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# MANAGEMENT OF INNOVATIVE PROCESSES IN WATER TRANSPORT

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## УПРАВЛІННЯ ІННОВАЦІЙНИМИ ПРОЦЕСАМИ НА ВОДНОМУ ТРАНСПОРТІ

***The modern development of water transport is taking place under conditions of increasing demands for the desired operational outcomes, as well as a growing emphasis on environmental sustainability and, above all, transportation safety. These demands are driven by the intensification of international trade flows, the increase in passenger and cargo volumes, and the complication of logistics chains. All these factors create the necessity for continuous improvement of both technological solutions and management approaches. In this context, innovation should be viewed as a key factor for the competitiveness and viability of water transport enterprises, as well as a foundation for reducing risks associated with vessel operation, navigation, and port activities. Accordingly, the outlined study aims to investigate the theoretical foundations and practical approaches to managing innovation processes in the field of water transport. The result of the study confirmed that managing innovation processes in water transport is critically important for adapting this sector to modern challenges and market demands. This process contributes to improving navigation safety, reducing negative environmental impact, increasing economic efficiency, and optimizing resource use. The implementation of innovations makes water transport more competitive, reliable, and resilient to changes, ensuring the sustainable development of the industry and strengthening its role in both international and domestic transportation. It has been stated that the management of innovation processes in water transport should be carried out through a specific cycle of managerial actions, where each stage logically follows the previous one. This cycle includes the sequential identification and evaluation of innovative ideas and technologies, planning of innovation activities with the determination of priorities and resources, coordination of innovation implementation at the enterprise and regional system levels with appropriate personnel training and adaptation of organizational structures, systematic monitoring and evaluation of effectiveness considering impacts on safety, economy, and the environment, as well as risk and change management related to innovation integration.***

**Сучасний розвиток водного транспорту відбувається в умовах посилення вимог до бажаного результату функціонування, а також зростання ролі екологічності та, перш за все, безпеки перевезень. Ці вимоги обумовлені інтенсифікацією міжнародних торговельних потоків, збільшенням обсягів пасажирських і вантажних перевезень, а також ускладненням логістичних ланцюгів. Усі ці фактори зумовлюють необхідність постійного вдосконалення як технологічних рішень, так і управлінських підходів. У цьому контексті інновації слід розглядати як ключовий чинник конкурентоспроможності та життєздатності підприємств водного транспорту, а також як основу для зниження ризиків, пов'язаних з експлуатацією суден, навігацією та портовою діяльністю. Відтак, метою окресленого дослідження є дослідження теоретичних засад та практичних підходів до управління інноваційними процесами у сфері водного транспорту. Результатом дослідження стало підтвердження того факту, що управління інноваційними процесами на водному транспорті є критично важливим для адаптації цієї сфери діяльності до сучасних викликів і ринкових вимог. Цей процес сприяє підвищенню безпеки судноплавства, зменшенню його негативного впливу на довкілля, підвищенню економічної ефективності та оптимізації використання ресурсів. Запровадження інновацій робить водний транспорт більш конкурентоспроможним, надійним і стійким до змін, що забезпечує сталий розвиток галузі та зміцнює її роль у внутрішніх і міжнародних перевезеннях. Встановлено, що ефективне управління інноваційними процесами на водному транспорті повинно ґрунтуватися на специфічному циклі управлінських дій, у якому кожен етап логічно продовжує попередній. Цей цикл охоплює: послідовну ідентифікацію та оцінку інноваційних ідей і технологій; планування інноваційної діяльності з визначенням пріоритетів і ресурсів; координацію впровадження інновацій на рівні підприємств та регіональних систем із відповідним навчанням персоналу та адаптацією організаційних структур; систематичний моніторинг і оцінку ефективності з урахуванням впливу на безпеку, економіку та довкілля; управління ризиками та змінами, пов'язаними з інтеграцією інновацій.**

*Key words: evaluation of innovative ideas; innovation activity planning; innovation implementation; monitoring and evaluation of effectiveness; transportation safety; water transport; risk and change management.*

*Ключові слова: оцінка інноваційних ідей; планування інноваційної діяльності; впровадження інновацій; моніторинг і оцінка ефективності; безпека перевезень; водний транспорт; управління ризиками й змінами.*

## PROBLEM STATEMENT

The modern development of water transport occurs amid increasing demands for enhanced efficiency, as well as a strengthened focus on environmental sustainability and, above all, transportation safety. These demands are driven by the intensification of international trade flows, the growth in passenger and cargo volumes, and the increasing complexity of logistics chains.

