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The use of Digital Technologies to Ensure Environmental Safety in the Context of the Green Economy Development

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ABSTRACT

The purpose of the article is to justify the use of digital technologies to ensure environmental safety in the context of the green economy development, taking into account its tasks and principles. The research methodology is a comprehensive approach that makes it possible to comprehensively approach the methods and techniques of scientific knowledge, to carry out a comprehensive analysis of the subject of research, to reveal the essence of the green economy and the purpose of implementing digital technologies to ensure environmental safety, to follow the system-forming connections between economic, social, and ecological processes in a global dimension, to highlight the directions of using digital technologies to ensure environmental safety, which gives a synergistic effect for the development of the green economy. It has been proven that the use of artificial intelligence technologies, information logistics systems make it possible to solve many problems in agriculture in the process of production, processing, transportation and preservation of agricultural products. Highlighting the negative consequences of digitization in relation to the environmental component, which includes the increase in energy consumption, electronic waste and cyber security, made it possible to outline directions for their leveling.

KEYWORDS: Digital technologies, environmental safety, green economy.

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El uso de tecnologías digitales para garantizar la seguridad ambiental en el contexto del desarrollo de una Economía Verde

RESUMEN

El propósito del artículo es justificar el uso de tecnologías digitales para garantizar la seguridad ambiental en el contexto del desarrollo de la economía verde, teniendo en cuenta sus tareas y principios. La metodología de la investigación es un enfoque integral que permite abordar los métodos y técnicas del conocimiento científico, realizar un análisis integral del tema de investigación, revelar la esencia de la economía verde y el propósito de implementar tecnologías digitales para garantizar la seguridad ambiental, seguir las conexiones que forman sistemas entre los procesos económicos, sociales y ecológicos en una dimensión global, resaltar las direcciones del uso de tecnologías digitales para garantizar la seguridad ambiental, lo que da un efecto sinérgico para el desarrollo de la economía verde. Se ha comprobado que el uso de tecnologías de inteligencia artificial y sistemas de logística de la información permiten resolver muchos problemas en la agricultura en el proceso de producción, procesamiento, transporte y conservación de productos agrícolas. Destacar las consecuencias negativas de la digitalización en relación al componente ambiental, que incluye el aumento del consumo de energía, los residuos electrónicos y la ciberseguridad, permitió trazar direcciones para su nivelación.

PALABRAS CLAVE: Tecnologías digitales, seguridad ambiental, economía verde.

Introduction

Ensuring environmental security in the context of the green economy development requires rational and efficient use of resources, which ensures the sustainability of the development of economic entities.

Various international organizations make forecasts regarding the exhaustion of resources and environmental pollution, so according to the forecasts of the Organization for Economic Cooperation and Development, under the modern method of production and consumption of resources to meet the growing needs of society in 50 years to 2050 on our planet from 61% to 72% built-up volume of flora and fauna, 7.5 million km² will be disturbed, which are not subject to natural restoration. According to Global Footprint Network estimates, the amount of resources that can be renewable is consumed on Earth for 7 months and 13 days per year, the rest of the consumed resources per year are non-renewable. That is, 38% of the energy consumed on Earth per year is non-renewable (Global Footprint Network). Such trends are becoming increasingly relevant to the

development of the green economy and ensuring environmental safety, which is facilitated by the introduction of information technologies. The main postulate of the green economy development is the statement that economic development directly depends on the natural environment, which provides resources, and ensuring the well-being of the population and social justice is possible due to the rational and efficient extraction and use of resources, ensuring cyclical production, and reducing environmental risks.

The purpose of the article is to justify the use of digital technologies to ensure environmental safety in the context of the green economy development. To achieve the goal of the study, the authors were:

-firstly, the timeliness of scientific research in this area is substantiated;

secondly, the tasks and principles of the green economy were highlighted, which made it possible to substantiate the need for the use of digital technologies to ensure environmental safety;

-thirdly, the advantages of using digital technologies in the production sphere, agriculture, at the government level, for the organization of the environmental monitoring system, increasing the efficiency of energy systems, etc. are highlighted;

-fourthly, the negative consequences of the introduction of digital technologies are clarified and directions for combating them are outlined;

-fifthly, the conducted research made it possible to prove the main results and identify further directions of scientific research in this context.

