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THE FORMATION OF THE SHIPBUILDING 4.0 TECHNOLOGICAL PLATFORM IN UKRAINE

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INTRODUCTION

The shipbuilding industry is one of the key spheres of the economy of any country, including Ukraine. Currently, domestic in our country needs reforming[1,2,3]. Solving the problem of creating an industry that is modern in terms of its technical, technological and economic indicators can be carried out due to the comprehensive development and implementation of new economic models, the latest technologies, the creation of appropriate institutional conditions, etc. Development and implementation of relevant programs and projects that will ensure effective functioning and subsequently provide competitive advantages to domestic enterprises on world shipbuilding markets should be considered the basis of the restoration of the shipbuilding industry in Ukraine.

1. Emergence of prerequisites of the problem and its formulation

A historical review proves that at the end of the 80s of the last century, the shipbuilding industry of Ukraine was one of the most developed in the world and, in terms of its technical and technological potential, met the most modern requirements of that period. This can be evidenced by the volumes (Fig. 1) and composition of shipbuilding products of individual shipbuilding enterprises[4].

[1] Борщ В. Стан та проблеми розвитку підприємств суднобудівельної галузі промисловості України. Економіка: реалії часу. 2014. № 3(13). С. 22-29.

[2] Лисенко С. Суднобудівна галузь України: проблеми та напрями її відродження. Економічний вісник НТУУ «КПІ». 2015. № 12. С. 139-145

[3] Стратегія розвитку суднобудівної промисловості України на період до 2030 року URL: https://www.ukrinform.ua/rubric-presshall/ 3322914-strategia-rozvitku-sudnobudivnoi-promislovosti-ukraini-na-period-do-2030-roku.html.

[4] Судостроение. Судоремонт. Металлоконструкции. URL: https://ocean shipyard.com/ru/

However, during the time of independence, the shipbuilding industry of Ukraine underwent significant changes, and currently its improvements do not satisfy the strategic interests of the state[5,6] (Tab. 1, Fig. 2).

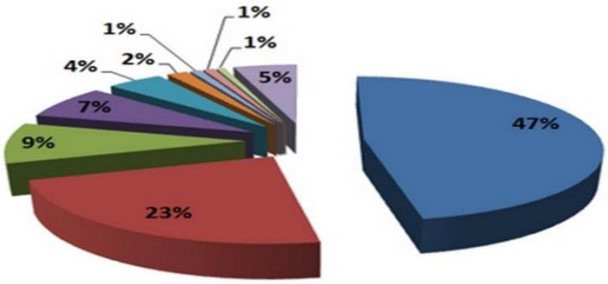

Figure 1. Volumes of shipbuilding products created by the «Ocean» shipyard: bulk carriers – 88 units, 2,950,847 DWT, 47%; tankers – 16 units, 1,210,294 DWT, 23%; universal vessels – 23 units, 465,732 DWT, 9%; trawlers – 57 units, 392,524 DWT, 7.45%; container ships – 8 units, 84,400 DWT, 1.6%; offshore vessels – 7 units, 13,401 DWT, 0.25%; Po-Po-type vessels – 2 units, 9,360 DWT, 0.18%; others – 194 units, 337,284 DWT, 6.4%

Table 1

Construction and renovation of ships, 2018-2020

№	Indicator	2018 year	2019 year	2020 year	In 3 years
1	Total ships built, incl.	13	14	18	45
1.1	- for export	1	3	4	8
1.2	- ON THE DOMESTIC MARKET	12	11	14	37
2	RENOVATED (MODERNIZED), INCL	181	282	315	778
2.1	- for export	49	125	134	308
2.2	- DOMESTIC MARKET	132	157	181	470

[5] Аналіз стану суднобудування України у 2020 році від асоціації «Укрсудпром» URL: https://maritimebusinessnews.com.ua/2021/08/ 19/213989/

[6] Аналіз стану суднобудування України у 2020 році URL:https://ua.sudohodstvo.org/analiz-stanu-sudnobuduvannya-ukrayiny-u-2020-roczi.

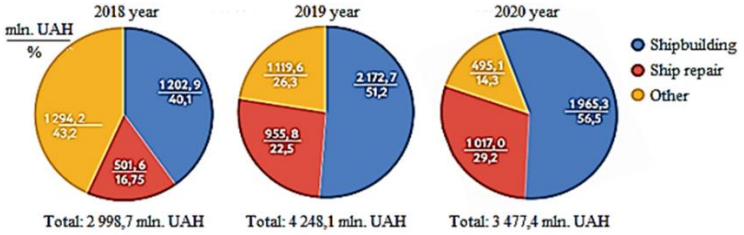

Figure 2. Production structure of shipbuilding enterprises of Ukraine

The unsatisfactory situation in the shipbuilding industry is explained by a number of reasons, the main of which should be considered: an ineffective system of measures regarding the privatization of shipbuilding enterprises; lack of a purposeful state policy to support its functioning; unbalancing of cooperation ties of industry enterprises; shortage of resource base; the professional and qualification crisis, which is caused by the inconsistency of the competences of the employees of enterprises with modern requirements; lack of available financial and human resources, etc.

Among the main unresolved issues that significantly affect the further development of the shipbuilding industry of the state and constitute a corresponding problem is also the issue of regulatory and legislative regulation of its activity.

The analysis of the main existing legislative acts (Tab. 2) showed their imperfection and the need for significant revision[7].

Table 2

Main regulatory and legal documents on issues of ensuring the activities of the shipbuilding industry of Ukraine (1992-2020)

Regulatory and legal support	Purpose of implementation
The period 1992-1994	
CABINET OF MINISTERS OF UKRAINE DECREE dated 4 February 1992, No. 69-r «On measures to improve the financial and economic situation of the Black Sea Shipyard» (Mykolaiv)».	Planning for scrapping and construction of new ships.

