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MODEL OF INNOVATION AND INVESTMENT SUPPORT FOR A SUSTAINABLE LEVEL OF COMPETITIVENESS OF FOOD INDUSTRY ENTERPRISES IN A CIRCULAR ECOSYSTEM

МОДЕЛЬ ІННОВАЦІЙНО-ІНВЕСТИЦІЙНОГО ЗАБЕЗПЕЧЕННЯ СТІЙКОГО РІВНЯ КОНКУРЕНТОСПРОМОЖНОСТІ ПІДПРИЄМСТВ ХАРЧОВОЇ ПРОМИСЛОВОСТІ В ЦИРКУЛЯРНІЙ ЕКОСИСТЕМІ

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The article explores theoretical, methodological and applied aspects of the formation of a model of innovation and investment support for a sustainable level of competitiveness of food industry enterprises in the conditions of the functioning of a circular ecosystem. The transformation processes in the food industry associated with the digitalization of the economy, environmental challenges, resource constraints and increased global competition are substantiated. It is determined that the condition for the long-term competitiveness of enterprises is the integration of innovative technologies, investment mechanisms, digital management platforms and environmentally friendly business processes. The introduction of resource-saving technologies, Smart solutions, Industry 4.0, ESG tools and digital monitoring systems contributes to increasing production productivity, optimizing resource use, minimizing waste and forming sustainable competitive advantages of enterprises.

Keywords: circular economy, innovation and investment support, competitiveness, food industry, sustainable development, digitalization, ESG integration.

У статті досліджено теоретико-методичні та прикладні аспекти формування моделі інноваційно-інвестиційного забезпечення стійкого рівня конкурентоспроможності підприємств харчової промисловості в умовах функціонування циркулярної екосистеми. Сучасні трансформаційні процеси, пов'язані з цифровізацією економіки, екологічними викликами, ресурсними обмеженнями та посиленням глобальної конкуренції, вимагають переходу підприємств харчової промисловості до циркулярної моделі розвитку. Визначено, що умовою довгострокової конкурентоспроможності підприємств є інтеграція інноваційних технологій, інвестиційних механізмів, цифрових платформ управління та екологічно орієнтованих бізнес-процесів. У процесі дослідження розроблено комплексну модель інноваційно-інвестиційного забезпечення конкурентоспроможності підприємств харчової промисловості, яка включає інноваційно-технологічний, інвестиційно-фінансовий, цифрово-аналітичний, екологічно-ресурсний та організаційно-управлінський блоки. Визначено їх функціональне призначення, структурні складові та механізми взаємодії в системі циркулярної економіки. Доведено, що впровадження ресурсозберігаючих технологій, smart-рішень, Industry 4.0, ESG-інструментів та цифрових систем моніторингу сприяє підвищенню продуктивності виробництва, оптимізації використання ресурсів, мінімізації відходів та формуванню стійких конкурентних переваг підприємств. Особливу увагу приділено інвестиційним механізмам підтримки циркулярних трансформацій, зокрема ESG-інвестиціям, зеленим облігаціям, грантовому фінансуванню та венчурному капіталу. Обґрунтовано необхідність формування інтегрованої системи управління інноваційно-інвестиційними процесами, яка сприяє зміцненню економічної, екологічної та соціальної стійкості підприємств. Реалізація запропонованої моделі дозволить



підвищити рівень конкурентоспроможності підприємств харчової промисловості, забезпечити ефективне використання ресурсного потенціалу та прискорити інтеграцію принципів циркулярної економіки у систему стратегічного управління підприємствами.

Ключові слова: циркулярна економіка, інноваційно-інвестиційне забезпечення, конкурентоспроможність, харчова промисловість, сталий розвиток, цифровізація, ESG-інтеграція.

Statement of the problem. The modern development of food industry enterprises takes place in conditions of increasing global competition, instability of resource supply, environmental challenges and transformation of consumer priorities. Traditional linear production models, based on the principle of "production – consumption – disposal", are increasingly losing efficiency due to the increase in the cost of energy and raw materials, increasing environmental restrictions and the need to ensure long-term economic sustainability. Under such conditions, food industry enterprises need to transition to a circular operating model, which involves a closed cycle of resource use, waste minimization, reuse of raw materials and integration of innovative technologies into production processes [5; 12; 13].

