of B/T ratio);

Δ – displacement (it is formed of B/D ratio);

v – vessel speed;

C<sub>b</sub> – the vessel block coefficient.

Results of comparative analysis of subsea construction vessel with specialized diving vessels and vessels as apparatus facility support vessels in tab.1.

**Tables 1**

**Comparative analysis of subsea construction vessel with specialized diving vessels and apparatus facility support vessels [7]<sup>7</sup>**

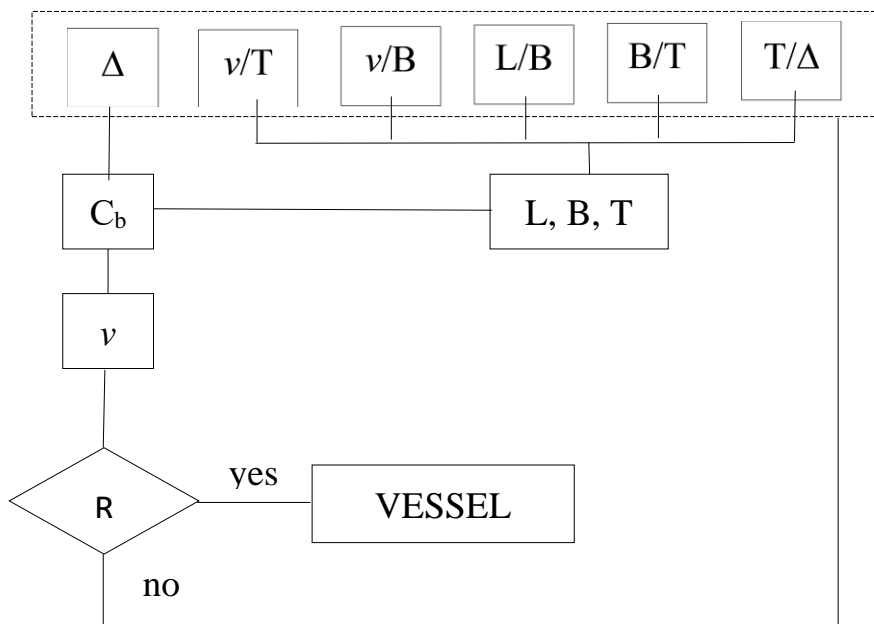
<b>Subsea construction vessel</b>	<b>Specialized diving vessels &amp; vessels of support apparatus facility</b>
The working platform with cargo deck	Existence the stationary diving complex
Existence of universal lifting gears	Existence the stationary apparatus facility
Cargo crane with submersible hook	The maximum adaptation of the installed apparatus facility or diving complex with the support vessel
Accommodations for service crew	
Possibility of installation of mobile technology equipment, apparatus facility & diving complex	Possibility of performance of transitions to any point of the World Ocean for operation on various projects
Flexibility at adaptation to the specific project	

**In a chapter 3** design limitations of operations and the main characteristics of subsea construction vessel are analyzed. The influence of the main dimensions and weight load on the speed of the vessel has been established. The block diagram (fig. 2) and criterion function of influence of the main dimension (formula 5) on vessel speed is made [8]<sup>8</sup>.

The values of the database of similar vessels were compared with the calculated values for the draft and width of the vessel for speed. Based on the dependencies, a mathematical expression describing the graphs was formed (formula 6) [8]<sup>8</sup>.

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8. Egorov A.G. Risk-based analysis of operational design restrictions and main design characteristics of subsea construction VESSELS / O.M.Abdullayev // Вестник Одесского Национального Университета – Одесса: - 2023. №1(68), - с.7 – 26.



**Fig. 2. Structural diagram of the influence of the main dimensions on the speed of the vessel**

$$v = Rf(\Delta, L, B, T), \quad (5)$$

here  $v$  – vessel speed;

$L, B, T$  – main dimension the designing vessel;

$R$  – identification risk the designing vessel;

$\Delta$  – displacement.