It should be noted that modern globalization challenges, growing environmental problems, growing unsatisfied demand and population size require increasing the rationality and efficiency of resource use, taking into account the needs of future generations. The outline and analysis of publication activity in this direction of scientific research proves the need to deepen scientific research in the direction of using digital technologies to ensure environmental safety in the context of the development of a green economy.

1. Literature Review

The issue of the role of digital technologies in ensuring environmental safety, taking into account the modern challenges of the green economy development, is becoming increasingly relevant and timely. Articles (Popelo O. et al., 2023; Marhasova V. et al., 2023;

Arefiev S., et al., 2022; Kholiavko N., et al., 2022), are devoted to various aspects of the development of education in the conditions of digitalization in order to ensure environmental safety and implement the concept of sustainable development. The functioning of eco-industrial parks, their innovative development in the conditions of the formation of a circular economy and within the framework of the implementation of the goals of sustainable development are attributed to scientific research (Tulchynska S. et al., 2022; Tkachenko T. et al., 2021; Pohrebniak A. et al., 2021; Petrashko L. et al., 2021; Tulchynska S. et al., 2021; Melnychenko A. et al., 2022).

Many publications are devoted to the problems of environmental safety in the context of the green economy development. Scholars (Yang H. et al., 2023) examine direct relationships between SME skills and strategic flexibility using the results of a Gaussian mixed model between environmental human resource management and government other constraints. The results of the study demonstrate that the right policy influence on human capital through flexible digitalization affects regional or state-owned enterprises and firms in conditions

The authors of the study (Jian Hou et al., 2023) evaluate China's digital economy based on the experience of regional data and build a nonlinear dynamic threshold model to incorporate the heterogeneous threshold of green technology innovation into the influencing mechanism. The authors investigated that green technology innovation has a heterogeneous threshold effect between the digital economy and carbon emissions: a lower level of green technology innovation contributes to the carbon impact of the digital economy to some extent, but when green technology innovation increases and exceeds the threshold, the digital economy can dramatically reduce regional emissions carbon.

Within the framework of article (Popkova E.G. et al., 2023), the use of ICT in the field of climate management is analyzed as the basis for increasing the effectiveness of the functioning of ecologically oriented entrepreneurship. The article is aimed at assessing the impact of the introduction of digital technologies on the effectiveness of business activity in the context of the green economy development.

According to the authors (Mingkai Z. et al., 2023), green innovation and digital economy are the new engine and driving force of China's high-quality development, and they will become the main direction of high-quality development in China. Scientists believe that it is important to investigate the interaction between them for the formulation

of economic development policies. The article develops a system for evaluating the effectiveness of green scientific and technical innovations and the level of the digital economy.

Within the framework of the study (Jiang C. et al., 2022), the authors determined the impact of digitalization and green technologies on health care outcomes. The results of research by scientists show that digitalization leads to an increase in life expectancy in the long term, although "green" technologies in the long term increase life expectancy, in the short term they have a negligible effect on health.

The authors (Bai H., 2021) argue that digital technologies have gained momentum in the last decade due to their links with digital entrepreneurship, digital economy, digital social interaction, green economy, etc. The results of the academics' research show that digital technologies have brought many benefits to organizations, such as centralization, access to new markets and transparency, which have become possible remotely only through the use of digital technologies in business operations.

The authors' study (Kantsalieva Z.L. et al., 2020) determined the current level of diffusion of "green" digital technologies in the economy, and also developed scenarios and recommendations to ensure the mass availability of these technologies for an accelerated "green" digital economy. The authors argue that instead of fragmented technology development, there is a need for systemic development that not only significantly increases the level of the green digital economy in countries with very high and high and medium levels of human development, but also reduces the gap between them, thus contributing to a balanced global "green » digital economy.

