ISSN 2413-9610
E-ISSN 2663-2365
УДК: 004; 005; 35; 336; 65

Харківський національний економічний університет імені Семена Кузнеця

УПРАВЛІННЯ РОЗВИТКОМ

Міжнародний економічний журнал

Заснований у 2002 році
Періодичність випуску: 4 рази на рік

Том 24, № 4

Харків – 2025

ISSN:2413-9610
E-ISSN: 2663-2365
UDC: 004; 005; 35; 336; 65

Simon Kuznets Kharkiv National University of Economics

DEVELOPMENT MANAGEMENT

International Economic Journal

Founded in 2002
Frequency of issue: Four times per year

Volume 24, No. 4

Kharkiv – 2025

ISSN 2413-9610
E-ISSN 2663-2365
УДК: 004; 005; 35; 336; 65

Засновник та видавець:
Харківський національний економічний університет імені Семена Кузнеця

Рік заснування: 2002

Рекомендовано до друку та поширення
через мережу Інтернет Вченою радою
Харківського національного економічного університету імені Семена Кузнеця
(протокол № 10 від 23 грудня 2025 р.)

Ідентифікатор медіа: R30-02689
(Рішення Національної ради України
з питань телебачення і радіомовлення
№ 177, протокол № 3 від 25 січня 2024 р.)

Журнал входить до переліку наукових фахових видань України
Категорія «Б». Спеціальності: 051 «Економіка»,
072 «Фінанси, банківська справа та страхування», 073 «Менеджмент»,
126 «Інформаційні системи та технології», 281 «Публічне управління та адміністрування»
(Наказ Міністерства освіти і науки України № 1643 від 28 грудня 2019 р.
та № 409 від 17 березня 2020 р.)

Журнал представлено у міжнародних наукометричних базах даних, репозитаріях та пошукових системах:
Фахові видання України, Національна бібліотека України імені В. І. Вернадського, Crossref, Universitäts Bibliothek Leipzig, BASE, Litmaps, ERIH PLUS, EconBiz, Polska Bibliografia Naukowa (PBN), WorldCat, Ulrichsweb Global Serials Directory, UCSB Library, Dimensions, German Union Catalogue of Serials (ZDB), University of Oslo Library, University of Hull Library, Search Oxford Libraries Online (SOLO), European University Institute (EUI), Cambridge University Library, Open Ukrainian Citation Index (OUCI)

Управління розвитком : міжнар. екон. журн. / [редкол.: Н. В. Трусова (голов. ред.) та ін.]. – Харків : Харківський національний економічний університет імені Семена Кузнеця, 2025. – Т. 24, № 4. – хх с.

Адреса редакції:
Харківський національний економічний університет імені Семена Кузнеця
61166, пров. Інженерний, 1-А, м. Харків, Україна
Тел. +380 (57) 702-03-04
E-mail: info@devma.com.ua
https://devma.com.ua/uk

ISSN:2413-9610
E-ISSN: 2663-2365
UDC: 004; 005; 35; 336; 65

Founder and publisher:
Simon Kuznets Kharkiv National University of Economics

Year of foundation: 2002

Recommended for printing and distribution
via the Internet by the Academic Council
of Simon Kuznets Kharkiv National University of Economics
(Minutes No. 10 of December 23, 2025)

Media identifier: R30-02689
(Decision of the National Council
of Television and Radio Broadcasting of Ukraine
No. 177, Minutes No. 3 of January 25, 2024)

The journal is included in the List of scientific professional publications of Ukraine
Category "B". Specialties: 0311 Economics, 0412 Finance, banking and insurance,
0413 Management and administration, 0612 Database and network design and administration
(Order of the Ministry of Education and Science of Ukraine No. 1643 of December 28, 2019
and No. 409 of March 17, 2020)

The journal is presented international scientometric databases,
repositoriesand scientific systems:
Professional Publications of Ukraine, Vernadsky National Library of Ukraine, Crossref,
Universitäts Bibliothek Leipzig, BASE, Litmaps, ERIH PLUS, EconBiz, Polska Bibliografia Naukowa (PBN),
WorldCat, Ulrichsweb Global Serials Directory, UCSB Library, Dimensions, German Union Catalogue of
Serials (ZDB), University of Oslo Library, University of Hull Library, Search Oxford Libraries Online (SOLO),
European University Institute (EUI), Cambridge University Library,
Open Ukrainian Citation Index (OUCI)

Development Management / Ed. by N. Trusova (Editor-in-Chief) et al. Kharkiv: Simon Kuznets Kharkiv National University of Economics, 2025. Vol. 24, No. 4. xx p.

Editors office address:
Simon Kuznets Kharkiv National University of Economics
61166, 1-A Inzhenerny Ln., Kharkiv, Ukraine
Tel. +380 (57) 702-03-04
E-mail: info@devma.com.ua
https://devma.com.ua/en

УПРАВЛІННЯ РОЗВИТКОМ Том 24, № 4

Редакційна колегія

DEVELOPMENT MANAGEMENT Volume 24, No. 4

Editorial Board

ЗМІСТ / CONTENTS

ISSN 2413-9610, E-ISSN 2663-2365 Journal homepage: https://devma.com.ua/en

DEVELOPMENT MANAGEMENT

UDC 351.72:336.143:004.738.5(477)
DOI: 10.63341/devt/4.2025.08

Vol. 24, No. 4. 2025

E-budgeting model in the architecture of financial resilience of territorial communities during the full-scale war

Larysa Gordiienko*
PhD in Economics, Associate Professor
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0000-0003-4971-6264

Oleh Kunitsyn
Postgraduate Student
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0009-0008-7552-7946

Abstract. The aim of the study was to develop an adaptive model of e-budgeting that would contribute to strengthening the financial resilience of territorial communities amid wartime and other crisis challenges. The research methodology was based on the mix of systems, comparative and structural-functional analysis, as well as on the best international practices, in particular, the Finnish OmaStadi system and the Ukrainian E-DEM platform. The results of the study demonstrated that effective implementation of e-budgeting has a positive impact on the transparency of governance processes, increases public participation and the optimal allocation of public resources. The analysis revealed key issues hindering the implementation of digital budgeting tools in Ukraine, including: low levels of digital literacy, insufficient infrastructure, weak engagement of vulnerable population groups in participatory budgeting processes and the absence of integrated mobile services. To enhance the financial resilience of territorial communities in the face of crisis and wartime challenges, a multi-level model for improving the e-budgeting system is proposed. This model encompasses directions for improving participatory budgeting practices, a system for their evaluation, expected outcomes from model implementation and its impact on key components of financial resilience. The proposed model for improving the implementation of electronic budgeting systems in support of the financial resilience of territorial communities has a potential to illustrate how areas for improvement influence the criteria of electronic budgeting systems, leading to qualitative outcomes. The practical significance of the study lies in the possible application of the adaptive e-budgeting model by local self-government bodies, civil society organisations, analytical centres and state institutions that monitor the financial activities of territorial communities

Keywords: public administration; participatory budgeting; digital platform; transparency; local community

INTRODUCTION

In the context of ongoing economic and political challenges, particularly amid full-scale war, the financial resilience of Ukraine's territorial communities has become a key element of endurance, as well as national recovery and sustainable development. Ensuring effective budget management, transparent allocation of funds and citizen engagement in decision-making processes has become not only a tool of effective public governance but also a factor in societal consolidation and support for local financial resilience. One of the promising mechanisms contributing to resilience is e-budgeting, which leverages digital platforms to enhance public participation in budgetary processes.

Article's History: Received: 23.06.2025; Revised: 28.10.2025; Accepted: 23.12.2025; Published: 12.01.2026

Suggested Citation:
Gordiienko, L., & Kunitsyn, O. (2025). E-budgeting model in the architecture of financial resilience of territorial communities during the full-scale war. *Development Management*, 24(4), 8-19. DOI: 10.63341/devt/4.2025.08.

*Corresponding author

E-budgeting enables citizens to influence the allocation of local financial resources, thereby promoting transparency, accountability and efficiency in the management of public finances. The potential implementation of e-budgeting represents a fundamental shift in the interaction between local authorities and community members. By integrating digital tools into budget planning, execution and monitoring, territorial communities not only increase citizen involvement in governance decisions but also strengthen trust in local self-government bodies.

The relevance of research in the field of e-governance, including the digitalisation of budgeting processes, is widely recognised within the Ukrainian academic discourse. Studies of digital governance and e-budgeting in Ukraine emphasise the promise of participatory budgeting for community development. For example, Ye.V. Maliarevskyi & V.O. Barannik (2021) examined participatory budgets in Ukraine. They concluded that empowering residents through local budget initiatives could drive social and territorial development. O.P. Basyuk (2022) analysed international experiences of digital budget optimisation. The researcher found that automating budget processes and embedding strong financial controls is crucial. A conceptual model for Ukraine's public finance digital transformation was subsequently proposed. N.Ye. Skorobohatova *et al*. (2024) investigated how accounting for wartime expenditures affects community budgets. Their research highlighted challenges in tracking and financing essential services under martial conditions, and proposed the ways to manage those challenges. M.M. Pityulich *et al*. (2023) identified key socio-economic determinants of community development. In their research they showed, how such factors affect the financial resilience of territorial communities. V. Kruhlov & D. Tereshchenko (2024) explored adaptive budgeting under crisis. They argued that digital tools could enable more responsive public financial management during emergencies.

J. Davies *et al*. (2022) used qualitative fieldwork in Scottish local councils to study embedding digital participatory budgeting. They found that formal adoption of digital participatory budgeting requires well-trained mediators and adequate resources, otherwise entrenched bureaucratic practices can stall innovations. K.S. Wackowski & L.Yu. Gordiienko (2025) analysed digitalisation of public services drawing on Poland's experience. In their paper, they noted that while digital platforms can improve service delivery, they must be tailored to local institutional contexts. However, it should be noted that existing studies pay insufficient attention to the local level, specifically, territorial communities, instead examining e-budgeting, participatory exercises and digitalisation of finance primarily at the national scale. Furthermore, there is a near-complete lack of publications analysing the impact of full-scale war as the most critical shock factor on the financial resilience of territorial communities. Financial resilience is defined as the ability of a territorial community to effectively manage its resources, maintain a balance between revenues and expenditures and proactively respond to economic shocks (Kunitsyn & Melnyk, 2025). Its significance has increased considerably in the context of full-scale armed aggression, which has confronted communities with existential challenges, including the need to mobilise resources and ensure the provision of essential functions under martial law. E-budgeting is aimed at supporting these functional capacities by improving spending transparency and enhancing the level of public oversight. Despite its advantages, the implementation of e-budgeting in Ukraine faces several challenges. These include limited digital infrastructure in some communities, low levels of digital literacy among citizens and resistance to change from entrenched budgeting practices. Overcoming these barriers requires targeted investments in technological capacity, public education and institutional preparedness.

The goal was to create an adaptive e-budgeting model that would help territorial communities increase their financial resilience in the face of war and other crises. To achieve this aim, the following objectives were set: to analyse existing e-budgeting platforms in Ukraine and abroad, identifying their advantages and disadvantages; to assess the effectiveness of implementing e-budgeting practices based on examples of Ukrainian territorial communities affected to varying degrees by the full-scale war; to propose a multi-level model for improving the implementation of the e-budgeting system as part of supporting the financial resilience of territorial communities. The novelty of the study lies in the attempt to integrate principles of digital budget resource management under conditions of high uncertainty, resource scarcity and risks characteristic of wartime.

MATERIALS AND METHODS

The research is based on a combination of comparative analysis of e-budgeting systems functioning in various territorial communities of Ukraine and a theoretical-conceptual analysis of the most effective e-budgeting models in global practice. This approach enabled a comprehensive examination of existing management practices in the field of e-budgeting, revealing both the advantages and shortcomings of the respective systems. The research proceeded through a structured multi-stage methodology. Literature review of Ukrainian and international studies on e-budgeting, participatory budgeting and local financial resilience was conducted. Then analysis of the next Ukrainian e-budgeting tools was done: E-DEM (Ukrainian e-democracy portal, 2021), Public Project (BePart, 2022) and The Interactive Community Budget (Cost Ukraine, 2025). The prepared analysis is based on the mix of systems, comparative and structural-functional analysis, to define the most used, which prove its effectiveness, system in-use in territorial communities. The next step is the similar analysis done for the most well-known foreign e-budgeting tools: OmaStadi from Finland (Mainiotech, 2021); Decide Madrid from Spain (Faster Capital, 2025); Go Vocal (2024) from Canada; Maptionnaire (2022) from Poland and Dalyvaujamasis biudžetas from Lithuania (EEA and Norway Grants, 2025). This informed the selection of analytical frameworks and identified best practices to examine in depth. Comparison of its advantages and disadvantages gave a possibility to empirically choose the most applicable one, to make a deeper structural analysis with the Ukrainian cases. The next step was purposive sampling that performed a case selection: two Ukrainian territorial communities

with contrasting wartime conditions were chosen. They are Novoiavorivsk territorial community in Lviv region and Kherson City, which was liberated from Russian occupation in autumn 2022. Novoiavorivsk territorial community is digitally advanced and largely untouched by conflict, while Kherson has been heavily impacted by the full-scale invasion. This allowed comparison of e-budgeting under divergent shock exposures. Data were gathered for the years 2021-2024, drawing on e-participation platform usage reports (Maptionnaire, 2022; Go Vocal, 2024; Faster Capital, 2025), qualitative information from territorial community websites (City of Helsinki, 2024; Novoiavorivsk City Council, 2024a), news and organisations releases (BePart, 2022; Decentralization portal, 2024; EEA and Norway Grants, 2025).

Based on the mentioned above, the study applied a combination of analytical methods. Comparative analysis component was used to identify differences in functionality and engagement possibilities of e-budgeting systems. This method was justified by the need to systematically contrast varied contexts and digital platforms itself. Structural-functional analysis component supported to examine system's components and their contributions to budgeting processes under stress. This highlighted how elements like mobile apps or transparency methods applied in each setting. Systems and contextual analysis component placed these findings among legal, social and technological environments. In particular, there was reviewed how Ukrainian financial regulations and digital literacy levels influence outcomes. Content analysis of platform helped characterise the intended features of each tool. Finally, model synthesis was used to integrate insights and propose an adaptive multi-level e-budgeting model for crisis resilience, drawing parallels with systems thinking. The mixed approach of combining qualitative review and case comparison ensures both breadth and depth. The methodology enabled a comprehensive examination of e-budgeting tools and their impact on community financial resilience under varying pressures caused by a full-scale invasion.

RESULTS AND DISCUSSION

Analysis of Ukrainian e-budgeting tools

Ukrainian scholars, including O.P. Basyuk (2022), define e-budgeting as the process of digital transformation of the budgeting system, which involves the use of information and communication technologies to automate budget procedures, enhance transparency, improve financial management efficiency and ensure open access to budget indicators and decision-making processes. E-budgeting tools are understood as software solutions that enable the automation of budget planning, control and analysis, integration of financial data, generation of electronic reporting and support of managerial decision-making (Popov *et al.*, 2023). The use of such tools contributes to increased transparency, accountability and active citizen engagement in local decision-making. Further development and enhancement of these platforms can strengthen democratic processes and improve the financial resilience of territorial communities through a more flexible and adaptive system for forming local budgets. Particular importance is the participatory budget (also known as the public budget or participatory budgeting), which, according to I.I. Bozhuk & U.O. Fomenko (2020), is an instrument that allows residents of territorial communities to directly influence the allocation of a portion of the local budget by submitting project proposals and participating in the voting process for their implementation.

It is worth agreeing with A.M. Oriol (2024), who argues that there is currently no universal e-budgeting system that fully meets the needs of both territorial communities and central authorities. At the same time, existing systems are capable of covering a wide range of tasks and generally shape the e-budgeting process. Their development can be observed both in Ukraine and internationally. Table 1 presents a comparison of the most widely used e-budgeting systems currently implemented in Ukrainian territorial communities (The EGAP Program, 2022; Council for the development of communities and territories, 2023; Decentralization portal, 2024).

Table 1. E-Budgeting tools in Ukrainian territorial communities

Platform	Developer / Foundation	The main functions	Territorial communities, which are using the system
E-DEM (Ukrainian e-democracy portal, 2021)	EGAP / East Europe Foundation	participatory budgeting; open public consultations; creation of local-level petitions; school participatory budgeting	For December 2024, the system is in-use in 546 communities across Ukraine
Public Project (BePart, 2022)	SocialBoost	the system ensures a full-cycle process of participatory budgeting	For December 2024, the system is in-use in more than 200 communities across Ukraine
The Interactive Community Budget (Cost Ukraine, 2025)	CASE Ukraine / USAID	community revenue and expenditure analysis; budget modelling; proposals for infrastructure projects	Usage statistics are not collected by the developer or external organisations

Source: created by the authors

The E-DEM platform, as rightly emphasised in Ukrainian e-democracy portal (2021), is the most widespread e-democracy tool in Ukraine, integrating key services for citizen engagement with local self-government bodies. One of the core functionalities is a participatory budgeting, which in fact is a tool that enables residents to submit their own initiatives and apply for funding from the local budget. In addition, important function is local petitions creation and management availability. It is a service for submitting electronic petitions aimed at drawing the attention of authorities to important community issues. A core function allowing users to report local problems using an interactive map usually called as "open community". It is also important, that platform has possibility to organise public consultations, which acts as a mechanism for gathering public opinion on pressing issues. School Participatory

Budgeting is quite an interesting educational initiative for students aimed at developing civic engagement skills through the design and implementation of projects, which is also available on E-DEM platform. Important to note that, to date, the E-DEM platform is the most widely used e-budgeting tool in Ukraine, implemented under the EGAP project of the East Europe Foundation (Ukrainian e-democracy portal, 2021).

Public Project (Table 1) is another widely used digital tool that automates the entire participatory budgeting cycle, from project submission to voting and reporting. Its main advantages include transparency, ensuring openness at every stage of the process, by requirements of detailed description of each step of decision-making, and making available this information accessible for community members. In addition, this tool has intuitive interface and easy navigation among services and section. Public Project has a hybrid identification system for authentication: via BankID, digital signature or a specific resident card, if the system is implemented in a community. The toll uses integration with social networks, email newsletters and communication tools for increasing engagement of community members. Since 2016, over 5 million users have visited the Public Project platform and the total value of implemented initiatives has exceeded 1 billion UAH (BePart, 2022).

The Interactive Community Budget platform is a tool developed by the analytical centre CASE Ukraine with support from the USAID programme. It allows citizens to explore, analyse and model local budgets in a convenient and visualised format. The tools provide an access to detailed information on budget items, which allow to make a revenue and expenditure Analysis. In addition, the tool allows users to create budget allocation scenarios, to make comparative analysis and determine the best possible option. Except this, internal function supports communication between users, enabling public engagement in discussions and voting. It is important to note that, unlike E-DEM and Public Project, The Interactive Community Budget is not a direct e-budgeting tool. Rather, it serves a supporting function, like enhancing awareness among citizens and local authorities about the principles and potential of participatory budgeting and preparing them for the implementation of full-fledged digital e-budgeting systems (Cost Ukraine, 2025).

As rightly noted by H.I. Jeakalo *et al*. (2020), e-budgeting serves as a powerful tool for engaging citizens in the processes of formulating and allocating public finances, offering a range of significant advantages. First and foremost, it enhances the transparency of budgeting processes by providing open access to information on revenues, expenditures and funding priorities. Such openness strengthens citizens' trust in government institutions, which is particularly important in the context of post-conflict recovery and democratic progress. In addition, e-budgeting stimulates active civic participation by enabling residents to directly influence decision-making, sets development priorities for their communities and implements projects that address real public needs. This contributes to an improved quality of life, as initiatives with tangible value for local communities are brought to fruition.

Analysis of foreign e-budgeting tools

Table 2 represents the most well-known e-budgeting tools that have been implemented in territorial communities abroad (OECD Observatory of Public Sector Innovation, 2015; Maptionnaire, 2022; City of Helsinki, 2025a), as well as in the countries and cities (communities) whose public administration systems have adopted e-budgeting. The table outlines the advantages and disadvantages of these solutions.

Table 2. International e-budgeting tools

Platform	Developer	City / Country of Use	Advantages	Disadvantages
OmaStadi (Mainiotech, 2021)	Decidim	Helsinki, Finland	Combines online tools with offline events (e.g., OmaStadi Expo) to foster citizen engagement. Budget of approximately €8.8 million. Innovative methods like a card game for co-design promote participation and understanding.	The platform proved to be complex for some users, leading to reduced activity in online discussions.
Decide Madrid (Faster Capital, 2025)	CONSUL	Madrid, Spain	High participation: over 400,000 registered users and a budget of €100 million. Offers both online and physical voting options.	Lack of detailed citizen-to-citizen discussions may limit the quality of decisions. Limited feedback on project implementation.
Go Vocal (2024)	In-house development	Toronto, Canada	Mobile app allows citizens to quickly submit proposals and vote. Integrated with social media for broader outreach.	Limited information on the platform's influence on decision-making and project implementation.
Maptionnaire (2022)	Maptionnaire	Warsaw, Poland	Interactive maps allow citizens to mark specific locations for improvement. User-friendly interface for proposal visualisation.	Focus on geospatial data may limit the range of topics discussed. Fewer opportunities for deep discussion and collaboration among users.
Dalyvaujamasis biudžetas (EEA and Norway Grants, 2025)	In-house development	Vilnius, Lithuania	Simple platform for submitting and voting on proposals. Focus on local initiatives and community projects.	Limited information on integration with other platforms or discussion tools. Potential functional limitations compared to more advanced systems.

Source: created by the authors

The comparative analysis of the international e-budgeting tools presented in Table 2, conducted to identify the potentially most functional model suitable for adaptation to Ukrainian realities, reveals the following. The OmaStadi platform in Helsinki, built on the open-source Decidim framework, exemplifies a robust model for digital participatory budgeting that fosters institutional transparency, inclusivity, and scalability. Launched in 2018, Decidim was selected for its modularity and democratic design, which Helsinki has since extended with approximately 20 custom modules and integrations aimed at enhancing usability, accessibility, and inclusive participation across device types and user groups (Decidim, 2022). OmaStadi operates on a biennial cycle: in the first year, citizens propose ideas, which are screened, co-developed with city experts in both online and offline workshops, and ultimately voted on by residents aged 12 and older; in the second year, the winning proposals are implemented (Shin *et al.*, 2022). Inclusivity is central to OmaStadi: the platform allows Helsinki residents to propose and vote, with interfaces available in seven languages and support facilitated through libraries, community centres and digital channels to reach diverse linguistic and cultural groups. Notably, younger residents participate actively: during one round, 29% of comprehensive-school-aged children voted – far exceeding turnout figures among older age groups (City of Helsinki, 2022). Transparency is institutionally embedded in the process: all stages, from proposal submission and cost assessments to iterative co-development and implementation tracking, are made publicly accessible via the OmaStadi website, ensuring accountability and city-citizen dialogue (City of Helsinki, 2025b).The OmaStadi platform also incorporated elements of gamification with a specially designed card game that functioned as a participatory tool to stimulate creativity, idea generation and collaborative brainstorming among residents. By transforming the often abstract and technical task of project ideation into an engaging, game-like activity, the platform succeeded in lowering barriers to entry, making participation more accessible and enjoyable, particularly for younger or less experienced contributors (Participedia, n.d.). Decidim's open, flexible architecture offers a scalable foundation for local participatory budgeting platforms, capable of integrating tailored modules, multilingual accessibility, transparent decision-making and engagement innovations to enhance democratic inclusion and responsiveness (Mainiotech, 2021).

The Decide Madrid platform is noteworthy as an example of a continuously functioning system for proposals and voting on civic initiatives funded by the city budget. The use of mechanisms for direct citizen initiatives, through petitions and voting, has ensured the system's stable operation, with more than 400 projects implemented. Ukrainian communities, especially in cities with a high level of digitalisation, should consider this model as a best practice that combines transparency, efficiency and social impact. It is essential to establish a regulatory framework enabling direct citizen initiatives in budget processes (Faster Capital, 2025). The Canadian approach to e-budgeting, illustrated by the case of Toronto, is suitable for adaptation at the district administration level in large Ukrainian cities. District-level budgets (approximately 750,000 Canadian dollars), project submission via interactive maps and mandatory voting are mechanisms that could be integrated in Ukraine. This decentralised model is particularly well-suited for communities with high population density and multi-level infrastructure (Go Vocal, 2024). Warsaw's experience with the use of interactive maps that allow citizens to pinpoint specific locations for improvement demonstrates the sustainability of participatory budgeting and the importance of a regular budgeting cycle. Annual participatory budgeting events, a high volume of proposals and the implementation of approximately 80% of selected projects point to an effective organisational model. As recommended by Maptionnaire (2022), annual participatory budgeting cycles should be implemented as a mandatory practice, with clearly defined procedures and key performance indicators for monitoring. For Ukraine, this provides a strong example of how systematic approaches and transparent communication with residents can foster trust in local authorities. The Lithuanian model demonstrates the benefits of scaling participatory budgeting nationwide. Given that over 70% of Lithuania's municipalities have implemented participatory budgeting using a unified digital platform, Ukraine could consider a scenario involving a centralised e-budgeting system capable of adapting to various community types. As highlighted in EEA and Norway Grants (2025), such a solution has the potential to reduce local development costs and ensure standardised approaches to public reporting and oversight.

The comparative analysis of e-budgeting tools (Table 2) confirms that, globally, governments are increasingly implementing e-budgeting systems to enhance transparency, efficiency and accountability in public financial management. According to a study by the European parliamentary research service (2015), e-budgeting involves the digitalisation of budget procedures, the dissemination of budget information in open formats and the use of big data to support policy-making. This reflects the widespread adoption of such practices in many countries, although it does not allow for the identification of a single dominant system. A World Bank report (The World Bank Blogs, 2022) also notes the global rise in cashless transactions, indicating a general trend toward the digitalisation of financial processes. While this trend is not synonymous with e-budgeting, it reflects the gradual emergence of a digital financial environment in which such systems can operate effectively. However, as current research shows, there is no unified international statistical record that would allow the identification of a single most widely used e-budgeting system globally. Based on the comparative analysis of leading international e-budgeting cases, the OmaStadi system in Helsinki was found to be the most effective. It is distinguished by its innovative approach to citizen engagement, process transparency and high efficiency in participatory budget formation. Thus, e-budgeting serves as a powerful instrument for the democratisation of financial governance, combining significant potential with the necessity of overcoming structural and social barriers. Based on the data and findings presented, the next section of this article will propose a model for improving the implementation of the e-budgeting system in the context of strengthening the financial resilience of territorial communities in Ukraine.

Comparative analysis on implementation of E-DEM and OmaStadi platforms

The one of the previous sections established that the most widely used e-budgeting platform in Ukraine is the E-DEM system. One of the most successful examples of E-DEM implementation is demonstrated by the Novoiavorivsk territorial community in Lviv Region. In 2024, this community ranked among the top 100 communities in terms of digital transformation, according to the Digital Transformation Index developed by Ukraine's Ministry of Digital Transformation (Novoiavorivsk City Council, 2024b). This indicates a high level of integration of digital tools into the community's public administration system, particularly the E-DEM platform. However, the experience of the Novoiavorivsk community is not fully representative for assessing the effectiveness of E-DEM under wartime conditions, as this community has not been significantly affected by the shock factors associated with the full-scale invasion. To obtain a more relevant picture of the functioning of the e-budgeting system under martial law, it is appropriate to analyse the experience of the Kherson territorial community. This community experienced russian occupation in 2022 and continues to suffer from intense shelling by the occupying forces, being located near the front line. This case allows for a deeper evaluation of the resilience, adaptability and potential of the E-DEM system under extreme conditions. Table 3 presents the results of a comparative analysis between the OmaStadi system (Helsinki) and the E-DEM system (Novoiavorivsk and Kherson territorial communities), aiming to identify directions for improving e-budgeting systems in Ukrainian territorial communities under full-scale war conditions.

Table 3. Comparative analysis of OmaStadi (Helsinki) and E-DEM (Novoiavorivsk and Kherson Territorial Communities) platforms

Criterion	OmaStadi (Helsinki)	E-DEM (Novoiavorivsk Community)	E-DEM (Kherson Community)
Inclusiveness	Active involvement of community members aged 12 and older	Participation is available to all community residents. A mobile application has been implemented for convenient access to services	No information found regarding specific measures to ensure inclusiveness
Citizen Participation Mechanisms	The process includes idea submission, co-development with experts, voting and implementation	Citizens can submit projects, vote and monitor implementation. The Novoiavorivsk community has introduced the "Novoiavorivsk SMART" mobile app, integrating E-DEM and other digital services	Local petition services, public consultations, participatory budgeting and "Open City" are integrated
Gamification	Game-based mechanisms are used to engage participants	Not available	Not available
Process Transparency	A high level of transparency is ensured through open access to information at all process stages	A basic level of transparency is provided through publication of information on the platform and in the mobile app	No information found regarding measures to ensure process transparency
Challenges and Limitations	The need to further engage all community groups and improve discussion processes	Low awareness among residents about the platform and the need for adaptation to wartime conditions	Low awareness among residents about the platform and the need for adaptation to wartime conditions

Source: created by the authors

A comparative analysis of the characteristics of the OmaStadi system (Helsinki) and E-DEM (Novoiavorivsk and Kherson territorial communities), presented in Table 3, revealed a number of gaps in the implementation of e-budgeting systems in Ukrainian territorial communities. Novoiavorivsk, being a relatively peaceful and well-resourced city, implemented advanced e-budgeting features, for example, a dedicated "Novoiavorivsk SMART" mobile app (Novoiavorivsk City Council, 2024a) that integrates the E-DEM platform. Its residents can submit projects, vote on them and monitor implementation conveniently via this app and open data portal. This has led to relatively higher engagement among local citizens. In contrast, Kherson's e-budgeting relies on the standard E-DEM system without such enhancements, and its participatory budget process lacks any mobile integration. Kherson's platform version shows no specific inclusion or transparency measures, like neither multi-channel access nor detailed public dashboards, reflecting both infrastructural constraints and the disruptions of a full-scale war (Kherson City Council, n.d.). Consequently, citizen awareness and involvement in Kherson's participatory budgeting process remain low, exacerbated by ongoing military actions.