[7] Слободян С. О., Харитонов Ю. М. Нормативно-правове забезпечення проєктів та програм впровадження технологічної платформи Shipbuilding 4.0 / Shipbuilding & marine infrastructure. – Вип. 2(14), 2020. – Одеса: видавничий дім «Гелветика». – С. 17-29: DOI https://doi.org/10.15589/smi2020.2(14).2

CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 06.03.1993 No. 405 «On the creation of conditions for the release of ships by the Black Sea Shipyard» (expired on the basis of the CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 09.19.1994 No. 644).	Provision of tax benefits to BSS: – exemption from payment of income tax and mandatory sale of proceeds in currency received for the delivery of ships; – exemption from payment of export and import duty on completed products and materials.
CABINET OF MINISTERS OF UKRAINE DECREE dated 11.05.1994 No. 325r «On the permission of SE «Shipbuilding Plant named after 61 Komunar» to sell ships (expired on the basis of the CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 31.08.2005 No. 832).	Reimbursement of costs for partially completed repair, modernization and maintenance of the large anti-submarine ships «Tashkent» and «Mykolaiv».
The period 1996-1999	
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 17 May 1997 No. 456 «On measures to stabilize the work of shipbuilding enterprises in 1997».	Opening a targeted credit line for financing shipbuilding programs and returning these credit resources and interest for their use to shipbuilding enterprises after the ship is sold to the customer.
DECREE OF THE PRESIDENT OF UKRAINE dated 12 July 1999 No. 813\99 «On measures to ensure the production activity of the SE «Kherson Shipbuilding Plant»«.	Restructuring of the debt of the State Enterprise « Kherson Shipbuilding Plant» to the bank for five years.
LAW OF UKRAINE dated 15.07.1999 No. 965-XIV «On writing off the tax debt of water transport enterprises that arose in connection with the restriction of navigation on the Danube»	Creation of conditions for the stabilization of the financial and economic condition of water transport enterprises, which suffered significant losses in connection with the restriction of navigation on the Danube because of NATO's military actions against the Federal Republic of Yugoslavia.
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 20 May 1997 No. 467 «On measures to stabilize the work of shipbuilding enterprises in Mykolaiv».	Direct subsidies from the State Budget for the completion of shipbuilding under concluded contracts, repayment of debts to enterprises and PSC from shipbuilding in Mykolaiv for the works performed by them in 1995-1996.

Continuation of Table 2

CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 29 February 1996 No. 254 «On measures to stabilize the work of shipbuilding enterprises».	Development during 1996 on the basis of BSS and KhSP, «Ocean» (Mykolaiv) and «Zaliv» (Kerch), SE « Shipyard named after 61 Communards» (Mykolaiv) of new principles of management of manufacturers of knowledge-intensive and competitive products with a long-term production cycle for their further implementation at other shipbuilding enterprises.
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 13 September 1999 No. 1669 «On additional measures to ensure the implementation of the construction project of bulk carriers of the «Panamax» type»	Conclusion of an internal credit agreement between the State Export-Import Bank and «Ocean» without the conclusion of a pledge agreement.
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 11 December 1998 No. 1959 «On the formation of the State joint-stock holding company «Black Sea Shipyard»«.	Increasing the efficiency of using the scientific, technical and production potential of the SE «Black Sea Shipyard», reducing the cost of building ships, improving the financial and economic situation, expanding the sales markets for its products.
LAW OF UKRAINE dated 18 November 1999 «On State Support Measures for the Shipbuilding Industry in Ukraine».	The first attempt to create effective regulatory and legal support of the industry, aimed at its stimulation.
The period 2000-2004	
LAW OF UKRAINE dated 21 December 2000 No. 2189-III «On the special regime of investment activity in the territories of priority development and the special economic zone «Port Crimea».	The creation of special business regimes that would reduce the tax pressure on the producer and create sufficient motivation to expand production volumes, intensify foreign economic activity, seek production contracts from foreign customers, increase the competitiveness of the industry, etc. The goal is achieved by creating special regimes of investment activity that are separate by type.
LAW OF UKRAINE dated 13 July 2000 No. 1909-III «On the Mykolaiv Special (Free) Economic Zone».	

Continuation of Table 2

LAW OF UKRAINE dated 15 June 2004 No. 1766-IV «On Amendments to Some Legislative Acts of Ukraine on State Support of the Shipbuilding Industry in Ukraine».	Implementation of state support measures for shipbuilding for the period 2005-2012, including financial support for shipbuilding due to cheaper loans, provision of benefits for payment of land tax, priority for VAT reimbursement by shipbuilding enterprises.
	Allowances are provided for the payment of import duty for materials and equipment for the purpose of building sea, river vessels and other watercraft.
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 28 July 2003 No. 1174 «On approval of the state program of industrial development for 2003-2011».	Restructuring of the production, scientific and technical potential of the industry's enterprises, the transformation of the shipbuilding complex into an industry, the activation of foreign economic activity, ensuring the loading of plant capacities.
The period from 2006 to the present	
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 27 March 2006 No. 368 «On approval of the list and volume of materials, equipment and accessories used for the construction of ships by enterprises of the shipbuilding industry and imported into the customs territory of Ukraine in accordance with the contracts concluded by these enterprises».	Establishment of a list of materials and equipment imported into Ukraine for shipbuilding by enterprises with payment of import duty at the rate of 0%.
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 5 September 2007 No. 1102 «On Amendments to the List of Shipbuilding Enterprises for Which Shipbuilding Industry Support Measures Are Introduced.»	Eight shipbuilding enterprises were excluded from the list and only three were added to the new one. At the same time, support is provided at the expense of cheaper loans.
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 14 February 2007 No. 221 «On approval of the procedure for the use in 2007 of the funds provided for in the State Budget for the support of shipbuilding industry enterprises by reducing the cost of loans.»	Introduction of a competitive procedure for aiding at the expense of budget funds. Fairly strict requirements have been established for both investment projects and their executors, who are reimbursed the amount of interest they paid for using medium-term (up to 3 years) and long-term (up to 5 years) loans.