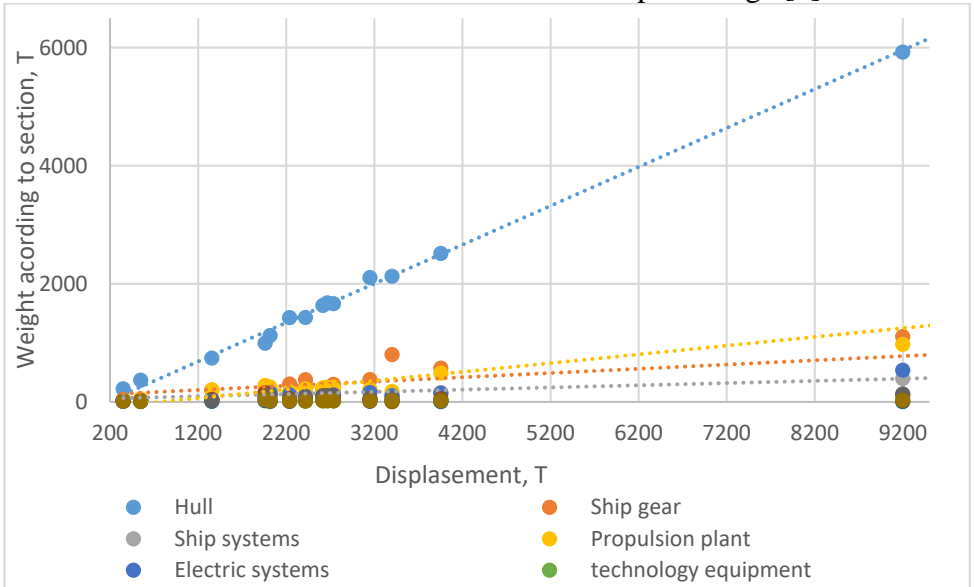
Risk analysis for operation of support vessels of underwater and technical works were carried out. Within the analysis the identification and the description of risks were considered, sources of risks were defined and the system of actions for anticipatory risks are developed [8, 20]<sup>8, 20</sup>.

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20. Abdullayev O.M. Risk analysis in the initial design phase of subsea construction vessels // - Бақы: Proceedings of Azerbaijan state marine academy, - 2025. №1, – с. 30 – 37.

The patterns of changes in the weight load by section and the displacement of the vessel have been established (frame 1) and the mathematical expression describing this regularity (formula 6) is obtained. The characteristic composition of the mass load by section in percentage terms is presented in tabular form, and the formula for calculating the values of the mass load by section of the vessel is presented.

Dependences of loading of masses according to sections from vessel displacement are compared using the database of similar vessels and the calculated maximum/minimum values in percentage [8]<sup>8</sup>.



**Graph 1. Dependence of loading of weight according to sections from the displacement of specialized vessels**

$$M_i = b * \Delta - M_i / \Delta, \quad (6)$$

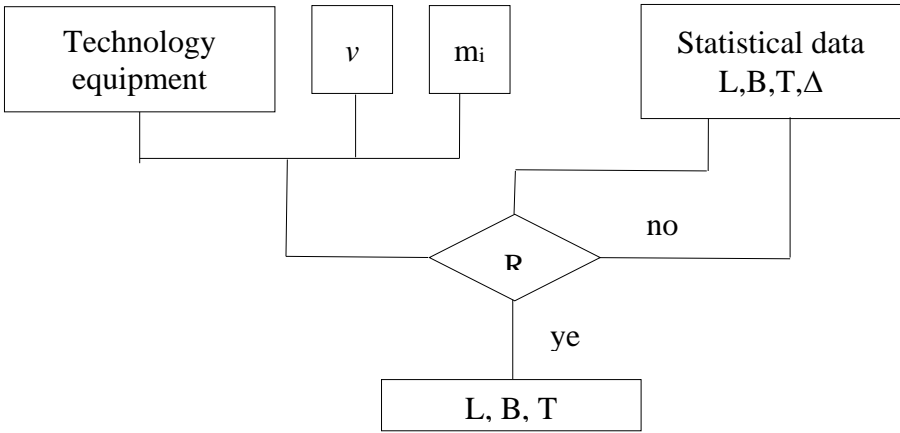
here  $M_i$  – weight according to section ( $m_H, m_{S.G.}, m_S, m_{P.P}, m_E, m_T, m_{S.P.}, m_{D.S.}, m_{L.L}, m_E.$ );

$m_H$  – hull weight;  
 $m_{S.G.}$  – ship gear weight;  
 $m_S$  – ship system weight;  
 $m_{P.P.}$  – propulsion plant weight;  
 $m_E$  – electrical system weight;  
 $m_T$  – technology equipment weight;  
 $m_{S.P.}$  – spare parts weight;  
 $m_{D.S.}$  – displacement stock;  
 $m_{L.L.}$  – liquid Lloyd weight;  
 $m_{E.}$  – equipment weight;  
 $\Delta$  – displacement.