Both communities shared certain weaknesses. Neither Novoiavorivsk nor Kherson currently uses gamification elements, unlike Helsinki's OmaStadi, which actively engages youth through game-like features. Additionally, both reported low overall awareness of participatory budgeting opportunities among residents. In sum, Novoiavorivsk leveraged better digital tools, mobile app and wider criteria of participation, to involve more citizens, whereas Kherson suffered from limited adoption and outreach under wartime conditions. These contrasts imply several causal insights and lessons. The first one is that infrastructure and stability matter. Novoiavorivsk's infrastructure investments and absence of direct conflict enabled smoother e-budgeting implementation. In Kherson, conflict-related resource diversion and population displacement hindered similar progress. The next one is that technology alone is not enough. Even with E-DEM in place, both communities face low engagement, indicating that without active promotion and support, digital tools underperform. In addition, it is the

fact that transition of best practices requires adaptation. Features like gamification or mobile access (inherited from the Helsinki model) could improve outcomes, but must be tailored for ongoing wartime conditions, so, for example taking into account power outages or displacement.

Based on the conducted analysis, the following directions for improving participatory and e-budgeting can be proposed. There should be enhancing inclusiveness by ensuring the participation of all population groups, including youth, persons with disabilities and internally displaced persons, through targeted programmes and initiatives. In addition, it is important to improve community engagement in project development by strengthening cooperation with experts and local authorities. This can be facilitated by integrating e-budgeting systems with mobile applications, thereby expanding functionality and improving access to key information (Gavkalova & Kunitsyn, 2024). It can be effective to make an introduction of gamification practices, drawing from the Helsinki model, to attract young people to e-budgeting processes. This could enhance the system's effectiveness by leveraging game-based mechanisms. The next is highly important increasing of transparency at all stages of the budgeting process to improve public trust in the culture of participatory budgeting and digital fiscal systems (Barida *et al.*, 2024). Finally, implementation of embed rapid response mechanisms within the budgeting process to provide timely support to communities during emergencies.

Proposal model for improving the implementation of e-budgeting systems

Based on the identified gaps and proposed improvement directions for implementing e-budgeting systems in Ukrainian territorial communities, the following points should also be considered. The effectiveness of implementation can be achieved through the synergy of all proposed improvement directions. Adaptability to wartime conditions should be viewed as a key success factor in the current context of full-scale war. Evaluation of improvement efforts in e-budgeting implementation should be based on financial indicators that demonstrate a high level of financial resilience in the community. In addition to the above and taking into account the experience of Ukrainian communities in adapting e-budgeting systems to such extraordinary challenges as full-scale war (Lobodina *et al.*, 2022), it is reasonable to recommend that international territorial communities consider adopting the positive practices of Ukrainian communities. To strengthen the financial resilience of Ukrainian territorial communities under wartime conditions, this study developed a model for improving the implementation of e-budgeting systems as an informational tool (Fig. 1).

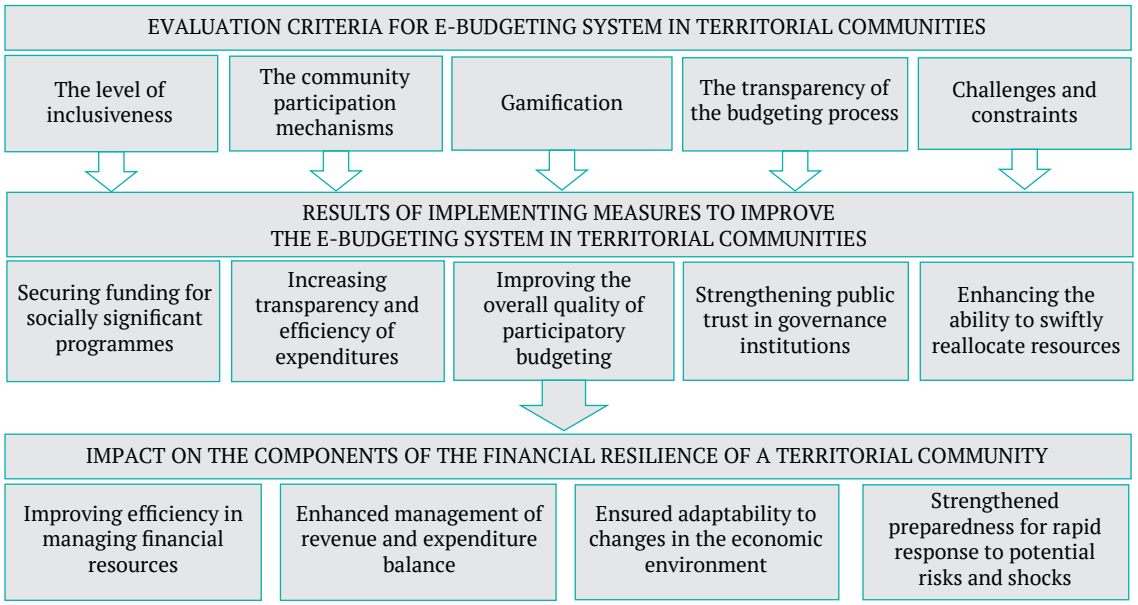

Figure 1. A model for enhancing the implementation of e-budgeting system to support the financial resilience of Ukraine's territorial communities

Source: created by the authors

The model shown in Figure 1 is structured as a multi-level analytical framework. This model should be read as a theory-of-change for how targeted improvements to e-budgeting translate into measurable process performance, near-term governance outcomes and ultimately into the capacities of financial resilience of a territorial community. Structurally, it links four levels: strategic directions for improving the implementation of e-budgeting; a system of criteria to assess the effectiveness of the implemented improvements; the expected outcomes of implementation; and the impact of the proposed measures on the key components of the financial resilience of territorial communities. In the Ukrainian wartime context, the model functions as an informational and managerial tool to align scarce administrative effort with the largest resilience gains, consistent with the study's definition of financial resilience as the ability to manage resources, maintain budgetary balance and respond proactively to shocks.

At the first level of the model, five strategic directions for improving the implementation of e-budgeting are defined. Enhancing inclusiveness is not only about open access, since it requires targeted design for hard-to-reach groups, for example internally displaced persons, persons with disabilities, elderly and the youth. Operational measures include multi-channel participation, accessibility compliance, multilingual interfaces (Ukrainian, Crimean Tatar, English, Polish, Romanian, Slovakian, Hungarian), and assisted submission points via social service centres. In war-affected communities, inclusiveness also entails flexible identity verification for residents with damaged documents and temporary residence. Active citizen engagement in project development shifts participation upstream from voting to co-design. Effective practices include budget-literacy micro-courses and moderated deliberation that reduces elite capture and aligns projects to legal/engineering standards. Embedding these practices in the e-budgeting workflow increases the share of implementable proposals while reducing downstream procurement bottlenecks. Gamification of participatory budgeting is treated as a means, not an end. Appropriate use involves short "quests" that mirror the real process, for example completing a needs-assessment quiz to unlock a project-draft template, transparent badges for constructive behaviours, like peer-review or evidence provision, and community-level leader boards tied to non-monetary recognition, thereby avoiding perverse incentives. Properly tuned, gamification raises engagement from younger cohorts without diluting deliberative quality. Ensuring transparency across the budgeting cycle means having an easy-way accessibility to all the stages of budgeting cycle for community member. It means that community member should have an access to detailed information about project idea, its technical review, costed shortlist, contract details, implementation flow, and be able to participate in post audit. In addition, it is important to highlight, that linking e-budgeting data to procurement and treasury events creates traceability from vote to expenditure, which also has a potential to increase transparency. Providing a rapid response to community needs embeds agility in the platform: emergency tranches with shorter cycles, delegated thresholds for micro-allocations, geo-tagged incident reporting integrated with civil protection and pre-approved "shelf projects" ready for immediate launch are good to have for an effective e-budgeting system. In frontline or de-occupied communities, this reduces the latency from community signal to budgetary action.

The second level of the model presents a system of criteria to assess the effectiveness of the implemented improvements. Each direction is mapped to observable, auditable indicators that can be tracked within the platform and through administrative data. The level of inclusiveness can be measured via coverage ratios, for example, share of active users among eligible residents or participation rates by different dimension based on provided users' personal information. In addition, accessibility metrics like share of submissions via assistive channels or completion rates on mobile vs. desktop can be also useful to properly determine the level of inclusiveness in territorial community. Citizen participation mechanisms are assessed by process quality: conversion rates as percentage of ideas, which turned to real proposals, average review time, number and completion of co-design sessions or proportion of successful proposals with documented evidence, like photos or cost sheets. Gamification could be evaluated using engagement depth, like median session length and repeated participation across cycles. Also, contribution quality, which is measure by peer-review helpfulness scores, and drop-off analysis to ensure that "points" do not crowd out deliberation, can be helpful to properly measure gamification's level of implementation. Transparency can be measured by presence of itemised costs and contracts, which are evidence of each step in a pipeline. Challenges and constraints could be explicitly recorded: platform uptime, cyber-incidents, staff hours per cycle, legal exceptions used and energy/connectivity disruptions. These indicators enable a diagnostic dashboard and support the construction of a composite performance index using normalised scores with transparent weights calibrated to community priorities.

The third level of the model (Fig. 1) focuses on the expected outcomes of implementation. Increasing transparency and efficiency of expenditures translates into fewer off-cycle budget amendments, lower variance between approved and executed project costs and higher audit pass rates. Improving the overall quality of participatory budgeting is seen in a rising share of technically viable proposals, stronger geographic equity of funded projects and higher completion rates on time and on budget. Strengthening public trust is evidenced by repeated participation across cycles and favourable trust-in-local-government survey scores. Securing funding for socially significant programmes is reflected in the proportion of projects aligned with social protection, education, health and basic infrastructure. Enhancing the ability to swiftly reallocate resources becomes visible through shorter cycle times and the successful activation of emergency tranches without breaching fiscal rules. These results are the near-term "transmission belt" that carries process improvements into fiscal resilience effects. At the fourth, the model illustrates the impact of the proposed measures on the key components of the financial resilience of territorial communities. Enhanced management of revenue-expenditure balance arises from better project costing and fewer failed implementations, improving predictability of cash flows and limiting waste. Ensured adaptability to economic changes could be achieved by institutionalising data-driven reprioritisation and emergency micro-cycles that keep service delivery responsive under constrained revenues. Strengthened preparedness for rapid response follows from pre-vetted projects, integrated geo-data and clear mandates for the main responsible actors. Improving efficiency in managing financial resources reflects transaction cost reductions, tighter procurement alignment and evidence-based sequencing of investments. Together, these channels reinforce the credibility of local public finance, facilitate access to intergovernmental transfers and donor funds, and reduce the risk of fiscal distress under wartime volatility.

It is important to note that the proposed model is built upon a logic of step-by-step interaction among its component levels. The improvement directions outlined at the first level serve as prerequisites for the formation of certain qualitative characteristics of electronic budgeting, which are presented at the second level of the model in the form of assessment criteria. The application of the criteria defined

at the second level directly influences the achievement of third-level outcomes, such as increased transparency of expenditures, improved funding of social programmes and strengthened trust in local authorities. These outcomes, in turn, act as transmitters of influence on the financial resilience of territorial communities, which is represented at the fourth level. It should be emphasised that the outcomes achievable at the third level ensure better resource management, revenue-expenditure balance and community preparedness for crisis situations. Thus, the model reveals a cause-and-effect relationship: initiatives at the respective levels of public governance trigger structural shifts in the budgeting process, which ultimately lead to enhanced financial adaptability and resilience of communities, including under wartime and post-war conditions.

Several barriers may hinder the efforts to improve the effectiveness of electronic budgeting systems in Ukraine's territorial communities. As noted by H. Voznyak *et al*. (2024), technical limitations, such as insufficient access to modern technologies and infrastructure, remain a challenge in many regions. Another major issue is the low level of digital literacy, both among citizens and local government representatives. In addition, there is often resistance to innovation, driven by entrenched traditional budgeting practices. To overcome these challenges, H. Voznyak *et al*. suggests implementing the following comprehensive measures. First, invest in the development of digital infrastructure to ensure reliable internet access in every community. Second, organise digital literacy training programmes for both officials and residents. Third, foster cultural change by demonstrating the advantages of digital solutions and involving stakeholders in the implementation process. Fourth, strengthen the legal and regulatory framework to ensure transparency, accountability and citizen participation in the budgeting process. These measures aim to overcome the outlined barriers and enhance the implementation of electronic budgeting systems.

Therefore, electronic budgeting should be viewed not only as a technical and economic tool but also as a critical mechanism for democratising governance, increasing public finance transparency and strengthening the financial sustainability of communities. This is especially relevant in the context of Ukraine's reconstruction, where the effectiveness of local self-governance determines not only the quality of life of citizens but also the long-term stability of the country as a whole. Electronic budgeting systems can form the foundation for a new culture of interaction between the state and citizens, one that reflects the real needs of communities and supports their sustainable development. The proposed model not only enables a structured assessment of the current state of electronic budgeting in a community but also provides practical guidance for its improvement. It integrates technological, economic and social components, offering a systemic vision of the interconnection between digital participation tools, the quality of the budgeting process and the long-term financial capacity of the community. This is particularly relevant in the context of high uncertainty and limited resources caused by the ongoing full-scale war and represents a novel, flexible approach to public administration. Obtained results resonated with and extend recent international research on digital participatory budgeting, community resilience and e-budgeting. B. Shin *et al*. (2024) catalogued digital participation tools and found that many e-budgeting platforms facilitate citizen-to-government information flow, but suffer from limited accountability features. Novoiavorivsk's system provides open data and project tracking for partial transparency, whereas Kherson's platform offers minimal feedback mechanisms – mirroring B. Shin *et al*. conclusion that "prominent deficiencies" remain in showing citizens how decisions are made. Similarly, V.R. Levesque *et al*. (2024) research showed in rural Maine that municipal digital services enhance community resilience during crises. The results of research extended this by demonstrating a concrete fiscal example: communities with more developed e-budgeting tools (Novoiavorivsk territorial community) were better able to engage stakeholders and maintain budget functions, suggesting stronger resilience. V.R. Levesque *et al*. confirm that more extensive digital services (information portals, online transactions, e-democracy) correlate with greater resilience, which aligns with recommendation that robust e-budgeting is a resilience-building strategy.

Several studies emphasise that governance context and digital divides shape outcomes. For instance, S. Kozaman Aygün & T. İnal Çekiç (2025) made hypothesis that e-participation can widen inequalities if not everyone can engage online. This finding reflected in Kherson's low participation under martial law, where many citizens lack secure Internet connection or digital literacy. The results of research correlated with A.M. Oriol (2024) formulation that "no universal e-budgeting system" exists and solutions must fit local needs, particularly in crisis. H. Voznyak *et al*. (2024) focused on Ukraine's war context and found that well-designed budgetary instruments can largely preserve community resilience. In line with them, there is an observation that neither Kherson nor Novoiavorivsk saw catastrophic budget collapse despite war. Financial stability of these communities was maintained via central transfers and local flexibility. H. Voznyak *et al*. reported that 90% of communities' resilience remained stable when defence-related tax shifts occurred, supporting inference that adaptive budgeting frameworks, like emergency funds, helped shield communities from full disruption. On the other hand, some research highlights challenges not fully addressed by technology alone. M. Bisogno *et al.* (2022) stress that e-participation boosts transparency but must be coupled with accountability frameworks. The research we've done, studied similarly notes that transparency gains from e-budgeting, for example, public visibility of projects, require institutional support to translate into trust and civic action. T.A.N.N. Susanti Oktaviani & C. Kuntadi (2022) emphasised leadership and resources in e-budget adoption, while it was determined, that Novoiavorivsk's proactive leadership, for example, pushing a mobile app and outreach, contrasts with Kherson's more reactive stance. This suggests that capacity-building, which is based on trained officials and funding for tech, is essential. This conclusion echoed in the actual literature. Contributions of this study include a war-time perspective: even under extreme shocks, maintaining participatory budget practices can support resilience, provided they adapt to emergency needs. Globally, the discourse on e-participation and resilience is evolving. Recent works emphasise digital inclusion

and local empowerment. This vision was extended by explicitly linking e-budgeting design to community financial endurance during the deepest kind of crisis. Upon critical reflection it was noted that most scholarship assumes peacetime conditions case highlights that during full-scale conflict, priorities shift and digital tools, like e-budgeting systems, must be agile.

CONCLUSIONS

The conducted study allows to conclude that electronic budgeting is not only a tool for the digital transformation of public administration at the local level, but also one of the mechanisms for ensuring the financial resilience of territorial communities in times of crisis. In examining the digital tools of electronic budgeting in Ukraine's territorial communities, it was found that this domain is not merely a technological innovation but forms part of the broader process of public sector digitalisation under the ongoing decentralisation reform. In the current context, particularly amid full-scale war and the imperative for effective post-war recovery, enhancing the transparency of the budgeting process, engaging citizens in decision-making and fostering trust between government and society are critically important.

An analysis of existing Ukrainian electronic budgeting platforms has shown the gradual introduction of digital solutions into public finance management. Each of these systems has its own specificity, functional features and level of integration with local government bodies. The particular value is the experience of Helsinki, where the OmaStadi platform operates on the open-source software Decidim, offering a flexible setup of citizen participation tools. At the same time, several barriers hinder the full realisation of electronic budgeting potential in Ukraine. These include uneven digital infrastructure development, limited digital literacy in some regions, low levels of trust in government institutions and insufficient integration of e-budgeting platforms with other components of e-governance. Addressing these challenges requires a comprehensive national policy that combines infrastructure investment, digital literacy training programmes, support for local-level innovations and development of open data systems.

The proposed model for improving the implementation of electronic budgeting systems in support of the financial resilience of Ukraine's territorial communities illustrates how areas for improvement influence the criteria of electronic budgeting systems, leading to qualitative outcomes that positively affect the community's financial resilience. Future research should focus on empirically validating the proposed model across a wide range of territorial communities, developing integrated digital budgeting ecosystems and formulating performance indicators that take into account social, economic and security conditions. Another promising direction is the development of recommendations for adapting Ukraine's experience to the needs of other countries facing or potentially facing shock events similar to those experienced by Ukraine.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

REFERENCES

[1] Barida, N., Demydenko, L., Nakonechna, Y., Tretiak, D., & Miedviedkova, N. (2024). Ensuring transparency and publicity of local budgets in Ukraine in the face of new challenges. *Amazonia Investiga*, 13(73), 56-73. doi: 10.34069/AI/2024.73.01.5.

[2] Basyuk, O.P. (2022). Digital technologies in optimizing the budget process: Best international practices and conclusions for Ukraine. *Problems of Public Administration*, 1(60), 116-131. doi: 10.26565/1684-8489-2022-1-08.

[3] BePart. (2022). *Initiative "Public project"*. Retrieved from https://bepartforum.org/initiatives/hromadskyi-project.

[4] Bisogno, M., Cuadrado-Ballesteros, B., & Santis, S. (2022). Do e-government initiatives and e-participation affect the level of budget transparency? *International Public Management Journal,* 25(3), 365-391. doi: 10.1080/10967494.2022.2042437.

[5] Bozhuk, I.I., & Fomenko, U.O. (2020). The public budget as a tool for local democracy development. *Comparative and Analytical Law*, 1(2020), 297-299.

[6] City of Helsinki. (2022). *OmaStadi complements the participation possibilities of the residents of Helsinki*. Retrieved from https://www.hel.fi/en/news/omastadi-complements-the-participation-possibilities-of-the-residents-of-helsinki.

[7] City of Helsinki. (2024). *Young people voted most actively in OmaStadi*. Retrieved from https://www.hel.fi/en/news/young-people-voted-most-actively-in-omastadi.

[8] City of Helsinki. (2025a). *OmaStadi makes Helsinki better – do you know what participatory budgeting is?* Retrieved from https://www.hel.fi/en/news/omastadi-makes-helsinki-better-do-you-know-what-participatory-budgeting-is.

[9] City of Helsinki. (2025b). *OmaStadi: Information for residents*. Retrieved from https://omastadi.hel.fi/pages/information.

[10] Cost Ukraine. (2025). *Interactive community budget*. Retrieved from https://cost.ua/interactive-community-budget.

[11] Council for the development of communities and territories. (2023). *Electronic services in communities: How to improve communication with residents?* Retrieved from https://surli.cc/itmgai.

[12] Davies, J., Arana-Catania, M., & Procter, R. (2022). Embedding digital participatory budgeting within local government: Motivations, strategies and barriers faced. In *ICEGOV' 22: Proceedings of the 15th international conference on theory and practice of electronic governance* (pp. 98-104). Guimarães. doi: 10.1145/3560107.3560124.

[13] Decentralization portal. (2024). *How to make participatory budgeting effective: Expert recommendations*. Retrieved from https://decentralization.gov.ua/news/14353.

[14] Decidim. (2022). *Decidim and the city of Helsinki*. Retrieved from https://decidim.org/blog/2022-06-01-decidim-and-the-city-of-helsinki.
[15] EEA and Norway Grants. (2025). *Participatory budgeting for youth engagement in Lithuania*. Retrieved from https://eeagrants.org/archive/2014-2021/projects/LT-ACTIVECITIZENS-0080.
[16] European parliamentary research service. (2015). *Participatory budgeting: A democratic tool for a better allocation of public funds*. Retrieved from https://www.europarl.europa.eu/RegData/etudes/BRIE/2015/572796/EPRS_BRI(2015)572796_EN.pdf.
[17] Faster Capital. (2025). *Budget participation: Digital tools for budget participation – trends and challenges*. Retrieved from https://fastercapital.com/content/Budget-Participation--Digital-Tools-for-Budget-Participation--Trends-and-Challenges.html.
[18] Gavkalova, N.L., & Kunitsyn, O.M. (2024). Boosters of IT innovations in Ukraine's public sector. In *All-Ukrainian scientific and practical conference "Modern Trends and Development of Socio-Economic Systems"* (pp. 305-308). Kharkiv: Kharkiv National University of Economics.
[19] Go Vocal. (2024). *What is participatory budgeting?* Retrieved from https://www.govocal.com/en-uk/blog/what-is-participatory-budgeting.
[20] Jeakalo, H.I., Zaiats, M.Ya., & Vakun, O.V. (2020). The essence and content of e-governance: Conceptual dimension. *Public Administration: Improvement and Development*, 8. doi: 10.32702/2307-2156-2020.8.52.
[21] Kherson City Council. (n.d.). *Local petitions.* Retrieved from https://miskrada-kherson.gov.ua/e-dem/petition.
[22] Kozaman Aygün, S., & İnal Çekiç, T. (2025). Sustainable urban governance and the digital divide: Patterns of e-participation in Istanbul. *Sustainability*, 17(11), article number 4913. doi: 10.3390/su17114913.
[23] Kruhlov, V., & Tereshchenko, D. (2024). Adaptive budgeting under emergencies and wartime uncertainty: The role of digital tools in public financial management. *Problems of Public Administration*, 2(65), 43-62. doi: 10.26565/1684-8489-2024-2-03.
[24] Kunitsyn, O.M., & Melnyk, V.I. (2025). Theoretical principles of determining the financial resilience of territorial communities of Ukraine. *Successes and Achievements in Science*, 4(14), 270-280. doi: 10.52058/3041-1254-2025-4(14)-270-280.
[25] Levesque, V.R., Bell, K.P., & Johnson, E.S. (2024). The role of municipal digital services in advancing rural resilience. *Government Information Quarterly*, 41(1). doi: 10.1016/j.giq.2023.101883.
[26] Lobodina, Z., Demchyshyn, V., Kizyma, T., Berezka, K., & Kizyma, A. (2022). Functioning of participatory budgets: Current status, modernization trends and modeling under public finance reform. *Bulletin of Economics*, 4, 8-27. doi: 10.35774/visnyk2022.04.008.
[27] Mainiotech. (2021). *Participatory budgeting – city of Helsinki references*. Retrieved from https://www.mainiotech.fi/en/references/participatory-budgeting.
[28] Maliarevskyi, Ye.V., & Barannik, V.O. (2021). *Civic budgets in Ukraine as a promising tool for community and territorial development*. Dnipro: National Institute for Strategic Studies.
[29] Maptionnaire. (2022). *Participatory budgeting examples*. Retrieved from https://surl.li/wpeyjp.
[30] Novoiavorivsk City Council. (2024a). *Launch of the mobile application "Novoiavorivsk SMART".* Retrieved from https://novmiskrada.gov.ua/2024/03/25/zapuskayemo-mobilnyj-dodatok-novoyavorivsk-smart.
[31] Novoiavorivsk City Council. (2024b). *The Novoiavorivsk Community as an example of digital transformation development*. Retrieved from https://surl.li/omnzqi.
[32] OECD Observatory of Public Sector Innovation. (2015). *Decide Madrid – participatory democracy platform*. Retrieved from https://oecd-opsi.org/innovations/decide-madrid.
[33] Oriol, A.M. (2024). *Digital tools for managing our public finances: How well-tooled are we?* Retrieved from https://odi.org/en/insights/digital-tools-for-managing-our-public-finances-how-well-tooled-are-we.
[34] Participedia. (n.d.). *OmaStadi – participatory budgeting in Helsinki, Finland (2018-ongoing)*. Retrieved from https://participedia.net/case/omastadi-participatory-budgeting-in-helsinki-finland-2018-ongoing.
[35] Pityulich, M.M., Krupka, A.Ya., Minkovych, V.T., & Chakii, O.I. (2023). Development determinants and their impact on the financial resilience of territorial communities. *Regional Economic*, 107(1), 34-44. doi: 10.36818/1562-0905-2023-1-4.
[36] Popov, D.I., Kotukha, O.C., & Olashyn, M.M. (2023). Digitalization of the budget system of Ukraine as a publicity increase tool bodies of state authority. *Problems of Modern Transformations. Series: Law, Public Management and Administration*, 7. doi: 10.54929/2786-5746-2023-7-01-11.
[37] Shin, B., Floch, J., Rask, M., Bæck, P., Edgar, C., Berditchevskaia, A., & Branlat, M. (2024). A systematic analysis of digital tools for citizen participation. *Government Information Quarterly*, 41(3), article number 101954. doi: 10.1016/j.giq.2024.101954.
[38] Shin, B., Rask, M., & Tuominen, P. (2022). Learning through online participation: A longitudinal analysis of participatory budgeting using Big Data indicators. *Information Polity*, 27(4), 517-538. doi: 10.3233/IP-211551.
[39] Skorobohatova, N.Ye., Petrenko, K.V., & Ivanova, T.V. (2024). Accounting for expenditure on territorial communities during war. *Economic Bulletin of NTUU "KPI"*, 30, 23-28. doi: 10.20535/2307-5651.30.2024.313032.
[40] Susanti Oktaviani, T.A.N.N., & Kuntadi, C. (2022). Leadership styles, communications, and resources affecting the development of e-budgeting in the public sector. *Dinasti International Journal of Education Management and Social Science*, 4(1), 25-38. doi: 10.31933/dijemss.v4i1.1454.

[41] The EGAP program. (2022). *E-governance for accountability and participation*. Retrieved from https://egap.in.ua.
[42] The World Bank Blogs. (2022). *A survey of the global payment systems in six charts*. Retrieved from https://blogs.worldbank.org/en/psd/a-survey-of-the-global-payment-systems-in-six-charts.
[43] Ukrainian e-democracy portal. (2021). Retrieved from https://e-dem.ua.
[44] Voznyak, H., Patytska, K., Mulska, O., Zherebylo, I., & Sorokovyi, D. (2024). Resilience of territorial communities amid the war against Ukraine: The role of budgetary instruments. *Public and Municipal Finance*, 13(1), 41-54. doi: 10.21511/pmf.13(1).2024.04.
[45] Wackowski, K.S., & Gordiienko, L.Yu. (2025). Digitalization in the field of public services: The experience of Poland. In *Public administration in Ukraine: Historical experience and prospects for development. Materials from the all-Ukrainian scientific and practical conference* (pp. 223-224). Kyiv: Taras Shevchenko National University of Kyiv.