Scientists (Chekalin V. et al., 2020) investigate the issue of trends in the influence of green digital technologies on the formation of economic processes and environmental changes.

In article (Srivastva A.N. et al., 2022), the authors investigated that nanocomposites from environmentally friendly metals are used both in solving energy and environmental problems. The easy processing and low production cost of these polymer materials also attract environmental chemists to develop new polymer-metal composites within the development of the green economy.

The authors (Haibin Qu et al., 2023) believe that smart delivery systems are important for modifying pesticides and improving utilization rates, but the economic and

environmental risks of carriers limit their practical application. As a conclusion, the scientists' research provides insight into efficient and sustainable agricultural production with the construction of an environmentally friendly nanocapsule platform using a co-crystalline engineering strategy to ensure environmental safety.

2. Methodology

The methodology of an integrated approach to justify the directions of using digital technologies to ensure environmental safety in the context of the development of a green economy makes it possible to approach the methods and techniques of scientific knowledge in a comprehensive manner, to carry out a comprehensive analysis of the research subject, which is the process of implementing and using digital technologies to ensure environmental safety. The use of an integrated approach made it possible to reveal the essence of the green economy and the purpose of implementing digital technologies to ensure environmental safety, to trace the system-forming connections between economic, social, and environmental processes in the global dimension and in relation to the subjects of social relations, to single out the directions of using digital technologies to ensure environmental security, which gives a synergistic effect for the development of the green economy. Also, with the application of the methodology of the integrated approach, the shortcomings of the use of digital technologies were outlined and the directions for their leveling were substantiated.

3. Results

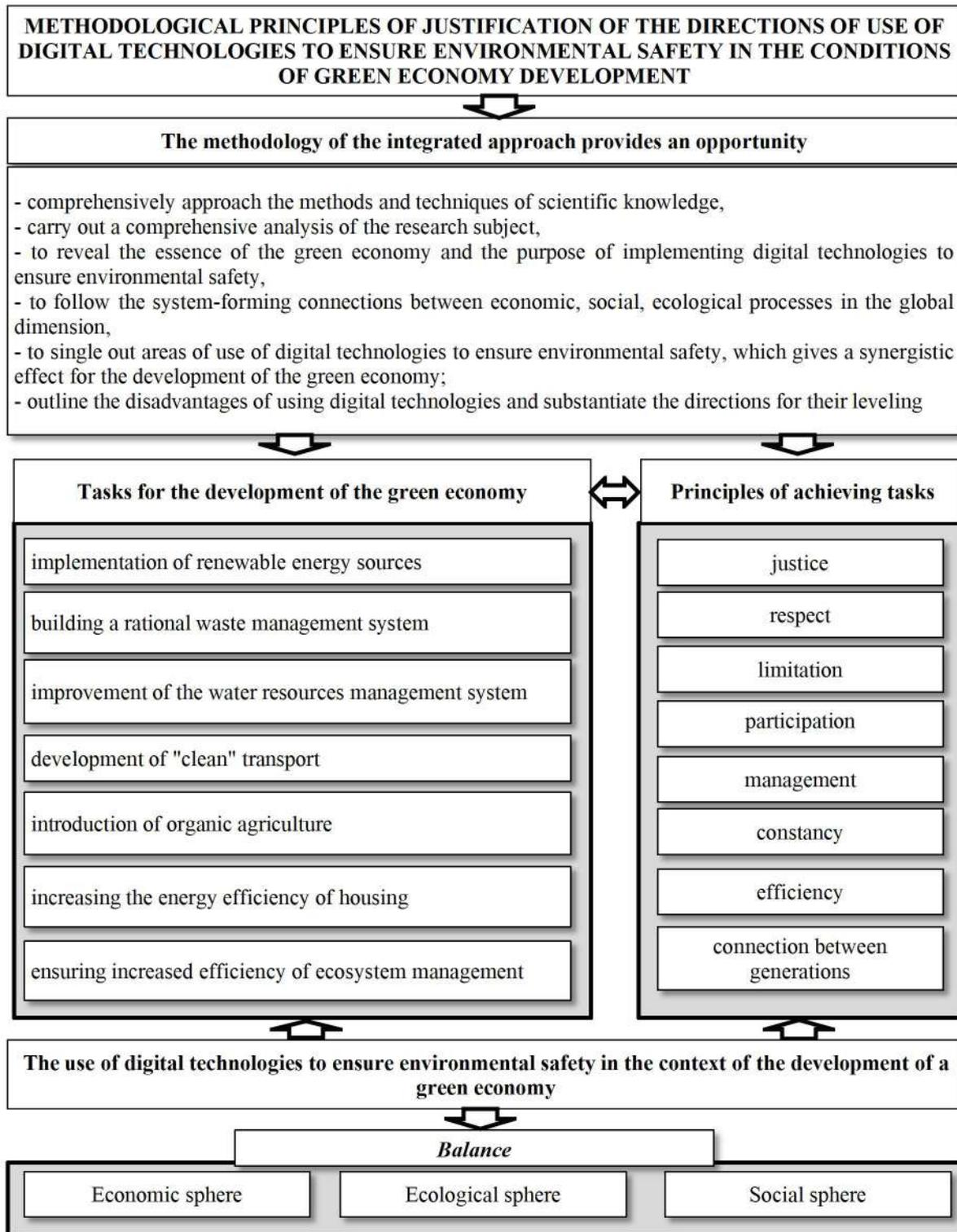
It is appropriate to mention the following main tasks of the green economy: introduction of renewable energy sources; building a rational waste management system; improvement of the water resources management system; development of "clean" transport; introduction of organic agriculture; increasing the energy efficiency of housing; ensuring increased efficiency of ecosystem management (Fig. 1).