All these factors create a necessity for the continuous improvement of both technological solutions and management approaches. In this context, innovation should be regarded as a key factor in the competitiveness and viability of water transport enterprises, as well as a foundation for reducing risks associated with vessel operation, navigation, and port activities.

For example, modern AIS systems allow real-time tracking of the position, speed, and course of vessels, significantly reducing the risk of collisions, especially in areas with heavy traffic. The implementation of such solutions in the Black Sea region, as part of the "Blue Safe Maritime Corridor" operation (by IMO decision), has enabled the creation of safe humanitarian routes for ships within the conflict zone in the Black Sea. The use of IoT sensors for continuous monitoring of engine condition, hull

integrity, and fuel systems enables the early detection of malfunctions and helps prevent accidents. In practice, this has allowed major shipping companies (Maersk, Rolls-Royce, Wartsila (Fleet Operations Solution)) to reduce repair costs by 15—18% and increase the technical readiness of their fleets.

Therefore, effective management of innovation processes in the field of water transport is currently essential, as it not only enhances the safety of waterborne transportation but also helps minimize the impact of human factors, optimize resource use, and adapt transport systems to conditions of an unstable external environment.

## ANALYSIS OF RESEARCH AND PUBLICATIONS

The problems of implementing innovations to improve the efficiency, safety, and environmental sustainability of water transport are examined in detail in the works of Bulets N.V., Herzanych V.M., Savko I.I., Savko Ya.I. [3], Valiavska N.O., Korniiiko Ya.R., and Ushatskyi R.V. [5]. In particular, their studies highlight such key issues as insufficient funding of innovation projects and the difficulty of attracting investments, technical challenges in adapting new technologies to the specific features of

**Table 1. Main areas covered by the management of innovation processes in the field of water transport**

| Areas of innovation                       | Specification of innovation features by direction                                                                                                                                                                                                                                                                   | Specifics of managing innovation processes                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Technological innovations                 | Implementation of automated navigation and traffic control systems (AIS, ECDIS, traffic monitoring systems).<br>Use of IoT sensors to monitor the technical condition of vessels and enable predictive maintenance.<br>Modernization of engines and fuel systems to reduce emissions and improve energy efficiency. | Formation of a management action cycle that includes:<br>- Identification and evaluation of innovative ideas and technologies.<br>- Planning of innovation activities.<br>- Coordination of the implementation of innovative solutions at the enterprise and regional transport system levels.<br>- Monitoring and evaluation of innovation effectiveness.<br>- Risk and change management. |
| Organizational and managerial innovations | Development and implementation of digital platforms for voyage planning and fleet management.<br>Optimization of logistics chains using Big Data and AI technologies.<br>Formation of integrated safety management systems in accordance with international standards (ISM Code).                                   |                                                                                                                                                                                                                                                                                                                                                                                             |
| Innovations in personnel training         | Use of VR/AR simulators for crew training in realistic emergency scenarios.<br>Implementation of remote platforms for the professional development of seafarers and port personnel.                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                             |
| Environmental innovations                 | Implementation of vessels powered by alternative energy sources (LNG, hydrogen, electric drives).<br>Ballast water treatment systems and reduction of harmful emissions.                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                             |
| Infrastructure innovations                | Automation of port operations (smart ports).<br>Use of unmanned vessels for water area monitoring and inspections.                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                             |

Source: compiled based on [1; 4; 6].

water transport; organizational barriers and resistance to change among both personnel and management.

At the same time, the specifics of managing innovation processes in water transport have not yet been sufficiently covered in the existing scientific literature, which highlights the need for further research in this area.

## FORMULATION OF THE ARTICLE'S OBJECTIVES

The purpose of the article is to study the theoretical foundations and practical approaches to managing innovation processes in the field of water transport.

## THE PAPER MAIN BODY

Hrebeniuk H. M., Charkina T. Yu., and Polishko T. V. emphasize that managing innovation processes in water transport is a purposeful activity involving the planning, organization, coordination, control, and implementation of advanced technological, organizational, and managerial solutions aimed at improving the efficiency, safety, environmental sustainability, and competitiveness of waterway transportation [6]. Accordingly, within the framework of their study, the authors examine this process as one that entails the integration of scientific and technological achievements, digital technologies, and modern management methods into the operations of shipping companies, ports, and other sector entities (such as ship repair enterprises, logistics operators, customs services, freight forwarding companies, insurance firms, and state regulatory bodies [2]).