Модель електронного бюджетування в архітектурі фінансової стійкості територіальних громад під час повномасштабної війни

Лариса Гордієнко
Кандидат економічних наук, доцент
Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки, 9А, м. Харків, Україна
https://orcid.org/0000-0003-4971-6264

Олег Куніцин
Аспірант
Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки, 9А, м. Харків, Україна
https://orcid.org/0009-0008-7552-7946

Анотація. Метою дослідження було розроблення адаптивної моделі електронного бюджетування, яка сприятиме зміцненню фінансової стійкості територіальних громад в умовах повномасштабної війни та інших кризових викликів. Методологія дослідження ґрунтувалася на поєднанні системного, порівняльного та структурно-функціонального аналізу, а також на порівнянні міжнародних практик, зокрема фінської системи OmaStadi та української платформи E-DEM. Результати дослідження засвідчили, що ефективна імплементація електронного бюджетування позитивно впливає на прозорість управлінських процесів, підвищує громадську участь та забезпечує оптимальний розподіл публічних ресурсів. Проведений аналіз виявив ключові проблеми, які стримують упровадження цифрових інструментів бюджетування в Україні, серед яких: низький рівень цифрової грамотності, недостатня інфраструктура, слабка залученість вразливих груп населення до процесів партисипативного бюджетування та відсутність інтегрованих мобільних сервісів. Для підвищення фінансової стійкості територіальних громад у кризових та воєнних умовах запропоновано багаторівневу модель удосконалення системи електронного бюджетування. Вона охоплює напрями розвитку практик партисипативного бюджетування, систему їх оцінювання, очікувані результати впровадження моделі та її вплив на ключові складові фінансової стійкості. Запропонована модель удосконалення впровадження систем електронного бюджетування для підтримки фінансової стійкості територіальних має потенціал продемонструвати, як напрями вдосконалення впливають на критерії електронних бюджетних систем, що призводить до якісних результатів. Практичне значення дослідження полягає у можливості застосування адаптивної моделі електронного бюджетування органами місцевого самоврядування, інститутами громадянського суспільства, аналітичними центрами та державними інституціями, які здійснюють моніторинг фінансової діяльності територіальних громад

Ключові слова: публічне управління; партисипативне бюджетування; цифрова платформа; прозорість; місцева громада

ISSN 2413-9610, E-ISSN 2663-2365 Journal homepage: https://devma.com.ua/en

DEVELOPMENT MANAGEMENT

UDC 005.53:338.3
DOI: 10.63341/devt/4.2025.20

Vol. 24, No. 4. 2025

Using a modified indicator of overall equipment efficiency for management decision-making

Olena Velyka*
PhD in Economics, Associate Professor
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0000-0002-0072-5867

Inna Kozlova
PhD in Economics, Associate Professor
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0000-0002-5107-6668

Abstract. The relevance of the study was determined by the need to take into account energy consumption costs, which are a significant item in the cost of production, when making management decisions. The aim of the study was to improve the formation of management decisions based on the assessment of a modified indicator of equipment efficiency, which takes into account the level of energy consumption (OEEe). The methodological basis of the study included the use of methods of analysis and synthesis, comparison and generalisation, visualisation of empirical data based on a diagram of the dynamics of the components of the overall equipment effectiveness indicator using the example of a company that manufactures packaging products for the first half of 2025. This gave grounds to argue that it is necessary to more fully assess the resource and economic efficiency of equipment by introducing an additional component, "E – energy efficiency", which reflects the ratio of minimum and actual energy consumption in the production of a unit of output. Using the example of calculating OEEe for a production line for the manufacture of aluminium tubes, it was established that, with comparable values of overall equipment efficiency, there may be significant differences in specific energy consumption costs, which directly affects the cost and profitability of products. The results of the analysis proved that the main source of energy losses is an increase in the number of equipment changeovers required to fulfil small-volume orders. It is proposed to use the OEEe indicator for making management decisions aimed at optimising the production programme, managing the order portfolio, justifying investment decisions and forming a staff motivation system. The practical significance of the research results lies in the fact that the OEEe indicator can be used as a tool to increase energy efficiency, identify hidden economic losses, and integrate the indicator into the management reporting system

Keywords: management; production cost; equipment performance; changeovers; energy efficiency; specific energy consumption

INTRODUCTION

The main goal of managers of any enterprise is to increase its profits. One of the ways to achieve this in a manufacturing enterprise is to increase performance and production efficiency. Equipment is an important part of the production system, and both the level of labour productivity and the quantity, quality and cost of goods produced on it directly depend on the efficiency of its use. The simplest indicator for assessing the efficiency of equipment use is the ratio of productive equipment usage time to planned production time. However, calculating this indicator does not allow for the identification of production losses and analysis of equipment or production line performance. The overall

Article's History: Received: 08.07.2025; Revised: 03.11.2025; Accepted: 23.12.2025; Published: 12.01.2026

Suggested Citation:
Velyka, O., & Kozlova, I. (2025). Using a modified indicator of overall equipment efficiency for management decision-making. *Development Management*, 24(4), 20-30. DOI: 10.63341/devt/4.2025.20.

*Corresponding author

equipment effectiveness (OEE) indicator has become more widely used among scientists and managers. OEE tools are widely used as key performance indicators (KPIs), which, in combination with lean manufacturing technologies, allow companies to increase their competitiveness. Scientists L.d.C. Ng Corrales *et al*. (2020) used analysis of information from electronic scientific databases to study the evolution of the OEE indicator, the frequency and results of its use. At that time, they counted 847 documents and scientific articles, which proves the great interest of scientists in this issue. This interest has actively increased since 2015 and has covered not only publications devoted to technology and production issues, but also management, business development, logistics, etc. Over time, companies in various industries have also tried to adapt the OEE indicator to the specifics of their production or developed new modifications of the indicator.

According to researchers F.A.S. Piran *et al*. (2020), increasing the level of equipment utilisation efficiency can also increase the competitiveness of a company. Thus, they proposed comparing the results of a comprehensive analysis of performance and overall production efficiency (DEA/OEE). As a result, they found that managers' actions aimed solely at improving the OEE indicator reduce the efficiency of operations by increasing resource consumption, do not necessarily increase production levels, and may even reduce technical efficiency. Based on the calculation of the OEE indicator, researchers E.T. Prasetio & A. Oktora (2024) proposed to identify the causes of inefficient equipment use and reduced performance when using a moulding machine. To do this, they first used a Pareto chart, which was compiled based on values for six major losses and allowed to establish that in 81.6% of cases, equipment problems are related to breakdowns, reduced operating speed, and equipment configuration issues. The authors then used the principles of cause-and-effect decomposition borrowed from the Ishikawa method and comprehensive analysis to identify the main problems leading to losses in areas such as equipment, methods, personnel, materials and machines. I. Kustiyawan *et al*. (2023) used the OEE indicator to determine the efficiency of automated packaging machines with a tracking system using two-dimensional barcodes and proposed ways to improve it. Their research was conducted for a company that manufactures pharmaceutical packaging. The authors calculated the three main components of the OEE indicator and identified two main problems for each of them. As a result, six major losses were identified: breakdowns, planned downtime, idle time and minor stoppages, speed losses, product shortages, and start-up deviations. Based on the assessment of the values of these losses, the authors constructed a "fishbone" diagram and identified the root causes of problems on the automatic packaging line, which made it possible to reduce its unproductive labour time.

The use of the OEE indicator to reduce costs in additive manufacturing was considered by S. Basak *et al.* (2022). In doing so, they retained the traditional structure of the OEE indicator and adapted it to the specifics of their production. The authors also presented management ideas that can maximise the efficiency of the additive manufacturing process using the OEE indicator. There is also a trend in scientific literature that studies the efficiency of equipment use without the help of the OEE indicator. For example, researchers N. Safonik & V. Vatashchuk (2023) analysed the features of increasing the efficiency of reproduction and use of fixed assets of an enterprise using the depreciation coefficient, suitability coefficient, return on assets, capital intensity and capital-labour ratio indicators. N. Lutska *et al*. (2024) proposed to evaluate the efficiency of the use of fixed assets of an enterprise based on an analysis of their technical condition using the renewal, disposal, growth, depreciation and suitability coefficients, as well as using indicators of return on assets, capital intensity, profitability and net profit. Researcher O. Iastremska (2023) linked the efficiency of equipment use to the number of defective products and the need to manage product quality. Pareto analysis was used to analyse the situation and justify proposals to reduce product defects, and an Ishikawa diagram was used to identify the relationships between factors. Thus, despite the considerable interest of scientists in issues related to the efficiency of equipment operation, a number of issues remain unresolved, namely: the energy consumption of equipment is not taken into account, which is relevant in the context of rising tariffs; many proposals for improving the OEE indicator focus only on the technical aspects of equipment use and do not take into account the fact that problems may be related to imperfect planning of the production programme or insufficient motivation of employees. The aim of this study was to improve the management decision-making mechanism by evaluating a modified equipment efficiency indicator that takes energy consumption parameters into account. Identifying and solving problems related to low levels of this indicator will enable managers to increase labour productivity and equipment efficiency at manufacturing enterprises.

MATERIALS AND METHODS

The study was conducted based on the processing of statistical data for "Tube Plant" LLC. The selection of this enterprise is due to the fact that it is one of the most well-known companies manufacturing packaging products for the pharmaceutical and cosmetic industries, not only in Kharkiv but in Ukraine as a whole. Furthermore, the company's products are actively used by European companies located in Spain, Italy, Latvia, and elsewhere. Despite the crisis years, the enterprise not only continues to operate but is also actively developing.

The production line for the manufacture of aluminium tubes was considered as the object of the study. The line consists of seven technological sections that sequentially perform operations (turning, trimming, internal and external lacquering, printing, applying a latex ring, and screwing on caps). Production is small and medium-scale, which is associated with frequent equipment changeovers. To assess the prerequisites for the current level of availability of the production system, retrospective and historical analysis of operational data was used. The analysis covered the period 2019-2023 and was based on the company's internal reporting on the volume and structure of orders, the duration of production cycles and the number of equipment changeovers, obtained by the authors. Particular attention was paid to the period after 2022, which was characterised by the company's entry into European markets and an increase in the share of small-batch orders. Changes in the

structure of orders were assessed through a comparative analysis of average batch sizes, start-up frequency and downtime, which made it possible to identify their impact on equipment availability.

The calculations used the following statistical data of the enterprise for the first half of 2025, which made it possible to determine the volumes of high-quality and defective products, the planned and actual operating time of the equipment, and its downtime. The analysis of equipment utilisation efficiency was carried out using the overall equipment effectiveness indicator, which consists of three components: operational readiness (availability) of the working operation, efficiency (performance) of the working operation, and quality coefficient (Chikwendu *et al.*, 2020). The relationship between these components can be represented by the following formula:

$$OEE = A \times P \times Q, \quad (1)$$

where A – availability; P – performance; Q – quality. Operational readiness (availability) of a working operation is defined as the proportion of time when the equipment produced or could have been producing output, i.e. was in working order. Availability makes it possible to compare the time during which the equipment was actually used with the time during which its use was planned. This indicator is calculated using the following formula:

$$A = \frac{t_{actual}}{t_{planned}}, \quad (2)$$

where t_{actual} – actual production time; $t_{planned}$ – planned production time. Efficiency (performance) of the working operation is the proportion of time defined as the actual time spent on production at the maximum (ideal) speed for the given equipment. It can also be defined as the ratio of the quantity of output actually produced to the maximum possible quantity that could have been produced on the given equipment. The performance indicator takes into account losses associated with reduced production speed due to equipment wear, the use of materials of inadequate quality, or the influence of human factors. This indicator is calculated using the following formula:

$$P = \frac{V_{actual}}{V_{max}}, \quad (3)$$

where V_{actual} – the quantity of output actually produced; V_{max} – the maximum possible quantity of output that can be produced on the given equipment. The quality coefficient shows the share of acceptable output in the total production volume of the line. It compares the number of units that have passed quality control with the total number of units produced on the given equipment. This indicator is calculated using the following formula:

$$Q = \frac{V_{quality}}{V_{actual}}, \quad (4)$$

where $V_{quality}$ – the quantity of quality products; V_{actual} – the quantity of products that were actually manufactured. Statistical and economic analysis methods, a systematic approach, and scientific generalisation were used to justify the methodology for calculating the overall equipment effectiveness indicator, taking into account energy efficiency. The efficiency of equipment use was assessed based on a modified overall equipment effectiveness (OEEe) indicator, adapted to the conditions of small-batch production with a high frequency of changeovers. The OEEe calculation was based on the classic OEE structure, but the interpretation scale was adjusted to take into account industry specifics and real limitations of the production system. The efficiency level assessment intervals were determined based on benchmarking analysis of companies with similar types of production, as well as analysis of internal historical dynamics of indicators. In particular, the range of 50-79% was classified as "typical functioning" because, in conditions of high order variability and frequent changeovers, achieving values typical of classic mass production (65-85%) is structurally limited. Values below 50% were interpreted as low efficiency, indicating systemic losses in availability, performance or quality. It is proposed to calculate the "E – energy efficiency" component as the ratio of the minimum required energy consumption per unit of output (under ideal conditions) to the actual energy consumption per unit of output:

$$E = \frac{E_{min}}{E_{actual}}, \quad (5)$$

where E_{min} – minimum energy consumption per unit of output; E_{actual} – actual energy consumption per unit of output. Minimum energy consumption per unit of output is calculated as the ratio of minimum energy consumption to maximum possible output. Actual energy consumption per unit of output is determined as the ratio of energy consumed to actual output. Then the formula for calculating the equipment efficiency indicator, taking into account energy efficiency, is as follows:

$$OEEe = OEE \times E = A \times P \times Q \times E, \quad (6)$$

where $OEEe$ – overall equipment effectiveness, taking into account energy consumption; E – energy efficiency. The global standards for the components of the OEE indicator are as follows: availability – 90%, performance – 95%, quality – 99%, which results in an OEE value of 85% (Chikwendu *et al.*, 2020; Kliment *et al.*, 2020). The calculated value of the overall equipment effectiveness indicator can also be compared with reference values: 100% – ideal level, equipment operates quickly and without errors; 85% – global level, which is a long-term goal for many companies; 65% – typical level, which indicates opportunities for improving equipment utilisation; 40% – low level, which is usually found in companies that have not previously paid attention to equipment utilisation efficiency.

To form a scale for determining the level of production efficiency based on the OEEe indicator, the method of structural-parametric synthesis was used. This method is based on the structure of OEEe as the product of the elements of availability, performance, quality and energy efficiency. Since each of these elements is limited to the range [0;1] and does not reach its maximum in real conditions, the upper limit of OEEe was determined as the limit value corresponding to the minimum technological and energy losses. On this basis, high, medium and low OEEe intervals were identified, reflecting different types of losses and equipment operating modes. As already noted, each component A, P and Q has its own stable range. The maximum value of the energy efficiency component E is 95% (Patterson *et*

al., 2023). It follows that even with good production organisation, the maximum achievable value of OEEe can be:

$$OEEe_{max} = 0.90 \times 0.95 \times 0.99 \times 0.95 = 0.80.$$

Thus, an OEEe value above 0.80 corresponds to modes with minimal energy and time losses, while values below 0.50 indicate the presence of systemic losses. The resulting scale is the result of a parametric interpretation of the OEEe model, rather than an empirical comparison, which makes it reproducible and applicable to different types of equipment. The main purpose of calculating the OEEe indicator is not so much to compare its value with the proposed standards, but rather to identify the reasons for the low efficiency of equipment use at the enterprise and to formulate management decisions to improve the situation. Thus, it is necessary to constantly monitor the dynamics of this indicator, identify the causes of losses and respond to them promptly. The information obtained should be accumulated and provided to the enterprise manager for analysis in the form of graphs.

To determine the factors that influence the level of the OEEe indicator and its components, the principles of cause-and-effect analysis based on the logic of the Ishikawa methodology were used. Classic graphical "fishbone" diagrams were not constructed because many factors are interrelated and may influence several components of the OEEe indicator simultaneously. However, the structure of factors was formed according to similar principles of cause decomposition, which made it possible to systematically identify the key loss factors for each component and show their interrelationship. To establish the correspondence between the results of the OEEe calculation and management decisions, a method of analysis and synthesis was used, which took into account the factors affecting this indicator and the results of observations of equipment operation. For each component of the OEEe indicator, typical situations that affect its value were identified. The method of analytical generalisation was used to establish possible causes and practical management measures that reflect the relationship between changes in the OEEe indicator and decisions that managers can make to improve equipment performance.

RESULTS

The overall equipment effectiveness indicator allows for the analysis of performance losses and the identification of problem areas in production. It provides an answer to the most important question for a company manager: how to quickly and significantly increase output without increasing production capacity. The OEE indicator can be used in established operating modes, mainly for mass, large-scale and serial production. The advantage of using this indicator is its comprehensive nature and the ability to identify the causes of low equipment efficiency. The overall equipment effectiveness indicator can also be used to track changes in its dynamics, compare its values for different similar types of equipment, or compare its values for the same type of equipment but in different shifts. Calculations of the overall equipment effectiveness indicator for one of the enterprise's production lines (Fig. 1) showed that it corresponds to typical production (for typical production, the indicator values should be between 65% and 85%).

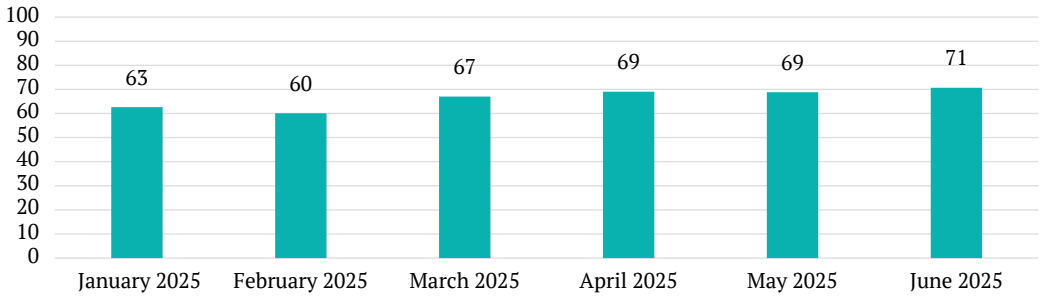

Figure 1. OEE – overall equipment effectiveness for "Tube Plant" LLC, %

Source: developed by the authors

Considering the individual components of the overall equipment effectiveness indicator (Fig. 2), it can be seen that the highest values were for the "*Q* – quality" component. The share of quality products in the total production volume is 95-96%, i.e. 4-5% of products are defective. It should be noted that during the production process, at various stages, part of the manufactured products (about 2%) was selected for quality control, which is a requirement of the technological process. Thus, the actual amount of products manufactured that were of inadequate quality accounted for 2-3% of total production. The "*P* – performance" component also had quite high values, amounting to 92-98%, i.e. 2-8% of time losses were associated with short downtimes that did not require the intervention of repair personnel (minor malfunctions, material interruptions, tool cleaning, etc.) or with natural factors reducing performance (fatigue deformation of parts, equipment wear, i.e. everything that reduced the rated performance).

The biggest problems at the enterprise that led to a decrease in equipment efficiency were identified in component "*A* – availability". The availability indicator was 67-78%, meaning that 22-33% of time was not spent on direct production, but was lost due to unscheduled and scheduled downtime. Unplanned downtime at the enterprise included stoppages for tool and fixture replacement, equipment breakdowns, lack of materials, the need to replace paint or printing plates due to poor-quality printing, and similar issues. Planned or start-up downtime included line stoppages for changeovers to produce items of different sizes.

Since 2022, following the company's entry into new European markets, the number of small-volume orders has increased, each requiring time for changeovers. This

became the main reason for the low values of the "*A* – availability" component, leading to less efficient use of equipment. It should also be noted that the equipment was not switched off during changeovers and continued to consume electricity, the share of which in production cost was relatively high, amounting to 11-14%. The overall efficiency of the equipment does not directly take into account electricity losses. However, as a result of downtime, shortages or re-adjustments (i.e. when any of the OEE components decrease), specific energy consumption increases because electricity is used inefficiently. That is, when assessing the efficiency of equipment use, it is also advisable to consider energy efficiency as another aspect of losses, along with losses in availability, performance and quality.

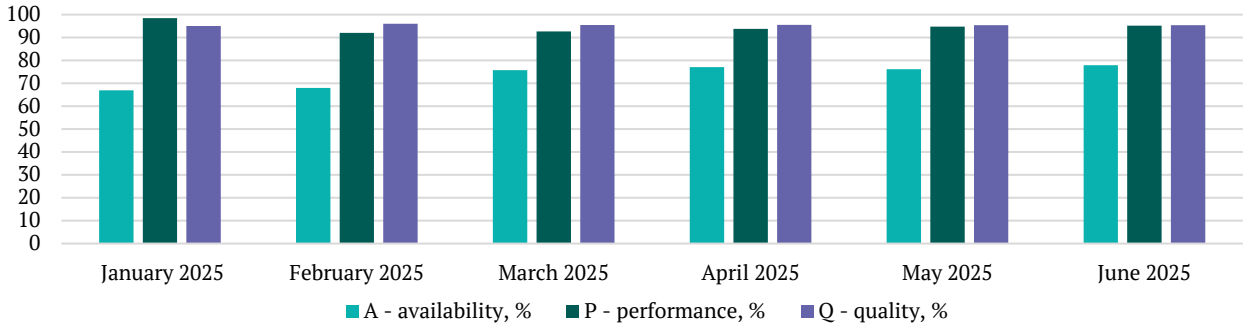

Figure 2. Components of overall equipment effectiveness for "Tube Plant" LLC

Source: developed by the authors

If only the OEE indicator is used to assess the efficiency of equipment, it is possible to take into account losses in time, speed or quality. However, in modern production conditions, it is also necessary to take into account resource losses associated with energy consumption. A critical situation for management is when the share of electricity costs in the cost structure is constantly growing, not only due to the constant increase in tariffs, but also due to the inefficient use of equipment, which leads to an increase in energy consumption. If energy consumption costs are not taken into account when calculating OEE, this can lead to a situation where two production periods with the same OEE values can have completely different financial results due to different specific energy costs. In other words, the overall equipment effectiveness indicator does not provide a complete picture, limiting managers' ability to assess the real impact of production decisions on costs and profits.

Taking into account the "*E* – energy efficiency" component when calculating OEE made it possible to integrate another key factor into the production management system – the energy component of the cost price. This gave managers the opportunity to evaluate production efficiency not only in terms of volume and quality, but also in terms of production costs. They were also able to identify hidden financial losses associated with the irrational organisation of equipment operation (e.g., as a result of frequent changeovers), justify changes in the policy of forming the order portfolio and production plan taking into account energy efficiency, and make investment decisions based on more comprehensive indicators. Thus, the transition from the OEE indicator to the overall efficiency indicator, which takes into account energy costs, is a logical development of the equipment efficiency assessment methodology. This has ensured a closer link between production indicators and the strategic management goals of the enterprise. It was proposed to use the following scale to determine the level of production efficiency based on the obtained OEEe values (Table 1).

Table 1. Scale for determining the level of production efficiency based on the OEEe indicator

Level	OEEe	Energy efficiency characteristics
Perfect production	100%	Ideal equipment operation without energy losses
World-class production	80-99%	Equipment operates with minimal energy losses; settings, loading and planning are optimal
Typical production	50-79%	Moderate energy losses associated with changeovers, downtime or unstable loading
Low level of production efficiency	30-49%	Systemic energy losses, high proportion of long changeovers and frequent transitions between orders

Source: developed by the authors

To calculate the OEEe value for the production line, the minimum energy consumption per unit of output was first determined. For the enterprise under review, the term "energy consumption" refers to electricity consumption, i.e. the consumption of electrical energy in kW per hour. This approach was due to the fact that the production line uses electricity as its main energy source, while other types of energy (heat, gas, steam) are not used in the production process. Accordingly, when calculating E_{min}, the best operating conditions of the equipment were taken into account, namely, the adjustment of the line for the production of one order and its continuous production during two shifts. Under these conditions, the highest energy consumption occurred during the warm-up and adjustment of the equipment, which lasted an average of two hours. Then, energy consumption decreased and averaged 150 kW per hour. The

maximum possible output was determined taking into account the speed of the equipment (80 units/min) and the operating time of the line. As a result, it was determined that in the analysed period, the overall efficiency of the equipment, taking into account energy efficiency, was 41-52%, which corresponds to a low level of production efficiency (Fig. 3). That is, if the OEE values indicated that the production level was typical, the OEEe values already indicate its low level. This is due to the low values of the "*E* – energy efficiency" component, which ranged from 60 to 83%.

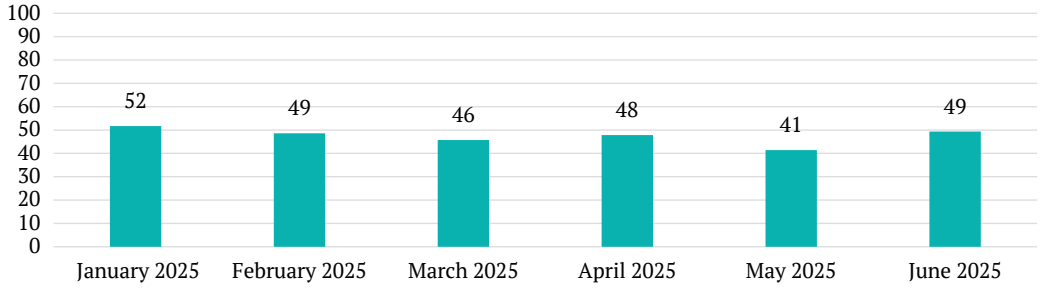

Figure 3. OEEe – overall equipment effectiveness taking into account energy efficiency for "Tube Plant" LLC, %
Source: developed by the authors

To determine the reasons for the deterioration in OEEe values, changes in each of its components were examined, as well as the factors that influenced them. To this end, it is proposed to use the diagram shown in Figure 4.

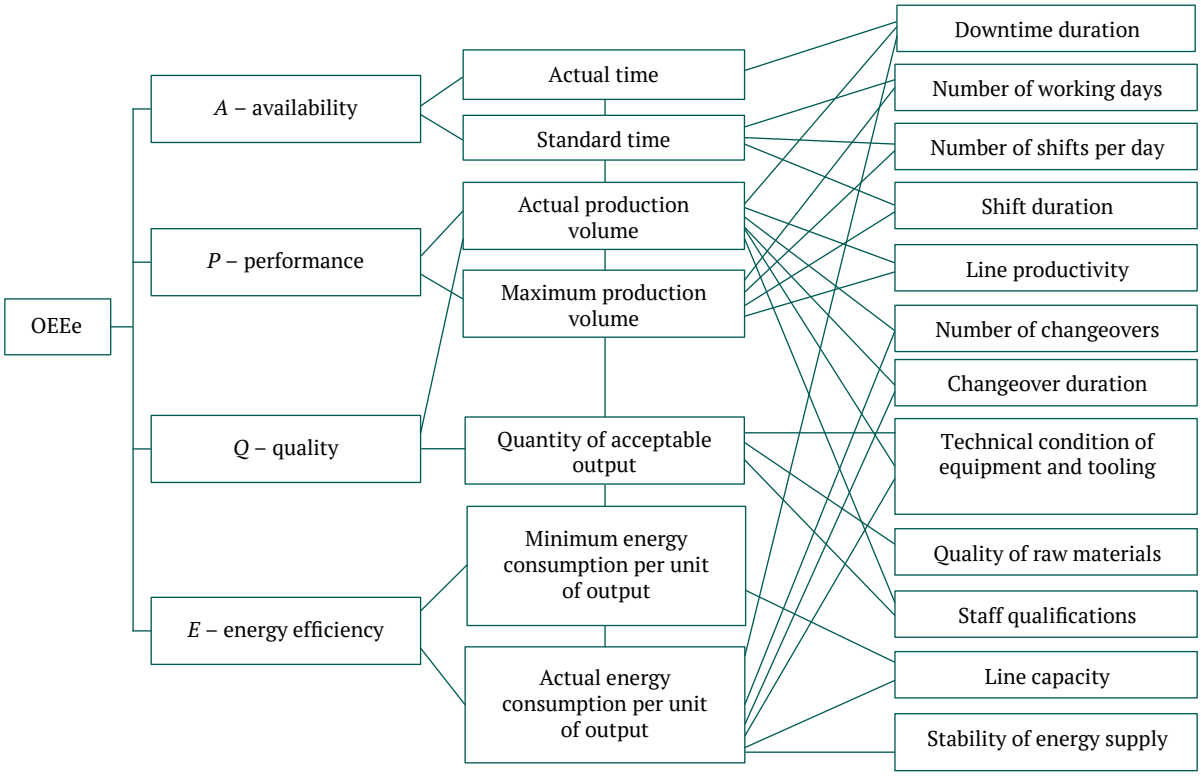

Figure 4. Factors affecting the level of OEEe
Source: developed by the authors

The above factors prove that changes in the overall efficiency of equipment, taking into account energy efficiency, are directly related not only to the technical parameters of the equipment itself, but also to the organisation of the production process. It is important for managers to translate the calculated values of the indicator into practical actions. For this purpose, it is advisable to use Table 2, which shows the relationship between the results of the OEEe calculation, the identified key problem areas of OEEe, and possible management decisions that can be made on their basis.

Table 2. Key management decisions based on OEEe calculation results

Problems	Interpretation	Management decision
Decrease in OEEe value with stable OEE level	The equipment formally operates without downtime or defects, but actual energy consumption exceeds the norm (e.g., due to frequent changeovers or partial loading)	review the order portfolio in favour of consolidating batches, combining small orders by type and size; optimise the production programme to reduce the number of changeovers; introduce the "energy load" criterion when planning the production programme
Increase in OEEe value after combining orders or changes in production schedules	Improvements in the organisation of the production process have reduced specific energy consumption	approve the new planning algorithm as a standard; introduce OEEe into the KPI system for economists in the planning department and line managers; use OEEe calculations to justify minimum order sizes
Different OEEe values on different machines or lines	Identification of "energy-intensive" areas where actual specific energy consumption is higher	optimise the production programme to maximise the utilisation of energy-efficient machines and lines; consider the feasibility of replacing equipment with low OEEe with more efficient equipment; use OEEe to justify investment projects
Correlation between OEEe level and product cost	The increase in production costs is associated with increased energy consumption, rather than direct production losses	include the OEEe indicator in the management reporting system; take energy costs into account when calculating the cost of production; consider the OEEe indicator as a factor of competitiveness, especially in the context of rising electricity tariffs
Lack of OEEe use in employee motivation system	OEEs makes it possible to consider not only the volume and quality of output, but also the rational use of resource	introduce a bonus scale for achieving OEEe targets; motivate economists in the planning department and line managers for rational planning of the production programme; combine OEEe growth with the company's energy conservation programmes

Note: KPI – key performance indicators used to measure and achieve the strategic goals of a company or a specific employee
Source: developed by the authors

Thus, the overall equipment effectiveness indicator, taking into account energy efficiency, is transformed from a technical indicator into a management tool. It allows for improved planning and management of orders at the operational management level and will serve as a basis for justifying investments and a source of cost optimisation at the strategic management level. At the analysed enterprise, the overall efficiency of equipment, taking into account energy efficiency on the production line, decreased significantly in May compared to April (Fig. 3). Analysis of the reasons for this decrease showed that the values of components *A*, *P* and *Q* remained almost unchanged during this period. The deterioration in energy efficiency had the greatest impact on the decline in the overall efficiency of equipment use.

The energy efficiency indicator depends on the minimum and actual energy consumption per unit of output. The minimum value for "Tube Plant" LLC was unchanged and depended on the capacity of the line and the duration of its operation. Actual energy consumption depended on the actual volume of products manufactured and the actual amount of electricity consumed. In turn, these indicators depended on the number of orders requiring equipment changeovers on the line and their complexity. In May, the company had many small-volume orders that required equipment changeovers. During changeovers, the line was not switched off and continued to consume electricity without producing finished products. The line also operated irregularly, with frequent stops for adjustments, which prevented it from reaching an energy-efficient operating mode and increased specific energy consumption.