The patterns of changes in the main dimensions and coefficients of completeness of the vessel are defined. The values of the database of similar vessels and the calculated values of width/length, width/draught and draft/displacement of subsea construction vessel, are compared by the described, corresponding mathematical expression [8]<sup>8</sup>.

The graphic model of formation of coefficient of the general completeness described by criterion function and mathematical expression is constructed.

Formations of overall dimensions of subsea construction vessel is presented in the block diagram (fig. 3). It has been established that the influences of factors of processing equipment, vessel speed and characteristics of weight loading is described by linear function. Defined possible minimum and maximum ratios of the main dimension of SCV [8]<sup>8</sup>.



**Fig. 3. Structural diagram of formation of overall dimensions of SCV**

**Chapter 4** is devoted to the development of an algorithm of automated design of subsea construction vessel. As an algorithm component, formation of dimensions of propulsion plant is considered, the criterion function reflecting the power of the main propulsion plant (formula 7) is received [9]<sup>9</sup>:

$$N_{M.P.P.} = f(N_{P.C.}, N_{T.E.}, N_{S.C.}). \quad (7)$$

here  $N_{M.P.P.}$  – power of main propulsion plant;

$N_{P.C.}$  – power of propulsion complex;

$N_{T.E.}$  – power of technology equipment;

$N_{S.C.}$  – power of ship consumer.

The influence of the parameters of the power plant on the main dimensions of the vessel, reflected in the structural model, has been established. Mathematical expressions for determination of width of the engine room, volumes of stocks of the propulsion plant and the sizes of double boards are received.

A formula has been derived that determines the width of the vessel depending on the size of the power plant. The values of the calculated data and database are determined, depending on the power on the number of diesel generators, the total power of diesel generators

on the width of the vessel, the speed of the vessel and the lifting capacity of the main crane on the power of the propulsion complex [9]<sup>9</sup>.

The principles of choosing crane equipment are considered, the main parameters of lifting equipment are systematized. Values of the database of similar vessels and design data obtained on formulas are compared. Dependences of depth of immersion of a hook, deep-water loading capacity of the crane, the boom radius with a loading capacity of the crane and a crane cargo capacity are received from vessel displacement [9]<sup>9</sup>.

The structure and dimensions of a mobile diving complex and mobile deep-water diving complex of modular type is defined. In the block diagram necessary construction features of SCV for functioning of a diving complex are systematized. The settlement formula for determination of the area of the cargo deck of a mobile diving complex, necessary for installation, on the vessel is received [9]<sup>9</sup>.

The block diagram in which necessary construction features of SCV for functioning of apparatus facility (ROV/AUV) are generalized is constructed. Structures of equipment of stationary and mobile complex and also apparatus facility are defined. The formula of calculation of the necessary area of the cargo deck for installation of apparatus facility is derived. Dependences of values of the database and design data of depth of a submersible of apparatus facility on vessel width are constructed.

The block diagram in which need design features for functioning of the manned submersibles (MS) are systematized is made. Values of the database and design data of depth of immersion of MS, and displacement of the vessel of the MS support from vessel width are compared.

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9. Абдуллаев О.М. Метод формирования элементов алгоритма проектирования судна обеспечения подводно-технических работ с использованием базы данных однотипных судов // - Санкт Петербург: Вестник Государственного Университета Морского и Речного Флота им. С.О. Макарова, - 2023. Том15, №4, – с. 680 – 691.

Dimensions of the perspective mobile technology equipment installed on the vessel are defined. In the block diagram of a systematized design features of vessels for installation of mobile technology equipment.