The problem of forming effective innovation and investment support for the competitiveness of food industry enterprises in the conditions of a circular economy is of particular relevance. The innovative activity of enterprises determines the level of their technological modernization, energy efficiency and environmental safety, while investment support creates financial prerequisites for the implementation of strategic changes. At the same time, existing mechanisms for financing innovative transformations remain insufficiently adapted to the conditions of a circular ecosystem, which hinders the introduction of resource-saving technologies, digital management platforms and environmentally friendly business models [3; 4].

Deepening digitalization processes, integration of ESG management principles and increasing requirements for environmental responsibility of enterprises necessitate the development of a comprehensive innovation and investment model for ensuring a sustainable level of competitiveness of food industry enterprises in a circular ecosystem. Such a model should combine innovative development tools, investment support mechanisms and digital technologies for managing resource flows and a system for assessing the effectiveness of circular transformations. That is why there is a need to form a holistic scientific and methodological approach to ensuring sustainable competitiveness of food industry enterprises on the basis of a circular economy.

Analysis of recent research and publications. The issue of forming innovative and investment support for the competitiveness of food industry enterprises in the conditions of a circular economy is actively studied by both Ukrainian and foreign scientists. In particular, G. Chiaraluce substantiates the importance of circular models in ensuring resource efficiency of agri-food chains and emphasizes the need to integrate innovative mechanisms for waste management and resource reuse [5]. A significant contribution to the development of the concept of innovative transformation of the food industry was made by S. Nosratabadi, A. Mosavi and Z. Lakner, who identified the directions of business model innovations in the food sector, in particular digitalization, e-commerce and integration of environmental management tools [12]. The problems of implementing eco-innovations in a circular economy are considered in the study of M. Hamam, who proved that product and process innovations are determining factors in the formation of competitive advantages of agri-food enterprises [8]. Also important are the studies of K. Łukiewska, who proves that digital technologies Industry 4.0 form the basis of long-term international competitiveness of food industry enterprises [11].

Among Ukrainian scientists, the works of L. Strashynska and V. Strashynsky deserve attention, in which the impact of modern technologies on ensuring the competitiveness of food industry products is determined and the need for digital modernization of production systems is substantiated [4]. At the same time, despite significant scientific achievements, the issues of forming a comprehensive model of innovation and investment ensuring a sustainable level of competitiveness of food industry enterprises remain insufficiently developed.

Formation of the objectives of the article (task statement). The purpose of the study is to develop a comprehensive model of innovation and investment to ensure a sustainable level of competitiveness of food industry enterprises in a circular ecosystem by integrating innovation, investment, digital, environmental, and organizational and management components.

Summary of the main research material. In the modern conditions of the functioning of

the food industry, ensuring a sustainable level of competitiveness of enterprises increasingly depends on the ability to integrate innovation and investment mechanisms into the circular economy system. The concept of a circular ecosystem involves the creation of closed production cycles, minimizing resource losses, digitalization of management processes and the formation of an environmentally oriented model of enterprise development [5; 2].

The proposed model of innovation and investment ensuring a sustainable level of competitiveness of food industry enterprises in a circular ecosystem is based on a synergistic combination of five components, namely innovation and technology, investment and financial, digital and analytical, environmental and resource, organizational and management and innovation and technology [1].

The use of innovative technologies contributes to increasing the adaptability of enterprises to changes in the market environment and forms long-term competitive advantages [11; 4], therefore, the elements of the innovation and technological component in the model (technological modernization of production, implementation of Industry 4.0, use of smart technologies, development of FoodTech innovations [6; 9], automation

of logistics processes, implementation of product quality control systems) form the basis of technological modernization of food industry enterprises in order to ensure the conditions for the implementation of resource-saving technologies, automated production management systems, biotechnological solutions and digital transformation tools to reduce energy consumption, minimize raw material losses, reduce environmental impact, improve product quality and optimize production costs (Table 1).

Elements of the investment and financial component in the model of innovation and investment support for a sustainable level of competitiveness of food industry enterprises in a circular ecosystem allow the accumulation and effective use of financial resources for the implementation of circular transformations of the enterprise. Investment support creates conditions for accelerating innovative development and ensuring a sustainable level of competitiveness of food industry enterprises through the use of equity, bank lending, state support programs, grant financing, ESG investments, green bonds, venture capital [3].

