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TURINYS

ORGANIZATIONAL MECHANISMS FOR THE IMPLEMENTATION OF THE CONCEPT OF THE CREATION IN UKRAINE OF MARINE ROBOTICS FOR ENVIRONMENTAL PURPOSES

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Annotation

The development of marine robotics is an important direction in the field of environmental protection, since modern robotic systems allow for effective monitoring of marine ecosystems, detection and elimination of pollution, and prevention of environmental disasters. The article considers the organizational mechanisms for implementing the Concept of creating marine robotics for environmental protection purposes in Ukraine. The key elements of an effective organizational structure that ensures the interaction of research institutions, production enterprises, state bodies, and international partners are identified. The global and domestic experience of implementing marine robotic systems in environmental protection is analyzed. A model of interaction between the subjects of the process of development, testing, implementation, and operation of marine robotic platforms is proposed. The main attention is paid to the interdisciplinary approach, integration of innovative technologies, staffing, and international cooperation.

Key words: marine robotics, environmental protection activities, organizational structure, environmental monitoring, automated systems, public administration, innovative technologies, international cooperation, development and implementation, underwater autonomous vehicles.

INTRODUCTION

The implementation of the "Concept of creating marine robotics for environmental protection in Ukraine" requires a comprehensive approach based on a clear and effective organizational structure. This structure ensures the interaction of all necessary elements: scientific research, design, production (including testing) and personnel training for all stages of implementation. It is aimed at achieving the key goals of the concept, in particular, the creation of high-tech solutions for environmental protection activities, the formation of an innovative production sector and the integration of Ukraine into the international environmental community. The main task of the organizational structure is to ensure clear coordination between various participants in the process, including state bodies, scientific institutions, design bureaus, manufacturing enterprises, educational institutions and operating organizations. The structure should guarantee the efficiency of work at each stage, from conducting fundamental research to serial production and the introduction of robotic systems into environmental protection activities.

Relevance of the research. The increase in anthropogenic input to the marine ecosystems of Ukraine requires the development and introduction of effective environmental technologies. One of the promising directions is the use of marine robotics, which allows monitoring of the environmental situation, eliminating the legacy of pollution and supporting the development of pollution. marine resources. In this context, it is important to create an effective organizational structure for the implementation of the "Concept of marine robotics for environmental purposes created in Ukraine" to ensure mutual cooperation government bodies, scientific institutions, industrial enterprises and international partners.

Tracking problem. One of the main problems is the lack of an integrated approach to the development of marine robotics technology in Ukraine. The original initiatives are fragmentary, and

their implementation is complicated by the lack of coordination between the scientific sphere, industry and government structures. Nowadays there is light evidence of the importance of integration of these sectors within the framework of a single organizational structure.

Meta and task of investigation. The purpose of this article is to develop an organizational structure for the implementation of the concept of the development of marine robotics in Ukraine, to ensure effective interaction between key participants in the process, Acceptable integration of Ukraine with international environmental awareness and advancement of the technological level of Galusia.

To achieve this goal, the following tasks were set:

- analyze the light evidence of the creation of organizational structures for the development and implementation of environmental technologies;
- identify key benefits to the organizational structure of concept implementation;
- develop a model of interaction between scientific institutions, government bodies, enterprises and international partners;
- evaluate mechanisms for coordination and financing of marine robotics;
- develop recommendations for the integration of lighting programs in the process of implementing the concept.

Object of investigation. The object of investigation is the organizational structure of the implementation of the concept of the creation of marine robotics for environmental purposes in Ukraine.

Research methodology. The investigation is based on a variety of such methods:

- system analysis - to examine the interconnections between warehouse organizational structures;
- annual analysis – to assess the light evidence of the implementation of marine robotic systems in environmental activities;
- expert assessment – to formulate propositions in order to thoroughly develop the organizational structure;
- economic and mathematical modeling – to analyze the effectiveness of resource provision for the implementation of the concept.

Scientific novelty. The scientific novelty of the article lies in the development of an organizational structure adapted to Ukrainian conditions for the implementation of the concept of marine robotics, which combines modern technological approaches and effective management mechanisms.

1. LITERATURE REVIEW

The development of marine robotics for environmental protection purposes is a relevant area of research both in Ukraine and abroad. Domestic scientists are actively working on creating effective organizational models for the implementation of marine robotic systems, in particular for environmental monitoring and pollution elimination.

The development of organizational structures for the implementation of high-tech environmental projects is the subject of numerous scientific studies. In particular, international experience indicates the effectiveness of such management models as public-private partnerships, the integration of academic science into industrial projects [1], as well as an interdisciplinary approach to creating technologies to protect marine ecosystems [2].

A significant contribution to the development of this area was made by V.S. Blintsov, who studied methodological approaches to the design of autonomous underwater vehicles and the development of integrated control systems for underwater robots [3]. His works outline the main requirements for navigation and control systems for underwater unmanned platforms used for environmental monitoring and pollution search.