The fulfillment of the assigned tasks requires compliance with the following principles:

- justice, which is achieved by equality of opportunities to use resources;
- respect, which implies social equality and well-being for all;

- limitations based on the accounting and limitations of ecological loads of the ecosystem;

Figure 1. Methodological principles of substantiation of directions for the use of digital technologies to ensure environmental safety in the context of the green economy development



Source: built by the authors

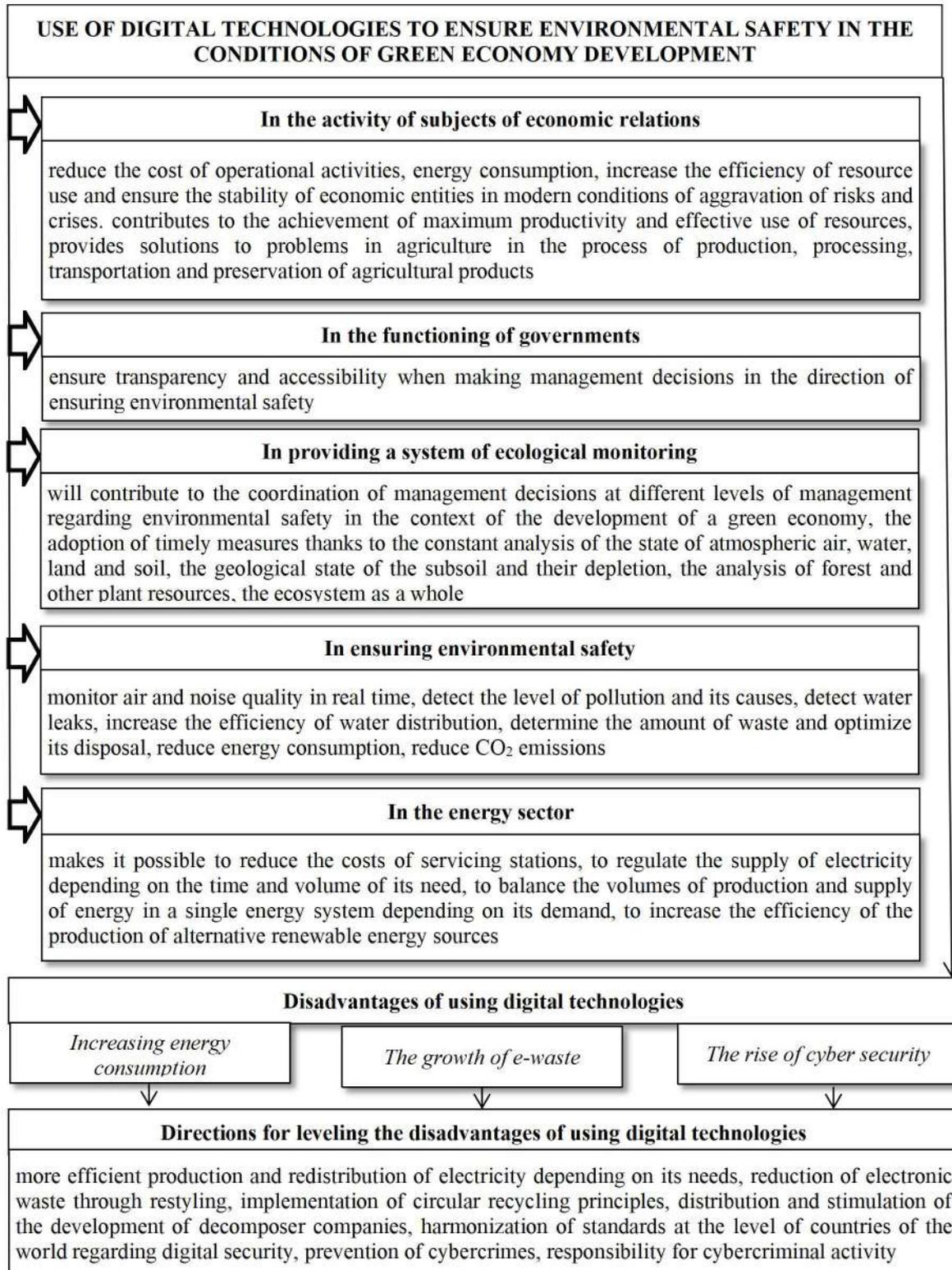
- participation, which involves the involvement of all subjects of the economy in decision-making and their compliance;
- management, which is ensured by transparency and reporting on the use of resources and the burden on environmental safety;
- sustainability, which corresponds to the principles of sustainable development of its economic, ecological and social components;
- efficiency achieved through rational production and consumption;
- communication between generations, which involves the careful use of exhaustive resources and ensuring the implementation of technologies for their preservation, taking into account the needs of future generations.

The outlined tasks and principles of the green economy require ensuring environmental safety through the use of digital technologies, which make it possible to comprehensively approach the solution of the tasks and improve the existing approaches to their achievement.

Digital technologies were initially considered from the point of view of increasing the efficiency of already existing business processes due to the increase in product quality, cost reduction, reduction of production time, optimization of logistics chains. Today, the role of digital technologies and their impact has changed radically not only in relation to business entities, but also in relation to the entire society and its further development. By joining digital systems, the rationality and efficiency of the use of resources, production and sales of products and services increases, new opportunities are opened and new values are formed in the market (Fig. 2).

Today, digital technologies are increasingly being used in the activities of economic entities. Information has become as important a resource for production as other material resources, modern technologies make it possible to process large information arrays, which contribute to the adoption of more effective management decisions regarding the satisfaction of demand, use of resources, adaptation to environmental changes and their forecasting. The implementation of digital technologies and electronic document circulation at enterprises reduce the costs of paper needs. On a planetary scale, this is a significant advantage. Thus, according to UN data, over the past 40 years, paper consumption has increased by 400%, which leads to the destruction of forest areas, according to experts' estimates, 35% of wood is used for paper production.