Continuation of Table 2

Shipbuilding development strategy until 2020. APPROVED by the CABINET OF MINISTERS OF UKRAINE DECREE dated 6 May 2009 No. 581	The main problem that the Strategy aims to solve is to prevent the decline of domestic shipbuilding, the emergence of a threat to economic independence, and Ukraine's loss of the status of a maritime state.
LAW OF UKRAINE dated 6 September 2012 No. 5209-VI «On conducting an economic experiment on state support for the shipbuilding industry».	Shipbuilding is recognized as a priority branch of the economy. In addition, the scope of the Law extends not only to shipbuilding, but also to ship repair and research and development organizations.

An important regulatory document should also be considered the developed project of the Shipbuilding Development Strategy until 2030. The project envisages: the creation of a shipbuilding cluster, the application of the special economic zone functioning mechanism; prohibition of confiscation of property in the execution of defense orders; prohibition of seizure of funds deposited as an advance, or credit funds for orders for the manufacture/repair of ships; compensation by the state of part of the interest on the loan in the national currency in the case of the purchase of devices, equipment of domestic production for shipbuilding and ship repair works, etc. However, non-acceptance of procedural actions regarding the approval of the Strategy, the implementation of its provisions in the activities of the industry restrains the further development of shipbuilding.

The analysis of the state's shipbuilding industry, the identified main reasons for its unsatisfactory development prove that the implementation of the tasks of its further effective functioning is an actual scientific and applied problem, the solution of which is of national importance.

2. Development directions of the technological platform Shipbuilding 4.0

At present a specific feature of the further development of the shipbuilding industry of the leading shipbuilding countries is the implementation in all spheres of activity of enterprises and organizations of the relevant sector of the economy of the processes of digitalization of the stages of the ship's life cycle and the creation of its digital double. These processes are the basis of the technological platform (TP) of Shipbuilding 4.0.

According to[8,9,10,11], the elements of the Shipbuilding 4.0 technological platform are components of the stage of development of Industry 4.0 in relation to shipbuilding problems. They include the following elements: modeling and numerical experiments; blockchain technology; «cloud» technologies; Big Data technologies; cybersecurity; artificial intelligence technologies; 3D-printing, 3D-scanning, 3D-modeling; digital platforms; technologies for obtaining and directly applying new materials; Internet of Things; robotization of processes; virtual and augmented reality; autonomous transport elements and systems.

The relevance of implementing the elements of the Shipbuilding 4.0 technological platform at shipbuilding enterprises and in organizations of the shipbuilding industry of Ukraine is justified by the positive experience of countries – shipbuilding leaders.

The formation of the elements of the Shipbuilding 4.0 technological platform in Ukraine requires the creation of an appropriate regulatory framework related to issues of digital development and informatization of the shipbuilding complex. The analysis of the regulatory framework regarding the shipbuilding industry and digitalization processes proves that these issues are not settled and need to be developed (Tab. 3).

Table 3

Regulatory and legal support for digital development and informatization of Ukrainian society

Regulatory and legal support	Purpose of implementation
CABINET OF MINISTERS OF UKRAINE DECREE dated 15 May 2013 No. 386. «On the approval of the Information Society Development Strategy in Ukraine».	Determination of the basic principles, strategic goals of the development of the information society in the state, tasks and main directions, stages and mechanisms of the implementation of this Strategy, taking into account modern trends and features of the development of Ukraine in the perspective of 2020.

[8] A vision for the European industry until 2030 / Final report of the Industry 2030 high level industrial roundtable (2019). Publications Office of the EU. URL: http://op.europa.eu/en/publication-detail/-/publication/339d0a1b-bcab-11e9-9d01-01aa75ed71a1

[9] Hribernik K., 2016. Industry 4.0 in the Maritime Sector, SEA, Tokio, Japan.

[10] Torres A. Identifying Challenges and success factors towards Implementing Industry 4.0 technologies in the Shipbuilding Industry. Delft University of Technology, 2018. – 156 p.

[11] Bernard Ash. Digital shipyard sounds great but what is it? The technologies making it possible. DXC Technology Company. November 2018. – 11 p.

Continuation of Table 3

LAW OF UKRAINE dated 4 February 1998 No. 74/98-VR «On the National Informatization Program».	Determination of the general principles of formation, implementation and adjustment of the National Informatization Program.
CABINET OF MINISTERS OF UKRAINE DECREE dated 16 November 2016 No. 918 «Concept of the development of the system of electronic services in Ukraine».	Determination of directions, mechanism and terms of formation of an effective system of electronic services in Ukraine.
CABINET OF MINISTERS OF UKRAINE DECREE dated 15 May 2002 No. 247. «On approval of the Concept of software legalization and combating its illegal use».	Determination of scientific and practical measures aimed at improving the legal framework for the legalization of software and combating its illegal use.
CABINET OF MINISTERS OF UKRAINE DECREE Ukraine dated 17 January 2018 No. 67 «Concept of development of digital economy and society of Ukraine for 2018-2020».	Implementation of an accelerated scenario of digital development, as the most relevant for Ukraine in terms of challenges, needs and opportunities.
Order of the State Agency for Electronic Government of Ukraine dated 13 August 2018 No. 51 «On approval of electronic message formats and data exchange of the system of electronic interaction of state electronic information resources».	Establishing requirements for electronic communication and data exchange, which are used during the creation of web services and web clients and their use in the system of electronic interaction of state electronic information resources.
LAW OF UKRAINE dated 22 May 2003 No. 851-IV «On Electronic Documents and Electronic Document Management».	Establishing the basic organizational and legal principles of electronic document circulation and the use of electronic documents.
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 30 January 2019 No. 56. «Some issues of digital development».	Ensuring the implementation of the principles of the state policy of digital development and the proper organization of the implementation of the envisaged tasks using digital technologies.
LAW OF UKRAINE dated 18 November 2003 No. 1280-IV «On Telecommunications».	Determining the powers of the state to manage and regulate telecommunications activities, the rights, duties and responsibilities of persons participating in the activity or using the services.
LAW OF UKRAINE dated 13 November 1992 No. 2657-XII «On Information».	Regulation of relations regarding the creation, collection, receipt, storage, use, distribution, protection of information.