At the same time, the areas of financing food industry enterprises are equipment modernization, implementation of digital platforms, development of environmental

Table 1

**Elements of the innovation and technological component
in the model of innovation and investment ensuring a sustainable level
of competitiveness of food industry enterprises in a circular ecosystem**

| Element | Purpose | Circular effect | Expected result |
|-------------------------|--|--|--|
| Industry 4.0 | Production automation and digital integration of processes | Optimization of resource use and minimization of losses (60-85%) | Increased productivity (50-80%) |
| Smart technologies | Digital monitoring of resource flows | Control of energy and resource consumption (55-80%) | Cost reduction (45-75%) |
| FoodTech-solutions | Biotechnology and production of ecological products | Use of secondary raw materials and biowaste (65-90%) | Market expansion (55-85%) |
| ERP systems | Integration of management and logistics processes | Coordination of circular supply chains (50-75%) | Resource optimization (45-70%) |
| AI Analytics | Demand Forecasting and Inventory Management | Reducing Overproduction and Food Waste (60-88%) | Increasing Competitiveness (55-85%) |
| Zero Waste Technologies | Minimization of production waste | Formation of a closed production cycle (80-95%) | Increasing environmental sustainability (70-90%) |
| IoT systems | Control of energy and water use | Increase in resource efficiency (65-85%) | Reduce environmental impact (55-80%) |

Source: developed by the author

technologies, construction of energy-efficient production systems, implementation of waste disposal systems (Table 2).

Digital transformation, as a determining factor of the effective functioning of the circular ecosystem of food industry enterprises, allows integration into global circular value chains [12; 11], and the elements of the digital-analytical component in the model of innovation and investment support for a sustainable level of competitiveness of enterprises in the industry are formed from Big Data analytics, demand forecasting systems, IoT solutions, Blockchain technologies, digital logistics management platforms, CRM and ERP systems [7].

The use of digital technologies allows food industry enterprises to optimize production processes, ensure transparency of supply chains, control the use of resources, reduce logistics costs, and increase the speed of management decisions (Table 3).

The circular business model allows food industry enterprises not only to reduce environmental risks, but also to create additional economic value through the reuse of resources [5; 8].

The elements of the ecological and resource component in the model make it possible to implement a closed-loop process for the use of resources and minimize the negative impact of production on the environment, and, its tools (waste recycling, reuse of raw materials, energy efficiency, decarbonization of production, environmental audit, environmental certification) are implemented through zero-waste production technologies (Zero Waste), bioenergy plants, use of secondary raw materials, water purification systems, alternative energy sources [10; 14], (Table 4).

The elements of the organizational and management block in the model of innovation and investment support for a sustainable level of competitiveness of food industry enterprises in a circular ecosystem ensure coordination of the interaction of all elements of the model, which, according to the structure of the components (strategic management, ESG management, risk management, human resources, partnerships and connections, a system of performance-analytical indicators (PAI) for assessing the effectiveness of the activities of entities) are based in the management system on adaptability,

Table 2

Elements of the investment and financial component in the model of innovation and investment support for a sustainable level of competitiveness of food industry enterprises in a circular ecosystem

| Element | Purpose | Circular effect | Expected result |
|-------------------|---|---|--|
| ESG investments | Financing environmental modernization | Reducing environmental burden and decarbonization (70-90%) | Increasing sustainability (65-85%) |
| Green bonds | Implementation of energy-efficient and resource-saving projects | Formation of low-carbon production (65-88%) | Reduction of energy consumption (60-80%) |
| Venture Capital | Funding Innovative Food Technologies | Development of circular foodtech solutions and zero waste technologies (60-85%) | Technological renewal (55-80%) |
| Government grants | Support for circular environmental projects | Development of recycling and reuse of resources (70-92%) | Investment activity (65-88%) |
| Bank lending | Updating fixed assets and digital infrastructure | Increasing resource efficiency of production (70-92%) | Technological modernization (65-88%) |
| Green Financing | Investing in renewable energy and waste recycling | Forming closed production cycles (55-80%) | Environmental safety (50-75%) |
| Impact-Investing | Support for socio-ecological business models | Integration of circular economy principles (75-95%) | Increased competitiveness (70-90%) |