As a result of calculating the OEEe indicator and analysing the factors that caused its deterioration, the company's managers identified the main problem, namely a reduction in energy efficiency at a fairly stable OEE level. To solve this problem, the following management decisions were proposed. The quality of order portfolio management needs to be improved. The main problem is that the greater the number of small orders processed by the company, the more frequent the changeovers become, which increases downtime, raises energy consumption and reduces OEEe. To overcome this issue, the planning department's economists should take a more thorough approach to grouping orders, taking into account tube diameter and length, type of raw material, thread type, cap type and colour, printing complexity, etc. At the same time, order fulfilment times and possible energy costs should also be taken into account. It is also advisable to set an economically justified minimum order size. If the customer's order volume is lower than this, either refuse the order or significantly increase its selling price. It is also necessary to investigate the feasibility of modernising equipment. Since the OEEe indicator varies across different production lines, especially due to the energy efficiency component, this may be an indicator of the need to make a decision on re-equipping or modernising the line.

It is also necessary to introduce a system of motivation for economists in the planning department and line managers not only for the quantity of products manufactured, but also for the achieved OEEe level. This is because the higher the OEEe value, the lower the losses of the enterprise, including energy consumption, and the higher the contribution of production line employees to the financial result. This measure will contribute to the formation of a reasonable order priority, coordinate changeovers, prevent defects and improve work planning. In the future, this may become the basis for the formation of KPIs for economists

in the planning department and production line employees. The use of a modified overall equipment effectiveness indicator that takes energy efficiency into account has made it possible not only to more accurately assess the technical efficiency of equipment, but also to link the performance of the production line to the economic and financial indicators of the enterprise. Including OEEe in the management analysis system will provide managers with more reliable information for decision-making. It will also make it possible to use OEEe as a management reporting tool and as a basis for KPI development.

DISCUSSION

Calculations of the proposed OEEe indicator, which is a modification of the overall equipment effectiveness indicator and takes energy consumption into account, have revealed a number of features that are not reflected in the calculation of the classic OEE indicator. In particular, with comparable OEE values across different shifts and production lines, significant differences in specific energy consumption were identified, which led to a reduction in the OEEe value. This proves the necessity of including the "*E* – energy efficiency" component in the system for assessing overall equipment effectiveness.

An analysis of data from the manufacturing enterprise showed that the main source of additional energy losses was the increase in the number of changeovers caused by the reduction in order sizes. As a result, the equipment operates at less than full capacity, and the electricity consumption per unit of output increases. This directly affects the cost and profitability of products, confirming the importance of the OEEe indicator for management decision-making. Assessing the efficiency of equipment use based on the proposed OEEe indicator, which takes into account the level of energy consumption of the enterprise in the production of products, will allow for a comprehensive analysis and identification of the main problems associated with the inefficient use of equipment. Based on the analysis of the values obtained for both the indicator itself and its components, enterprise managers will be able to make management decisions aimed not only at improving the efficiency of equipment use, but also at improving the economic and financial performance of the enterprise, reducing its costs and increasing profits. The results obtained were based on current scientific developments in the field of efficient equipment use. According to R.M. Nachiappan & N. Anantharaman (2006), measuring the efficiency of individual equipment in a factory is insufficient because the production system is focused on a production line consisting of mass-produced machines. They proposed using the Overall Line Effectiveness indicator in a continuous flow production system.

Authors A. Agárdi & K. Nehéz (2021) considered the task of production planning, which depends on the type of equipment and changeover time and is limited by time parameters regarding available time and maintenance time. They chose to minimise changeover time as the objective function and the number of orders, the number of machines, their production capacity, order setup time, etc. as the constraints of the function. To solve the optimisation problem, the authors used a so-called genetic algorithm based on partial search. It starts with a population of random solutions and iteratively creates elements of the next population through mutations. Indeed, the efficiency of equipment use depends on the type of equipment and its capacity. Changeover time affects the efficiency of equipment use because no production takes place during this time and performance decreases. Moreover, equipment usually continues to operate and consume electricity during changeovers. This made it possible to formulate and substantiate the hypothesis that equipment effectiveness is influenced not only by its availability and the quantity and quality of output, but also by the energy consumption associated with setting up and producing an order. If energy consumption per unit of output increases, this may indicate a growing number of small orders requiring frequent changeovers, a decline in the skill level of line workers leading to longer setup times, or a deterioration in the condition of the equipment itself, which, due to wear, requires more time for maintenance.

The problems between the number of changeovers and the need to increase production flexibility were explored in an article by L. Van De Ginste *et al*. (2022). Modern customer requirements increasingly complicate performance indicators, because the constant change of products at production stations leads to a decline in the "A – availability" component of the OEE indicator due to the growing number and duration of changeovers. The authors proposed that, when assessing equipment effectiveness, flexibility indicators should also be taken into account through the calculation of the OEE_{flex}, indicator, which includes elements such as mobility, homogeneity and range. Mobility is related to the time spent on changeovers. The higher the mobility, the faster the equipment can be reconfigured to produce new products. It is debatable whether it is appropriate to single out mobility as a separate element of OEE or whether it is sufficient to take into account the time for changeovers when calculating the "A – availability" component when determining the planned production time. If the changeover time is mandatory for product manufacturing, then the planned time should not be calculated as the product of the number of work shifts and their duration, but should be reduced by the time required to change over the equipment to order, provided that the production plan is optimal.

M. Braglia *et al*. (2008; 2021) believed that the overall efficiency of OEE equipment can only be used to evaluate the performance of individual equipment, which does not allow for the evaluation of the efficiency of the production system as a whole when the machines are connected in a production line. To overcome this problem, they proposed a comprehensive approach to assessing line performance based on the calculation of an object-oriented modelling indicator. The authors developed a classification of losses depending on whether they are associated with specific equipment or distributed throughout the line. That is, according to the authors, the OEE indicator cannot be used to evaluate the efficiency of the entire line. Indeed, the classical version of OEE calculation is intended only for a single machine and allows its performance and bottlenecks to be identified. However, the OEE indicator can also be used to assess the effectiveness of the entire production line, taking into account the following features: availability is calculated not for individual machines but for the whole line; performance is taken at the level of the slowest machine in

the line; and quality is determined by the final quantity of output at the end of the line. Accordingly, the OEE value for individual equipment reflects its own effectiveness, whereas the OEE value for the production line reflects the coordination of equipment operation and the absence of losses between them. At the same time, the overall OEE for the line is usually lower than that of the best individual machines. C. Phukapak *et al*. (2024) used the OEE indicator as one of the factors influencing the optimisation of the fruit juice manufacturing process. To do this, they examined the juice production process and used the OEE indicator to identify its bottlenecks. Although the authors provided values for labour, raw materials, packaging, overhead costs, and downtime costs, their research focused more on technical than managerial issues of production improvement, namely the response of equipment to changes in temperature conditions and load settings.

M. Zubair *et al*. (2021) used the OEE indicator to identify key factors that could improve overall equipment effectiveness and performance in the pharmaceutical industry. They calculated the OEE for three main types of equipment and compared their values with each other. This allowed the authors to determine which equipment was used least efficiently and led to a decrease in the performance of the entire line. The main problems that led to low equipment efficiency were unplanned downtime and poor quality parts. It is debatable whether it is possible to compare three types of equipment that are completely different in terms of purpose, performance and speed using the OEE indicator. The article by P.H. Tsarouhas (2020) presents the results of an analysis of the OEE level for an ice cream manufacturing company. Using the Pareto method, the author identified six main losses that lead to equipment downtime, namely: equipment failure, setup and adjustment, downtime, speed reduction, and defects in the production process. A distinctive feature of the study is that the author calculated the OEE indicator not only for a month, but also for each working day and week. This made it possible to identify problems with the use of equipment in a specific period.

F. Kechaou *et al*. (2024) found that, since the introduction of the OEE indicator, several main methods for its calculation have emerged. As a result, somewhat different outcomes may be obtained, leading to slightly different conclusions about how to improve equipment effectiveness. In some cases, an inappropriate choice of calculation method may lead to incorrect or less effective improvement measures. Thus, the authors devoted their study to comparing the main measurement systems used in industry and identified and justified the key characteristics that should be considered when selecting an OEE measurement system. In other words, the authors focused more on the choice of the measurement system for overall equipment effectiveness than on identifying ways to improve it through specific managerial decisions. On the one hand, it can be agreed that accurate measurement not only allows the OEE value to be determined correctly, but also helps to identify appropriate ways of improving it. On the other hand, if a company's management decides to use the OEE indicator for decision-making, it is likely to apply the calculation method that best reflects the specific nature of the company's operations, or to adapt existing methods accordingly.

The study by P. Dobra & J. Jósvai (2022) was not aimed at determining the level of OEE achieved by a company, but rather at establishing its forecast value. According to the authors, accurate forecasts contribute to more efficient use of resources and the timely fulfilment of orders. They proposed making such forecasts not only with mathematical models based on previous-period results, but also through human forecasting based on surveys of machine setters. On the one hand, this approach is reasonable, because people may anticipate problems that could arise during order execution but have not yet appeared in previous OEE calculations. On the other hand, the authors did not assess the level of experience of the machine setters or the consistency of their opinions, apart from stating that they should have many years of experience. Moreover, even surveying machine setters did not always make it possible to identify the problems that led to a decline in overall equipment effectiveness. The main issues that made OEE forecasting impossible were unpredictable shortages of raw materials, equipment breakdowns, poor-quality materials, urgent orders, and similar factors. Thus, the reviewed studies are based on the calculation of OEE components and the search for ways to improve their values, taking into account the specifics of the production process, operating conditions, and the parameters of particular equipment. Thus, the results of these studies cannot be directly applied to companies operating in other industries, producing different products, or using different types of equipment. Wherever possible, the findings should be adapted to the specific features of a particular enterprise. The analysis of recent studies on overall equipment effectiveness has demonstrated the advisability of modifying its calculation to reflect the characteristics of a production enterprise that consumes large amounts of electricity. It can be concluded that existing approaches to OEE calculation should be supplemented with an energy-efficiency component. This would make it possible to account for energy consumption not only during production, but also during equipment setup for orders or during downtime. It would also help to identify problems of inefficient resource use even when overall equipment effectiveness indicators appear satisfactory. As a result, this provides a basis for managerial decisions aimed at reducing production costs and increasing company profits through improved equipment utilisation.

CONCLUSIONS

Despite its widespread use, the overall equipment effectiveness (OEE) indicator has limitations – it does not reflect resource losses, primarily those related to energy consumption, which is a significant item in the cost of production of a manufacturing enterprise. To overcome this shortcoming, it is proposed to use a modified OEEe indicator, which includes an "*E* – energy efficiency" component that compares minimum and actual specific energy consumption. The calculations of OEEe showed that, with the same OEE values, different production periods can have significantly different energy costs, which confirms the need to take into account the energy component when assessing the efficiency of equipment.

A common factor in the decrease in OEEe at the studied enterprise was an increase in small orders, which increased the number of changeovers and led to an increase

in energy costs and production costs. The use of the OEEe indicator will improve the effectiveness of management decisions at the operational level (it will allow optimising the order portfolio, production programme and taking into account the results when forming the employee motivation system) and at the strategic level (calculating the cost of production, establishing the main directions for equipment modernisation and justifying investment decisions). The inclusion of the OEEe indicator in the management accounting system will ensure a more comprehensive assessment of the efficiency of the enterprise's production activities and will allow the technical efficiency of equipment to be linked to its economic and financial indicators.

Thus, the use of the OEEe indicator allows for the identification of hidden energy losses, which is relevant for enterprises where the share of energy consumption costs in the cost price is high. Managers will be able to identify ways to save resources not only by optimising time, but also by reducing energy consumption. They will be able to see how much electricity is consumed above the minimum required level and identify the reasons for excess consumption. Based on this, a motivation system can be introduced for various employees involved in planning and executing production plans. For example, it is possible to make changes to the enterprise's pricing policy and significantly differentiate sales prices depending on order volumes in order to encourage buyers not to split one large order into a bunch of small ones throughout the year.

Thus, the OEEe calculation will allow not only to directly determine the overall efficiency of the equipment, but also to establish the reasons for its deterioration and, on this basis, to make management decisions to improve the situation, reduce specific energy consumption, reduce unproductive losses, which in turn will reduce the cost and increase the profit of the enterprise. The current version of the OEEe calculation takes into account only one type of resource – electricity. In the future, it is advisable to develop the use of OEEe taking into account various types of energy resources (heat, gas, steam), which will allow creating a universal indicator for comprehensive assessment of the energy efficiency of equipment use. This will improve the effectiveness of management decisions at enterprises that consume various types of energy and whose share in the cost of production is significant.

ACKNOWLEDGEMENTS
None.

FUNDING
None.

CONFLICT OF INTEREST
None.

REFERENCES
[1] Agárdi, A., & Nehéz, K. (2021). The unrelated parallel machines scheduling problem with machine and job dependent setup times, availability constraints, time windows and maintenance time. *Management and Production Engineering Review*, 12(3), 15-24. doi: 10.24425/mper.2021.138527.

[2] Basak, S., Baumers, M., Holweg, M., Hague, R., & Tuck, C. (2022). Reducing production losses in additive manufacturing using overall equipment effectiveness. *Additive Manufacturing*, 56, article number 102904. doi: 10.1016/j.addma.2022.102904.

[3] Braglia, M., Castellano, D., Frosolini, M., Gallo, M., & Marrazzini, L. (2021). Revised overall labour effectiveness. *International Journal of Productivity and Performance Management*, 6(70), 1317-1335. doi: 10.1108/IJPPM-08-2019-0368.

[4] Braglia, M., Frosolini, M., & Zammori, F. (2008). Overall equipment effectiveness of a manufacturing line (OEEML). *Journal of Manufacturing Technology Management*, 20(1), 8-29. doi: 10.1108/17410380910925389.

[5] Chikwendu, O.C., Chima, A.S., & Edith, M.C. (2020). The optimization of overall equipment effectiveness factors in a pharmaceutical company. *Heliyon*, 6(4), article number e03796. doi: 10.1016/j.heliyon. 2020.e03796.

[6] Dobra, P., & Jósvai, J. (2022). Assembly line overall equipment effectiveness (OEE) prediction from human estimation to supervised machine learning. *Journal of Manufacturing and Materials Processing*, 6(3), article number 59. doi: 10.3390/jmmp6030059.

[7] Iastremska, O. (2023). Management of reject reduction at an industrial enterprise: The theoretical and practical aspects. *The Problems of Economy*, 1(55), 111-129. doi: 10.32983/2222-0712-2023-1-111-129.

[8] Kechaou, F., Addouche, S.-A., & Zolghadri, M. (2024). A comparative study of overall equipment effectiveness measurement systems. *Production Planning & Control*, 35(1), 1-20. doi: 10.1080/09537287.2022.2037166.

[9] Kliment, M., Trebuna, P., Pekarcikova, M., Straka, M., Trojan, J., & Duda, R. (2020). Production efficiency evaluation and products' quality improvement using simulation. *International Journal of Simulation Modelling*, 19(3), 470-481. doi: 10.2507/IJSIMM19-3-528.

[10] Kustiyawan, I., Roestan, M.R., & Riani, C. (2023). Automated packaging machine analysis with the overall equipment efficiency method. *International Journal of Industrial Engineering & Production Research*, 34(4), 1-14. doi: 10.22068/ijiepr.34.4.14.

[11] Lutska, N., Tsiutsiak, I., & Tsiutsiak. A. (2024). The essence of fixed assets and their efficiency analysis in the context of digital transformation. *Galician Economic Journal*, 6(91), 71-80. doi: 10.33108/galicianvisnyk_tntu2024.06.071.

[12] Nachiappan, R.M., & Anantharaman, N. (2006). Evaluation of overall line effectiveness (OLE) in a continuous product line manufacturing system. *Journal of Manufacturing Technology Management*, 17(7), 987-1008. doi: 10.1108/17410380610688278.

[13] Ng Corrales, L.d.C., Lambán, M.P., Hernandez Korner, M.E., & Royo, J. (2020). Overall equipment effectiveness: Systematic literature review and overview of different approaches. *Applied Sciences*, 10(18), article number 6469. doi: 10.3390/app10186469.

[14] Patterson, M., Singh, P., & Cho, H. (2023). The current state of the industrial energy assessment and its impacts on the manufacturing industry. *Energy Reports*, 8, 7297-7311. doi: 10.1016/j.egyr.2022.05.242.
[15] Phukapak, C, Pawaree, N., & Wichapa, N. (2024). Comparison of desirability function (DF) and overall equipment effectiveness (OEE) with mathematical model for optimization in fruit juice production process. *Cogent Engineering*, 11(1), article number 2412365. doi: 10.1080/23311916.2024.2412365.
[16] Piran, F.A.S., De Paris, A., Lacerda, D.P., Camargo, L.F.R., Serrano, R., & Cassel, R.A. (2020). Overall equipment effectiveness: Required but not enough-an analysis integrating overall equipment effect and data envelopment analysis. *Global Journal of Flexible Systems Management*, 21(2), 191-206. doi: 10.1007/s40171-020-00238-6.
[17] Prasetio, E.T., & Oktora, A. (2024). Evaluation of the effectiveness of die casting machines using overall equipment effectiveness (OEE). *Jurnal Teknologi dan Manajemen*, 22(1), 99-106. doi: 10.52330/jtm.v22i1.239.
[18] Safonik, N., & Vatashchuk, V. (2023). Improving the efficiency of reproduction and use of fixed assets of transport industry enterprises. *Economy and Society*, 51. doi: 10.32782/2524-0072/2023-51-23.
[19] Tsarouhas, P.H. (2020). Overall equipment effectiveness (OEE) evaluation for an automated ice cream production line: A case study. *International Journal of Productivity and Performance Management*, 69(5), 1009-1032. doi: 10.1108/IJPPM-03-2019-0126.
[20] Van De Ginste, L., Aghezzaf, E.H., & Cottyn, J. (2022). The role of equipment flexibility in overall equipment effectiveness (OEE)-driven process improvement. *Procedia CIRP*, 107, 289-294. doi: 10.1016/j.procir.2022.04.047.
[21] Zubair, M., Maqsood, S., Habib, T., Muhammad, Usman Jan Q.M., Nadir, U., Waseem, M., & Yaseen, Q.M. (2021) Manufacturing productivity analysis by applying overall equipment effectiveness metric in a pharmaceutical industry. *Cogent Engineering*, 8(1), article number 1953681. doi: 10.1080/23311916.2021.1953681.

Використання модифікованого показника загальної ефективності обладнання для формування управлінських рішень

Олена Велика
Кандидат економічних наук, доцент
Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки, 9А, м. Харків, Україна
https://orcid.org/0000-0002-0072-5867

Інна Козлова
Кандидат економічних наук, доцент
Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки, 9А, м. Харків, Україна
https://orcid.org/0000-0002-5107-6668

Анотація. Актуальність дослідження зумовлена необхідністю врахування при прийнятті управлінських рішень витрат на енергоспоживання, що є значущою статтею у собівартості продукції. Метою дослідження було удосконалення формування управлінських рішень на основі оцінювання модифікованого показника ефективності використання обладнання, якій враховує рівень енергоспоживання (OEEe). Методична основа дослідження включала застосування методів аналізу і синтезу, методу порівняння та методу узагальнення, візуалізації емпіричних даних на основі діаграми динаміки складових показника загальної ефективності обладнання на прикладі підприємства, що виробляє пакувальну продукцію за перше півріччя 2025 року. Це дало підстави стверджувати, що необхідно більш повно оцінювати ресурсну та економічну ефективність роботи обладнання за допомогою введення додаткової складової «E – енергоефективність», яка відображає відношення мінімального та фактичного енергоспоживання при виробництві одиниці продукції. На прикладі розрахунку OEEe для виробничої лінії з випуску алюмінієвих туб було встановлено, що при зіставних значеннях загальної ефективності обладнання можливі значні розбіжності у питомих витратах на енергоспоживання, що напряму впливає на собівартість та прибутковість продукції. Результати аналізу довели, що основним джерелом енерговтрат є збільшення кількості переналадок обладнання для виконання невеликих за розмірами замовлень. Запропоновано використання показника OEEe для прийняття управлінських рішень, спрямованих на оптимізацію виробничої програми, управління портфелем замовлень, обґрунтування інвестиційних рішень та формування системи мотивації персоналу. Практична значущість результатів дослідження полягає у тому, що показник OEEe можливо використовувати як інструмент для збільшення енергоефективності, встановлення скритих економічних втрат та інтеграції показника до системи управлінської звітності

Ключові слова: менеджмент; собівартість продукції; продуктивність обладнання; переналадки; енергоефективність; питоме енергоспоживання

ISSN 2413-9610, E-ISSN 2663-2365 Journal homepage: https://devma.com.ua/en

DEVELOPMENT MANAGEMENT

UDC 338.43
DOI: 10.63341/devt/4.2025.31

Vol. 24, No. 4. 2025

Sustainable food production and strategic management: An in-depth analysis

Andrii Ivashura*
PhD in Agriculture, Associate Professor
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0000-0002-0022-7489

Hanifa Jafarli
Doctor of Economics, Professor
Azerbaijan State University of Economics
AZ1001, 6 Istiqlaliyyat Str., Baku, Azerbaijan
https://orcid.org/0000-0002-8104-2426

Olga Protasenko
PhD in Technical Sciences, Assistant Professor
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0000-0002-8203-5703

Abstract. The study aimed to conduct an in-depth analysis of the principles of sustainable food production, identify key challenges and develop strategic recommendations for overcoming them in the global and regional contexts of Ukraine. The research methodology was based on a comprehensive interdisciplinary approach combining comparative, analytical and systemic methods for a complete assessment of the environmental, economic and social components of food systems in the context of contemporary global challenges, food sector development trends and the impact of technological transformations. An in-depth analysis of the theoretical foundations of sustainable food production was conducted, state and corporate strategies for food resource management were studied, and international initiatives, cooperation programmes and innovative technological solutions aimed at improving the efficiency and sustainability of agricultural and food systems were examined. The study established that effective strategic management contributes to the deep integration of environmental, social and economic factors into food production systems, ensuring the balanced development of the agricultural sector. A set of recommendations has been developed on adapting international experience to the conditions in Ukraine, particularly in the field of agrotechnology development, improving public administration mechanisms and training highly qualified personnel for the food sector. Successful cases from EU countries, the US and China were analysed, their effective models for implementing sustainable practices were identified, and the possibilities for application of the approaches in the domestic context were determined. At the same time, the study determined that imperfect institutional mechanisms, limited financial resources and insufficient coordination between public and private structures remain key barriers to sustainability. The practical value of the study is determined by the possible use of the results by specialists in the field of strategic management, public policy and agricultural development to improve the effectiveness of national food security programmes and achieve the UN Sustainable Development Goals

Keywords: sustainable development; institutional mechanisms; crisis adaptation; global challenges to the food system; ecological and economic relations; responsible production; innovative development; natural resources

Article's History: Received: 14.08.2025; Revised: 10.11.2025; Accepted: 23.12.2025; Published: 12.01.2026

Suggested Citation:
Ivashura, I., Jafarli, H., & Protasenko, O. (2025). Sustainable food production and strategic management: An in-depth analysis. *Development Management*, 24(4), 31-47. DOI: 10.63341/devt/4.2025.31.

*Corresponding author

INTRODUCTION

Food systems are in crisis due to a range of global and local challenges, affecting environmental, economic and social stability. Population growth, climate change, natural resource degradation, biodiversity loss and socio-economic inequality reduce efficiency of traditional agricultural production models. Ukraine is experiencing the effects of temperature increase, droughts and declining soil fertility, which risk food security and agriculture efficiency. Increase in socio-economic differentiation, urbanisation, market instability and geopolitical risks further also increase the vulnerability of food systems by limiting access to resources and technologies. Intensive farming models prioritising maximum yields have depleted ecosystems and increased anthropogenic impacts on the government. Therefore, strategic management for balance of economic efficiency, social equality and environmental responsibility is necessary. There is a need to identify efficient institutional, technological and management mechanisms that can transform existing food systems into sustainable, adaptive and equitable structures that can address complex challenges.

Food systems are under pressure from a multitude of interrelated factors and are undergoing a critical transition caused by profound structural changes. The expected population growth to 9.7 billion by 2050 will require a significant increase in food production. According to M. van Dijk *et al*. (2021), global food production must increase by 50-70% to meet increased demand. As noted by S. Juri *et al*. (2024), new qualitative threats also contribute to quantitative challenges, as climate change, soil and natural resource degradation, increased socio-economic inequality, and growing instability in agricultural and food markets undermine the resilience of food systems. Socio-economic transformations also affect the situation. Accelerated urbanisation, with more than 55% of the population living in urban agglomerations, is reducing the amount of agricultural land and increasing dependence on complex global supply chains. As noted by T. Varzakas & S. Smaoui (2024), economic inequality remains one of the key factors of food insecurity: approximately 9.2% of the global population lives in extreme poverty, while more than a quarter of the population faces moderate or severe food insecurity. Gender inequality and limited access to education for smallholder farmers in developing countries further impede the adoption of innovative and sustainable agricultural practices. Regarding climate risks, O. Ndehedehe *et al*. (2025) confirmed the substantial impact of extreme events on water resources. The study emphasised active, innovative implementation rather than response. Successful cases of water consumption reduction by 90% demonstrate that strategic management should prioritise technologies that reduce dependence on vulnerable resources.

Traditional agricultural production models, particularly intensive farming, increase environmental impact on natural systems. According to FAO (2018), agriculture produces approximately 24% of global greenhouse gas emissions, including methane from livestock and emissions related to deforestation. Excessive use of pesticides and mineral fertilisers causes soil degradation and water pollution, while the dominance of monocultures reduces agrobiodiversity. The historical example of the "green revolution" in India illustrates this contradiction: M. Crippa *et al*. (2024) noted that despite significant increases in crop yields, the long-term consequences included the depletion of up to 40% of agricultural land in the state of Punjab. From an economic perspective, such production models often prove unsustainable, as small farmers face high resource costs and limited access to market infrastructure. Sustainable food production concept offers an alternative approach, which the FAO (2018) defines as a system that ensures food security and adequate nutrition for all while preserving the economic, social and environmental foundations for future generations. The implementation of this concept involves the reduction of environmental pressure, the conservation of natural resources, the improvement of the economic viability of agricultural production and the enhancement of social justice. In this context, strategic management becomes crucial in the integration of technological innovations (precision farming, artificial intelligence (AI) and blockchain), effective policy instruments and social initiatives into a comprehensive model of food system transformation. In the analysed studies, researchers insufficiently addressed integrated models of strategic management that would combine environmental, social and economic aspects in the context of Ukraine, especially in the context of military risks and regional disparities. Most studies address individual challenges (climate, soil or inequality), ignoring comprehensive tools for transformation at the national level, which necessitated the study. Therefore, the research relevance of efficient strategic solutions that can be scaled in both global and local contexts, covering the specificities of individual regions to overcome global and regional challenges such as climate risks, high technology costs, skilled labour shortages and geopolitical conflicts, is determined. The study aimed to conduct an analysis of the principles of sustainable food production, identify the main challenges and formulate strategic recommendations for overcoming them at the global and regional levels in the context of Ukraine.

MATERIALS AND METHODS

The methodological basis of the study was based on the use of a mixed approach to conduct an in-depth analysis of the principles of sustainable food production, identify key challenges and barriers to their implementation, and develop practical recommendations for strategic management in various agricultural and food models. The analysis of previously published interviews, in particular by S. Juri *et al*. (2024), M. Crippa *et al*. (2024), and D. Saccone & E. Vallino (2025), was conducted using a set of criteria based on the role and sphere of influence of stakeholders to ensure the representativeness of food system levels. In particular, the samples covered a range of experts and practitioners, from farmers to representatives of international organisations. A key element was to achieve data integrity, i.e. the interviews had to contain "different perspectives and expectations" on critical aspects of sustainability, such as technological innovation, social justice (e.g. gender-sensitive policies) and institutional practices. The findings from the interview material were integrated with other secondary sources. These sources included official reports from leading international organisations (FAO, IPCC, UNEP,

OECD, World Bank) as well as international open databases. An analysis of cases in countries such as the Netherlands, Ukraine and Denmark (Europe), Brazil, the United States and Costa Rica (America), China, Japan, India (Asia), Zimbabwe, Ethiopia and Kenya (Africa), as well as several others (including Bangladesh and Ghana), was used to identify both successful models for implementing sustainable solutions and typical problems that hinder progress in the EU and worldwide.

To develop scenarios for the development of the system, a scenario modelling method was used, combining elements of expert assessment and simulation analysis. At the first stage, key forces and factors of uncertainty were identified based on a review of the literature and expert consultations (using the Delphi method). At the second stage, a morphological analysis of possible combinations of factors was conducted, which was used to form a coordinated set of alternative development scenarios, in particular, the "catastrophic climate shock" scenario. Further assessment of the scenarios was conducted by simulation modelling of their potential consequences for the sustainability of the system using specific indicators. The key advantage of the mixed approach was the integration of qualitative and quantitative data. This synthesis provides a more complete and reliable overview of the analysed phenomenon, creating a basis for practice-oriented recommendations for strategic management of sustainable food production. The study of sustainable food production used comparative analysis to identify differences and common patterns in strategies implemented in different socio-economic and geographical contexts. This approach was used to assess how specific factors – from political institutions and technological infrastructure to climatic conditions and cultural norms – shape the characteristics of sustainable agricultural production. A comparison of practices in developed and emerging countries was used for a differentiated analysis of universal and context-dependent solutions.

The comparative analysis process in the study was based on a comprehensive set of criteria. The selection of regions and case studies was determined by the main criterion – representativeness in terms of the diversity of agri-food models, which was used to compare countries with high-tech intensive agriculture (such as the Netherlands) with countries with developing agricultural systems (such as Ethiopia or India). The comparison was conducted using key sustainability metrics, using systematised data from primary and secondary sources, including national statistics, scientific research and field observations. The main subject criteria for comparison included environmental footprint (assessment of greenhouse gas emissions, resource use and Life Cycle Assessment (LCA) results), technological readiness (level of implementation of sustainable and regenerative agriculture, as well as economic barriers), governance and policy (effectiveness of legislative changes, subsidies and institutional practices), and socio-economic aspects (including analysis of social justice and gender-sensitive policies). The integration of these approaches identified systemic conflicts and points of agreement between different priorities – for example, between increasing productivity and conserving natural resources, or between economic efficiency and social inclusion. This approach was used to develop strategies that simultaneously meet the requirements of environmental sustainability, economic feasibility and social justice. It also reinforces the correlation between science and practice, providing a basis for decision-making based on comprehensive and objective information.