Continuation of Table 3

LAW OF UKRAINE dated 5 July 1994 No. 81/94-VR «On the protection of information in automated systems».	Regulation of legal relations regarding the protection of information in automated systems, subject to compliance with the ownership rights of individuals and legal entities to information and the right to access it.
CABINET OF MINISTERS OF UKRAINE RESOLUTION dated 10 May 2018 No. 357 «Some issues of the organization of electronic interaction of state information resources».	Creation of application programming interfaces to ensure access and connection to priority state electronic information resources.
LAW OF UKRAINE dated 5 October 2017 No. 2163-VIII «On the Basic Principles of Cyber Security of Ukraine».	Ensuring the protection of vital interests of citizens, the state, and national interests of Ukraine in cyberspace.

It should be noted that one of the key directions of the formation of the technological platform is the issue of legal regulation by the state, first of all, it is the issue of the application of the latest intelligent systems at enterprises of the shipbuilding industry, digital management of the development of shipbuilding and ship repair, organization and implementation of projects and programs at the state level implementation of the technological platform Shipbuilding 4.0, creation of a unified information space of the shipbuilding industry, etc.

The experience of shipbuilding countries proves that one of the main conditions for the effective functioning of enterprises and organizations of the shipbuilding complex is the granting to enterprises of the industry of various kinds of preferences, state investments, especially in scientific research and the implementation of innovations (Tab. 4), which are literally absent in Ukraine. For example, in South Korea and Japan, the credit term is extended to 13 years, while the credit rate is 5-8% per annum, and the loan for the construction of new ships in Japan is 60-80% of their construction cost. Support of domestic shipbuilding enterprises in European countries provides shipbuilding crediting for a period of up to 10 years under the terms of a loan of up to 30% of the construction cost, at the same time, the lending rate is no more than 5% per annum. The loan term for shipbuilding in the USA can reach 25 years, while the loan amounts to 37.5% of the cost of the vessel.

Table 4

State measures to support the development of the shipbuilding industry

	Subsidies for the construction	Assistance in moderniza-tion of	Adoption of the shipyard financing	Subsidies for the construction	Assistance in conducting scientific	Tax benefits	Reduction of customs tariffs	Nationalizati on of shipyards
Australia	+					+	+	
Belgium	+			+	+		+	+
Denmark	+		+		+	+		
Finland	+		+	+	+		+	
France	+	+		+	+			
Germany	+	+	+	+	+	+	+	
Greece			+	+		+	+	
Italy	+	+	+	+	+	+	+	+
Japan	+	+	+	+	+			+
South Korea	+	+	+	+	+	+	+	
Netherla nds	+	+	+	+	+		+	
Norway	+		+	+	+			
USA		+		+	+			

State support for conducting scientific research works in different shipbuilding countries is different and is a significant incentive for the development of the shipbuilding industry:

– in European countries, about 10% of the annual turnover of shipbuilding enterprises is directed annually to the performance of scientific support for shipbuilding;

– in South Korea and Japan, approximately 50% of the costs of conducting scientific research in the field of shipbuilding are provided by the state;

– in China, research and development in the field of shipbuilding is almost 100% financed by the state.

The development of measures to support domestic shipbuilding under the conditions of the formation of the technological platform Shipbuilding 4.0 should be considered one of the priorities.

Conducted studies on the existing potential of domestic shipbuilding prove that the enterprises of the industry can provide activities in the following directions: military shipbuilding, coastal shipbuilding, construction of sea transport vessels, vessels of mixed navigation, construction of sailing and motor yachts, vessels of the fishing fleet, river vessels, etc. At the same time, existing unbalanced cooperative relations

need their coordination at the stage of formation of the shipbuilding cluster of Ukraine, the necessity of which is emphasized in various publications[12,13]. The direction of managing the processes of cluster formation, under the conditions of the implementation of a technological platform as a basis for the development of the industry, is one of those that requires special attention. Fig. 3, 4 show possible models of shipbuilding cluster creation and management.

The main processes that ensure the formation of a regional shipbuilding cluster should be considered: the identification of project stakeholders, the organization of work on the formation and creation of a coordination center, the determination of the «potential» of the intended participants of the cluster for the appropriate period, as well as «white spots» that restrain the processes of cluster organization.

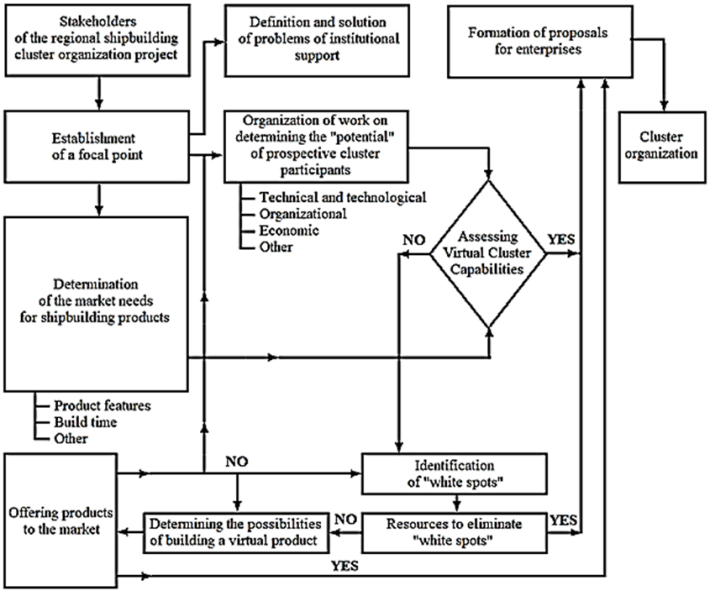

Fig. 3. Conceptual model of regional cluster formation

[12] Кластери суднобудування URL: https://ucluster.org/universitet/klastery-ukraina/2012-study/perspektivni-napryamki-klasterizacii-vodnikh-resursiv/klasteri-sudnobuduvannya/