Graphs of comparison of values of design data and the database of the area of the cargo deck and width of the vessel, the area of the cargo deck and length of the vessel, the area of the moon pool and width of the vessel are provided. The considered frame is described by mathematical expression (8):

$$\alpha_i = b * S - \alpha_i / S \quad (8)$$

here  $\alpha_i$  – the generalized parameter

$(n, B_{P.P.}, v_{P.P.}, N, G_{S.C.}, L_B, \Delta, S_{M.P.})$ ;

$n$  – the number of the installed diesel generators;

$B_{P.P.}$  – the vessel width depending on the power of a propulsion plant;

$v_{P.P.}$  – the vessel speed, depending on the power of a propulsion plant;

$N$  – power of propulsion plant;

$G_{S.C.}$  – cargo capacity the submersible hook;

$L_B$  – crane boom reach;

$\Delta$  – displacement;

$S_{M.P.}$  – moon pool square;

$S$  – dimension parameters  $(N, G, N_P, d_{H.S.}, S_{C.D.}, D_{S.D.})$ ;

$G$  – crane cargo capacity;

$N_P$  – power of propulsion complex;

$d_{H.S.}$  – hook submersible deep;

$D_{S.D.}$  – apparatus facility submersible deep;

$S_{C.D.}$  – cargo deck square;

$\alpha_i / S$  – ratios of the studied and measured parameters, determined on a formula (9):

$b$  – correlation coefficient, the considering regularity of in question ratios determined by a formula (10):

$$\alpha_i/S = \sum_{i=1}^n \bar{\alpha}_i - b * \sum_{i=1}^n S_i \quad (9)$$

$$b = \frac{\sum_{i=1}^n (S - \bar{S}_i)(\alpha - \bar{\alpha}_i)}{\sqrt{\sum_{i=1}^n (S - \bar{S}_i)^2 \sum_{i=1}^n (\alpha - \bar{\alpha}_i)^2}} \quad (10)$$

Improved method of formation of shape of the perspective vessel by means of configuration of the vessel and by zoning of rooms, specified in the block diagram.

It is proposed to make formation of a surface of SCV in accordance with criterion function of cross metacentric height and effective power of the main engines. Group of shell of subsea construction vessel are developed and addition of effective power of the main engines from vessel speed, cross metacentric height from draft are constructed, [10]<sup>10</sup>.

The mathematical model for formation of the weight load according to sections of the vessel is received. The formula for determination of value of loading of masses according to sections with use of values of the database of similar vessels is derived. The method of the choice of the main dimension and the flowchart of calculation of the main dimension of the designed vessel is developed [10]<sup>10</sup>.

Efficiency criteria for optimizing the main dimensions have been determined, and a graphical model of the interaction between optimization criteria and variable elements has been developed. Functions for optimizing the width and draft of the vessel were developed, and on their basis a mathematical model for optimizing the width and draft of the vessel was obtained.

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10. Лебедева М.П. Алгоритм проектирования судов обеспечения подводно-технических работ методом базы данных / О.М.Абдуллаев // Научные проблемы водного транспорта. Волжский Государственный Университет Водного Транспорта, - Нижний Новгород: - 2023. №76(3) – с. 32 – 49.

**In a chapter 5** discusses the implementation of the methodology for selecting the main dimensions of the designed vessel and assessing the running, maneuvering and seaworthiness. In the block diagram vessels, performing SCV with use of apparatus facility and complexes are systematized.

Optimization of structures of the equipment of a perspective vessels, mobile technological facility and complexes is performed and presented in the block diagram. New classification of subsea construction vessels taking into account the established apparatus facility and complexes is made.

The principles of improvement of the choice of the main dimensions and assessment of seaworthy qualities of the perspective vessel are considered. The nomogram (graph 2) is developed for definition of the main dimension of the projected vessels on the basis of data on the loading capacity of the crane, depth of immersion of a hook and divers and also ROV/AUV, MS and the required area of the cargo deck [12]<sup>12</sup>.