O.V. Blintsov and V.A. Nadtochiy considered the problems of automation of marine technological complexes with remotely controlled underwater vehicles of the working class. In their research [4] they focus on the adaptation of modern digital technologies to environmental underwater systems, in particular the use of artificial intelligence and data analysis to automate the processes of information collection.

Research by G.V. Babkin [5] is aimed at the development of project management models in the field of marine robotics. In particular, he proposed the concept of integrated management of the processes of design, testing and implementation of marine robotic systems for environmental tasks.

In addition, the works of V.O. Stepanenko [6] emphasize the importance of developing marine infrastructure, in particular for the use of robotic systems in the field of environmental monitoring and control of the state of water resources.

Thus, Ukrainian scientists, in particular, are actively researching and implementing marine robotics technologies to solve environmental problems, which contributes to the preservation and restoration of Ukraine's marine ecosystems.

2. REQUIREMENTS FOR THE ORGANIZATIONAL STRUCTURE FOR IMPLEMENTING THE CONCEPT

The implementation of the „Concept of creating marine robotics for environmental protection purposes in Ukraine" requires the creation of an organizational structure that will meet modern challenges and ensure the achievement of the set goals. The requirements for this structure should take into account the specifics of working with high-tech solutions, effective resource management, and the integration of all necessary areas of activity, are presented in table 1.

Table 1. *Requirements for the organizational structure of the „Concept for the creation of marine robotics for environmental protection purposes in Ukraine"*

Requirements	Realization
Complexity and interdisciplinarity	The organizational structure should cover all aspects of the concept implementation: from scientific research and design to production, testing, operation and training.
	Ensuring an interdisciplinary approach through the interaction of scientists, engineers, ecologists, economists and robotics specialists
Clear division of functions	Definition of separate functional blocks for each area of activity (science, design, production, testing, operation, personnel training)
	Avoiding duplication of tasks between different participants
Flexibility and adaptability	The ability to adapt the structure to changes in technological, environmental or economic conditions
	Ensuring a rapid response to new challenges and tasks, including international environmental initiatives or new standards
Integration with international partners	Providing opportunities for cooperation with international organizations, companies and scientific institutions
	Compliance with international standards in the field of environmental protection, robotics and innovation
Innovation orientation	Creating conditions for the development and implementation of the latest technologies
	Promoting innovation through support for startups, scientific research and pilot projects
Transparency and accountability	Establishing mechanisms for monitoring task performance at each stage of implementation
	Transparency in financial transactions, resource use and performance evaluation
Ensuring human resource potential	Integration of the training system into each stage: science, design, production, testing and operation
	Organization of educational programs, trainings and internships for specialists of various levels
	Attracting young people and retraining existing staff to work with new technologies
Effective resource management	Optimization of the use of financial, human and technical resources
	Ensuring coordination between different participants to avoid resource losses
Implementation of digital solutions	Using modern IT systems for project management , progress monitoring, and information exchange
	Integration of digital platforms for collecting, analyzing and using environmental data

Long-term and sustainable	Creating a structure capable of ensuring sustainable development of the industry even after the completion of the initial stage of concept implementation
	Integration of mechanisms to support national production, science and education to ensure continuous progress
Compliance with national interests	The structure should contribute to the country's economic development, in particular through the creation of new jobs and the development of the high-tech sector
	Ensuring the protection and restoration of Ukraine's natural resources to improve the quality of life of the population
Compliance with regulatory requirements	Alignment of the structure with the current legislation of Ukraine
	Implementation of mechanisms that meet international legal standards
Synergy of participants	Ensuring effective interaction between government agencies, scientific institutions, manufacturing enterprises, international partners and public organizations
	Creating conditions for collective decision-making and integration of efforts of all stakeholders

The requirements for the organizational structure emphasize its flexibility, multifunctionality, and compliance with modern challenges. Such a structure will become a reliable basis for the implementation of the concept, ensuring not only the successful development and implementation of technologies, but also the long-term development of the industry in the context of environmental protection activities in Ukraine.

3. FEATURES OF FORMING AN ORGANIZATIONAL STRUCTURE FOR IMPLEMENTING THE CONCEPT

The formation of an organizational structure for the implementation of the „Concept of creating marine robotics for environmental protection purposes in Ukraine" requires taking into account a number of key features. These features ensure management efficiency, integration of various areas of activity, and achievement of the strategic goals of the concept, are presented in table 2.