[13] Підготовка до створення Миколаївського суднобудівного кластеру URL: https://shipbuilding.mk.ua/?p=1641

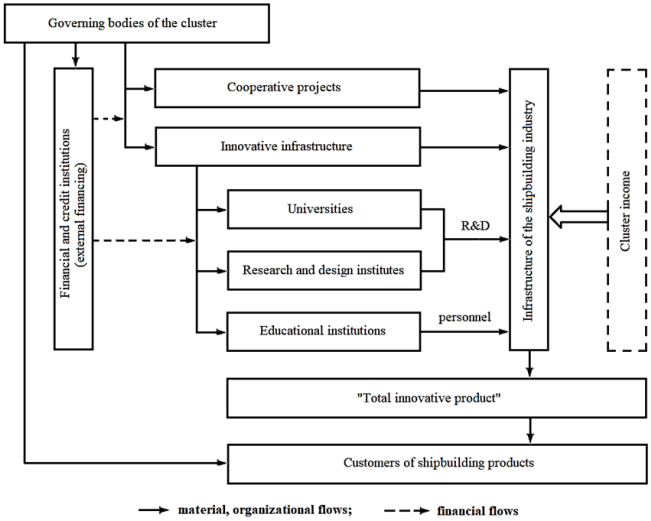

Fig. 4. Shipbuilding cluster management model

According to the conducted studies, it is possible to conclude that the main participants of the shipbuilding cluster should be considered (Fig. 5): enterprises and organizations of the infrastructure of the shipbuilding industry, territorial communities, customers of shipbuilding products, financial and credit institutions, supervisory bodies, project stakeholders. Enterprises and organizations of shipbuilding infrastructure should include professional training institutions for the shipbuilding industry, research and design organizations, directly shipbuilding enterprises, organizations and enterprises.

Requests of the shipbuilding industry regarding issues of scientific and personnel support for the further development of domestic shipbuilding should be resolved at a faster pace. The importance of organizational activity in the direction of reforming the educational components of the educational process, the orientation of scientific research aimed at overcoming the challenges of the Shipbuilding 4.0 technological platform – a priority direction. Ensuring the training of specialists is one of the decisive stages, which determines the ability to implement TA tasks. Based on the results of the performance of the priority tasks of the stage, the needs of shipbuilding and ship repair enterprises for relevant specialists will be determined according to the directions of the structure of the technological platform, the needs for material and technical support

of educational programs will be determined, the composition and competences of scientific and pedagogical workers who are able to provide the task of training specialists, etc. will be determined.

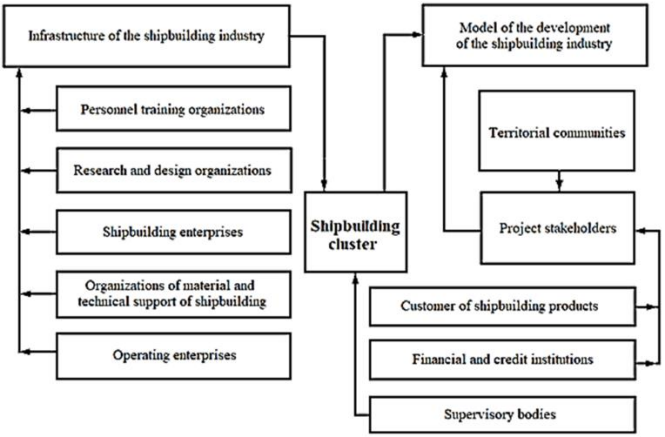

Fig. 5. The main participants of the shipbuilding cluster of material and technical support of the shipbuilding industry, operating enterprises

To implement the project for the training of specialists, a generalized structural model of the management of the project formation process (Fig. 6) is proposed for its implementation in relation to higher educational institutions in the shipbuilding field.

An important role in the formation of the Shipbuilding 4.0 technological platform should be given to the direction of starting a new organizational form in the activities of supervisory bodies under the conditions of digitalization. One of these bodies is the Register of Shipping of Ukraine[14] (RSU).

The development and approval of rules and technical requirements for ensuring the fulfillment of conditions for the safety of navigation of vessels and their environmental safety, the preservation of transported goods, ensuring the protection of life and health of passengers and crews of vessels are among the main tasks of the RSU. All stages of the ship's life cycle are related to the activities of the RSU (Fig. 7).

[14] Classification partnership Register of shipping of Ukraine URL: http://www.shipregister.ua/

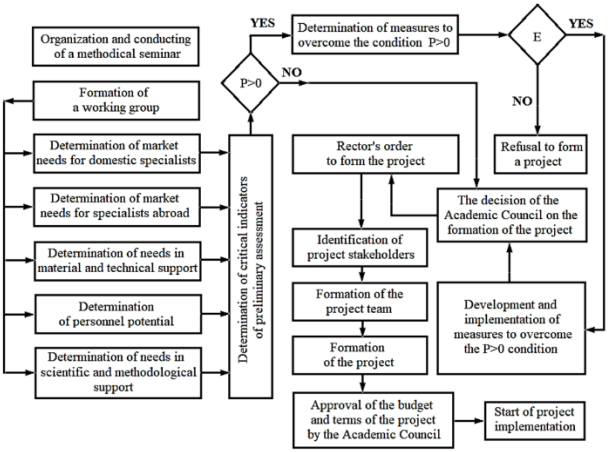

Fig. 6. Generalized structural management model of the process of forming a personnel training project for the implementation of the tasks of the technological platform Shipbuilding 4.0