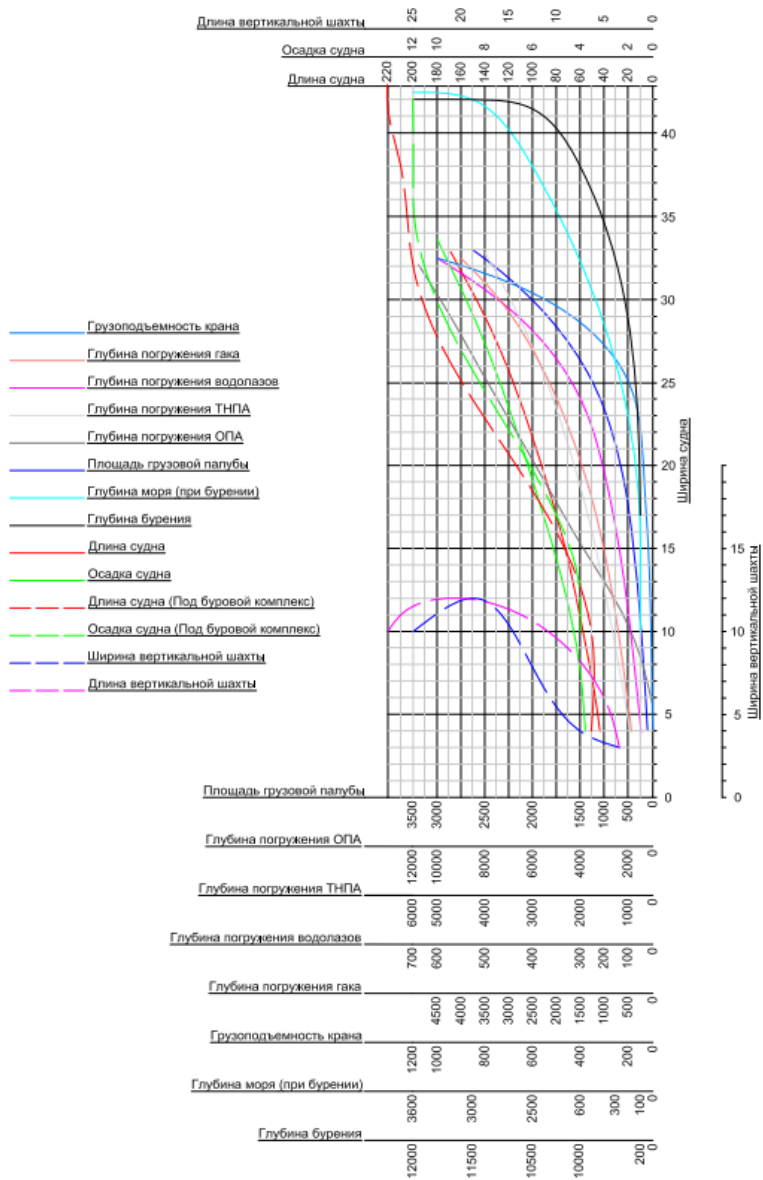
Preliminary economic estimate, the analysis of result of a research and search of an optimal solution is executed. The made diagram model allows to systematize the analysis of results and search of optimal design solutions. Assessment of scientific, technology and economic effects of a research with the received index - **7.75** is made. The expected technical and economic effect of developed design decisions is calculated.

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12. Bashirov R.D., Abdullayev O.M. Classification of subsea construction vessels and evaluation of study effectiveness // 2<sup>nd</sup> international scientific-practical conference “Machine Building and Energy: New Concepts and Technologies”, - Baku 2024. Vol. 148. – pp. 217 – 223.

With use of the developed nomogram a 3D model is presented for the perspective subsea construction vessel for use to water areas of the Caspian Sea (fig. 4) and a general view (fig. 5) of the perspective vessel. The main technical characteristics of the designed perspective SCV are presented in table 2, [12, 13, 14]<sup>12, 13, 14</sup>.

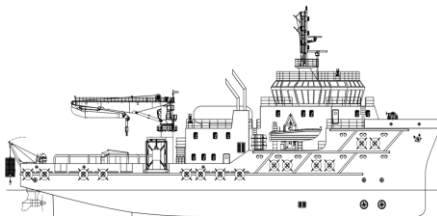
- 
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  14. Abdullayev O.M. Model for selecting and analyzing the influence of lifting gears on the main dimensions of subsea construction vessel // Odesa: Herald of the Odesa National Maritime University, - 2024. №3(74), - pp. 7 – 18.



**Graph 2. The nomogram for determination of width of the subsea construction vessel [15, 16, 17, 18, 21]<sup>15,16,17,18</sup> (See page 26).**



**Fig. 4. 3D-model of perspective SCV**



**Fig. 5. General view of perspective SCV**

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15. Абдуллаев О.М., Абдуллаев Р.О. Разработка номограммы выбора главных размерений судов обеспечения подводно-технических работ // XIX International scientific-technical conferece on “Water Transport Problems”, - Баку: - 02 – 03 май – 2024. – с.15 – 17.
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  21. Egorov A.G., Abdullayev O.M., Rzayev R.E., Hajinskiy H.M. Creation of mathematic model of definition of main dimension of subsea construction vessel of new generation: influence of pipe-laying equipment // Odesa: Heraldof the Odesa National Maritime Uneversity, - 2025. №2(76), - pp. 10 – 32.