Table 2. *Formation of an organizational structure for the implementation of the concept*

Features	**Directions**	**Realization**
Orientation to an interdisciplinary approach	Interaction of different industries	Integration of knowledge and experience in the fields of science, engineering, ecology, economics, education and management
		Ensuring communication between specialists from different disciplines to achieve synergy
		Integration of knowledge and experience in the fields of science, engineering, ecology, economics, education and management
	Harmonization of tasks	Coordination of the goals of each direction to jointly achieve the results of the concept
Involving a wide range of participants	Public sector	Governments providing funding, regulation and strategic support
	Scientific institutions	Institutes, universities, research centers conducting fundamental and applied research
	Private sector	Innovative companies, startups, manufacturing enterprises and investors
	International partners	Technology companies, scientific institutes and international organizations that contribute to Ukraine's integration into the global innovation market

Flexibility and adaptability	Ability to change	The ability to quickly make changes to the structure to adapt to new challenges, including changes in international standards, technologies, or the environmental situation
	Pilot projects	Introducing pilot programs to test new ideas and solutions before their large-scale implementation
Integration of innovative technologies	Digitalization of management	Using modern IT solutions for project management , data exchange and progress monitoring
	Implementation of the latest technologies	Application of artificial intelligence, automation, big data (Big Data) to improve work efficiency
Transparency and accountability	Open management	Ensuring transparency in decision-making, resource allocation, and task execution
	Monitoring and reporting	Regular assessment of task performance with public presentation of results
Formation of human resources potential	Training of specialists	Creation of programs for training specialists in the fields of science, design, production, and operation
	Educational initiatives	Engaging universities, vocational schools, and training centers to ensure access to quality education
	Internships and trainings	Organization of experience exchange programs with international partners
Centralized management with decentralized execution	Single coordination center	Centralized management of all stages of concept implementation
	Autonomy of functional blocks	Granting autonomy to individual units to perform specific tasks
Distribution of functions and responsibilities	Clear specialization	Defining specific functions for each unit or division
	Integration of activities	Coordination of the work of different units to achieve a common goal
Orientation to international standards	Harmonization of processes	Compliance with international standards and best practices in the field of ecology, engineering and management
	Certification	Ensuring compliance of developed technologies with international quality certificates
Sustainable development	Long-term effectiveness	Formation of a structure that ensures sustainable development of the industry after the completion of the initial stages of concept implementation
	Rational use of resources	Minimizing costs and maximizing efficiency in all processes

The specifics of forming an organizational structure for the implementation of the concept are based on the principles of integration, flexibility, transparency, and innovation orientation. Such a structure should ensure effective interaction between all participants, guaranteeing the achievement of the goals of the concept and contributing to the sustainable development of the high-tech industry in the interests of Ukraine.

4. ORGANIZATIONAL STRUCTURE FOR IMPLEMENTING THE CONCEPT

Successful implementation of the concept requires a clear, multi-level organizational structure that ensures effective interaction between the scientific sphere, design, production, testing, personnel training and operation. The proposed organizational structure is presented below, are presented in table 3.

Table 3. *Organizational structure for implementing the concept*

Elements	Structure
1. Central Coordination Body	
Goal	Management of the implementation of the concept, coordination of interaction between all participants, monitoring of task performance
Functions	Development of an overall strategy and plans for implementing the concept
	Monitoring the implementation of project stages
	Allocation of resources between participants
	Monitoring and evaluation of results
Composition	Representatives of government bodies (Ministry of Environmental Protection, Ministry of Education and Science, Ministry of Economy)
	Heads of key scientific institutions, universities, design and production centers
	International experts (if necessary)
2. Research unit	
Goal	Conducting fundamental and applied research to create technologies that will become the basis for robotic systems
Functions	Development of new materials, sensors and energy-saving systems
	Conducting environmental monitoring and studying the state of the marine environment
	Development of algorithms and software for robotic systems
Composition	Academic institutions (Institutes of the National Academy of Sciences of Ukraine in Physics, Chemistry, Ecology, Robotics)
	Universities (specialized departments in robotics, marine ecology, and programming)
	Research centers
3. Design unit	
Goal	Transforming scientific developments into practical engineering solutions ready for production
Functions	Design of autonomous underwater vehicles, remotely controlled robots and sensor systems
	Developing prototypes and testing their functionality
	Ensuring the integration of modern technologies (artificial intelligence, sensors, energy-saving solutions)
Composition	Engineering and design offices
	Startups and innovative companies in the field of robotics
	Consortia with international partners
4. Production unit	
Goal	Mass production of robotic systems and components for the implementation of environmental protection tasks
Functions	Production of housings, sensors, power sources and other robot components
	Assembly of autonomous and remotely controlled devices
	Integration of technologies into finished products
Composition	State and private enterprises with experience in mechanical engineering, electronics and software
	Component manufacturers (batteries, sensors, etc.)
	International partner production platforms