RESULTS

Technological innovations in the strategic management of sustainable food production

Technological innovations are a central element in the strategic management of food systems, which ensure transition to sustainable (SFS) and adaptive models. Their strategic impact is evident not only in increased operational efficiency, but also in a fundamental shift in approaches to planning, risk management, transparency and addressing global challenges. The transformative power of technology depends on economic and administrative strategies, social needs and support across a wide range of societal and structural forces. Within the framework of strategic management, they act not only as tools for improving efficiency, but also as elements of systemic transformation of the food sector.

One of the most developed technological areas is precision farming (PF) and digital agriculture, which represent the integration of sensor systems, the Internet of Things (IoT), satellite monitoring, AI and machine learning algorithms for microzonal resource management. The use of advanced data analytics and computer vision for targeted application of resources, such as spraying weeds with up to 90% savings in agrochemicals, is radically transforming corporate business models. The strategy of agricultural producers and equipment suppliers is shifting from selling physical volumes of resources to selling "results" or "services". This requires a strategic shift from the maximisation of gross production volume to the optimisation of margins while minimising environmental externalities. Management methods prioritise data as a key production asset, and strategic planning is shifting from annual to seasonal and operational, based on real-time models (digital twins), requiring significant investment in digital infrastructure and expertise.

The integration of satellite data into control mechanisms automatically monitors agricultural plots to confirm compliance with financial support (subsidy) conditions. This transforms public administration from resource-intensive manual control to risk-oriented and transparent monitoring. Strategically, the government is shifting from controlling the costs of economic entities to controlling results and compliance with environmental standards, thereby increasing the efficiency of budget funds. Research also emphasises the significant improvement of strategic planning in the agricultural sector through the use of short-term yield forecasting algorithms based on highly spatially detailed data (Pokal *et al*., 2024), which facilitates adaptation of cultivation strategies to changing environmental conditions. IoT-based precision irrigation technologies can significantly improve water efficiency (Xing & Wang, 2024), which is a critical strategic imperative for regions prone to desertification (e.g., southern Ukraine). The strategic integration of ICT into national programmes requires support both in terms of digital infrastructure and through the development of institutional knowledge

management mechanisms to ensure the widespread adoption of innovations.

Development of biotechnology, including genetic engineering, cultured meat and alternative protein sources, is also relevant. The vector of development of biotechnological solutions is a fundamental driver of strategic restructuring of food systems. These technologies, which involve manipulation at the cellular level and the creation of food and feed substitutes, go beyond technological change to become a key factor in strategic management. At the corporate level, the success of innovative areas offering alternative proteins poses an existential challenge to traditional agribusiness conglomerates. Their strategy is inevitably transforming: from the former desire for a monopoly on protein to the need for strategic diversification of protein sources. This requires large companies to internalise disruptive innovations to minimise the risk of market displacement and necessitates a reassessment of the value of tangible assets (farms, land), which can be replaced by high-tech, resource-saving production facilities, radically changing the approach to capital investment and long-term planning.

At the sectoral and government levels, biotechnology is becoming critical for macro-risk management. Livestock management is transitioning to biological and climate risk management related to animal health and greenhouse gas emissions. Genetic engineering facilitates a preventive adaptive strategy. This is a strategic method for the reduction of agrochemical use and the stabilisation of crop yields in extreme climate conditions, making agriculture more sustainable (Gupta, 2024). In addition, for large economic entities, the implementation of national programmes to increase the production of alternative proteins is a direct strategy for national food independence and reducing geopolitical risks, aimed at minimising critical dependence on international imports of key raw materials. The development of cell-based agriculture and plant-based alternatives is an imperative for environmental sustainability: the production of these proteins requires significantly fewer resources, forcing governments and institutions to strategically rethink the parameters of natural resource efficiency. Strategic management is moving away from a volume-based, extensive strategy (increasing acreage) to a cost- and resource-efficient strategy (precision agriculture), where the metric of success is determined not by gross production, but by minimising external environmental effects and increasing productivity per unit of resource used.

Regenerative agriculture (RA) is becoming the third basis of technological transformation of sustainable food systems. RA is a set of agricultural practices (such as no-till, mulching, crop rotation, and cover cropping) that are strategically aimed at improving soil health and increasing its organic carbon content, transforming soil from a simple carrier into a strategic asset and carbon reservoir. Investments in programmes that encourage farmers to adopt CSA practices reflect a strategic shift from simple procurement management to supply chain sustainability management. Large processors and retailers are strategically investing in the sustainability of their raw material base, not only for environmental reasons, but also to hedge supply risks and manage financial attractiveness. This simplifies access to cheaper green financing (ESG investments) and strategic management of reputational risks in response to growing consumer demand. Healthy soil becomes an insurance policy against climate volatility, integrating into financial models as an investment in sustainability rather than just an operating expense. The integration of soil health improvement measures into national emission reduction strategies (as is the practice in Canada) is a prime example of the strategic positioning of the agricultural sector. The state is strategically transforming the agricultural sector from a mere food producer into an active carbon sink. This creates new opportunities for international climate finance and increases the sector's competitiveness in global markets, which are increasingly demanding carbon-neutral products. Technological innovations alone are insufficient for a complete strategic transformation of food systems. They must be supported by changes in policies and the regulatory framework, the creation of market incentives, the provision of stable financing, and the formation of public trust in new technologies.

Political and economic mechanisms of strategic management

The development of strategic frameworks, roadmaps, key performance indicators (KPIs) and development scenarios in the field of political and economic food management mechanisms is a multi-stage, cyclical process that governments and institutions implement based on systematic analysis, integrating political decisions and economic instruments to achieve sustainability and security goals. The strategic framework is first established, beginning with an analysis of the food security system and vulnerability assessment using UN SDG reporting and SWOT/PESTEL analysis. This stage provides a long-term vision and goals (e.g., transition to a resource-efficient system), which are then validated through multi-stakeholder consultations with science and business. The integration of a long-term vision based on ESG principles and the UN Sustainable Development Goals (SDGs) into national and regional strategies is the basis of further development. The European Union's Farm to Fork Strategy is a notable example of specific targets for reduction of pesticide, antibiotic and fertiliser use, as well as an increase in organic farming by 2030 (Moschitz *et al.*, 2021). Another example is Singapore's National Food Security Strategy ("30 by 30"), which aims to produce 30% of the national food needs locally by 2030 through intensive investment in vertical farms and aquaculture in a land-constrained environment (Calvo-Baltanás *et al.*, 2025). Similarly, China's "Number One" strategy focuses primarily on self-sufficiency in staple crops based on a strategic framework to tightly control acreage and government procurement (Shih *et al.*, 2025).

The integration of social innovations that ensure the inclusiveness of strategic management and the sustainability of local communities is a substantial vector for reinforcing political and economic mechanisms. In this context, the example of the Indian association SEWA (Self-Employed Women's Association) is noteworthy, as it demonstrates how a collective organisation of self-employed women farmers can overcome structural barriers to access to financial resources, land rights and markets. SEWA transforms social capital into tangible economic leverage through cooperation mechanisms, incorporating

small producers in the formation of value chains on an equal footing with large agricultural holdings. A similar social trajectory is demonstrated by organic coffee cooperatives in Costa Rica, where strategic management is based on the principles of fair trade and shared responsibility for ecosystems. These cooperatives act as social stabilisers, providing not only environmental certification of products, but also funding for health care and education for community members, making agricultural production the foundation of regional prosperity. At the same time, rethinking the role of FAO (2022) Farmer Field Schools exceeds the scope outside of political interpretation as an instrument of state support. Within the framework of strategic management, FFS act primarily as an institutional mechanism for building social capital through horizontal learning and peer-to-peer problem solving. In contrast to traditional top-down models, these frameworks form a networked structure of interaction, where sustainable soil cultivation methods and plant protection become a public asset. This transforms farmers from objects of state regulation into strategic change agents capable of self-organisation and collective adaptation to climate risks. Thus, the combination of economic incentives with a substantial social foundation, based on cooperation and knowledge sharing, becomes a decisive factor in the success of any national strategy for sustainable food production, ensuring legitimacy and long-term sustainability in a changing global environment.

Next, the strategic vision is transformed into specific roadmaps by deconstructing the goals into medium-term programmes and short-term tasks. At this stage, political and economic mechanisms are applied directly: economic levers are used in the form of subsidies for regenerative agriculture, tax breaks and R&D funding, as well as political levers through the establishment of regulatory standards (e.g. pesticide restrictions) and land policy. The success of roadmaps depends on adaptive governance mechanisms that can be used for flexible revision of strategies based on empirical data, as was the case with the adaptation of Canada and New Zealand's national food strategies in response to the logistical shocks caused by the COVID-19 pandemic. India's roadmap for sustainable development of the agri-food sector for the period up to 2030 provides for a clear division of responsibilities between the central government, states and private businesses, especially in water management and digitalisation of farming services (Chand, 2022).

At the same time, KPIs that are critical for monitoring progress are being established. Modern KPIs cover three dimensions of sustainability: economic (e.g., price volatility and agricultural export index), environmental (GHG emissions per unit of production based on LCA and percentage of land with regenerative practices) and social (food accessibility index and malnutrition rate). Denmark uses detailed KPIs for reducing greenhouse gas emissions in agriculture, which are directly linked to subsidy programmes and investment priorities (Schokker *et al.*, 2022). Another example is the World Bank and FAO, which use the Food Security Index as a KPI to assess the effectiveness of national investments in agriculture (MOPAN, 2024), which can be used for progress comparison between countries and financial assistance to be adjusted. Moreover, international giants (such as Unilever) use KPIs on the percentage of raw materials sourced from renewable sources and integrate them into their ESG reports (Tan, 2025), creating additional pressure on governments to set appropriate national standards. This ensures transparent monitoring and adaptive management based on these measurements.

The cycle is completed by the development of scenarios for the improvement of the sustainability of the system. Governments conduct scenario modelling of several possible future scenarios (from climate disasters to sustainable growth), assess the sustainability of existing mechanisms under these conditions, and develop adaptive policies and response plans (e.g., the creation of strategic food reserves) that are activated when certain "triggers" are reached. Governments model various development scenarios (e.g., "catastrophic climate shock" or "global supply chain disruption") to assess the stress resilience of national food reserves and infrastructure. A typical example is the modelling of the impact of drought or flooding on the yield of major crops and the assessment of the need for strategic reserves, which is regularly conducted by the FAO and the International Food Policy Research Institute (IFPRI). For instance, Australia employs scenario analysis to assess the impact of different levels of extreme weather events on export markets and domestic water supplies, which has led to the development of diversified investment programmes in irrigation technologies and early warning systems (Christopher *et al.*, 2025).

Political and economic instruments are central in shaping an institutional environment that promotes sustainable food production. These include support for farmers, fiscal incentives, international agreements and aid programmes to improve the resilience of food systems in the context of climate and economic risks. Their efficiency significantly depends on the coherence of strategic management, the availability of resources, and consideration of the specificities of the local context (Sgarbi & Nadeu, 2023). Subsidy policies aimed at promoting sustainable practices have a significant impact on farmers' adaptation to climate change and transition to environmentally friendly methods. Programmes such as CAP in the EU, PM-KUSUM in India or tax incentives in the US encourage the adoption of precision farming, renewable energy and organic farming; however, they also face several institutional barriers (European Commission, n.d.a; MNRE, 2022; McFadden *et al.*, 2023).

International agreements, including the Paris Agreement and SDG 2, are used as a basis for global efforts, but implementation remains fragmented. FAO (2018), CGIAR (2022) and UNFCCC (n.d.) programmes provide technical assistance and funding, but coverage of beneficiaries in low-income countries remains limited. Smallholder support programmes are substantial, especially in developing countries. Initiatives such as PSNP in Ethiopia, PMFBY in India, or IFAD (2022) microfinance help overcome the vulnerability of rural households and promote social inclusion (World Bank, 2021). However, limited access, high rates, and weak institutional infrastructure remain barriers. In China, the introduction of agro-environmental subsidies (2022-2025), including grants for integrated land use, has reduced erosion by 12% in pilot regions. Strategic management at the provincial level has contributed to more efficient allocation of funds (Chang & Wang, 2023).

In Kenya, Pula (n.d.) digital microinsurance programme covers more than 6 million farmers and is linked to satellite data. This reduces transaction costs and improves drought resilience (Table 1).

Table 1. Political and economic measures for sustainable production: examples, tools, efficiency

Tool	Example of a country/region	Implementation method	Effects and risks
Ecological subsidies	EU (CAP 2023)	30% of the budget for green practices	More than 20% organic land, fewer pesticides, bureaucracy
Renewable energy	India (PM-KUSUM)	Solar pump subsidies	10% less CO_2 emissions, but insufficient coverage
Tax breaks	USA (USDA 2023)	Tax reduction for precision farming	More than 25% of implementations in 5 years, but not available to everyone
International treaties	SDG 2, Paris Agreement	Global commitments, financing	10 billion USD through the GCF, but with insufficient implementation
Climatic agronomy	CGIAR	New resistant varieties	15% higher yield, limited coverage
Farmer support	Ethiopia (PSNP), India (PMFBY)	Microloans, insurance, grants	15% more income, but low accessibility
Strategic management at the provincial level	China, pilot regions	Introduction of agri-environmental subsidies (2022-2025), including grants for integrated land use	12% reduction in erosion, increased efficiency of resource allocation
Development of software linked to satellite data	Kenya	Digital microinsurance programme from Pula	Lower transaction costs and improved drought resilience

Source: compiled by the authors based on FAO (2018), World Bank (2021), MNRE (2022), CGIAR (2022), IFAD (2022), UNFCCC (n.d.), F. Sgarbi & E. Nadeu (2023), Y. Chang & S. Wang (2023), J. McFadden *et al*. (2023), Pula (n.d.), European Commission (n.d.a)

In contrast to international cases analysed, where political and economic instruments are implemented in conditions of relative institutional stability, their application in Ukraine differs significantly under the influence of martial law. State subsidies are being redistributed in favour of food security, and the "Affordable Loans 5-7-9%" programme has been adapted to the needs of the agricultural sector. At the same time, funding remains limited and access to resources is uneven, particularly for farmers in the eastern regions of the country. This indicates a decline in the effectiveness of standard financial instruments in crisis conditions and highlights the need for their flexible combination with direct support for vulnerable groups and international coordination mechanisms. Incorporating territorial differences, the level of institutional maturity and the social structure of agricultural systems, the strategic integration of such measures forms a more sustainable basis for the transformation of food systems in times of global crisis.

Social aspects of sustainable food production

Social factors are substantial in shaping sustainable food systems, as they go beyond economic efficiency to promote community engagement, expand access to knowledge and technology, and ensure social justice and equal opportunities. Strategic management of the food sector cannot be successful without deep integration of social capital. One of the key areas is the development of educational initiatives that transform the traditional model of knowledge transfer. Field school programmes and online courses supported by international organisations demonstrate high potential for democratising access to knowledge on agroecological and regenerative practices. The use of digital platforms (mobile applications) in African countries has become an example of how accessible training can increase crop yields and operational efficiency on farms. The knowledge management strategy is shifting from centralised expertise to decentralised, scalable self-learning. This is also crucial for gender strategy, as expanding the participation of women, who represent a significant portion of the workforce, in training programmes directly increases the overall productivity of the sector.

Integration of local communities into decision-making through cooperative forms of management improves sustainability at both the microeconomic and sectoral levels. The creation of organic farmers' cooperatives in Latin American countries or the involvement of communities in the restoration of degraded land in East African countries not only improves the economic situation of participants but also strengthens the food security of millions of people. Cooperative models, including the institutional participation of marginalised groups, are a strategy for increasing market access and bargaining power for small producers. For the state, cooperation is an effective mechanism for internalising externalities (e.g. soil restoration) and reducing administrative costs for supporting small farms. Fair trade mechanisms that provide producers with stable prices and premiums are a strategic tool for managing ethical and financial risks in supply chains. More than 1.9 million farmers in 70 countries receive economic and social benefits from participating in certified chains (Jodrell & de Bruin, 2024). Therefore, producers can reinvest premiums into environmental projects and local infrastructure, which in turn minimises the risks of supply instability for end processors. For large market actors, investment in fair trade is not charity, but a strategy for managing reputation capital and ensuring the long-term sustainability of the raw material base.

Despite successful examples, there are significant universal barriers: limited access to educational resources in remote regions, high certification costs, and a lack of start-up capital for cooperation. Strategic management requires an integrated approach: combining educational programmes with government support and the introduction of digital technologies. The effectiveness of these measures varies depending on the institutional context. In

countries with developed infrastructure, regulatory mechanisms, and subsidies that create institutional incentives for sustainable practices are central. In developing countries, the focus is shifted towards social mobilisation and expanding access to knowledge and markets. The most sustainable results are achieved when these approaches are integrated, as they address financial, institutional and cultural barriers that hinder the expansion of successful models. Thus, strategic management should address the institutionalisation of social inclusion as a necessary prerequisite for economic and environmental sustainability. Modern strategies for sustainable food production show significant progress, but their implementation requires systemic support (Table 2).

Table 2. Integration of sustainable food production approaches: measures, regional cases and KPIs (2021-2025)

Tool	Example of a country/region	Implementation method	Effects and risks
Technological	EU	Introduction of precision farming in the Netherlands	25% higher yield; 30% less water consumption; 20% less fertiliser use
	Kenya	Mobile agricultural applications (iCow, DigiFarm)	15% higher yield; 20% higher household income
Political and economic	EU	Subsidies for sustainable practices (CAP, Farm to Fork Strategy)	A 35% increase in organic farming areas by 2030.
	India	Agro-environmental subsidies (PM-KUSUM, India)	20% increase in the share of sustainable farms; 30% increase in access to solar systems
Social	Global	FAO Farmer Field Schools Programme	1 million trained farmers in 90 countries
	India	SEWA women cooperatives	1.5 million women with access to markets; 25% increase in cooperative profits
	Costa Rica	Organic coffee cooperatives	20% increase in farmers' income; greater use of sustainable practices

Source: compiled by the authors based on Indian Council of Agricultural Research (n.d.), T. Reardon *et al*. (2022), FAO (2022), IFAD (2022), V. Mehta (2023), E.M.B.M. Karunathilake *et al*. (2023), Fairtrade International (2024), D. Jodrell & W. de Bruin (2024), T. Issayas & Y. Lemma (2025)

Efficient in developed countries, technological and policy measures require institutional adaptation for the global South. Social initiatives have a long-term impact, promoting social justice and inclusion, but require comprehensive support to expand. Relevant social and institutional mechanisms for sustainable agricultural production are also being developed in Ukraine. The National Strategy for Digital Transformation of the Agricultural Sector until 2030 includes measures to expand access to knowledge and innovation in rural areas (Law of Ukraine No. 1163-r, 2023). The cooperative movement, supported by the Ukrainian Agrarian Council, is increasingly substantial in enhancing social inclusion and collective resilience (Agroreview, 2025). The development of cooperatives also strengthens the sustainability of the agricultural sector, especially in times of war, when cooperative forms help to pool resources, restore logistics and ensure food security at the local level.

Fair Trade principles are implemented through national and international programmes that focus on training, cooperation and support for SMEs in the agricultural sector. Ukraine is still poorly integrated into global Fair Trade supply chains. However, some organic producers are already obtaining relevant certification. The main barriers remain limited access to knowledge in remote villages, high certification costs, lack of capital, and weak institutional support. These problems can be addressed by accelerating digitalisation, expanding state and international support programmes, and increasing the participation of non-governmental organisations. The most sustainable results are achieved when several approaches are integrated: educational programmes, subsidies, the introduction of digital solutions, and institutional reforms. Elements of these models are gradually taking shape, but for a large-scale effect, institutional consolidation of strategies such as the development of rural digital platforms and the introduction of training programmes at the community level is necessary. Integration of educational, digital and cooperative strategies with the support of the state and international partners creates conditions for the social sustainability of food systems in Ukraine and forms the prerequisites for an inclusive and equitable agricultural revival. Thus, the integration of approaches demonstrates that the maximum effect is achieved at the intersection of technology, social policy and institutional regulation. Notably, strategic management is central for such integration, ensuring coordination of activities, risk assessment and adaptation of decisions to the regional context.

Strategic management in food systems: From classical models to integrated approaches

The historical evolution of strategic planning models in the agricultural and food sector reflects a fundamental paradigm shift from linear growth to systemic sustainability. The classical planning models that dominated the last century were based on the assumption of infinite access to natural resources and the priority of increasing production volumes without due consideration of environmental and social constraints. However, with the onset of the 21st century, such approaches have become inadequate due to the intensification of climate crises, critical resource depletion and growing pressure from stakeholders. This has led to an objective need to transition to systemic approaches, where the strategic framework includes ESG (Environmental, Social, Governance) principles, the triple bottom line (TBL) concept, and the long-term benchmarks of the Sustainable Development Goals (SDGs) (Chopra *et al*., 2024).

Modern concepts of sustainable development integration are based on a transition from short-term horizontal planning to transdisciplinary thinking based on

scenarios and cyclicality. Strategic documents must also address planetary boundaries and social thresholds, which are embodied in the use of the "donut sustainability" framework (Turner & Wills, 2022). A central element of this process is the introduction of Life Cycle Assessment (LCA), which provides scientific forecasting of the consequences for products and technologies. The use of LCA can evaluate the results of implementing regenerative farming methods, which can reduce CO_2 emissions by 15% compared to traditional systems, while increasing resource efficiency and resistance to external stresses.

Institutional mechanisms for the implementation of sustainable management strategies form a complex architecture adapted to modern challenges. The development of a priority matrix to identify significant ESG issues and correlate them with stakeholder expectations and regulatory trends is central at the planning level. Strategic environmental assessment performs a predictive control function, analysing the impact of programmes and investment decisions on ecosystems and social groups even before they are implemented. Scenario planning, especially in its climate-oriented modification using system dynamics methods (Vensim or Stella software), integrates time uncertainties into management thinking. This creates adaptive behaviour models in conditions of instability, including parameters of infrastructure vulnerability and agrosystem stress resistance. Integrated reporting acts as a mechanism for transparency, aligning the financial and non-financial logic of activities, demonstrating transformations and long-term effects through the prism of public trust and inclusiveness of decisions. Assessment of the effectiveness of these strategies requires a system of quantitative KPIs, which serve as operationalisers of sustainable strategies. Such indicators can be used for real-time monitoring, control and decision-making, ensuring transparency and accountability of the process. A set of industry KPIs for sustainable food production is presented in Table 3.

Table 3. Strategic KPIs for sustainable food production

Area	KPI indicator	Unit of measurement	Explanation/example	Source/method
Ecological	Production carbon footprint	kg CO_2-equiv. / t of produce	Overall emissions	GHG Protocol, ISO 14067
	Production water footprint	l / kg of produce	Water accounting by type: Blue, green, grey	Water Footprint Network
	Soil degradation index	% of lost fertility	Assessment of erosion, compaction and contamination	FAO, National Soil Service
	Share of organic/eco-certified areas	% of total sown area	Direct indicator of sustainable practices	Global Organic Monitor, national statistics
Economic	Added value per unit of natural resource	USD/m^3 of water, USD/ha of land	Eco-efficiency in the production cycle	WBCSD, FAO
	Share of sustainable procurement in the supply chain	% of contracts with certificates	For instance, Rainforest Alliance, FSC, etc.	Corporate reporting, GRI
Social	Percentage of employees covered by the social security system	%	ILO, OOH standards	GRI, local labour inspections
	The proportion of women in the management of agricultural enterprises	%	Gender inclusiveness indicator	OECD, UN Women
	Level of compliance with land use rights	% of agreements reached	Legitimacy and stability of the lease	World Bank Land Governance Framework
Institutional	Availability of an integrated LCA/ESG/ system (methodology for assessing the full life cycle of products (from field to shelf))	binary (yes/no)	Reflects the maturity of consistency management	GRI, ISO 14001/14040, IR Framework (international frameworks for non-financial reporting)
	Frequency of sustainable development strategy updates	times/year or planning cycle	Reflects adaptability to external risks	Internal audit, corporate documents
	Level of compliance with SDGs (based on self-assessment)	index from 0 to 1	Integration with the UN's global goals	SDG (Sustainable Development Goals)

Note: GHG Protocol (Greenhouse Gas) – provides most used standards and guidelines for greenhouse gas accounting; ISO 14067 – international standard, establishes requirements for calculating and reporting the carbon footprint of products; Global Organic Monitor – monitoring of the global market for organic products and its trends or the area of agricultural land on which organic farming is practised; WBCSD (World Business Council for Sustainable Development) – World Business Council for Sustainable Development, a global network of more than 250 leading companies that view sustainable development as a key factor in competitiveness; GRI (Global Reporting Initiative), IR (Integrated Reporting Framework), ESG (Environmental, Social, Governance) – international frameworks for non-financial reporting; OECD (Organisation for Economic Co-operation and Development) – a forum and knowledge centre for sharing data, analytics and best practices in public policy; LCA (Life Cycle Assessment) – a methodology for assessing the entire life cycle of a product (from field to shelf)

Source: compiled by the authors based on World Resources Institute & World Business Council for Sustainable Development (n.d.)

A comparison of international practices demonstrates the high efficiency of integrated approaches. In the European Union, the Farm to Fork strategy sets a goal of reducing the use of chemical pesticides by 50% by 2030 (European Commission, n.d.b), while India's PM-KUSUM programme is achieving a 10% reduction in CO_2 emissions through solar transformation (MNRE, 2022). Technological modernisation in the United States through the use of drones has reduced pesticide use by 20-30%, and in the Netherlands, digital platforms are demonstrating the potential to reduce water consumption by 90%. Social integration is most evident in the experience of Costa Rica, where the development of organic coffee cooperatives has led to a 15% increase in exports (FAO, 2018). It is necessary to improve the analysis of social aspects through the cases of SEWA women's cooperatives in India, which have become a model of inclusive growth. Moreover, in a social context, the institutional consolidation of FAO (2022) Farmer Field Schools programmes should be considered, which ensures the stability of rural communities through the mass training of farmers. In addition, blockchain initiatives in India show a 30% reduction in corruption in the distribution of subsidies, confirming the importance of combining technology with social justice (NITI Aayog, n.d.).

Despite successful examples, there are critical challenges and constraints that hinder sustainable transformation. Globally, climate threats in African regions are projected to reduce crop yields by 20-30% (Simane *et al.*, 2025). In Ukraine, the process of integrating sustainability remains fragmented due to a weak methodological base and institutional dependence on outdated models (Path Dependency), which leads to a decline in the level of organic carbon in soils. Military conflict creates multidimensional risks that traditional strategies cannot simultaneously mitigate. The solution to these problems for Ukraine lies in the implementation of a "digital twin" that combines data on mining, soil conditions and logistics for predictive management. Ukrainian policy should be supported by successful practices: expanding digital services similar to Kenya (where iCow mobile applications increased yields by 10-15%), developing cooperatives based on the SEWA and Central American models, and institutionalising FAO Farmer Field Schools educational programmes. A combination of economic incentives, similar to EU measures, with technological and social innovations will form a development model that combines economic efficiency with environmental sustainability and national security in the context of global transformations of the 21st century.

Cases of strategic management in food systems: Successes and failures

An analysis of empirical cases in the field of sustainable food production shows that strategic management in this area depends not only on the level of technology or the volume of investment, but on the ability to integrate long-term sustainable development goals, incorporating local characteristics, institutional constraints and global challenges (Table 4).

Table 4. Successful cases of strategic management of food systems

Region/country	Base approach	Key strategies	Results and consequences
Netherlands	High-tech agriculture	PPP (public-private partnership), subsidies for technology, and farmer education	Tomato yield is 5 times higher than average, water consumption is reduced by 90%, and CO_2 emissions by 20%
Costa Rica	Agroecology and organic farming	Ban on GMOs, cooperatives, support for Fairtrade	15% growth in exports, 50% reforestation, and involvement of women
Ethiopia	Integrating food aid and ecological restoration	PSNP programme, satellite monitoring, farmer participation	1.5 million hectares restored, food security improved for 8 million people
Japan	Vertical farms with AI	Robotisation, hydroponics, state subsidies	-95% water, +300% productivity, no pesticides
Ukraine	ESG and closed loop	Biogas, biowaste, KPI-oriented management	CO_2 -35% by 2030, investment in bioenergy +25%

Source: compiled by the authors based on Safaricom PLC (2022), OECD (2023a; 2023b), Quarterlytics (2023), AgroNews (2025)

A range of countries have implemented successful models of sustainable food production, where close coordination between public and private structures, along with widespread innovation, is a key factor. One example is the Netherlands, where, despite a shortage of natural resources, one of these models is in place. Government incentive strategies, such as top-level sector policy, form a "triple helix" of interaction between government, academia and business. This association encourages the adoption of precision farming, IoT, drones and AI analytics in greenhouses and fields, optimising resources, reducing emissions and increasing yields (OECD, 2023a; 2023b). With government investment in agricultural R&D, subsidy programmes for agritech start-ups and strict monitoring of emissions, the Netherlands has achieved a 90% reduction in water consumption and a 300% increase in crop yields compared to the global average.

Another case of strategic success is Costa Rica, where the government is consistently implementing agricultural transition by combining a ban on GMOs, support for organic agriculture, and the development of cooperatives, especially in indigenous and mountainous regions. This approach is supported by fair trade programmes and cross-border ecotourism, which have contributed to the restoration of more than half of degraded forests and a 15% increase in the value of agricultural exports. The restoration of forests in the country has been made possible by land policies that include payments to land users for preserving or restoring vegetation (Payments for Environmental Services), as well as the introduction of a system for protecting biological corridors and a ban on logging. As a result, Costa Rica has changed from a country with one of the highest rates of deforestation in the 1980s to a regional example of environmental sustainability and leadership

in organic exports (OECD, 2023a; 2023b). Spread Co., Ltd. (Techno Farm, Kyoto and Fukuroi) has introduced fully automated vertical farms: AI systems, robots, LED lighting and hydroponics, which provide a significant increase in yield while drastically reducing water consumption (by up to 95%) and eliminating the use of chemicals. Based on the analysis, the company produces up to 30,000 lettuce heads per day with minimal water consumption, and automated management has increased yields several times compared to traditional farming. In terms of strategic support, the Japanese government is promoting the Smart Agriculture initiative through inter-ministerial programmes (SIPs) and the NARO laboratory. Projects include robotics, hydroponic installations, and AI monitoring aimed at creating sustainable farms that reduce resource use and increase yields. Japanese vertical farms with AI and hydroponics are becoming a model for highly efficient and resource-saving agricultural systems through these programmes, via METI and other agencies. (Liu *et al*., 2022).