Figure 2. Advantages, disadvantages and directions of their leveling in relation to the use of digital technologies to ensure environmental safety in the conditions of the green economy development



Source: built by the authors

Such digital technologies as 5G, cloud computing, 3-D printing, blockchain and others significantly reduce the cost of operational activities, energy consumption, increase the efficiency of resource use, and increase the stability of economic entities in today's conditions of aggravation of risks and crises. The development of electronic commerce, electronic banking, and virtual meetings make it possible to reduce the number of trips and thereby reduce environmental pollution. The paradigmatic philosophy of implementing Industry 4.0 principles at enterprises contributes to achieving maximum productivity and efficient use of resources.

Modern conditions of globalization processes lead to the strategic integration of the environmental policy of the governments of the countries of the world, which is possible due to the use of digital technologies in the form of electronic governance of the environmental sphere, automation of environmental data systems, which makes it possible to ensure transparency and accessibility when making management decisions in the direction of ensuring environmental safety. The adoption of management decisions using digital technologies at the level of international organizations and governments of countries of the world increases their quality and contributes to slowing down climate change, improving the environmental situation, and observing the principles of the formation of a green economy.

It is important to ensure the functioning and development of the environmental monitoring system at all levels of management, which includes monitoring the state of atmospheric air, water, land and soil, the geological state of the subsoil and its depletion, forest and other plant resources, the ecosystem as a whole. The environmental monitoring system due to the implementation of modern digital technologies will contribute to the coordination of management decisions at various levels regarding environmental safety in the context of the green economy development. Obtaining and processing complete information on the state of the environment, resource use, pollution and other information, its processing, accumulation and storage in a single system contributes to the adoption of effective decisions to ensure environmental safety, the development of strategies to increase the rationality of the use and attraction of resources, forecasting environmental changes taking into account the economic and social development.

The use of artificial intelligence technologies, information logistics systems makes it possible to solve many problems in agriculture in the process of production, processing, transportation and preservation of agricultural products.

Digital technologies, for example through the use of IoT and artificial intelligence technologies, make it possible to monitor air or noise quality in real time, identify the level of air pollution and its causes, water pollution and leaks, increase the efficiency of water distribution, determine the amount of waste and optimize its disposal, reduce energy consumption, reduce CO₂ emissions.

Implementation of digital technologies plays a big role in more efficient use of energy. This is not only the introduction of various devices for accounting and adjusting the use of energy, but also increasing the productivity of its production. For example, the creation of information systems for the regulation of wind power plants and the use of artificial intelligence makes it possible to reduce the costs of their maintenance, to regulate the supply of electricity depending on the time and volume of its need. The use of digital technologies that allow you to adjust the direction of solar panels depending on the direction of the sun's rays during the day is 45% more efficient than static solar panels.

Therefore, the use of various digital technologies makes it possible to balance the volumes of production and supply of energy in a single energy system depending on its needs, to increase the efficiency of the production of alternative renewable energy sources.

Today, innovative projects are being actively implemented, which are based on digital technologies and involve the development of smart cities, ecological transport, smart agriculture, electronic governments, etc. All this activates the development of the green economy and increases environmental safety.

It should be noted that the use of digital technologies to ensure environmental safety in the context of the green economy development, like any process, has certain negative trends. The negative consequences of digitalization in relation to the environmental component include:

First, the growth of energy consumption. Yes, indeed, digital technologies require the use of electricity, which leads to carbon emissions. According to experts, information and communication technologies consume 3.6% of the total demand for electricity in the world and create 1.4% of carbon emissions. But, at the same time, digital technologies help to more efficiently produce and redistribute electricity depending on its needs.

Second, the growth of e-waste. According to experts' estimates, electronic waste, consisting of used electrical appliances, electronic casing, computers, and various electronic gadgets, makes up about 2% of the total volume. In this direction, many leading manufacturers of electronic packaging are already implementing a policy to reduce such waste through restyling, implementation of circular recycling principles, etc. It is important in this direction to spread and stimulate the development of demo poser companies, whose work is based on waste as a resource from which, as a result of processing and other transformations, new materials are created to ensure the production processes of various spheres of economic activity.