Considering the above provisions, the main areas covered by the management of innovation processes in the field of water transport include: technological

innovations; organizational and managerial innovations; innovations in personnel training; environmental innovations; and infrastructure innovations. These areas are described in more detail in Table 1.

Based on the provided data, it is evident that the management of the innovation processes in water transport presented in the table should be carried out within a specific cycle of managerial actions, each element of which is a logical continuation of the previous one. This cycle includes [4; 6]:

1. Identification and evaluation of innovative ideas and technologies capable of delivering significant improvements in the safety, efficiency, or environmental sustainability of transportation.

2. Planning of innovation activities involves developing a strategy for implementing new technologies, defining priority areas, and allocating resources.

3. Coordination of the implementation of innovative solutions at the level of water transport enterprises and regional transport systems, including staff training and adaptation of organizational structures.

4. Monitoring and evaluation of innovation effectiveness, analyzing their impact on water transport safety, economic performance, and the environment.

5. Risk and change management related to the integration of innovative technologies and processes.

So, each component of the innovation management cycle in water transport creates a closed loop that promotes continuous improvement in the safety, efficiency, and environmental sustainability of transportation.

Identification and evaluation of innovative ideas and technologies is the first and extremely important component of the innovation management cycle in water transport. It involves detecting promising

**Table 2. Components of identification and evaluation of innovative ideas and technologies in water transport**

| Components                       | Identification of innovations                                                                                                                                                                                                                                                                                                                                 | Оцінка інновацій                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Characteristics of the component | Systematic search for new ideas, technologies, products, or processes that can be applied in water transport.*                                                                                                                                                                                                                                                | аналіз знайдених ідей і технологій з точки зору їхньої доцільності, ефективності, ризиків, економічної вигоди, технічної сумісності та екологічного впливу.                                                                                                                                                                                                 |
| Implementation features          | Establishment of information-gathering channels (scientific publications, exhibitions, conferences, patents).<br>Creation of specialized teams or departments responsible for innovation scouting.<br>Implementation of a system for continuous monitoring of the market and technological trends.<br>Use of analytical tools to select relevant innovations. | Development of evaluation criteria (cost-effectiveness, safety, environmental impact, technical integration).<br>Conducting expert evaluations and SWOT analysis.<br>Organization of pilot projects or prototyping.<br>Involvement of multidisciplinary teams for comprehensive assessment.<br>Decision-making based on collected data and recommendations. |
| Implementation results           | Ensuring integration between R&D departments, rolling stock operations, and transport safety.<br>Establishing clear criteria for innovation evaluation.<br>Flexibility and readiness for change.                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                             |

Note:

\* Enables the monitoring of scientific and technological developments, analysis of market trends, and study of the experience of other companies and industries.

\*\* Allows for substantiating decisions regarding the adoption or rejection of a particular innovation, ensuring the rational use of resources and maximizing the positive impact on the safety, efficiency, and sustainable development of water transport.

Source: compiled based on [6].

technological solutions and assessing their potential to improve safety, efficiency, and environmental performance of transportation, in accordance with the specifics outlined in Table 2.

Based on the provided data, it is evident that important aspects of management at this stage include:

— ensuring integration between R&D, operations, and transport safety departments;

— establishing clear criteria for innovation evaluation (economic benefit, impact on safety, environmental considerations, compatibility with existing systems);

**Table 3. Components of innovation activity planning in water transport**

| Components              | Analysis of available resources and development of a plan for their optimal use                                                                                                                                                                                                                                                                                                   | <u>Definition of stages for innovation implementation</u>                                                                                                                                                                                                               |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Implementation features | A systematic process of assessing the available financial, technical, human, and material resources of an enterprise or transport system to determine their potential for supporting innovation projects. This stage includes identifying resource constraints, the need for additional investments, and developing specific measures for the rational allocation of resources.** | A process of developing a phased plan for the implementation of innovative solutions, which involves clearly dividing the work into logical phases with defined specific tasks, deadlines, responsible persons, and criteria for evaluating the results of each stage.* |
| Implementation results  | Development of a step-by-step implementation plan with specific deadlines.<br>Appointment of responsible persons for each stage.<br>Establishment of criteria for evaluating interim and final results.<br>Consideration of potential risks and measures for their mitigation.                                                                                                    | Clear structure for innovation implementation.<br>Monitoring of implementation progress.<br>Ability to adjust the plan based on interim evaluations.                                                                                                                    |

Note:

\* Allows for systematizing the implementation of innovations, ensuring control over the progress of work, promptly identifying potential problems, and adjusting actions to achieve set goals with minimal risks and costs.