In Kenya, the introduction of mobile agricultural technologies, including the iCow and DigiFarm platforms, as well as the active participation of women's cooperatives, resulted in a significant improvement in farming productivity and economic integration. The iCow users, especially in the counties of Uasin Gishu, Nyandarua, and Bomet, reported an increase in milk income of approximately 50,000-130,000 kg per year (approximately 400-1,000 USD), while average annual milk production per cow increased from ~1,964 litres to ~2,359 litres (i.e. ~20%) compared to controls. DigiFarm has shown rapid growth: more than 700,000 registered farmers successfully accessed loans, training and inputs via mobile phones within a year of launch, improving farm productivity and resilience. The involvement of local communities and cooperatives has contributed to a reduction in household costs of approximately 20%, particularly through optimised procurement, knowledge sharing and collective access to resources (Safaricom PLC, 2022). Despite the war, successful pilot projects were implemented in some regions of Ukraine. For instance, in the Poltava region, cooperatives of small producers, supported by USAID grants, reported an 18% increase in income. In the Lviv region, the introduction of drip irrigation and training programs increased crop yields by 23% (AgroNews, 2025). It is also worth noting the example of Ukraine: the MHP agricultural holding has become a pioneer in ESG-oriented agribusiness, selling biogas stations, a bio-waste disposal system, and digital KPI platforms. This ensures 35% reduction in CO_2 emissions by 2030 and increased energy efficiency, despite external challenges, including war and energy crises (Quarterlytics, 2023) (Table 5).

Table 5. Failed cases of strategic management

Country/region	Primary issue	Cause	Consequences
India (Punjab)	Excessive use of agrochemicals	Lack of education, monitoring, and strategic planning	Degradation of 40% of land, increased morbidity, and river pollution
Brasil	Deforestation for agricultural purposes	Priority of exports, weak interagency coordination	20% loss of the Amazon rainforest, 15% increase in CO_2 emissions, loss of biodiversity
Zimbabwe	Land reform without support	Lack of training, investment, and infrastructure	40% reduction in production, 60% increase in food insecurity
Ukraine	Lack of a strategy to support farming	Lack of monitoring of policy effectiveness. Insufficient involvement of communities in the development of local programs	Low level of fund absorption (less than 50% of planned subsidies were implemented in 2021). Only about 72% of the planned budget of 6.5 billion UAH was used

Source: compiled by the authors based on World Bank (2022), V. Kravchenko (2022), Ukraine: Largest amount of state support in 2021 received by five agriculture companies (2022), P. Greenfield (2023)

In contrast to successful examples, there are several cases where strategic management was either absent or ineffective, leading to persistent environmental, economic, and social dysfunctions. In Punjab (India), the consequences of the "green revolution" resulted in environmental and agricultural crises: despite increased crop yields, excessive use of fertilisers and pesticides, lack of effective agricultural education and lack of monitoring led to the degradation of over 40% of arable land and serious river pollution. Experts recorded a drop in organic carbon content to 0.3-0.8%, while the minimum acceptable level is 1%. This is indicated in the government report. According to the Department of Planning, about 39% of the state's territory is completely degraded, and 50% suffers from a serious deficiency of nutrients (such as nitrogen and phosphorus), which highlights the institutional inability to adapt to long-term environmental challenges.

In Brazil, the strategic emphasis on agricultural exports, accompanied by the relaxation of environmental regulations under the Bolsonaro administration, caused a major increase in deforestation in the Amazon and higher greenhouse gas emissions. At the same time, the agricultural lobby has actively influenced decision-making, undermining the national and international climate commitments. The lack of coordination between the federal government and the provinces has undermined full compliance with environmental standards and prompted a response from the international community, including import restrictions by the EU under sustainable supply chain rules (e.g., EUDR). After years of scientific observation, evidence has confirmed that under Bolsonaro's leadership, deforestation in the Amazon has reached a 15-year high, directly impacting the country's climate and global sustainability. According to INPE (Brazilian Institute for Space Research), carbon emissions from deforestation have increased significantly (from an average of 0.24 gigatons per year in 2010-18 to 0.44 GtC in 2019-2020, respectively), and foreign buyers, especially from the EU, have expressed serious concerns about the origin of imported products and their environmental responsibility (Greenfield, 2023). Thus, the

priority on short-term gains and weak institutional infrastructure resulted in a significant deterioration of the environmental situation in the country and increased pressure from the international community, primarily the EU. Similar examples are observed in Zimbabwe, where land reform was implemented without strategic support: the lack of investment, agricultural infrastructure, and support for new farmers led to a 40% drop in crop yields and a 60% increase in food insecurity (World Bank, 2022). In Ukraine, the government's 2020-2022 programs to support farming often lacked a specific implementation strategy. Low absorption of funds (less than 50% of planned subsidies were implemented in 2021) State programs to support farming in 2021 faced significant underfunding; in fact, only about 72% of the planned budget of 6.5 billion UAH was used, and the lack of effective monitoring and corruption schemes significantly reduced the effectiveness of these measures (Kravchenko, 2022; Ukraine: Largest…, 2022).

Analysing these cases, several critical conditions for strategic success in food systems can be identified. Effective systemic management with clear interagency coordination is vital. Programs that integrate agricultural innovation, environmental goals, and social mechanisms demonstrate the greatest resilience and adaptability. Strategies need to be localised. Approaches that factor in the local context, education levels, infrastructure readiness, and cultural characteristics are more sustainable than universal or export-oriented models. KPI-based assessment is key. Quantitative indicators such as carbon footprint, hectares restored, and food security index can be used to manage results and adjust policies in real time. Ukraine needs a multi-level strategy that combines decentralised planning based on up-to-date data with the introduction of innovations incorporated into educational and financial systems. It is necessary to ensure the active participation of local producers in collaborative management processes and to introduce a comprehensive performance assessment system that incorporates indicators of yield, income level, environmental footprint, and community engagement. Thus, sustainable strategic management is not a set of policies, but a dynamic system that demands a balance between the interests of the economy, the environment, and society. Successful cases point to the potential of sustainable models as a driver of economic growth, while unsuccessful examples point to the high cost of ignoring sustainable development and strategic analysis. In the case of Ukraine, future sustainability requires an adaptive, transparent, regionally sensitive management system that incorporates international experience but is based on local potential.

Comparative analysis of regional strategies for sustainable food production

Determination of the differences in regional approaches to sustainable food production can not only reveal effective models, but also adapt them to the conditions of individual countries, including Ukraine. The European Union, the United States, Asia, and Africa demonstrate varying degrees of institutional maturity, resource availability, and political will, which determine the trajectories of food system development. The EU (e.g., the Netherlands, Denmark) emphasises technological leadership, bioeconomy, digitalisation, and institutional frameworks – from Farm to Fork strategies to the Green Deal (European Commission, n.d.b). These approaches are supported by a comprehensive system of subsidies and research centres (e.g. Wageningen University), digital platforms and certification mechanisms, which ensure sustainability to be measured and managed using KPIs. The United States is relying on private investment, agribusiness holdings, and USDA initiatives. Although advanced precision farming technologies are being developed, structural vulnerabilities remain: the dominance of large farms, dependence on monocultures, and low environmental sustainability in some regions. African and Asian countries such as Ethiopia, India, and Kenya are demonstrating potential through low-cost technologies, cooperative movements, local community participation, and international programmes. In Kenya, for example, digital platforms and mobile technologies provide access to credit and agricultural advice, increasing yields and incomes by 25-40% (IFAD, 2022). In India, the PM-KUSUM programme (subsidies for solar installations) has reduced CO_2 emissions and costs, but requires transparent monitoring (Indian Council of Agricultural Research, n.d.).

Ukraine, being at the forefront of global trends and local challenges, is a special case. On the one hand, the country has high agro-industrial potential, fertile black soil and an export orientation. On the other hand, it suffers from institutional instability, limited access to finance, vulnerability to external shocks (including war) and weak coordination of sustainable initiatives (Escoto, 2020). Although Ukraine has introduced elements of sustainable agriculture – organic production, pilot digital farms, precision irrigation projects – these practices still cover only about 5-7% of the total sector (Ivashura *et al.*, 2022). In addition, there is no comprehensive mechanism for monitoring sustainability and strategic management at the national level, which limits the scaling up of successful practices. Therefore, Ukraine can use an adaptive model that combines the best practices of the EU (institutional support and regulatory framework), African countries (inclusive approaches and cooperation), and the US (technological transformation). However, this requires investment in science, sustainability standards, digital transformation, and a KPI system at all levels of government.

Global cooperation is a catalyst for the transformation of food systems towards sustainable development. International organisations, including FAO, CGIAR, IFAD and GCF, are actively investing in projects aimed at reducing vulnerability, developing agroecology and adapting to climate change. Examples include GCF investments in biofarms in Asia and Africa, CGIAR (2023) platforms for crop genomics, and FAO (2018) initiatives on agro-landscape planning. For Ukraine, cooperation with the FAO, GEF, and the European Investment Bank (EIB) has become particularly relevant in the context of the war. Programmes to support farmers, restore logistics, and introduce alternative technologies (mobile elevators, drones) have become not only a factor for survival, but also an incentive for more sustainable production (Escoto, 2020). However, access to international assistance requires institutional maturity, transparency, and strategic integration into national policy. The lack of a single coordination centre for sustainable agriculture in Ukraine, fragmented policies, and competition between agencies weaken the effect of international initiatives. The

introduction of a national platform for sustainable agricultural development with the participation of civil society organisations, the Ministry of Agrarian Policy and the business sector could strengthen strategic management and the integration of global resources into national priorities.

Recommendations for strategic management of sustainable food production in Ukraine

To develop an effective strategy for sustainable food production in Ukraine, it is necessary to define the areas in which international experience can be tailored to national realities, as this approach will overcome existing technological, institutional and social barriers. A key element of the modernisation of the domestic agricultural sector should be large-scale digitalisation and the introduction of modern technological solutions, using Kenya's successful practice of expanding digital services and specialised agricultural applications as a benchmark. In the Ukrainian context, the creation of similar mobile platforms and integrated management systems will provide small and medium-sized farmers with rapid access to market data, weather forecasts and expert advice, which will significantly increase the efficiency of resource use and the transparency of all value chains.

The practical implementation of the digital twin concept in conditions of active hostilities and budgetary constraints in Ukraine should be based on the principles of lean innovation and the use of open-access data. Instead of creating expensive closed systems, it is advisable to use the synergy of free satellite images from the Sentinel-2 (Copernicus) programme and open-source machine learning algorithms to automatically detect funnel formations and chemical burns on the soil. This approach provides initial monitoring of land conditions without the need for expensive manned aviation or commercial space services. The logistical implementation model requires the creation of a two-tier data structure: the first tier is formed through crowdsourced mobile platforms, where farmers and representatives of local communities independently record the coordinates of damage, and the second tier involves automated verification of this data by state authorities through integration with the Land Cadastre. This transforms the digital model into a dynamic risk management tool that prioritises demining and recultivation costs only in those areas with the highest potential for restoring fertility, ensuring maximum economic efficiency of every hryvnia invested in conditions of martial law.

Within the framework of strategic management, social components and the development of inclusive economic models that have proven their viability on a global scale are noteworthy. The model of the Indian association SEWA and the experience of organic coffee cooperatives in Costa Rica and other Central American countries should become the foundation for developing mechanisms to support farmers' cooperatives, particularly women's cooperatives, in Ukraine. The implementation of such approaches will not only contribute to improved financial stability of rural communities through shared access to markets and modern processing technologies, but will also ensure self-employment among the population and increase food security at the local level. Institutional strengthening of Ukrainian sustainable development policy requires the systematic implementation of educational programmes aimed at disseminating knowledge about environmentally friendly production methods. It is advisable to consolidate initiatives at the state level, following the example of FAO Farmer Field Schools, which have proven their effectiveness in transferring practical experience in regenerative agriculture and biological plant protection. The creation of a network of regional knowledge transfer centres in Ukraine will ensure adaptation of farmers to climate change and implement sustainable management principles directly into the production process, which is critical for maintaining soil fertility in the long term.

Further refinement of the strategy requires a profound transformation of political and economic incentives, which must correlate with measures implemented in the European Union and India. For Ukraine, it is necessary to move away from traditional models of direct subsidies towards flexible economic instruments that encourage compliance with ESG standards and the achievement of Sustainable Development Goals. This involves the introduction of a system of "green" payments for the application of environmental practices, expanding access to preferential lending for high-value-added projects, and creating a favourable investment climate for low-carbon technologies. The proposed set of measures justifies the key areas for improving Ukraine's sustainable agricultural production policy, demonstrating its high potential in the context of global trends. Combining the innovative digital experience of developing countries with the systematic regulatory mechanisms of developed economies will transform Ukraine's agricultural sector into a high-tech and socially responsible industry. Such an integrated approach will not only increase the competitiveness of domestic products on world markets but also form a sustainable production model capable of effectively countering modern geopolitical and climatic challenges.

DISCUSSION

The results of the study are consistent with trends that emphasise the need for a balance between economic efficiency, environmental sustainability and social inclusiveness. The results indicate a direct correlation between short-term planning and resource degradation, confirming the hypothesis that sustainable food production requires not just technological upgrades, but fundamental changes in strategic management. This phenomenon is a consequence of path dependency, where strategic decisions continue to follow outdated, intensive models despite obvious environmental and economic losses. This conclusion is partially confirmed by R. Chand (2022), highlighting the need for a transformational vision for the agricultural sector. However, this study enters into a key debate with this approach and argues that vision alone is not enough: it must be backed by institutional power and inter-agency coordination. The analysis shows that economic pressure on productivity dominates environmental sustainability if it is not restrained by mandatory KPI monitoring and transparent accountability. The critical role of key performance indicators (KPIs) was addressed by J. Schokker *et al*. (2022), justifying the implementation of climate risk indicators. This study does not deny the need for KPIs, but questions their universality and the effectiveness of implementation.

Systemic failures in monitoring, highlighted in the MOPAN (2024) assessment of food organisations, are a more critical barrier to sustainability than the choice of specific KPIs. Low transparency effectively devalues even the best KPIs. Research data from M.W. Jordon *et al*. (2022) and A.M. Prairie *et al*. (2023) confirm that the implementation of integrated CSA systems not only preserves but also increases organic carbon stocks in the soil, creating the conditions for the development of carbon neutrality strategies in agriculture. CSP changes strategic management at the sector level, transforming it from a simple production system to an ecosystem service. This requires governments to develop policies that encourage carbon sequestration and create carbon markets where farmers can monetise environmental benefits, ensuring that environmental sustainability becomes a financially attractive strategy.

The case of Ukraine (72% of the budget for state programmes remains unused) is an indicator not only of institutional weakness, but also of high corruption risks and ineffective management. This institutional failure creates a favourable environment for the misuse of funds, which is a critical barrier to attracting international financing. The conclusion of the article reinforces the position of MOPAN (2024), transforming the requirement for transparency into a requirement for strict institutional accountability as the basis for sustainable development and overcoming institutional path dependency. M. Bastidas-Orrego *et al*. (2023) examined policy instruments for green infrastructure. This study reinforces this argument, emphasising that in crisis regions, investments must not only be "green" but also integrated into the national system of geopolitical and military risk management, ensuring the physical resilience of assets. This requires the development of unique instruments, such as Sovereign War Risk Guarantees, to stimulate private capital.

Strategic adaptation is another significant point of discussion. The concept of localising strategies resonates with the analysis of corporate sustainability strategies, particularly K. Tan (2025). However, it is necessary to distinguish between national and corporate strategies by proposing a Hybrid Resilience Framework. This framework requires that national strategies be differentiated by region and include adaptation to geopolitical threats that go beyond traditional risk management. Traditional, linear scenario planning (regarding climate or the market) has proven ineffective in the context of geopolitical challenges, such as full-scale invasion, which requires a dynamic rebalancing between export-oriented and domestically oriented production models.

Y.-Y. Shih *et al*. (2025) on restructuring global supply chains through the "China-plus-one" strategy (pull-push-lock) is valuable. However, a more complex strategic challenge emerges in the Ukrainian context: the country must maintain key export markets while ensuring domestic food security, which requires the implementation of a hybrid strategy of localisation and global integration, as opposed to simple supply chain diversification. For agribusiness as a whole, the importance of scenario planning for climate disaster resilience is emphasised. This need must be expanded by requiring the integration of military risk scenario planning (destruction of logistics, mining of territories) into any long-term agricultural strategy. This includes not only risk assessment, but also planning for the rapid replacement of critical infrastructure (e.g., mobile grain elevators). Furthermore, it is proposed that the strategy include government mechanisms for insuring military risks and targeted funding programmes for demining and restoration, making investments in resilience physically secure. Innovative solutions such as controlled environment agriculture (CEA) demonstrate the potential to increase productivity by up to 300%. The analysis argues that in the context of post-conflict recovery, CEA is not just a technological improvement but a strategic necessity for the rapid and safe restoration of production in damaged areas.

The issue of energy sustainability is also critical. Concerning the circular economy, the conclusions of M. Fazle Rabbi & M. Bin Amin (2024) on the role of AI and blockchain in increasing transparency and optimising supply chains are indisputable. The contribution of the study consists of an analysis of the use of these tools for rapid environmental restoration, in particular for monitoring and decontaminating degraded soils. To finance sustainability in high-risk conditions, it is necessary to move away from traditional lending models. Blended finance, which combines concessional public capital or guarantees with private investment, should be the key mechanism. This should be accompanied by the issuance of Targeted Green Bonds, the proceeds of which are strictly directed towards soil restoration projects and the implementation of low-carbon technologies.

While emphasising the technological potential of CEA, the sustainability strategy cannot ignore social justice. Without inclusive financial mechanisms for small and medium-sized farms, the introduction of high-tech solutions (CEA, AI) will only exacerbate regional and social inequalities. It is necessary to create decentralised innovation hubs that facilitate the transfer of knowledge and technology. This requires the development of Green Skills among workers and managers, as well as the development of a new training and certification system that meets the requirements of a high-tech and sustainable agricultural sector. This study emphasises general trends and proposes the introduction of a national concept of a "digital twin" for the agricultural sector. This tool can be used by government agencies and investors to conduct scenario modelling of the impact of strategic decisions (e.g., subsidising specific technologies) on sustainability (organic carbon growth) and national security. It transforms management from reactive to predictive, which is critical in conditions of high uncertainty. In addition, it provides uncompromising transparency for international partners, minimising corruption risks and facilitating capital attraction. This concept involves creation of a virtual, dynamic model of all key agricultural resources and infrastructure, combining: This model comprehensively combines Geospatial Data (soil condition, including organic carbon and pollution, mining data, water resource monitoring), Production Indicators (actual yield, resource consumption, energy efficiency, according to J. Schokker *et al*. (2022) and Logistics Networks (dynamic supply chain models, optimised to account for military risks and Hybrid Resilience).

Thus, the study complements existing literature by integrating aspects of sustainability with a critical analysis of geopolitical and military risk. The introduction of the concept of institutional dependence explains resilience

to change, while the hybrid resilience framework offers a mechanism for adapting to multidimensional crises. It is necessary to shift the focus from technological optimisation to institutional efficiency, financial innovation and digital transparency (through digital twins), which is a fundamentally new approach for countries facing permanent crisis challenges. The conclusion is that food security is, first and foremost, a strategy for national security, institutional resilience and social inclusion, and only then for environmental and economic efficiency.

CONCLUSIONS

Based on an in-depth analysis of sustainable food production principles and strategic management mechanisms, the study confirms that ensuring sustainability is a systemic challenge that requires the integration of economic, environmental and social mechanisms. The study established that progressive technologies (precision farming, regenerative agriculture, and blockchain) create the necessary potential for sustainable food production. At the same time, strategic management must be transformed from a set of separate policies into a dynamic process of multi-level governance and integrated risk management (climatic, geopolitical).

An analysis of successful and unsuccessful cases has revealed critical conditions for effective food system management. First, this requires a systematic approach with clear inter-agency coordination and integration of innovations. It also requires the localisation of strategies that take into account the local context, infrastructure and cultural characteristics. A key element is KPI-based assessment, which can be used for real-time management of results and policy adjustments (e.g. through monitoring of carbon footprint and food security index). At the same time, short-term planning, lack of transparent monitoring and corruption risks remain critical barriers. The study determined that achieving sustainability is context-dependent: in developed countries, it is achieved through technological advantage and institutional maturity, while in developing countries, it is achieved through social mobilisation and a focus on affordable agroecological solutions. Failures in strategic management lead to significant quantitative losses. The consequences of export-oriented strategies are reflected in increased CO emissions, which undermine international climate commitments. The low effectiveness of financial strategies to support farming is a direct indicator of weak monitoring and corruption risks. In contrast, targeted, KPI-oriented strategies demonstrate high potential: innovative case studies confirm a 90% reduction in water consumption and a 300% increase in productivity. Management models focused on climate KPIs ensure the achievement of CO_2 emission reduction targets of 35% and the successful restoration of degraded land.

The implementation of strategic management of sustainable food production in Ukraine should integrate innovations into financial and educational mechanisms. It is recommended to develop comprehensive sustainable development strategies with a horizon of 10-30 years, introduce transparent financing mechanisms, and support sustainable technologies and adaptation measures. The combination of targeted investments, subsidies and inter-agency cooperation yields positive results. Further research should focus on developing models of climate and economic change scenarios for Ukraine's agricultural sector. This requires the creation of KPI systems for assessing the environmental footprint and food security. It is necessary to explore the potential of AI, biotechnology and circular economy models as strategic resources for post-conflict recovery, as well as to study mechanisms for scaling up successful cooperative models and technology transfer for small and medium-sized farms.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

REFERENCES

[1] AgroNews. (2025). *Irrigation increases crop yields and farmers' incomes in Southern and Eastern Ukraine*. Retrieved from https://surl.li/wezeid.

[2] Agroreview. (2025). *Ukraine begins a new stage in the development of agricultural cooperatives*. Retrieved from https://agroreview.com/en/newsen/agripolicy/ukraine-begins-new-stage-the/.

[3] Bastidas-Orrego, L.M., Jaramillo, N., Castillo-Grisales, J.A., & Ceballos, Y.F. (2023). A systematic review of the evaluation of agricultural policies: Using prisma. *Heliyon*, 9(10), article number e20292. doi: 10.1016/j.heliyon.2023.e20292.

[4] Calvo-Baltanás, V., Vilcinskas, A., Brück, T., Kloas, W., Wilke, T., Rufino, M., Henkel, M., Zorn, H., Monje, O., & Asseng, S. (2025). The future potential of controlled environment agriculture. *PNAS Nexus*, 4(4), article number pgaf078. doi: 10.1093/pnasnexus/pgaf078.

[5] CGIAR. (2022). *CGIAR initiative on climate resilience: 2022 technical report*. Retrieved from https://hdl.handle.net/10568/130097.

[6] CGIAR. (2023). *Annual technical report 2023: Transforming food, land, and water systems for resilience*. Retrieved from https://www.cgiar.org/initiative/climate-resilience/.

[7] Chand, R. (2022). Indian agriculture towards 2030 – need for a transformative vision. In R. Chand, P. Joshi & S. Khadka (Eds.), *Indian agriculture towards 2030. India studies in business and economics* (pp. 1-7). Singapore: Springer. doi: 10.1007/978-981-19-0763-0_1.

[8] Chang, Y., & Wang, S. (2023). China's pilot free trade zone and green high-quality development: An empirical study from the perspective of green finance. *Environmental Science and Pollution Research*, 30, 88918-88935. doi: 10.1007/s11356-023-28729-w.

[9] Chopra, S.S., Senadheera, S.S., Dissanayake, P.D., Withana, P.A., Chib, R., Rhee, J.H., & Ok, Y.S. (2024). Navigating the challenges of environmental, social, and governance (ESG) reporting: The path to broader sustainable development. *Sustainability*, 16(2), article number 606. doi: 10.3390/su16020606.
[10] Christopher, E., Ndehedehe, O., Adeyeri, V., & Ferreira, W. (2025). Terrestrial water storage in Australia under stress from compound climate extremes. *Resources, Environment and Sustainability*, 21, article number 100242. doi: 10.1016/j.resenv.2025.100242.
[11] Crippa, M., *et al*. (2024). Insights into the spatial distribution of global, national, and subnational greenhouse gas emissions in the emissions database for global atmospheric research (EDGAR v8.0). *Earth System Science Data*, 16(6), 2811-2830. doi: 10.5194/essd-16-2811-2024.
[12] Escoto, E. (2020). *Agroecology and local markets: Sources of hope during the COVID-19 pandemic in Latin America*. Retrieved from https://www.groundswellinternational.org/blog/agroecology-and-local-markets-sources-of-hope-during-the-covid-19-pandemic-in-latin-america/.
[13] European Commission. (n.d.a). *Common agricultural policy reform*. Retrieved from https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy.
[14] European Commission. (n.d.b). *Farm to fork strategy: For a fair, healthy and environmentally-friendly food system*. Retrieved from https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en.
[15] Fairtrade International. (2024). *Monitoring the scope and benefits of fairtrade: Overview – monitoring report, 15th edition*. Retrieved from https://www.fairtrade.net/en/get-involved/library/monitoring-the-scope-and-benefits-of-fairtrade--overview---monit.html.
[16] FAO. (2018). *Scaling up agroecology initiative: Transforming food and agricultural systems in support of the SDGs*. Retrieved from https://openknowledge.fao.org/server/api/core/bitstreams/d7e5b4ae-80b6-4173-9adf-6f9f845be8a1/content.
[17] FAO. (2022). *Farmer field schools: building capacities to achieve a successful agroecological transition*. Retrieved from https://revues.cirad.fr/index.php/perspective/article/view/36887/36999.
[18] Fazle Rabbi, M., & Bin Amin, M. (2024). Circular economy and sustainable practices in the food industry: A comprehensive bibliometric analysis. *Cleaner and Responsible Consumption*, 14, article number 100206. doi: 10.1016/j.clrc.2024.100206.
[19] Greenfield, P. (2023). *Amazon's emissions "doubled" under first half of Bolsonaro presidency*. Retrieved from https://www.theguardian.com/environment/2023/aug/23/amazons-emissions-doubled-under-first-half-of-bolsonaros-presidency-aoe.
[20] Gupta, P.K. (2024). Drought-tolerant transgenic wheat HB4: A hope for the future. *Trends in Biotechnology*, 42(7), 807-809. doi: 10.1016/j.tibtech.2023.12.007.
[21] IFAD. (2022). *Digital agricultural advisory services for smallholder farmers*. Retrieved from https://www.ifad.org/en/web/latest/-/digital-agricultural-advisory-services-for-smallholder-farmers.
[22] Indian Council of Agricultural Research. (n.d.). *Krishi vigyan kendra – farm science centre*. Retrieved from https://icar.org.in/en/agricultural-extension-division/krishi-vigyan-kendra-kvk-farm-science-centre.
[23] Issayas, T., & Lemma, Y. (2025). *Ethiopia invests big in restoring degraded land*. Retrieved from https://www.wri.org/insights/ethiopia-invests-big-restoring-degraded-land.
[24] Ivashura, A., Protasenko, O., Mykhailova, E., & Severinov, O. (2022). Study of strategies for sustainable production and consumption in the economic conditions of Ukraine. *Economics of Development*, 21(1), 8-16. doi: 10.57111/econ.21(1).2022.8-16.
[25] Jodrell, D., & de Bruin, W. (2024). *Fairtrade international evidence map 2021 to 2024: Evidencing the theory of change*. Retrieved from https://www.fairtrade.net/content/dam/fairtrade/fairtrade-international/library/2025/evidence-mapping/Fairtrade%20Evidence%20Mapping%20report%202025.pdf.
[26] Jordon, M.W., Evans, C., Ostle, N.J., Jones, D.L., Chadwick, D.R., & Tipping, E. (2022). Can regenerative agriculture increase national soil carbon stocks? Simulated country-scale adoption of reduced tillage using RothC. *Science of The Total Environment*, 825, article number 153955. doi: 10.1016/j.scitotenv.2022.153955.
[27] Juri, S., Terry, N., & Pereira, L.M. (2024). Demystifying food systems transformation: A review of the state of the field. *Ecology and Society*, 29(2), article number 5. doi: 10.5751/ES-14525-290205.
[28] Karunathilake, E.M.B.M., Le, A.T., Heo, S., Chung, Y.S., & Mansoor, S. (2023). The path to smart farming: Innovations and opportunities in precision agriculture. *Agriculture*, 13(8), article number 1593. doi: 10.3390/agriculture13081593.
[29] Kravchenko, V. (2022). *From 2023, state subsidies in the agro industry will whittle away. The new grant format may be more effective, but the reform is done at the most critical time for the industry*. Retrieved from https://surl.li/tpdnzq.
[30] Law of Ukraine No. 1163-r "On the Approval of the Strategy for the Development of Agriculture and Rural Areas in Ukraine for the Period Up to 2030 and the Approval of the Operational Plan of Measures for its Implementation in 2025-2027". (2023, November). Retrieved from https://zakon.rada.gov.ua/laws/show/en/1163-2024-%D1%80?lang=en#top.
[31] Liu, J., Oita, A., Hayashi, K., & Matsubae, K. (2022). Sustainability of vertical farming in comparison with conventional farming: A case study in Miyagi prefecture, Japan, on nitrogen and phosphorus footprint. *Sustainability*, 14(2), article number 1042. doi: 10.3390/su14021042.
[32] McFadden, J., Njuki, E., & Griffin, T. (2023). Precision agriculture in the digital era: Recent adoption on U.S. farms. *USDA Economic Information Bulletin*, 248, article number EIB-248. https://doi.org/10.22004/ag.econ.333550.