**Table 2****Technical data the SCV**

<b>Name</b>	<b>Dimension</b>
Length overall, m	53.6
Length perpendiculars, m	50.0
Beam, m	16.0
Load draft, m	3.0
Maximum displacement, t	1600.0
Cargo deck square, m <sup>2</sup>	170.0
Speed, knots	12.0
Power of propulsion plant, kW	3x1200
Cargo crane, t	50.0

The photo (fig. 6) of the supply boat developed with the use of the methods developed in the real work is also presented. The main technical characteristics of the built supply boat are given in table 3.

**fig. 6. Photo of the built boat**

**Table 3****Main technical data of the support boat of 1547 project**

<b>Name</b>	<b>Dimension</b>
Length overall, m	26.0
Length perpendiculars, m	25.0
Beam, m	6.6
Load draft, m	1.6
Maximum displacement, t	107.0
Cargo deck square, m <sup>2</sup>	50.0
Speed, knots	9.0
Power of propulsion plant, kW	300
Cargo crane, t	0.98

Thus, the comparative analysis of subsea construction vessel with specialized vessels and the vessels of apparatus facility confirmed efficiency and expediency of an improvement of design methods of SCV.

The perspective directions of further researches on improvement of bases of design of SCV are specified. Therefore, the hypothesis of scientific research has been confirmed, the goal and objectives of the dissertation work to improve the scientific foundations of design of SCV have been achieved.

### **CONCLUSION**

Within research and development executed in the present thesis the following scientific and practical results are received:

1. On the basis of the system analysis interrelations of overall dimensions and operating parameters of technology equipment, diving systems and apparatus facility with the main dimension of the designed vessel are established.
2. Based on the results of a comparative analysis of technical characteristics and functionality, important design features of subsea construction vessel, specialized diving vessel and vessels of support of apparatus facility were identified.

3. Using a database of similar vessels, the nature of the influence of the main dimensions and weight load in sections on the speed of the designed vessel was established.
4. Based on risk analysis taking into account design limitations, - methods of risk theory and system-optimized design of SCV were synthesized. Using a database of vessels similar in purpose, patterns of changes in the weight load depending on the speed of the vessel were established.
5. The nature of changes of the main dimension of the designed vessel is revealed and the dependence of width of the vessel on overall dimensions of the propulsion plant is established. Dependences of parameters of cargo and lifting gear on the main dimension of the vessel are established. Design features of vessels taking into account parameters of diving systems and apparatus facility are defined.
6. Methods of formation of structural elements and appearance of SCV when using mobile technological complex taking into account the surface of the hull and zoning of rooms are developed.
7. An automated design algorithm has been compiled using a database of similar vessel, and efficiency criteria have been established for solving the problem of optimizing the design process of SCV.
8. New classification of SCV taking into account the installed technology equipment, a diving complex and apparatus facility is offered.
9. The nomogram is developed for definition of the main dimension of SCV at early design stages, taking into account design features and parameters of technology equipment, diving system and apparatus facility.
10. Preliminary estimate of scientific, technical and economy efficiency of technical and technological developments is executed and the perspective directions of further researches on implementation of the bases of design of SCV are specified.

**The main results of the dissertation are published in the following works:**

1. Баширов Р.Д. Системный анализ и критерии оптимизации технологического оборудования многоцелевого судна с краном грузоподъемностью 300т / О.М.Абдуллаев // Морской вестник, - Санкт Петербург: - 2015. №2, - с. 20.
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**The personal contribution made by the degree candidate  
in the works published in co-authorship:**

1. Works [3, 7, 9, 13, 14, 18, 20] as the author are executed independently without co-authorship.
2. In works [1, 2, 4, 5, 6, 8, 10, 11, 12, 15, 16, 17, 19, 21] statement of tasks and carrying out experiments are executed by the applicant, and processing of results of researches and preparation of articles for the publication are executed together with coauthors.




The defense will be held on **24 october 2025** years at **14:00** at the meeting of the Dissertation council BFD2.02 of Supreme Attestation Commission under the President of the Republik Azerbaijan operating at Azerbaijan State Oil and Industry University.

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Signed for print: 08. 09. 2025 year

Paper format: A5

Volume: 37818 numbers

Number of hard copies: 20