\*\* Ensures the identification of resource constraints, the need for additional investments, and the development of specific measures for the rational allocation of resources.

Source: compiled based on [2—3; 6].

**Table 4. Components of coordination for the implementation of innovative solutions at the level of water transport enterprises**

| Components              | Ensuring interaction between departments, personnel, and partners                                                                                                                                                                 | Personnel training                                                                                                                                                                               | Adaptation of existing organizational structures to changes.                                                                                                                                                                     |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Implementation features | Management of cross-functional interaction, which includes coordinating the activities of various structural units, optimizing information flows, and joint planning of activities.*                                              | Professional training and skills development aimed at enhancing employee qualifications, adapting to new technologies, and changes in work processes.**                                          | Organizational transformation or reorganization involving the renewal of business processes, redistribution of responsibilities, and creation of new departments or roles necessary to support innovation. ***                   |
| Implementation results  | Ensuring synchronization of actions between departments and partners. Effective communication and information exchange. Minimizing conflicts and duplication of work. Timely and high-quality implementation of new technologies. | Development of necessary knowledge and skills for working with innovative systems. Enhancement of professional competence of personnel. Adaptation of employees to changes and new requirements. | Increasing the flexibility of the organizational structure. Improving the distribution of responsibilities. Ensuring effective support of innovation processes. Enhancing the overall efficiency of the enterprise's operations. |

Note:

\*Allows for the realization of synergy of resources and knowledge, eliminates communication barriers, and enables effective implementation of innovative projects, thereby increasing the overall productivity and competitiveness of the organization.

\*\*Enables the implementation of trainings, seminars, advanced courses, as well as practical learning, which ensures effective innovation adoption and enhances organizational productivity.

\*\*\*Facilitates increased organizational flexibility and efficiency, ensuring the ability to respond promptly to internal and external changes, as well as supporting innovative development and competitiveness.

Source: compiled based on [3—4; 6].

— maintaining flexibility and readiness for change in the event of new technological breakthroughs or changes in external conditions.

Planning of innovation activities, as a component of the innovation management cycle in water transport, involves a systematic approach to the preparation and organization of innovation implementation. It includes the development of a clear strategy that defines the main goals and priority areas of innovation activities, taking into account the current needs for safety, efficiency, and environmental sustainability of transportation. Accordingly, during planning:

1. An analysis of available resources (financial, technical, and human) is conducted, and a plan for their optimal use is developed to achieve the set objectives.

2. The stages of innovation implementation, timelines, responsible units, and criteria for evaluating the success of implementation are defined.

The components outlined above are described in more detail in Table 3.

Coordination of the implementation of innovative solutions at the level of water transport enterprises and regional transport systems should be understood as a set of management measures aimed at organizing and synchronizing the actions of all involved parties for the effective execution of innovation projects.

This component of the innovation management cycle includes [4; 6]:

— ensuring interaction between departments (technical and management teams), operational staff, and external partners in order to implement new technologies in a timely and high-quality manner;

— training personnel to develop the necessary knowledge and skills for working with innovative systems;

— adapting existing organizational structures to changes, which includes updating business processes, distributing responsibilities, and creating new departments or roles needed to support innovation.

The above components are described in more detail in Table 4.

Monitoring and evaluation of the effectiveness of innovations is a systematic process of collecting, analyzing, and interpreting data regarding the implemented innovative solutions in water transport. This component of the innovation management cycle includes:

— regular tracking of key performance indicators (KPIs), such as the number of accident cases, operational costs, fuel consumption, volumes of harmful emissions, and other relevant parameters;

— identification of successful practices and detection of problem areas.

The components of monitoring and evaluating the effectiveness of innovations in water transport described above are detailed in Table 5.

Monitoring and evaluation of innovation effectiveness are key actions to ensure the sustainability of innovation

**Table 5. Components of monitoring and evaluation of innovation effectiveness in water transport**

| Components              | Regular tracking of key performance indicators (KPIs)                                                                                                                                                                                                                                                                                                                                                                                                                                   | Identification of successful practices and detection of problem areas.                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Implementation features | A systematic process of collecting, analyzing, and monitoring key performance parameters of water transport operations that reflect the degree of achievement of set goals regarding safety, efficiency, and environmental friendliness of transportation.*                                                                                                                                                                                                                             | The process of analyzing the results of implementing innovative solutions to identify the most effective methods and approaches, as well as to determine areas where difficulties or shortcomings arise**                                                                                                                                                                                                                            |
| Implementation results  | Defining specific KPIs (e.g., number of accidents, vessel downtime, fuel consumption, level of harmful emissions).<br>Collecting data in real time or at regular intervals using sensors, automated monitoring systems, and digital platforms.<br>Analyzing the collected data to identify trends, deviations from standards, and potential issues.<br>Providing information for management decision-making to improve the quality and safety of transportation and optimize resources. | Comparing actual performance indicators with planned or normative values.<br>Identifying examples of successful innovation implementation that have positively impacted the safety, efficiency, or environmental sustainability of transportation.<br>Analyzing the causes of problematic situations or declines in performance.<br>Developing recommendations for spreading best practices and eliminating identified shortcomings. |

Note:

\* Enables prompt response to changes in system operations and promotes continuous improvement of water transport activities.