Source: developed by the author

Table 3

Elements of the digital-analytical component in the model of innovation and investment support for a sustainable level of competitiveness of food industry enterprises in the circular ecosystem

| Element | Purpose | Circular effect | Expected result |
|--------------|---|--|---|
| Big Data | Market and resource flow analysis | Forecasting efficient resource use and reducing losses (60-88%) | Increasing adaptability (55-85%) |
| IoT | Monitoring of equipment, energy and water consumption | Control of resource efficiency and minimization of overspending (65-90%) | Reduction of accident rate (60-85%) |
| Blockchain | Control of circular supply chains | Traceability of raw material movement and resource reuse (70-92%) | Transparency of operations (65-88%) |
| ERP | Production and logistics resource management | Coordination of closed production cycles (55-80%) | Production efficiency (50-75%) |
| CRM | Customer Relationship Management | Developing Demand for Eco-Friendly Products (50-75%) | Increasing Loyalty (45-70%) |
| Digital Twin | Digital modeling of production processes | Optimization of resource consumption and waste reduction (75-95%) | Increase in environmental efficiency (70-90%) |
| AI Analytics | Production and Waste Forecasting | Reduction of Overproduction and Food Losses (70-93%) | Increase in Competitiveness (65-88%) |

Source: formed by the authors

innovation, digital integration, transparency, and environmental responsibility [15], (Table. 5).

Effective management ensures the integration of all components of the model and contributes to the formation of a long-term competitive strategy of the enterprise.

The generalization of the considered elements of the innovative and technological, investment and financial, digital and analytical, environmental and resource and organizational and managerial components allows us to form a holistic view of the multi-level architecture of ensuring a sustainable level of competitiveness of food industry enterprises in the conditions of a circular ecosystem.

The interaction of these components provides a synergistic effect, which is manifested in increasing resource efficiency, accelerating innovative transformations, enhancing investment attractiveness and reducing the environmental load of production processes. In this context, there is a need to integrate the considered components into a single conceptual and methodological structure, which allows us to systematically reflect the mechanism of their interaction and impact on the competitiveness of enterprises. That is why it is advisable to further present a generalized model of innovation and

investment ensuring a sustainable level of competitiveness of food industry enterprises in a circular ecosystem, which reflects the logic, structure and relationships between all identified elements (Fig. 1).

The proposed model provides a comprehensive approach to the formation of competitive advantages of food industry enterprises in the conditions of circular transformation of the economy.

Conclusions. Thus, the need to form a comprehensive model of innovation and investment to ensure a sustainable level of competitiveness of food industry enterprises in the conditions of a circular ecosystem is due to the introduction of integrated innovative technologies, digital solutions, environmental management tools and effective investment support mechanisms. The proposed model is based on the interaction of innovation and technology, investment and financial, digital analytical, environmental resource and organizational and management components, which ensures the formation of long-term competitive advantages of enterprises.

The implementation of circular management principles in combination with the digitalization of production processes, ESG-oriented

Table 4

**Elements of the ecological and resource component
in the model of innovation and investment support for a sustainable level
of competitiveness of food industry enterprises in a circular ecosystem**

| Element | Purpose | Circular effect | Expected result |
|-------------------------|--|---|---|
| Zero Waste Technologies | Minimization of production waste | Formation of a waste-free production cycle (85-98%) | Cost reduction (80-95%) |
| Bioenergy | Use of biowaste for energy generation | Conversion of waste into a secondary energy resource (75-92%) | Energy independence (70-88%) |
| Recycling of resources | Reuse of raw materials and water resources | Closed loop of resource use (80-95%) | Resource efficiency (75-90%) |
| Environmental audit | Control of environmental indicators and resource consumption | Monitoring of circular production efficiency (65-85%) | ESG compliance (60-80%) |
| Alternative energy | Use of renewable energy sources | Decarbonization of circular production (70-90%) | Reduction of CO ₂ emissions (65-85%) |
| Recycling systems | Processing of production residues | Returning resources to the production cycle (78-94%) | Reducing the environmental burden (72-88%) |
| Eco-design | Eco-design of products and packaging | Extending product life cycles (75-92%) | Increasing environmental competitiveness (70-88%) |

Source: formed by the authors

Table 5

**Organizational and management elements in the model of innovation
and investment support for a sustainable level of competitiveness
of food industry enterprises in a circular ecosystem**

| Element | Purpose | Circular effect | Expected result |
|---|--|--|--|
| ESG management | Coordination of sustainable development and ecological transformation | Integration of circular economy principles into the management system (75-92%) | Improving reputation (70-88%) |
| Risk Management | Management of production, environmental and resource risks | Minimization of risks of resource losses and environmental threats (65-85%) | Sustainability of activities (60-80%) |
| Performance-Analytical Indicator System (PAI) | Assessment of economic, environmental and resource efficiency | Control of circular efficiency indicators (70-90%) | Control of results (65-85%) |
| HR Management | Formation of competencies in the field of digitalization and circular technologies | Development of human capital of the circular economy (60-82%) | Innovative activity (55-78%) |
| Partnerships (links) | Cooperation of participants in the circular ecosystem | Formation of closed value chains (80-95%) | Synergistic effect (75-90%) |
| Circular management | Management of closed production cycles | Coordination of resource reuse (85-98%) | Improvement of resource efficiency (8-95%) |
| Supply Chain Management | Circular Supply Chain Management | Optimization of Raw Material and Waste Flows (78-94%) | Cost Reduction (72-88%) |