5. Test unit	
Goal	Testing robotic systems in real marine environment conditions
Functions	Assessment of the performance of developed systems
	Testing systems in various environmental conditions (depth, temperature, pollution)
	Adaptation of designs and algorithms based on test data
	Assessment of the performance of developed systems
Composition	Test ranges in the Black and Azov Seas
	Laboratories for modeling marine environmental conditions
	Robotic systems certification and standardization centers
6. Educational block	
Goal	Training personnel for work in the field of science, design, production, testing and operation of robotic systems
Functions	Development of educational programs for universities, training centers and technical schools
	Conducting trainings, workshops and internships
	Integrating learning with practice by involving students in real projects
Composition	Universities with programs in robotics, ecology, and engineering
	Training centers for retraining specialists
	Cooperation with international educational institutions
7. Operational unit	
Goal	Application of created robotic systems for environmental protection activities
Functions	Monitoring the state of the marine environment
	Pollution elimination, biodiversity restoration
	Maintenance and modernization of robotic systems
Composition	Environmental organizations and state environmental inspections.
	Private companies specializing in environmental monitoring
	Local communities and volunteer organizations
8. Interaction of blocks	
Inter-block communication	The central coordinating body ensures coordination of actions between all blocks
	The research unit generates ideas and technologies that are transferred to the design unit for engineering implementation
	The production unit receives designs for serial production, while the test unit verifies their functionality.
	The educational unit provides training for each stage of the process
	The operational unit integrates the created systems into environmental protection activities
9. Advantages of the structure	
Realization	Ensuring a comprehensive approach to the implementation of the concept
	Clear division of functions between participants
	Maximum resource efficiency
	Flexibility in responding to changes and challenges

A feature of the concept implementation is the multi-level interaction between state bodies, research institutions, design and production enterprises, educational institutions and the private sector. The organizational structure should ensure synergy between these elements, allowing for the effective use of resources, the introduction of advanced technologies and the development of the country‘s human resources. The formation of such a structure is aimed at developing an effective

system that will become the basis for the creation of high-tech robotic solutions for environmental protection that meet the interests of Ukraine and contribute to its sustainable development in the international context.

CONCLUSIONS

1. The implementation of the Concept for the creation of marine robotics for environmental protection purposes in Ukraine requires a comprehensive approach, which includes research, design, production and operational components. The study determined that an effective organizational structure is a key factor in the successful implementation of marine robotics systems in environmental protection activities.

2. The proposed organizational model involves the interaction of state bodies, scientific institutions, industrial enterprises, educational institutions and international partners. Particular attention is paid to the issues of staffing, which is critically important for the formation of a high-tech marine robotics sector in Ukraine.

3. World experience proves that the implementation of marine robotics systems contributes to increasing the efficiency of environmental monitoring, timely detection of threats to the marine environment and rapid response to emergencies. The analysis of existing practices allowed us to formulate recommendations for improving project management mechanisms in this area, as well as to outline the prospects for Ukraine's integration into the international scientific and technical community.

4. Thus, the creation and implementation of an organizational structure for the development of marine robotics in Ukraine will contribute not only to solving environmental problems, but also to the formation of a competitive high-tech sector. The implementation of the proposed model will ensure the sustainable development of this industry, the rational use of natural resources and the effective protection of the marine environment.

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JŪRŲ ROBOTIKOS KONCEPCIJOS ĮGYVENDINIMO APLINKOSAUGOS TIKSLAIS UKRAINOJE ORGANIZACINIAI MECHANIZMAI

Santrauka

Šiuolaikinės robotikos sistemos leidžia veiksmingai stebėti jūrų ekosistemas, nustatyti ir pašalinti taršą bei užkirsti kelią ekologinėms nelaimėms. Jūrų robotikos vystymas yra svarbi aplinkos apsaugos srities kryptis. Straipsnyje nagrinėjami organizaciniai mechanizmai, skirti įgyvendinti jūrų robotikos kūrimo aplinkosaugos tikslais Ukrainoje koncepciją. Išskiriami pagrindiniai veiksmingos organizacinės struktūros, užtikrinančios mokslinių tyrimų institucijų, gamybos įmonių, valstybės institucijų ir tarptautinių partnerių sąveiką, elementai. Analizuojama pasaulinė ir vidaus patirtis diegiant jūrų robotikos sistemas aplinkosaugos srityje. Siūlomas jūrinių robotizuotų platformų kūrimo, testavimo, diegimo ir eksploatavimo proceso subjektų sąveikos modelis. Daugiausia dėmesio skiriama tarpdisciplininiam požiūriui, inovatyvių technologijų integravimui, personalo kompletavimui ir tarptautiniam bendradarbiavimui.

Pagrindiniai žodžiai: jūrų robotika, aplinkos apsaugos veikla, organizacinė struktūra, aplinkos stebėsena, automatizuotos sistemos, viešasis administravimas, inovatyvios technologijos, tarptautinis bendradarbiavimas, kūrimas ir diegimas, povandeninės autonominės transporto priemonės.

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