[33] Mehta, V. (2023) *Empowering producer women through peer-learning and mentorship. Case study: Self employed women's association's (SEWA) manager Ni school in India*. Retrieved from https://surl.li/jqlwcn.
[34] MNRE. (2022). *PM-KUSUM scheme guidelines*. Retrieved from https://surl.li/gyrdjl.
[35] MOPAN. (2024). *MOPAN assessment of Food and Agriculture Organization*. Paris: MOPAN.
[36] Moschitz, H., Müller, A., Kretzschmar, U., Haller, L., de Porras, M., Pfeifer, C., Oehen, B., Willer, H., & Stolz, H. (2021). How can the EU farm to fork strategy deliver on its organic promises? Some critical reflections. *EuroChoices*, 20(1), 30-36. doi: 10.1111/1746-692X.12294.
[37] Ndehedehe, O., Adeyeri, V., Ferreira, W., & Zhou, W. (2025). Terrestrial water storage in Australia under stress from compound climate extremes. *Resources, Environment and Sustainability*, 21, article number 100242. doi: 10.1016/j.resenv.2025.100242.
[38] NITI Aayog. (n.d.). Retrieved from https://www.niti.gov.in.
[39] OECD. (2023a). *Agricultural policy monitoring and evaluation 2023: Costa Rica*. Paris: OECD Publishing. doi: 10.1787/b14de474-en.
[40] OECD. (2023b). *Policies for the future of farming and food in the Netherlands*. Paris: OECD Publishing. doi: 10.1787/bb16dea4-en.
[41] Pokal, S., Zhou, Y., & Franz, T. (2024). Yield forecasting based on short time series with high spatial resolution data. *ArXiv*. doi: 10.48550/arXiv.2402.01946.
[42] Prairie, A.M., King, A.E., & Cotrufo, M.F. (2023). Restoring particulate and mineral-associated organic carbon through regenerative agriculture. *Proceedings of the National Academy of Sciences*, 120(21), article number e2217481120. doi: 10.1073/pnas.2217481120.
[43] Pula. (n.d.). Retrieved from https://www.pula-advisors.com.
[44] Quarterlytics. (2023). *MHP integrated annual report and accounts 2023*. Retrieved from https://quarterlytics.com/company/mhp_mhpc/annual-report-2023/.
[45] Reardon, T., Swinnen, J., & Vos, R. (2022). COVID-19 and resilience innovations in food supply chains: Two years later. In J. McDermott & J. Swinnen (Eds.), *COVID-19 and global food security: Two years later* (pp. 87-92). Washington: International Food Policy Research Institute (IFPRI). doi: 10.2499/9780896294226_13.
[46] Saccone, D., & Vallino, E. (2025). Global food security in a turbulent world: Reviewing the impacts of the pandemic, the war and climate change. *Agricultural and Food Economics*, 13, article number 47. doi: 10.1186/s40100-025-00388-0.
[47] Safaricom PLC. (2022). *Kenyan farmers say digital technologies key to productivity and sustainability, but urgent government support needed*. Retrieved from https://surl.li/bsjaid.
[48] Schokker, J., Kamilaris, A., & Karatsiolis, S. (2022). A review on key performance indicators for climate change. In V. Wohlgemuth, S. Naumann, G. Behrens & H.K. Arndt (Eds.), *Advances and new trends in environmental informatics* (pp. 273-292). Cham: Springer. doi: 10.1007/978-3-030-88063-7_17.
[49] Sgarbi, F., & Nadeu, E. (2023). *Resilience and sustainability in food systems research: A review of the main issues and knowledge gaps*. Brussels: Institute for European Environmental Policy.
[50] Shih, Y.-Y., Liu, M.-C., & Lin, C.-A. (2025). Supply-chain restructuring using the "China-plus-one" strategy: The push-pull-mooring perspective. *International Journal of Emerging Markets*, 21(2), 366-387. doi: 10.1108/ijoem-11-2023-1900.
[51] Simane, B., Kapwata, T., Naidoo, N., Cissé, G., Wright, C.Y., & Berhane, K. (2025). Ensuring Africa's food security by 2050: The role of population growth, climate-resilient strategies, and putative pathways to resilience. *Foods*, 14(2), article number 262. doi: 10.3390/foods14020262.
[52] Tan, K. (2025). *Integrating sustainability into the corporate strategy: A critical analysis of unilever's sustainable living plan*. doi: 10.13140/RG.2.2.20946.47040.
[53] Turner, R.A., & Wills, J. (2022). Downscaling doughnut economics for sustainability governance. *Current Opinion in Environmental Sustainability*, 56, article number 101180. doi: 10.1016/j.cosust.2022.101180.
[54] Ukraine: Largest amount of state support in 2021 received by five agriculture companies. (2022). Retrieved from https://surl.li/agotwt.
[55] UNFCCC. (n.d.). Retrieved from https://unfccc.int/.
[56] van Dijk, M., Morley, T., Rau, M.L., & Saghai, Y. (2021). A meta-analysis of projected global food demand and population at risk of hunger for the period 2010-2050. *Nature Food*, 2(7), 494-501. doi: 10.1038/s43016-021-00322-9.
[57] Varzakas, T., & Smaoui, S. (2024). Global food security and sustainability issues: The road to 2030 from nutrition and sustainable healthy diets to food systems change. *Foods*, 13(2), article number 306. doi: 10.3390/foods13020306.
[58] World Bank. (2021). *Productive safety net programme in Ethiopia*. Retrieved from https://surl.li/vkjeva.
[59] World Bank. (2022). *Zimbabwe economic update: Improving resilience to weather shocks and climate change*. Retrieved from https://www.worldbank.org/en/country/zimbabwe/publication/zimbabwe-economic-update-improving-resilience-to-afe-weather-shocks-and-climate-change.
[60] World Resources Institute & World Business Council for Sustainable Development. (n.d.). *Product life cycle accounting and reporting standard*. Retrieved from https://ghgprotocol.org/sites/default/files/standards/Product-Life-Cycle-Accounting-Reporting-Standard_041613.pdf.
[61] Xing, Y., & Wang, X. (2024). Precision agriculture and water conservation strategies for sustainable crop production in arid regions. *Plants*, 13(22), article number 3184. doi: 10.3390/plants13223184.

Стале виробництво продовольства та стратегічне управління: поглиблений аналіз

Андрій Івашура
Кандидат сільськогосподарських наук, доцент
Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки, 9А, м. Харків, Україна
https://orcid.org/0000-0002-0022-7489

Ханіфа Джафарлі
Доктор економічних наук, професор
Азербайджанський державний економічний університет
AZ1001, вул. Істікляліят, 6, м. Баку, Азербайджан
https://orcid.org/0000-0002-8104-2426

Ольга Протасенко
Кандидат технічних наук, доцент
Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки 9А, м. Харків, Україна
https://orcid.org/0000-0002-8203-5703

Анотація. Метою дослідження стало проведення поглибленого аналізу принципів сталого виробництва продовольства, виявлення ключових викликів та розробка стратегічних рекомендацій щодо їх подолання в глобальному та регіональному контекстах України. Методологія дослідження базувалась на комплексному міждисциплінарному підході, що поєднує порівняльний, аналітичний і системний методи, які дозволяють всебічно оцінити екологічні, економічні та соціальні компоненти продовольчих систем у контексті сучасних глобальних викликів, тенденцій розвитку продовольчого сектору та впливу технологічних трансформацій. Здійснено поглиблений аналіз теоретичних основ сталого виробництва продовольства, досліджено державні та корпоративні стратегії управління продовольчими ресурсами, вивчено міжнародні ініціативи, програми співробітництва та інноваційні технологічні рішення, спрямовані на підвищення ефективності та сталості агропродовольчих систем. Встановлено, що ефективне стратегічне управління сприяє глибокій інтеграції екологічних, соціальних і економічних факторів у систем продовольчого виробництва, забезпечуючи збалансований розвиток аграрної сфери. Розроблено комплекс рекомендацій щодо адаптації міжнародного досвіду до умов України, зокрема у сфері розвитку агротехнологій, вдосконалення механізмів державного управління та підготовки висококваліфікованих кадрів для продовольчого сектору. Проаналізовано успішні кейси країн ЄС, США та Китаю, визначено їхні ефективні моделі реалізації сталих практик і можливості застосування цих підходів у вітчизняному контексті. Водночас виявлено, що недосконалість інституційних механізмів, обмеженість фінансових ресурсів і недостатня координація між державними та приватними структурами залишаються ключовими бар'єрами на шляху до сталості. Практична цінність дослідження полягає у можливості використання його результатів фахівцями у сфері стратегічного управління, державної політики та аграрного розвитку для підвищення ефективності національних програм продовольчої безпеки та досягнення Цілей сталого розвитку ООН

Ключові слова: сталий розвиток; інституційні механізми; адаптація до криз; глобальні виклики продовольчої системи; еколого-економічні відносини; відповідальне виробництво; інноваційний розвиток; природні ресурси

ISSN 2413-9610, E-ISSN 2663-2365 Journal homepage: https://devma.com.ua/en

DEVELOPMENT MANAGEMENT

UDC 004.042.2:658.5
DOI: 10.63341/devt/4.2025.48

Vol. 24, No. 4. 2025

Overview of risk management methodologies and standards in IT projects, programmes, and portfolioss

Mykyta Savchenko*
Master, Assistant
State University of Trade and Economics
02156, 19 Kyoto Str., Kyiv, Ukraine
https://orcid.org/0009-0004-9754-748X

Abstract. The study aimed to systematise existing risk management methodologies and identify theoretical provisions regarding their potential suitability for IT projects. To achieve this goal, a comparative analysis and theoretical assessment of the high-level characteristics of risk management methodologies in IT projects were used. The comparative analysis revealed the features of the most commonly used risk management methodologies: ISO 31000:2018 was characterised by a high level of versatility; Project Management Body of Knowledge (PMBoK) and Risk Management in Portfolios, Programs, and Projects: A Practice Guide had a high degree of detail; Projects IN Controlled Environments (PRINCE2) was formal in nature, while Enterprise Risk Management (COSO ERM) was conceptual; Factor Analysis of Information Risk (FAIR) and Factor Analysis of Information Risk Artificial Intelligence Risk (FAIR AIR) focused heavily on the use of quantitative risk assessment tools; and "NIST Special Publication 800-37. Revision 2. Risk Management Framework for Information Systems and Organisations: A System Life Cycle Approach for Security and Privacy", "NIST AI 100-1. Artificial Intelligence Risk Management Framework (AI RMF 1.0)" and "NIST AI 600-1. Artificial Intelligence Risk Management Framework: Generative Artificial Intelligence Profile" ensured risk management in projects based on the use of artificial intelligence. The results of comparative analysis and research into the practical application of individual methodologies can be used to select the optimal methodology in a specific context

Keywords: digital transformation; analysis; monitoring; control; software

INTRODUCTION

In modern conditions of digital transformation, effective risk management has become one of the key factors for the success of information technology (IT) projects, programmes and portfolios. The dynamic development of IT, the emergence of new architectural solutions, rapid software updates and high market competition create an environment of increased uncertainty. Effective risk management of IT projects is only possible if a wide range of external and internal project environment factors are addressed. It is necessary to emphasise the need to incorporate modern trends in the IT services market: the integration of artificial intelligence into the software production cycle, the ever-growing relevance of cybersecurity, cloud transformation as a strategic necessity, zero-trust architecture, DevOps and Infrastructure as Code, cost optimisation, low- and no-code platforms, distributed teams, and the transformation of stakeholder demand and expectations in the context of the popularisation of artificial intelligence.

There is no established taxonomy of IT project risks in the scientific field. In addition to the basic risks for project activities (such as failure to comply with project constraints, market and regulatory risks, human capital risks, etc.), IT projects are also characterised by specific industry risks. K. Nazarova *et al*. (2023) referred to risks related to IT infrastructure, personnel, loss or leakage of information, as well as social, legal, market and technological risks. The study addressed technological risks, which include risks of software code obsolescence, integration risks, and cybercrime risks. According to J.J. Selvakumar *et al*. (2024), risk management can improve the

Article's History: Received: 19.05.2025; Revised: 30.10.2025; Accepted: 23.12.2025; Published: 12.01.2026

Suggested Citation:
Savchenko, M. (2025). Overview of risk management methodologies and standards in IT projects, programmes, and portfolios. *Development Management*, 24(4), 48-56. DOI: 10.63341/devt/4.2025.48.

*Corresponding author

effectiveness of IT projects and initiatives. This conclusion was made based on the results of a structured survey of 261 IT professionals, emphasising the existence of a directly proportional relationship between risk identification and analysis and the probability of success of an IT initiative. The existence of such a relationship was also confirmed by R. Testorelli *et al*. (2024) in an investigation of the impact of risk management on the value of projects in various segments of the economy. Based on data from 116 relevant studies, the authors presented a theoretical model in which the use of risk management methodologies and tools increased the economic, environmental and social value of projects and programmes.

V.I. Ziuziun & D.O. Liashenko (2025) presented an integrated conceptual model of risk management for IT projects that create online platforms with high-value transactions, considering that traditional approaches, in particular ISO 31000:2018 (2018), PMBoK and MSF, do not fully meet the challenges of the digital environment, in particular fraud and cyber threats. The study emphasised that the modern information environment requires a rethinking of existing approaches and the introduction of new, contextually determined approaches. Thus, the effectiveness of risk management in projects, programmes and portfolios depends not only on specific risk management methodologies or standards, but also on the characteristics of the environment in which they are used. A similar opinion was presented by L. Mohylna & I. Vorobiov (2024), identifying and investigating the determining factors of risk management effectiveness in innovation and investment projects.

In addition to the need to align existing management methodologies and standards with company strategies, challenges lie in the lack of unified protocols for identifying and documenting risks. This obstacle to risk management was documented, for example, by W. Albasyouni *et al*. (2025), in a comparative analysis of individual companies from local and multinational corporations operating in the Middle East, Asia and Latin America. According to the observations, the key difference is that multinational corporations use standardised risk management protocols, while local companies often face difficulties in formalising these practices.

In the field of risk management methodologies and standards, it is also worth considering the sources of risk, which have been studied by A. Tak & S. Chahal (2024). According to these experts, existing sources of risk include dynamic resource allocation, management model sustainability, risk integration, and information quality. A. Tak & S. Chahal emphasised that analysis of the barriers to implementing existing methodologies and standards is key to effective risk management in projects and programmes. Despite the existence of individual studies comparing key risk management approaches and standards, there is a need for a more systematic and comprehensive review covering their conceptual foundations and practical applications. The study aimed to systematise international risk management methodologies and assess their relevance in the context of IT projects, programmes and portfolios. Achieving this goal involved conducting a comparative analysis and critical assessment of existing approaches to risk management in the segment under study.

MATERIALS AND METHODS

Key international standards and methodologies were used as primary materials, including ISO 31000:2018 (2018), A Guide to the Project Management Body of Knowledge PMBOK® Guide Seventh Edition (Project Management Institute, 2021) and PRINCE2 Project Management Foundation (Version 7) (PRINCE2, n.d.). Risk Management in Portfolios, Programs, and Projects: A Practice Guide (Project Management Institute, 2024) and NIST Special Publication 800-37. Revision 2 (National Institute of Standards and Technology, 2018) were also used. Alongside mentioned documents, the Factor Analysis of Information Risk (FAIR) (FAIR Institute, n.d.) and Committee of Sponsoring Organisations of the Treadway Commission Enterprise Risk Management (COSO ERM) (Committee of Sponsoring Organizations, n.d.) were also analysed. Alongside mentioned methods, the NIST AI 100-1. Artificial Intelligence Risk Management Framework (AI RMF 1.0) (National Institute of Standards and Technology, 2023), NIST AI 600-1. Artificial Intelligence Risk Management Framework: Generative Artificial Intelligence Profile (National Institute of Standards and Technology, 2024) and A FAIR artificial intelligence (AI) Cyber Risk Playbook (Copeland, 2024) were also analysed.

To achieve the research objectives and ensure the objectivity of the results obtained, a set of theoretical methods of scientific cognition, comparative analysis, and a review of the features of risk management in IT projects were used, which made it possible to comprehensively analyse the features of risk management in IT projects, programmes, and portfolios. The comparative analysis method was used to compare risk management methodologies and standards in terms of structure, process stages, level of detail, and practical application possibilities. Comparative analysis made it possible to identify common features, differences, advantages, and limitations in the context of modern IT projects, programmes, and portfolios. The comparison was made based on the following criteria: the fundamental idea that the methodology seeks to implement to create value; the level of detail, i.e. the depth of disclosure of the proposed processes and tools; degree of formalisation as the level of requirements for documenting and formalising processes; and adaptability, which consists in whether the methodology can be used for the modification of the proposed processes for a specific industry, organisation, portfolio, programme or project. The paper also examined the specifics of applying the selected methodologies in the context of risk management in IT projects. The practical aspect of using methodologies was explored in terms of their strengths and weaknesses in increasing project resilience in an environment of constant change.

RESULTS

International risk management standards

Risk management is a complex process with a high entry threshold, which often requires fruitful interaction between stakeholder groups, functional units of the organisation, corporate strategy and organisational culture. Given the complexity of this process, several international institutions aim to create universal methodologies that would accumulate the best and most relevant achievements in the scientific and practical spheres. This knowledge is systematised, tested for compliance with current conditions, and

transferred to managers in the form of ready-made models, processes, and tools. In other cases, risk management is an objective necessity due to the high cost of errors and regulatory restrictions, such as in data management, finance, and construction. In such cases, the creation of universal methodologies is part of the regulation of a given field of activity, and following the methodology becomes an obligation of the business entity. Risk management methodologies are often components of overall project management methodologies (as in the case of PRINCE2 and PMBoK), but for the most part, they are comprehensive and autonomous and can be studied separately.

The most popular risk management methodologies include ISO 31000:2018 (2018) (as well as related standards that cover individual elements of risk management in greater detail, such as IEC 31010:2019 (2019)), PMBoK (as well as the more detailed separately published methodology Risk Management in Portfolios, Programs, and Projects), PRINCE2, NIST Risk Management Framework (RMF), APM Project Risk Analysis and Management (PRAM), ISACA COBIT, FAIR, COSO ERM, and others.

ISO 31000:2018 (2018) is an international standard for risk management that sets out general principles, frameworks and processes for managing risks in any organisation. The methodology involves eight interrelated principles for creating and protecting project value: continuous improvement, use of the best available information, consideration of human and cultural values, consideration of the dynamic nature of the project, integration, structure and complexity, individualisation (customisation) and inclusiveness.

PMBoK is a framework of interrelated processes from the Project Management Institute (2021) (PMI) designed for project management; it considers project risk management as a separate set of processes, which includes identification, quantitative and qualitative risk assessment, response planning, and monitoring. In modern editions (7th edition and 8th edition), the approach has become more principled, adaptive, and focused on contextual selection of techniques. PMBoK is well-suited for medium and large projects where it is necessary to formalise risk management processes in the project lifecycle.

PRINCE2 (n.d.) is a project management methodology that originated in the United Kingdom and is widely used in government and corporate environments. In PRINCE2, risk is considered one of the key topics and, similar to ISO 31000:2018, provides for a cycle that includes risk identification, assessment, planning, implementation and communication. The methodology emphasises the appointment of risk owners, the use of a risk register and the inclusion of a risk strategy in the project's initial documents. A key feature of the methodology is its transparency, which is achieved through an emphasis on clear roles and responsibilities.

NIST Special Publication 800-37 is a methodology developed for managing information security risks. RMF consists of a sequential cycle of stages: organisation preparation, information system categorisation, security measure selection and implementation, assessment, authorisation, and continuous monitoring (National Institute of Standards and Technology, 2018). In contrast to the universal ISO 31000:2018, RMF is designed to ensure cyber resilience and compliance with government security standards in the field of IT. Its main advantage is the integration of risk management into the life cycle processes of IT systems.

FAIR is a universal risk management methodology that places a strong emphasis on the need to measure risks quantitatively, in financial terms, rather than solely in percentage or qualitative categories (FAIR Institute, n.d.). FAIR is based on two key concepts: loss event frequency and loss magnitude, which can be used for modelling the probability of risks occurring and their potential financial consequences. A distinctive feature of FAIR is its emphasis on a quantitative approach to risk assessment, which can be used for more informed budget allocation, risk prioritisation, and demonstration of the effectiveness of management measures. The methodology is used in the banking, financial, technology, and government sectors to build models of the economic effectiveness of cybersecurity.

The FAIR-AIR Approach Playbook is a variation of the FAIR methodology adapted to the conditions of artificial intelligence risk management (Copeland, 2024). This approach combines the principles of quantitative risk analysis with models for assessing specific risks associated with artificial intelligence (AI), such as algorithmic bias, opaque decisions, reputational damage, privacy violations, or failure to comply with ethical standards. The main difference between FAIR-AIR and FAIR is the object of assessment and the context of application: FAIR focuses primarily on information and cyber risks associated with technological systems; FAIR-AIR emphasises the risks arising from the implementation of artificial intelligence systems, where uncertainty often has not only technical but also socio-ethical dimensions. FAIR-AIR retains the quantitative basis of FAIR, but supplements it with an assessment of qualitative parameters such as user trust, ethical decision-making and algorithm transparency. This approach can be used for a comprehensive analysis of the risks of new technologies, ensuring a balance between business interests, security and social responsibility.

COSO ERM is a basic approach to corporate risk management (Committee of Sponsoring Organisations, n.d.). COSO defines risk management as a process implemented by the board of directors, management and other employees to identify potential events that could affect the organisation and manage risks within its risk appetite. The COSO model emphasises the integration of risk management with corporate strategy, culture and internal control systems. This approach can be used to create a unified structure in which risks are viewed not only as threats, but also as a source of strategic opportunities.

NIST AI 100-1 emphasised the management of risks associated with the development, implementation, and use of artificial intelligence systems (National Institute of Standards and Technology, 2023). This methodology focuses on transparency, fairness, accountability, and reliability of AI solutions. The AI RMF structure consists of four functions: building a risk management culture and integrating it with other business processes, mapping, measuring, and managing risks. The methodology provides recommendations for assessing potential ethical, technical, and social risks arising from working with machine learning algorithms and generative AI.

NIST AI 600-1 is a specialised profile that extends the AI RMF to generative artificial intelligence systems

(National Institute of Standards and Technology, 2024). This document details approaches to managing risks related to content creation, copyright, misinformation, and model bias. A substantial feature is the emphasis on data security, transparency of training samples, and human oversight mechanisms. A comparative analysis of risk management methodologies based on key parameters is presented in Table 1 below.

Table 1. Comparative analysis of key risk management methodologies in IT projects

Methodology/standard	Fundamental idea (value creation)	Level of detail	Level of formalisation	Adaptability
ISO 31000:2018 (2018)	Creation of a universal risk management system aimed at achieving the organisation's goals through the integration of risk management into all processes.	Medium – principles, frameworks and general processes are defined without excessive detail on tools.	Low – requires development of internal policies and procedures.	High – easily adaptable to most industries where risk management is not directly regulated.
PMBoK 6th edition (2017)	Formation of a structured risk management process within the project to control the impact of uncertainty on project objectives.	High – specific processes, inputs, outputs, tools and techniques are described.	Medium – clear requirements for documenting each risk management process.	High – easily adaptable to most industries where risk management is not directly regulated. The idea of adaptability ("fitting in") is embedded in the very foundation of the methodology.
PRINCE2 (n.d.)	Ensuring controlled project management through systematic risk management, roles and responsibilities.	High – specific processes, inputs, outputs, tools and techniques are described.	High – mandatory templates, roles, risk logs.	Medium – possible modifications within the approved management structure.
Risk Management in Portfolios, Programs, and Projects: A Practice Guide (2024)	Ensuring consistency in risk management across portfolio, programme and project levels to achieve strategic objectives.	High – the relationships between management levels are described in detail.	Medium – clear requirements for documenting each risk management process.	High – easily adaptable to most industries where risk management is not directly regulated.
NIST Special Publication 800-37 (National Institute of Standards and Technology, 2018)	Integration of information security risk management into the IT system lifecycle.	High – clear stages, control measures and audit requirements.	Very high – strict documentation and compliance with state standards.	Low – limited possibility of modification due to its regulated nature.
FAIR (n.d.)	Quantitative assessment of information risks in financial units for making economically sound decisions.	High – detailed models for calculating frequency and loss values are described.	Medium – requires data collection, but not strict formalism.	High – easily adaptable to the industry, system or type of risk.
COSO ERM (n.d.)	Integration of risk management into corporate strategy to create added value by balancing risks and opportunities.	Medium – principles, components and interrelationships are described, without specific techniques.	Medium – requires customisation of processes.	High – suitable for adaptation to most sectors and business scales. At the same time, in contrast to most other methodologies, it does not mention the principles and process of adaptation.
NIST AI 100-1 (National Institute of Standards and Technology, 2023)	Improving the reliability, fairness, transparency and accountability of artificial intelligence systems.	High – defined and detailed functions for building a risk management culture and integrating it with other business processes, mapping, measuring and managing risks.	Medium – clear requirements for documenting each risk management process.	Medium (within a specific subject area) – created as a flexible framework for different types of AI solutions.
NIST AI 600-1 (National Institute of Standards and Technology, 2024)	Managing risks associated with generative artificial intelligence: content, copyright, bias, and data security.	High – detailed risk categories for generative models.	High – requires strict documentation of processes and control measures.	Medium (within a specific subject area) – adapts within the field of generative AI.
FAIR-AIR (2024)	Quantitative assessment of artificial intelligence risks, including ethical, social and reputational aspects.	Medium – general processes are defined without excessive detail on tools.	Medium – requires basic documentation and qualitative justification.	Medium (within a specific subject area) – flexible methodology adapted to any AI systems and industries.

Source: compiled by the author based on Committee of Sponsoring Organisations (n.d.), FAIR Institute (n.d.), Project Management Institute (2021), J.B. Copeland (2024)

The comparative analysis showed that all the risk management methodologies considered have a common goal, which is to create a systematic approach to identifying, assessing and controlling risks to increase the resilience of organisations to uncertainty. They are all based on a process approach that includes the stages of risk identification, analysis, response and monitoring, ensuring continuous improvement of management practices. In addition, each methodology integrates risk management into the overall corporate or project management system and considers risk as a factor that can have both a negative and positive impact on the achievement of strategic goals.

At the same time, there are significant differences between the methodologies that determine their scope of application and the depth of procedure development. ISO 31000:2018 is distinguished by its high level of versatility and fundamental nature, as it emphasises not specific tools but general risk management principles, making it suitable for any organisation, including IT companies. PMBoK is characterised by a high degree of detail, while the PRINCE2 methodology is characterised by a high level of formalisation and a clear distribution of roles and responsibilities, which ensures transparency in risk management, especially in large IT projects or government structures. NIST Special Publication 800-37 has a strong technical focus and was developed primarily to ensure cybersecurity and information system risk management (National Institute of Standards and Technology, 2018). Its normative nature makes this approach particularly effective for the public and corporate sectors, where compliance with security standards is required.

COSO ERM, in turn, is a principle-based methodology that covers risk management at the strategic level of an organisation, creating a foundation for building a corporate risk management culture, but it needs to be adapted for practical use in the IT field. FAIR and FAIR-AIR are risk management methodologies that focus on quantitative risk assessment. FAIR can be used to express risks in financial terms, which is beneficial for the justification of investment decisions in business activities. FAIR-AIR is an extension of the basic FAIR model and is used to assess risks associated with artificial intelligence, including algorithmic, ethical and systemic risks, while maintaining a quantitative approach and enabling the economic value of the potential consequences of risks to be assessed. NIST AI 100-1 and NIST AI 600-1 are a separate category, representing methodologies for managing risks associated with the development and application of artificial intelligence systems (National Institute of Standards and Technology, 2023; 2024). While NIST AI 100-1 is a universal framework for building systematic risk management in AI, NIST AI 600-1 is its profile, specially adapted to generative artificial intelligence and aimed at managing the risks of transparency, bias, reliability and cybersecurity.

In the context of IT projects, the choice of risk management system should be based on the suitability of the methodology to the level of decision-making and the characteristics of the organisational environment. At the strategic level, it is possible to use ISO 31000:2018 and COSO ERM as tools that set out the general principles of integrated risk management, but the assumption of their increased effectiveness needs further verification. At the project level, any of the methodologies considered in the study can be effective, as their usefulness is determined by the specific conditions of the project implementation. NIST Special Publication 800-37 focuses on ensuring an adequate level of information security (National Institute of Standards and Technology, 2018). FAIR, along with the other methodologies mentioned, also supports quantitative risk assessment and uses common tools, such as Monte Carlo modelling; at the same time, its advantage lies in its systematic structure for the financial interpretation of risk indicators and the justification of the economic feasibility of management decisions. Finally, NIST AI 100-1, NIST AI 600-1 and FAIR-AIR are crucial in implementation of artificial intelligence technologies, as they cover the specifics of the subject area. Based on the characteristics of individual methodologies, it is proposed to consider an integrated approach that provides comprehensive risk management, from the strategic level to specific digital systems and algorithms, creating a reliable foundation for the sustainable development of IT organisations.

Assessment of high-level characteristics of risk management methodologies in IT projects

The practical application of modern risk management methodologies demonstrates that organisations can combine several approaches depending on their field of activity, IT environment structure, and level of regulatory complexity. In this context, ISO 31000:2018 serves as a universal framework for shaping organisational culture, establishing procedures for identifying, assessing and treating risks, and ensuring coordination between departments. The practical strength of this methodology lies in its ability to provide a universal assessment of existing risks and ensure strategic alignment, which is particularly useful for organisations with complex structures or a high degree of IT dependency. At the same time, the main limitation of ISO 31000:2018 is its generality: the methodology describes principles but does not contain detailed instructions for implementing processes. This forces organisations to either develop internal processes or turn to other, more organised and detailed methodologies.

An example of such a methodology is PMBoK, which provides structured risk management within projects. In practice, framework approaches are effectively applied where it is necessary to document risks, track their impact on deadlines, budget or quality, and coordinate interaction between different teams. The strength of this methodology is its systematic nature, which makes it possible to formalise processes and integrate risk management into the project life cycle. However, given the rise of agile development approaches, excessive formalisation can hinder teams working in highly dynamic environments. In such cases, it is advisable to adapt the application of PMBoK by reducing the amount of documentation and emphasising the role of regular communication and short risk review cycles.