\*\* Allows for improved innovation management quality, adaptation of strategies and implementation methods, as well as minimizing risks in future operations.

Source: compiled based on [4–6].

processes and the achievement of the industry's long-term goals.

Risk and change management related to the integration of innovative technologies and processes, as a component of the innovation management cycle in water transport, is aimed at minimizing negative consequences and ensuring smooth implementation of innovations. It includes [4]:

- Identification of potential risks associated with technical, organizational, financial, and personnel aspects of implementing innovative solutions.

- Assessment and prioritization of risks based on their likelihood and impact on the safety, efficiency, and environmental sustainability of transportation.

- Development of measures to prevent or minimize negative consequences and monitoring their status.

- Adjustment of management actions according to changes in the external and internal environment.

The components described above are detailed in Table 6.

Effective risk and change management ensures the stability of water transport operations during the implementation of new technologies, reduces the likelihood of accidents and downtime, and promotes sustainable development of the industry.

## CONCLUSIONS

The study confirmed that managing innovation processes in water transport is critically important for adapting this sector to modern challenges and market demands. This process contributes to improving shipping safety, reducing negative environmental impacts, increasing economic efficiency, and optimizing resource use. The implementation of innovations makes water transport more competitive, reliable, and resilient to

changes, ensuring sustainable development of the industry and strengthening its role in international and domestic transportation.

It has been established that the effective management of innovation processes should be grounded in a structured cycle of managerial actions, where each stage logically follows the previous one. This cycle encompasses the sequential identification and evaluation of innovative ideas and technologies; the planning of innovation activities with clearly defined priorities and resources; the coordination of innovation implementation at both enterprise and regional system levels, supported by targeted staff training and the adaptation of organizational structures; systematic monitoring and evaluation of outcomes, taking into account their impact on safety, economic performance; environmental sustainability as well as risk and change management associated with the integration of innovations. Such an integrated approach creates a closed loop that fosters the continuous improvement of key water transport performance indicators — safety, efficiency, and environmental sustainability.

The prospects for further research lie in the development of adaptive innovation management models that take into account digital transformation and climate change in water transport.

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**Table 6. Risk and change management related to the integration of innovative technologies and processes in water transport**

| Components              | Identification of potential risks                                                                                                                         | Risk assessment and prioritization                                                                                                                                                | Development of measures to prevent or minimize negative consequences and monitoring their status.                                                                      | Adjustment of management actions in response to changes in the external and internal environment.                                                                                 |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Implementation features | A systematic process of collecting operational parameters of water transport.*                                                                            | Identification and ranking of risks based on their likelihood of occurrence and the degree of impact on safety, efficiency, and environmental sustainability of transportation.** | Planning and implementing actions to eliminate or reduce the impact of risks, as well as continuously monitoring the effectiveness of these measures.***               | Flexible updating of procedures, technologies, and resource allocation based on new conditions, monitoring data, and situational forecasts.****                                   |
| Implementation results  | Identification of key threats and vulnerabilities that may affect the innovation implementation process, enabling the development of preventive measures. | A clear understanding of risk priorities, allowing for effective allocation of resources and focusing on the most critical threats.                                               | Implementation of effective measures that reduce the likelihood of risks occurring and minimize their impact, along with continuous monitoring of their effectiveness. | Enhancing management flexibility and adaptability to ensure timely response to new challenges and conditions, maintaining the sustainability and success of innovation processes. |

Note:

\*Allows identifying negative changes related to safety, efficiency, and environmental sustainability of transportation, and promotes continuous improvement of water transport operations.

\*\* Helps management focus on those threats that are most likely to occur and have the greatest negative impact on the company's operations and reputation.

\*\*\* Assists management in developing actions aimed at reducing risks and monitoring their development.

\*\*\*\* Ensures the relevance of management decisions, enhancing the adaptability and resilience of the system to environmental changes.

Source: compiled based on [1-2; 4].

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