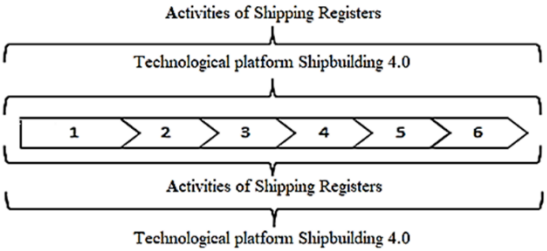

Fig. 7. The ship's life cycle and the mutual influence on it of the Shipbuilding 4.0 technological platform and the activities of the Register of Shipping of Ukraine: 1 – development of the technical task; 2 – design of object accounting; 3 – design of objects; 4 – object creation; 5 – complex test; 6 – facility operation, decommissioning and disposal

The analysis of the main normative-legislative documents and scientific publications regarding the activities of the Register of Shipping indicates that there is no solution in their substantive part to the task of adapting their activities to the conditions of the digital transformation of shipbuilding. The need to adapt the enterprise to the conditions of digital transformation is clearly demonstrated by the formed matrix of changes.

The basis of the matrix[15] is the statutory functions of the State Enterprise «Classification Society Register of Shipping of Ukraine» (Tab. 4).

Table 4

Matrix of changes

RSU functions	1	2	3	4	5	6	7	8	9
Evaluation of the functioning of the RSU at the present time	s	s	s	s	s	s	s	s	s
The need for operational changes under the conditions of the introduction of the Shipbuilding 4.0 technological platform/ degree of importance: – regulatory and legislative direction; – technical and technological direction; – organizational direction.									
	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi
	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi
	+/i	+/i	+/i	+/i	+/i	+/i	+/i	+/i	+/i
RSU functions	10	11	12	13	14	15	16	17	18
Evaluation of the functioning of the RSU at the present time	s	s	s	s	s	s	s	s	s
The need for operational changes under the conditions of the introduction of the Shipbuilding 4.0 technological platform/ degree of importance: – regulatory and legislative direction; – technical and technological direction; organizational direction.									
	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	-/ui	-/ui
	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	+/vi	-/ui	-/ui
	+/i	+/i	+/i	+/i	+/i	+/i	-/i	-/ui	-/ui

[15] Слободян С. О., Харитонов Ю. М. Проєкти розвитку наглядової діяльності регістру судноплавства України в умовах цифровізації / Shipbuilding & marine infrastructure. – Вип. 1(16), 2022. – Одеса: видавничий дім «Гелветика». – С. 4-14.

The following abbreviations are adopted in Tab. 4: a) functions of the RSU: 1 – technical (classification and convention) supervision (survey) of vessels regardless of ownership and departmental affiliation; 2 – development and approval of rules and technical requirements for ensuring compliance with the conditions of safety of navigation of vessels, protection of life and health of passengers, ship crews, preservation of transported goods, environmental safety of vessels; 3 – approval of design documentation and technical inspection of ships (during construction, conversion, and repair), ship mechanisms, equipment, devices, refrigeration units, containers, products and materials, ship supplies, etc.; 4 – approval of draft standards, technical conditions, management documents and other documents; 5 – carrying out a technical inspection of objects and processes of industry and transport; 6 – examination of the technical condition of ships and other watercraft and assessment of the value of ships and other watercraft, in accordance with current legislation; 7 – conformity assessment of products, processes, services, systems, personnel, etc., as an accredited/designated conformity assessment body established by legislation, as well as on behalf of other bodies or after being accredited/designated in other systems and non-legislatively regulated spheres; 8 – technical supervision of the state of hydrotechnical structures of the water transport complex during their design, construction and operation, regardless of the forms of ownership; 9 – technical supervision of measurement work in water areas, approach channels and waterways of the water transport complex of Ukraine; 10 – training and certification of personnel in the system of the Shipping Register of Ukraine; 11 – provision of surveying services (risk assessments, confirmation of compliance of products (cargo) with the terms of the transportation contract, inspection of the vessel before loading, supervision of loading and unloading, certification of the quality of the cargo in terms of packaging, marking and quantity; 12 – provision of consulting and engineering services within spheres of activity of the Enterprise, except for objects of conformity assessment; 13 – technical supervision of industrial safety of dangerous production facilities and their technical devices; 14 – carrying out defecation of ship structures by measuring their residual thicknesses, calculation of strength, capacity, unsinkability and other calculations according to ship structures, mechanisms, equipment, systems, as well as means of their operation; 15 – conducting technical inspections of emergency rescue and fire-fighting equipment, as well as means of communication and navigation equipment; 16 – conducting technical examination of vessels insured by insurance

companies, with by providing the necessary preliminary conclusions of the Enterprise; 17 – conducting seminars and conferences according to the Company's areas of activity; 18 – participation in the work of attestation commissions; b) evaluation of the functioning of the RSU – s – satisfactory; c) need for changes – + change is needed; – there is no need for changes; d) the degree of importance of the change – vi – very important; i – important; ui – unimportant.

The development and implementation of the elements of the Shipbuilding 4.0 technological platform have a significant impact on the processes of the supervisory activity of the RSU.

On the basis of the generalization, the main directions and projects of adaptation of the activities of the RSU to work in the conditions of digitalization are determined (Fig. 8).