Third, the growth of cyber security. Yes, any arrays of information and databases can be used both positively and negatively. Naturally, the fight against cybercrimes is carried out both at the level of individual enterprises and at the level of Governments and international organizations. The harmonization of standards at the level of the countries of the world regarding digital security, prevention of cybercrimes, and responsibility for cybercriminal activity can become an obstacle to cybercrime.

Despite the negative manifestations of digitalization, the implementation of digital technologies has great potential for ensuring environmental safety and the development of a green economy through the reduction of industrial emissions and their regulation, the creation of a system of environmental monitoring and assessment of the ecosystem. Digital transformation becomes the driving force of economic, ecological and social development, unites various subjects of globalization relations in the direction of achieving the goals of the green economy.

So, despite certain negative manifestations, the use of digital technologies to ensure environmental safety in the context of the green economy development has much more positive results. In general, the digitalization process is increasingly growing and global, its use in relation to environmental security is indisputable.

4. Discussion

Supporting the results of the authors' research (Ghaseminejad A. et al., 2023), we would like to note the relevance of the article, which considers the problem of reliable planning of facilities taking into account unpredictable standards of health care and environmental safety.

Considering the results of the study (Landi C. et al., 2023) to be relevant, he wants to note that today the use of sewage sludge and carbon in agriculture is a common practice for soil conditioning and crop fertilization, but recently there has been a safety problem for human health and the environment due to the presence of toxic compounds. Therefore, validation of the suitability of proteomics in combination with the bioanalytical tools researched by scientists is necessary.

Considering the timely study (Boisseaux P. et al., 2023), it should be noted that the authors investigate bioplastics derived from organic materials other than crude oil, often proposed as sustainable solutions to deal with processed plastic waste, but little is known about their ecotoxicity to aquatic species, which is extremely relevant. to ensure environmental safety.

Supporting the methodical approach to environmental safety risk assessment in the agricultural sector of the economy developed by the authors (Shkuratov O. et al., 2019), it should be noted that in order to prevent the introduction of complex methods of assessing environmental safety risks, scientists suggested using a binary method of management decision-making to determine the probability of their occurrence. As a result of the approbation of the methodical approach, the regions of Ukraine were grouped according to the level of environmental safety risk in the agrarian sector of the economy, which will make it possible to determine the appropriate strategic priorities.

Research (Matyushenko I. et al., 2015) is relevant, within the scope of the article, the authors considered the current trends in the development of the bioeconomy based on the application of biotechnology in environmental safety and agriculture, including genetically modified and other agricultural crops, which are important in the context of the green economy development and ensuring environmental safety.

Despite the large number of publications, we would like to note that the issue of using digital technologies to ensure environmental safety in the context of the green economy development is relevant and requires further research.

Conclusion

The conducted research makes it possible to note that the use of digital technologies at the level of various economic entities is a tool for ensuring environmental safety in the

context of the development of a green economy and makes it possible to achieve a balance of economic and environmental components, taking into account social social development.

The scientific novelty of this study is the justification of the use of digital technologies to ensure environmental safety in the context of the development of a green economy using a comprehensive approach, which involves highlighting the advantages of using digital technologies in the production sphere, agriculture, at the level of governments, for the organization of the environmental monitoring system, increasing the efficiency of energy systems , as well as highlighting the shortcomings of the use of digital technologies and directions for their leveling, which makes it possible to ensure the achievement of the goals of the green economy development in compliance with the principles of justice, advantage, limitation, participation, management, sustainability, efficiency and connection between generations.

Digital technologies increase environmental safety by introducing ecological production methods, reduce the negative impact on the environment. The use of digital technologies contributes to the development of the green economy by increasing the efficiency of production, reducing the demand for natural resources, reducing the use of non-renewable resources, increasing the effectiveness of environmental monitoring, etc.

Further directions of scientific exploration in the direction of the use of digital technologies to ensure environmental safety in the context of the development of a green economy are the solution of the problem of the contradiction of the greening of production, the strengthening of stimulation of the attraction of green investments and the development of innovative technologies, the formation of a new worldview of the population to the problems of environmental preservation.

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