Source: formed by the authors

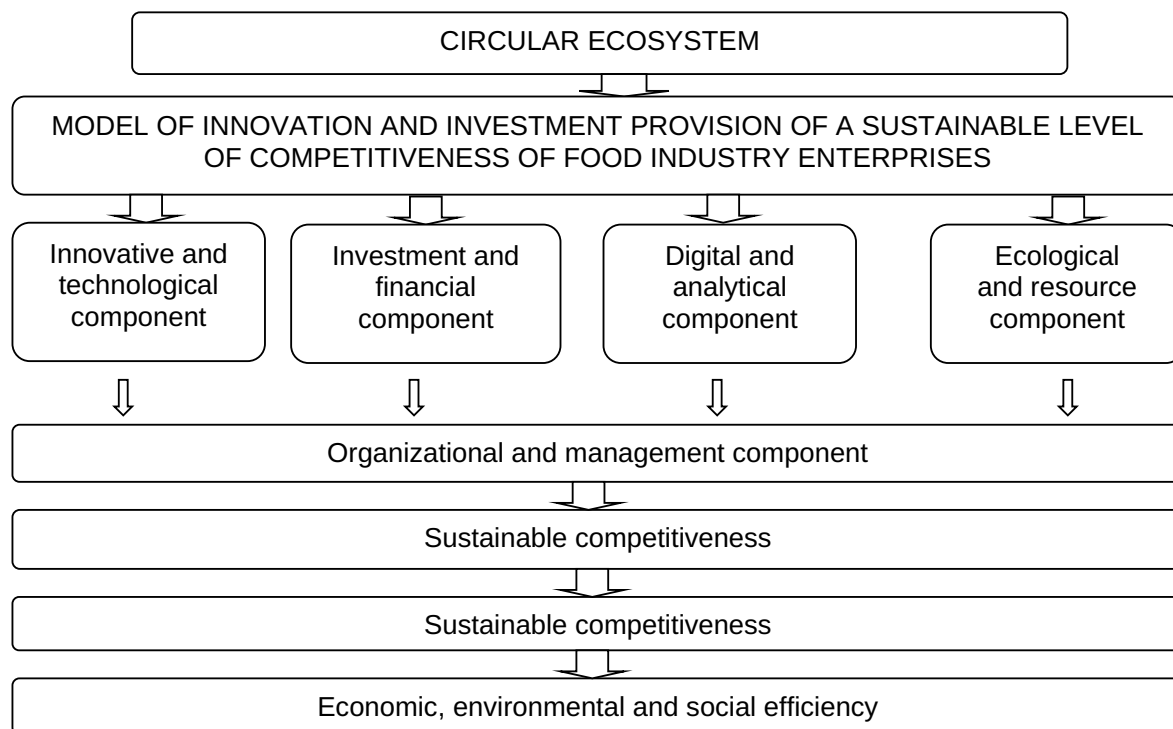


Figure 1. Model of innovation and investment ensuring a sustainable level of competitiveness of food industry enterprises in a circular ecosystem

Source: formed by the authors

management, innovative technologies and modern investment support mechanisms creates the prerequisites for increasing resource efficiency, reducing production costs, minimizing environmental impact and strengthening the competitive advantages of food industry enterprises. The synergistic interaction of the model elements ensures the formation of closed production cycles, the development of low-carbon production and increased adaptability of enterprises to environmental transformations.

The possibility of using the model as a tool for strategic management of innovation and investment processes of food industry enterprises

in the conditions of circular transformation of the economy will contribute to the intensification of investment activity, acceleration of technological modernization, development of environmentally friendly business models, increasing the level of resource efficiency and integration of enterprises into global circular value chains. Prospects for further research should be directed towards the development of an integrated system for assessing the level of circular competitiveness and mechanisms for adaptive management of innovation and investment development of enterprises in the conditions of the digital economy.

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