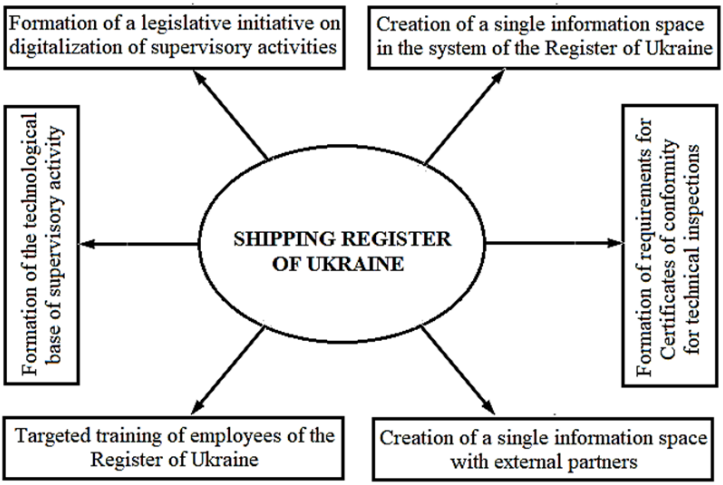

Fig. 8. The main directions and projects of adaptation of the activity of the RSU to work in conditions of digitalization

The following should be considered the main projects of adaptation of the activities of the RSU to the conditions of digital transformation:

– the project of targeted improvement of the qualifications of RSU employees;

– the project of forming a regulatory and legislative framework for the supervision of the RSU;

– the project of creating a Unified Information Space (UIS) with external partners;

– the project of forming the technological base of supervisory activity;

– the project of creating a Unified Information Space;

– a project for the formation of requirements for the provision of Certificates of Conformity for conducting technical inspections.

The first stage of adaptation of the activities of the RSU to the conditions of digital transformation should include the project in the direction of the formation of the regulatory and legislative framework for the supervision of the RSU and the project in the direction of the creation of the Unified Information Space.

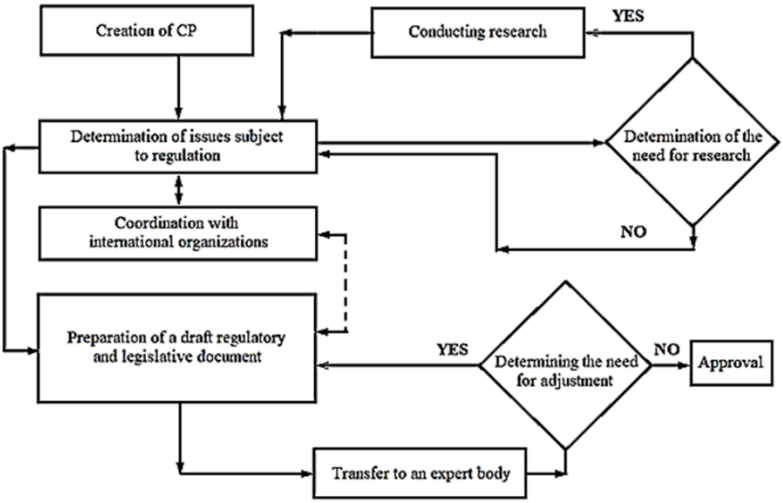

Fig. 9 A generalized process model of project management for the formation of a regulatory and legislative framework

In Fig. 10 is shown a fragment of the developed generalized process model of project management for the creation of the Unified Information Space.

The creation of a Unified Information Space in the system of the RSU and a Unified Information Space with external partners should be considered one of the main directions of the formation of the Shipbuilding 4.0 technological platform in Ukraine. Implementation of the tasks of this

direction will provide information needs with internal organizational structures and external partners. Separate issues of the projects of targeted training of RSU employees, the formation of requirements for the provision of Certificates of conformity for technical inspections and the formation of the technological base of supervisory activities are resolved within the framework of the project to create a Unified Information Space.

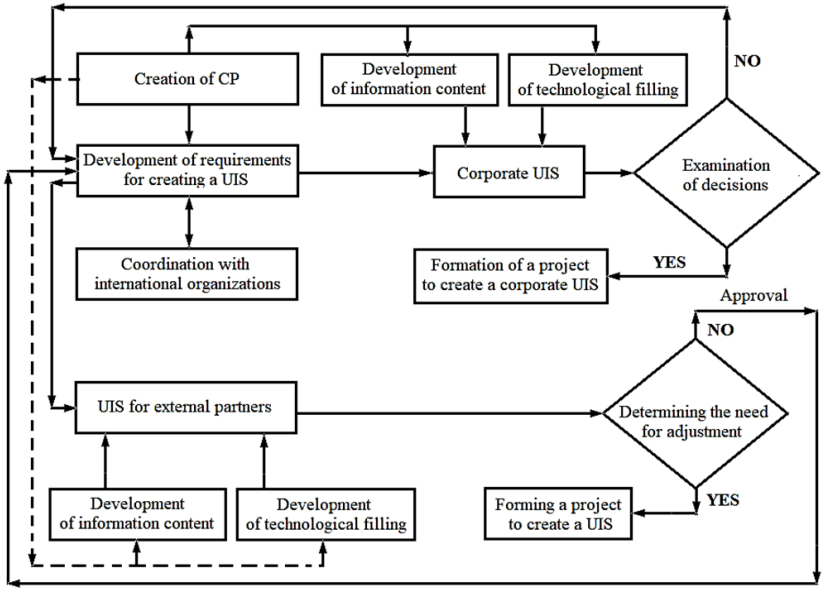

Fig. 10. A generalized process model of project management for the creation of the Unified Information Space

The development of projects related to the technical and technological development of shipbuilding enterprises should be considered one of the main directions of the formation of a technological platform. The effectiveness of projects in this direction will significantly depend on the chosen model of their implementation, including under the conditions of technology transfer.

According to[16], the level of development of the shipbuilding industry can be characterized by its technical and technological and organizational indicators:

$$U =< \mathrm{P}, \mathrm{O} >,$$

where U – level of technological development; P – technical and technological indicators; O – organizational indicators.

The goal of using technology transfer processes should be considered the achievement of the highest level of technological development of domestic shipbuilding, that is, the level existing in world practice at the relevant time:

$$U =< \mathrm{P}, \mathrm{O} >\rightarrow max$$

The proposed models of achieving different levels of technological development of the industry are characterized as follows.

The model of «gradual» transition assumes that its main feature should be considered a gradual transition from the actual level of technological development to the one following it.

For the «jump» model, the main feature should be considered the possibility of transition to a higher level of technological development, bypassing the next in order of the current level.

The «big jump» model differs from the «jump» model in that the significantly low initial level of technological development immediately reaches the maximum level, which takes place for a certain time (Fig. 11, 12).

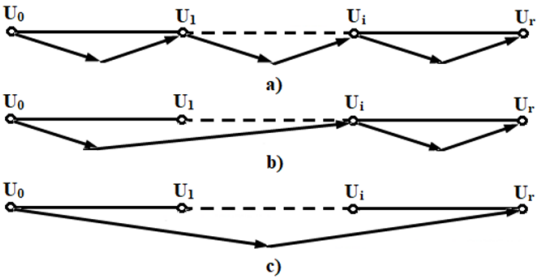

Fig. 11. Process models for achieving different levels of technological development: a – the model of «gradual» transition; b – the «jump» model; c – the «big jump» model

[16] Y. Kharytonov, S. Slobodian, M. Podaienko. Development of models of technology transfer for public works / Baltic Journal of Economic Studies. Vol. 7 No. 4 (2021): DOI: https://doi.org/10.30525/2256-0742/2021-7-4-214-225.

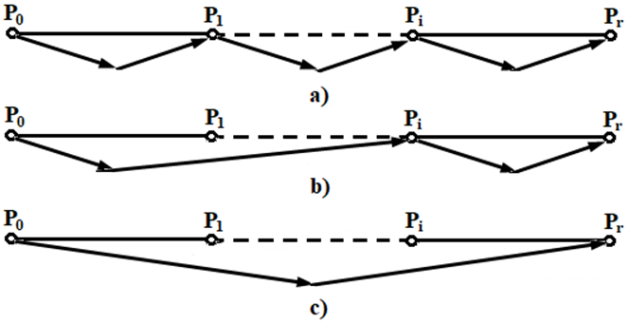

Fig. 12. Models of processes for achieving technical and technological indicators of different levels of technological development: a – the model of «gradual» transition; b – the «jump» model; c – the «big jump» model

When forming shipbuilding development projects, the conditions for selecting a transfer object by cost for various models of acquiring the appropriate technological level are adopted as follows:

$U_i = U_{max}$ **while** $C_{доп} \geq C_r$ **– for** the «big jump» model**;**
$U_i = U_{i+1}$ **while** $C_{доп} \geq C_{i+1}$**; – for** the model of «gradual» transition**;**
$U_i = U_{i+т}$ **while** $C_{доп} \geq C_{i+т}$**; – for** the «jump» model**,**

where U_i – level of technological development; U_{i+1} – the next level of technological development; $U_{i+т}$ – random level of technological development; $C_{доп}$ – allowable under the planning conditions, the cost of expenses related to the transfer procedures and the direct cost of the object and components of the transfer; C_r – the costs associated with the transfer procedures and the direct cost of the object and components of the transfer when moving to the highest level; C_{i+1} – the costs associated with the transfer procedures and directly the cost of the object and components of the transfer when moving to the nearest level; $C_{i+т}$ – the costs associated with the transfer procedures and directly the cost of the object and components of the transfer when moving to the random level.

The conditions for choosing a transfer object by time for different models of achieving a technological level are:

$U_i = U_{max}$ **while** $T_{доп} \geq T_r$ **– for** the «big jump» model;
$U_i = U_{i+1}$ **while** $T_{доп} \geq T_{i+1}$**; – for** the model of «gradual» transition**;**
$U_i = U_{i+т}$ **while** $T_{доп} \geq T_{i+т}$**; – for** the «jump» model**,**

where $T_{доп}$ – acceptable term of delivery of transfer objects; T_r – acceptable term of delivery of transfer objects when moving to the highest technological level; T_{i+1} – acceptable term of delivery of transfer objects when moving to the nearest technological level; $T_{i+т}$ – admissible term of supply of transfer objects when switching to a random technological level.

The list of potential transfer objects is formed as follows:

$$ST = \{ST_i, EST_i\}, SC = \{SC_i, ESC_i\},$$

where ST – a set of technology transfer objects that are selected over time; ST_i – object of technology transfer, which is selected by time; SC – a set of technology transfer objects that are selected by cost; EST_i – component of the object of technology transfer, which is selected over time; SC_i – the object of technology transfer, which is selected by cost; ESC_i – a component of a technology transfer facility that is selected by cost.

It should be noted that the selection of potential objects of technology transfer should consider the common and corporate interests of the cluster participants.

CONCLUSIONS

1. The experience of the shipbuilding countries indicates the effectiveness of the introduction of elements of the Shipbuilding 4.0 technological platform in the formation of projects and programs for their further development, which can become the basis for its application in the shipbuilding industry of Ukraine.

2. The main priority directions of action regarding the development of shipbuilding in Ukraine under the conditions of digitalization of the life cycle of shipbuilding and the creation of their digital counterparts have been determined. The main directions should be considered: improvement of regulatory and legal support; creation of a viable shipbuilding cluster; improvement of the personnel training system; adaptation of supervisory bodies to digitalization conditions; definition and justification of the model of achieving the appropriate level of the shipbuilding industry.

SUMMARY

Currently, shipbuilding is one of the key factors in the further development of the economies of the shipbuilding countries. The current state of the shipbuilding industry of Ukraine in terms of its technical, technological and economic indicators does not correspond to the strategic goals of the further development of the state. The conducted studies prove that the restoration of the shipbuilding industry should be implemented on

the basis of the creation and implementation of projects and programs that take into account the basic principles and content of the components of the Shipbuilding 4.0 technological platform. The main priority directions of the development of the shipbuilding industry have been identified: improvement of regulatory and legal support; creation of a viable shipbuilding cluster; improvement of the personnel training system; adaptation of supervisory bodies to digitalization conditions; definition and justification of the model of achieving the appropriate level of the shipbuilding industry.

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