Risk Management in Portfolios, Programs, and Projects delves deeper into the domain of uncertainty in project management and expands the scope to include programme and portfolio management (Project Management Institute, 2024). At the same time, the methodology focuses primarily not on scaling as simply the ability to cover a larger object, but on building a multi-level, holistic

corporate risk management system. The methodology reveals in detail the interrelationships between risk management levels, sets a clear framework of duties and responsibilities, and describes in detail the principles of effective interaction within and between levels. This ensures the complete versatility of the methodology in terms of its scope of application: it can be applied at the level of an individual project, programme or business unit, or it can be used as the basis for a corporate risk management system. The key challenge in implementing the methodology is the high requirements for corporate culture and maturity.

PRINCE2 (6th edition) can also be used to ensure the controllability of large projects, especially where strict change control and a clear accountability system are required. The practical advantage of the methodology is that it ensures transparency of decisions and predictability of results, which is relevant for IT initiatives in the public sector or in large transformation programmes. At the same time, the rigidity of PRINCE2 can be an issue in fast innovation cycles, where the focus of stakeholders shifts from controllability of the environment to speed and adaptability. In the field of information security, NIST Special Publication 800-37 is widely used in practice, enabling organisations to align their IT systems with industry and international standards (National Institute of Standards and Technology, 2018). The advantage of this methodology is its ability to ensure formalised compliance. However, the complexity and resource intensity of NIST Special Publication 800-37 can be an obstacle for organisations that do not have a developed information security function. To reduce the burden, it is recommended to apply NIST RMF selectively, focusing first on the most critical systems and then scaling the process to all IT assets.

Factor Analysis of Information Risk (FAIR) focuses on quantitative risk modelling and assessing the economic feasibility of response measures. Its key strength is its emphasis on financial consequences, which can be used for informed investment decisions. FAIR is widely used to model potential losses, assess the probability of incidents, and determine the optimal level of investment in response measures. At the same time, FAIR is dependent on quality data: the model operates at its highest efficiency when an organisation has sufficient historical and statistical data or can provide a correct assessment.

COSO ERM addressed the creation of a corporate risk management system, but in contrast to the PMI's framework, it focuses primarily on this level. This complicates the targeted implementation of the methodology locally at the level of individual projects. At the same time, COSO ERM can be cumbersome for organisations that do not have mature strategic management mechanisms. To overcome this, it is recommended to start with individual components of COSO ERM, such as the process of determining risk appetite or integrating risks into the budget cycle, gradually expanding the scope of application.

In the field of artificial intelligence, the latest frameworks NIST AI 100-1, NIST AI 600-1, and FAIR AIR provide practical mechanisms for controlling risks associated with incorrect predictions, generative system failures, or data leakage risks. Their competitive advantage is their specialisation in a specific, narrow field with in-depth disclosure of the specifics of working with its risks. The limitation is their relative novelty: organisations do not yet have established practices for effectively protecting artificial intelligence systems. It is recommended to start implementing the methodology with use-case profiles, which can be used to adapt requirements to specific AI systems.

During the theoretical comparison of the characteristics of the methodologies used, it was assumed that different approaches may have complementary strengths: ISO 31000:2018, due to its "lightness" and lack of formalisation, is well suited for forming general policies and principles of risk management at different levels of the organisation, PMBoK and PRINCE2 ensure operational discipline, PMI Risk Management in Portfolios, Programs and Projects provides tools for correct process scaling, NIST RMF ensures compliance with regulatory requirements and the highest standards, FAIR provides "light" and adaptive tools to improve the quality of management decisions based on quantitative risk assessment. COSO ERM builds flexible processes and principles for building a corporate risk management system, and the extension of some of these frameworks (NIST RMF, FAIR) can be adapted to the specific challenges of artificial intelligence systems. However, these conclusions are hypothetical and require empirical confirmation in different organisational contexts.

DISCUSSION

The key task of the study was to conduct a comparative analysis, which resulted in conclusions about the characteristics, strengths and weaknesses of individual risk management methodologies. The idea presented in the study regarding the need to compare and contextualise methodologies has been confirmed in previous studies, by B. Metin *et al*. (2024), arguing that objective risk assessment in the field requires analysis of information relating to business requirements, human factors and safety culture in the organisation. The ideas expressed by B. Metin *et al*. correlate with the theoretical comparison of the characteristics of methodologies presented in this study and the emphasis on the fact that each of them has both strengths and weaknesses in the context of risk management in IT projects. B. Teslim (2023) considered the idea that the effectiveness of risk identification and analysis is enhanced using artificial intelligence tools that facilitate rapid data collection and processing. Based on data obtained from 360 IT professionals, S. Kalogiannidis *et al*. (2024) concluded that AI-based data analysis and its integration into incident response planning improve risk assessment and support business continuity in an environment where enterprises face risks such as natural disasters, cyber-attacks, or economic fluctuations.

The presented study also considered the idea that the choice of risk management methodologies and standards largely depends on the context in which they are used. The idea of contextually determined choice of risk management methodologies was also confirmed in the study by I. Aswat & A. Carolin (2024). Experts noted that to improve the effectiveness of risk management, companies should further determine the needs and specifics of individual economic segments. This opinion partly correlates with the results of the study, but the difference lies in its different analytical focus. In contrast to I. Aswat & A. Carolin, who studied the accounting services sector, presented a study that analysed risk management methodologies in the IT segment.

A. Harju *et al*. (2024) analysed the risks arising for financial institutions when purchasing IT services, emphasising the specifics of the interaction between the financial sector and technology solution providers. This connection confirms the idea put forward in the work that the effectiveness of risk management methodologies and standards in the IT sphere largely depends on a detailed analysis of the context of their application and adaptation to the specifics of the project environment. A partial correspondence was also found between this work and the study by Y. Xu *et al*. (2024), which analysed the origins, connections and differences in the interpretation of risks in different disciplines and segments. The existence of such differences partly confirms the idea presented in this paper that context determines the assessment of risks and the choice of approaches to their minimisation. However, the correspondence is incomplete in the context of the relatively narrow scope of the presented study. Based on an analysis of the strengths and weaknesses of the most commonly used risk management methodologies, the paper considered the need for an integrated approach to risk management. This view has been confirmed in previous studies, for example, by D. Yuniarto & A.B.A. Rahman (2025). The thematic analysis of 61 scientific works presented by these researchers identified three groups of factors for the effective implementation and minimisation of risks in IT projects: support from the organisation's management, cross-functional cooperation, and risk-aware decision-making.

The results of the analysis indicate the feasibility of applying risk management methodologies in IT projects, particularly in the context of software development, to improve process control and timely identification of potential risks. After examining various risk minimisation and management strategies, O.T. Adebayo (2024) concluded that a proactive approach to threat management is effective. The study emphasised that risk management in the early stages of a project can ensure a timely response to potential threats. The general stages of risk management identified in the comparative analysis provide a basis for its implementation. The importance of early risk identification as an effective risk management strategy was also confirmed in the work of G. Kanyongo & N. Wadesango (2025). In contrast to the presented study, G. Kanyongo & N. Wadesango addressed cybersecurity risks. A high level of correspondence was also found between the presented study and the work of V.S. Balasubramaniam *et al*. (2023), in which the identification of risks in the early stages of the project life cycle was considered a substantial factor in the effectiveness of risk management in the field of IT. Overall, numerous similarities were identified between this study and previous works, suggesting the relevance of the chosen topic and the feasibility of further research. The contribution of this work to the existing academic discourse lies in its attempt to systematise and compare international methodologies and standards for risk management in the field of IT. A systematic analysis can be beneficial in managing new and existing risks in one of the most dynamic segments of the economy.

CONCLUSIONS

A comparative analysis revealed that methodologies differ in their level of detail. For example, ISO 31000:2018 has a high level of versatility, while PMBoK and Risk Management in Portfolios, Programs, and Projects: A Practice Guide are characterised by a higher degree of detail, focusing on risk management within the life cycle of projects, programmes, and portfolios. Key features of different risk management methodologies that may influence the choice of approach were also identified: PRINCE2 is characterised by a high level of formalisation, NIST RMF has a pronounced technical focus, COSO ERM is oriented towards building a risk management system in an organisation, while FAIR and FAIR-AIR provide structured quantitative risk assessment tools, which, however, are also used in many other methodologies.

The comparative analysis also revealed key features of NIST AI 100-1 and NIST AI 600-1, which are risk management methodologies for IT systems based on artificial intelligence. The limitations of the study are the theoretical scope and the need for further verification of the proposed strategies in the context of individual companies or projects. In future research, the use of empirical data collection tools, such as surveys, experiments, or statistical analysis, is recommended to support the above statements.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

REFERENCES

[1] Adebayo, O.T. (2024). Project risk management strategies: Best practices for identifying, assessing, and mitigating risks in project management. *IRE Journals*, 7(10), 371-381.

[2] Albasyouni, W., Kamara, J., & Heidrich, O. (2025). Key challenges and opportunities to improve risk assessments in the construction industry. *Buildings*, 15(11), article number 1832. doi: 10.3390/buildings15111832.

[3] Aswat, I., & Carolin, A. (2024). The role of information technology in risk management in the service sector (case study on accounting serviced firms in Pontianak). In *The 5th Asia-Pacific management research conference: "Adapting sustainability strategies in business and management"* (pp. 65-73). Pontianak: PPM School of Management. doi: 10.2478/9788367405850-007.

[4] Balasubramaniam, V.S., Mahadik, S., Khair, A., Goel, O., & Jain, A. (2023). Effective risk mitigation strategies in digital project management. *Innovative Research Thoughts*, 9(1), 538-567. doi: 10.36676/irt.v9.i1.1500.

[5] Committee of Sponsoring Organizations. (n.d.). *Guidance*. Retrieved from https://www.coso.org/guidance-erm.

[6] Copeland, J.B. (2024). *A FAIR artificial intelligence (AI) cyber risk playbook*. Retrieved from https://www.fairinstitute.org/blog/fair-artificial-intelligence-ai-cyber-risk-playbook.

[7] FAIR Institute. (n.d.). *What is FAIR?* Retrieved from https://www.fairinstitute.org/what-is-fair.

[8] Harju, A., Schaëfer, K., Hallikas, J., & Kähkönen, A.-K. (2024). The role of risk management practices in IT procurement: A case study from the financial services industry. *Journal of Purchasing and Supply Management*, 30(2), article number 100899. doi: 10.1016/j.pursup.2024.100899.
[9] IEC 31010:2019. (2019). *Risk management – risk assessment techniques*. Retrieved from https://www.iso.org/standard/72140.html.
[10] ISO 31000:2018. (2018). *Risk management – guidelines*. Retrieved from https://www.iso.org/standard/65694.html.
[11] Kalogiannidis, S., Kalfas, D., Papaevangelou, O., Giennarakis, G., & Chatzitheodoridis, F. (2024). The role of artificial intelligence technology in predictive risk assessment for business continuity: A case study of Greece. *Risks*, 12(2), article number 19. doi: 10.3390/risks12020019.
[12] Kanyongo, G., & Wadesango, N. (2025). Impact of cybersecurity on risk mitigation strategy by commercial banks in emerging markets: A legal perspective case study. *Corporate Law & Governance Review*, 7(1), 28-37. doi: 10.22495/clgrv7i1p3.
[13] Metin, B., Duran, S., Telli, E., Mutlutürk, M., & Wynn, M. (2024). IT risk management: Towards a system for enhancing objectivity in asset valuation that endangers a security culture. *Information*, 15(1), article number 55. doi: 10.3390/info15010055.
[14] Mohylna, L., & Vorobiov, I. (2024). Risk management of innovation and investment projects of an enterprise. *Economy and Society*, 66. doi: 10.32782/2524-0072/2024-66-130.
[15] National Institute of Standards and Technology. (2018). *NIST Special Publication 800-37. Revision 2. Risk management framework for information systems and organizations: A system life cycle approach for security and privacy*. Gaithersburg: National Institute of Standards and Technology. doi: 10.6028/NIST.SP.800-37r2.
[16] National Institute of Standards and Technology. (2023). *NIST AI 100-1. Artificial intelligence risk management framework (AI RMF 1.0)*. Gaithersburg: National Institute of Standards and Technology. doi: 10.6028/NIST.AI.100-1.
[17] National Institute of Standards and Technology. (2024). *NIST AI 600-1. Artificial intelligence risk management framework: Generative artificial intelligence profile*. Gaithersburg: National Institute of Standards and Technology. doi: 10.6028/NIST.AI.600-1.
[18] Nazarova, K., Parasii-Verhunenko, I., & Ostapets, A. (2023). Risk classification of IT industry companies. *Fruitful Knowledge*, 150(4), 120-137. doi: 10.31617/1.2023(150)08.
[19] PRINCE2. (n.d.). *PRINCE2® project management training*. Retrieved from https://www.prince2.com/eur/training/prince2?gad_source=1&gad_campaignid=22511484150&gbraid=0AAAABtHwdhs6aOdaoOdD17jgmG-DY-sU&gclid=Cj0KCQiArt_JBhCTARIsADQZaynyEP_2nY1VLht5VLZO1zIfy_CfcJybjkdcfkZll2ymv-It_OKPrpYaAlDgEALw_wcB.
[20] Project Management Institute. (2021). *A guide to the project management body of knowledge PMBoK® guide*. Newtown Square: Project Management Institute.
[21] Project Management Institute. (2024). *Risk management in portfolios, programs, and projects: A practice guide*. Newtown Square: Project Management Institute.
[22] Selvakumar, J.J., Suganya, G., Arthi, T.S., & Pachiyappan, S. (2024). Does risk management components influence on project success? Evidence from IT sector. *Journal of Project Management*, 9, 269-276. doi: 10.5267/j.jpm.2024.4.001.
[23] Tak, A., & Chahal, S. (2024). Risk management in agile AI/MI projects: Identifying and mitigating data and model risks. *Journal of Technology and Systems*, 6(3), 1-18. doi: 10.47941/jts.1824.
[24] Teslim, B. (2023). *Risk assessment in information security using AI: Utilizing predictive insights and threat modeling*. Retrieved from https://www.researchgate.net/publication/385746438_Risk_Assessment_in_Information_Security_Using_AI_Utilizing_Predictive_Insights_and_Threat_Modeling.
[25] Testorelli, R., Tiso, A., & Verbano, C. (2024). Value creation with project risk management: A holistic framework. *Sustainability*, 16(2), article number 753. doi: 10.3390/su16020753.
[26] Xu, Y., Reniers, G., & Yang, M. (2024). A multidisciplinary review into the evolution of risk concepts and their assessment methods. *Processes*, 12(11), article number 2449. doi: 10.3390/pr12112449.
[27] Yuniarto, D., & Rahman, A.B.A. (2025). Critical success factors for IT risk management in the digital transformation era: Insights from multiple case study. *Applied Information System and Management*, 8(1). doi: 10.15408/aism.v8i1.41090.
[28] Ziuziun, V.I., & Liashenko, D.O. (2025). Conceptual risk management model for the development of an online platform for high-value goods. *Collection of Scientific Works of NUK,* 1, 137-143. doi: 10.15589/znp2025.1(499).19.

Огляд методологій та стандартів управління ризиками в IT-проєктах, програмах та портфелях

Микита Савченко
Магістр, асистент
Державний торговельно-економічний університет
02156, вул. Кіото, 19, м. Київ, Україна
https://orcid.org/0009-0004-9754-748X

Анотація. Метою дослідження була систематизація наявних методологій управління ризиками та визначення теоретичних положень щодо їх потенційної придатності для IT-проєктів. Для досягнення поставленої мети був використаний метод компаративного аналізу та теоретичної оцінки високорівневих характеристик методологій управління ризиками в IT-проєктах. Компаративний аналіз дозволив виявити особливості найбільш часто уживаних методологій управління ризиками: ISO 31000:2018 характеризується високим рівнем універсальності; Project Management Body of Knowledge (PMBoK) та Risk Management in Portfolios, Programs, and Projects: A Practice Guide мають високий ступінь деталізації; Projects IN Controlled Environments (PRINCE2) носять формальний характер, а Enterprise Risk Management (COSO ERM) – концептуальний; Factor Analysis of Information Risk (FAIR) та Factor Analysis of Information Risk – Artificial Intelligence Risk (FAIR AIR) посилено фокусують увагу на використанні кількісних інструментів оцінювання ризиків; а «NIST Special Publication 800-37. Revision 2. Risk Management Framework for Information Systems and Organizations: A System Life Cycle Approach for Security and Privacy», «NIST AI 100-1. Artificial Intelligence Risk Management Framework (AI RMF 1.0)» та «NIST AI 600-1. Artificial Intelligence Risk Management Framework: Generative Artificial Intelligence Profile» забезпечують управління ризиками в проєктах, які базуються на використанні штучного інтелекту. Результати компаративного аналізу та дослідження особливостей практичного застосування окремих методологій можуть бути використані для обрання оптимальної методології в конкретному контексті

Ключові слова: цифрова трансформація; аналіз; моніторинг; контроль; програмне забезпечення

ISSN 2413-9610, E-ISSN 2663-2365 Journal homepage: https://devma.com.ua/en

DEVELOPMENT MANAGEMENT

UDC 339.923:061.1ЄС
DOI: 10.63341/devt/4.2025.57

Vol. 24, No. 4. 2025

Some aspects of the functioning of the European integration mechanism of public management of territorial development

Eduard Syromolot*
Postgraduate Student
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0009-0006-0118-4237

Nataliia Gavkalova
Doctor of Economics, Professor
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0000-0003-1208-9607

Abstract. The aim of the article was to study the history of the formation of the European Union cohesion policy through the identification and formulation of the European integration mechanism of public management of territorial development to ensure the effective participation of communities and regions of Ukraine in modern European integration processes of transition to functional territoriality as the basis of modern EU cohesion policy in the aspect of its functional territoriality and transition to a new model of territorial development "functional community – functional region – functional state". Steps to create a new territorial model for managing the European Union's structural funds in Ukraine by regional policy entities were proposed. These steps encompass the identification of geographical functional ties between regional policy entities that shape a new territory of cooperation going beyond the boundaries of existing administrative-territorial units and forming a new subject of regional policy formation. It implies a functional type of territories with the formation of a new database for programming socio-economic processes of development of local governments in conformity with the objectives of the updated state strategy for regional development of Ukraine. In consonance with the best European experience of seeing regions as a living laboratory for the development of territorial cooperation, measures were recommended to create a living laboratory for the development of the territories of communities of Slobozhanshchyna to develop a mechanism and tools to support functional types of territories at the level of the city of Kharkiv and the Kharkiv Region. There are also further arrangements to create the Kharkiv agglomeration, the Slobozhansk microregion of territorial cooperation and the Dergach subregion. These arrangements and initiatives were addressed publicly within the framework of the annual International Scientific Conference "Economic Development and the Legacy of Semen Kuznets" in 2024 and 2025

Keywords: territorial cohesion; territorial disparities; integrated interaction; intergovernmental management; process improvement; communities and regions

INTRODUCTION

A new modern challenge for the functioning of the state management system of regional development in Ukraine is the transition to a new investment model of territorial development management and entry into the European system of developing a territorial cohesion policy, which is aimed at overcoming existing territorial disparities and inequalities through targeted financial support from the European Union structural funds in order to achieve

Article's History: Received: 18.07.2025; Revised: 20.11.2025; Accepted: 23.12.2025; Published: 12.01.2026

Suggested Citation:
Syromolot, E., & Gavkalova, N. (2025). Some aspects of the functioning of the European integration mechanism of public management of territorial development. *Development Management*, 24(4), 57-71. DOI: 10.63341/devt/4.2025.57.

*Corresponding author

harmonious and balanced development of various functional types of territories. As stated by researcher V. Mogyl (2023), Ukraine, as a democratic and legal young state, is gradually implementing a foreign economic course for integration into the European Union, which remains a powerful global socio-economic and political centre. Scientists A. Soloviova & A. Fomin (2025) analysed the obstacles to Ukraine's membership in the European Union and focused on the essence of cohesion policy in overcoming territorial disparities of regions in the European Union for balanced and harmonious development, through investment in infrastructure, education, and innovation in the member states of the European Union, which is a critical stage of its development and expansion, promoting convergence and an example of the benefits of integration.

As argued by V. Kravtsiv & I. Storonyanska (2025), current trends and risks of spatial shifts in the economy of Ukraine in the context of hostilities have led to the highest rates of economic decline since Ukraine gained independence in 1991. The scientists assessed three ambitious tasks of updating the state strategy of regional development of Ukraine based on the introduction of a territorial approach, adopted in 2024, including tasks to define goals and management decisions for individual functional types of territories to form a territorial model of attracting funding from various sources for the implementation of projects for the restoration and reconstruction of the socio-economic development of Ukraine. The authors provided specific proposals in the context of regional development and ensuring Ukraine's capacity to use Ukraine Facility funds at the national, regional and local levels.

Researchers A. Paasi *et al*. (2022) achieved crucial conclusions for understanding the essence of the existence of functional types of territories, namely that territory, borders, and boundaries are not exclusively a state and territorial phenomenon. These concepts are ideas that are formed and take shape only in practice, in contrast to the traditional political and geographical definition of the concept of an administrative and territorial unit. Researcher O. Olkowska (2023) analysed the Polish law adopted in 2014, which establishes the rules for the implementation of cohesion policy programmes, the entities participating in the implementation of these programmes, and the method of cooperation between these entities. It covers two main areas: the rules for the implementation of programmes and cohesion policy, as well as the management and control system for the distribution of European Union funds. K. Jánošková (2024) interpreted the relationship between the use of European Structural and Investment Funds on economic indicators in Slovakia, namely, minor changes in gross domestic product and unemployment, which is a criterion for assessing the territorial impact of European integration policy on the example of Slovakia, which is also a direction of promising Ukrainian research on the topic of predicting socio-economic changes from participation in European Union programmes.

M. Bartůněk & P. Marek (2025) stressed the importance of new regional geography and the use of various data collection methods for studying the territorial identity of the region. The article analyses 76 studies of the territorial identity of regions obtained using the snowball method and targeted search on the Web of Science. The paper focuses on the use of secondary data sources, namely literature with spatial information, maps, census data, toponym databases, etc., which provide indirect, expert/governmental indicators for determining the boundaries of the functional type of territories. Researchers I. Zalodska *et al*. (2025) considered the basis for the post-war restoration of the territories of Ukraine to be the creation of a model for the reconfiguration of the administrative-territorial structure of Ukraine, namely for Donetsk, Luhansk, Zaporizhia, Kharkiv, and Kherson regions using three criteria for community capacity, namely population size, number of students and share of working-age population, understanding that communities in the indicated territories will not be able to independently replenish community budgets. M. Karpa *et al*. (2023) substantiated the theoretical provisions on the definition of "territorial development" as an essential characteristic of regional development and the relevance of developing a territorial development strategy for planning long-term socio-economic development of the regions of Ukraine. The focus is on the creation of networks of cooperation, public authorities, companies, universities and public organisations to create medium-term territorial development strategies is an important political step in regional development.

Researchers N. Kutsmus *et al*. (2025) considered the impact of the European Union's cohesion policy on achieving the UN Sustainable Development Goals from the point of view of the political creation of the European Union and achieving high indicators of the level of economic development, highlighting that it is aimed at levelling economic and social differences between the member states of the European Union, and as such requires further action in the context of its improvement and conducting broad political discussions and discussing the implementation of its priorities. At the same time, the issue of studying the role of functional types of territories as drivers of territorial renewal and development, researching the functioning as new subjects of regional policy and public management of territorial development of the European Union in the introduction of better procedures for the preparation, management, monitoring, and control of programmes and projects of the European Structural Funds from the point of view of studying the mechanism of functioning of territorial cohesion policy, which is constantly being improved in the process of implementing European integration policy, remains unexamined. Therefore, the purpose of the study was to determine the essence of modern European integration policy, namely the functioning of the European integration mechanism of public management of territorial development, the object of which is functional types of territories, which have become full-fledged subjects of developing a European integration policy of territorial cooperation, taking into account the experience of the EU cohesion policy and modern challenges facing the regions of Ukraine.

MATERIALS AND METHODS

The proposed study analysed the source base of regulatory documents and studies that form and investigate the policy of territorial cohesion of the EU and regional development of Ukraine. Structural and functional analysis was used to study the methodology for forming the policy of territorial cohesion of the EU and the policy of regional

development of Ukraine, as a modern European integration process of synchronisation and harmonisation of these policies, comparative analysis methods were used to determine the types of functional territories as areas of public management of territorial development, and modelling methods were used to build a conceptual strategy for creating functional territories as a new territorial model for managing EU funds. The comparative analysis method was used to compare European standards for identifying functional territories with the norms of current legislation of Ukraine. The analysis process involved determining common features that define the self-sufficiency of territories within the framework of cohesion policy. By systematising the results obtained, an author's classification was formed, which is based on five groups of criteria covering critical areas of public management of territorial development. The systematisation method allowed structuring the collected data into a hypothesis about the functioning of the European integration mechanism of public management of territorial development, which is constantly being improved and contributes to the formation of a modern policy of development of functional territoriality. The historical method was also used to describe the stages of the formation of European integration policy.

The source base of the study was an array of regulatory legal acts of the European Union and the legislation of Ukraine in the field of decentralisation and regional development. 25 strategic documents and 19 scientific works indexed in the Scopus and Web of Science databases were selected for analysis. The selection criteria were: relevance to the topic of European integration, focus on territorial development, and practical significance for the transformation of public administration in conditions of war and recovery. The analysis of the primary sources of the formation of Ukraine's European integration policy (Association Agreement…, 2014) allowed focusing attention on a critical dimension of Ukraine's European integration obligations in the field of regional development, setting out in Article 446, namely the accent on studying the methods of forming the European Union's regional policy in the context of the development of backward territories and territorial cooperation; strengthening cooperation with the participation of socio-economic entities.

The synthesis was used to combine the results of the analysis of the primary source base of regulatory documents, scientific sources, international reports and statistical data, which allowed identifying the main trends and patterns in highlighting and considering modern priorities and trends of the common administrative space for the formation of regional development policies of Ukraine and territorial cohesion of the European Union. Structural and functional analysis of the methodology for the formation of functional types of territories (Integrated territorial investments…, 2019), as a modern component of European policy (Functional territories…, 2023), allowed these functional types to be identified (Functional areas in the EU, n.d.), as subjects of regional policy management and a territorial model for managing the financial assets of the structural funds of the cohesion policy of the European Union.

The modelling method was used as a task for monitoring and evaluating the implementation of the regional policy of Ukraine (Law of Ukraine No. 156-VIII, 2015). It highlighted the focus on developing programmes and projects for functional types of territories through the creation of special mechanisms for the state support. This support was based on building a new socio-economic database for functional regions for devising regional and local strategies aimed at developing functional types of territories. These approaches should be considered in the context of experimental management of regional development (Recommendations for policy…, 2022) and conducting laboratory modelling predictions (EU border regions…, n.d.), as a component of the modern European policy for the development of functional types of territories, based on the theoretical, methodological and practical experience of the development of European territorial cooperation.

Given the systematisation of the provisions of the report on regional policy of Ukraine (Report on the results…, n.d.), the report of the European Commission (Commission staff working document, 2024) and the Territorial Agenda 2030 (2020), a three-level model of management of functional types of territories in Ukraine was proposed, namely "functional community-functional region-functional state". In light of the analysis of the totality of data on the functioning of the policies of territorial cohesion of the European Union and regional development of Ukraine, a vision of a European integration mechanism of public management of the development of territories was recommended for local governments of Ukraine to increase the administrative potential and capacity in creating a modern territorial model of management of the funds of the European Union structural funds.

RESULTS

The modern European integration process of synchronisation and harmonisation of regional development policies of Ukraine and territorial cohesion of the EU

The functioning of the EU has three major stages of the formation of European integration policy, namely the process of the creation, development, and enlargement of the EU (Consolidated Versions…, 2016). Within these stages, there was a constant improvement of the European integration mechanism of public management of territorial development based on unchanged institutional principles to reduce uneven development of territories, support the outermost regions and eliminate regional imbalances through the development of policies and thematic actions, on the one hand, and on the other hand, ensuring the implementation of support for territorial cohesion through the proper functioning of the EU structural funds, which are the main financial instruments for achieving harmonious, balanced and sustainable development of EU territories.

The current processes of updating the regional policy of Ukraine are formed on the basis of identifying the challenges of regional development of Ukraine (Resolution of the Cabinet of Ministers of Ukraine No. N 587, 2002), in the list of which it is necessary to identify a new challenge regarding the ability of the regional development management system of Ukraine to adapt to the practice of functioning of the EU territorial cohesion policy. It is possible through the formulation of tasks and the best management solutions of the modern European integration process for the synchronisation and harmonisation of the regional

development policy of Ukraine and the territorial cohesion policy of the EU based on the definition of a common vision of the development features of the territories of Ukraine and the EU, namely in the context of supporting lagging territories through the development of territorial cooperation to reduce territorial differentiation, unlock the potential and increase the competitiveness of regions, territories of communities and regions, and the creation of special mechanisms for supporting and developing functional types of territories.

The legislator, characterising the above challenge, defines management measures in the context of creating a regulatory framework for the management of EU structural funds, which are defined in Articles 174 and 175 of the Treaty on the Functioning of the EU (Consolidated Versions..., 2016). The measures are determined through the formation of capable structures that will form a new territorial model of EU funds management at the regional and local levels, which is the basis for the formation of a common administrative space for interstate management of European integration with the identification of the modern European integration process of synchronisation and harmonisation of regional development policies of Ukraine and territorial cohesion of the European Union for the formulation and project identification of joint management decisions and actions at the national, regional and local levels of government of Ukraine.

As part of the dissertation research, relevant topics of regional development in Ukraine were identified, components of the European integration mechanism of public management of territorial development were defined (Table 1), based on the study of the history of the functioning of the EU territorial cohesion policy. It will contribute to the convergence of management systems of regional development policies in Ukraine and territorial cohesion in the EU, which will lead to the expansion of the participation of communities and regions of Ukraine in European projects through the creation of a system of support for the development of functional types of territories at the local and regional levels of government in Ukraine.

Table 2. Components of the European integration mechanism of public management of territorial development

Name	Characteristic
European integration mechanism for interstate management of territorial development	It is created on the basis of the concluded EU agreements: Treaties of Rome, Treaty of Brussels, Treaty of Maastricht, Treaty of Amsterdam, Treaty of Nice, Treaty of Lisbon. Ensuring the functioning: EU structural funds. Multiannual financial programmes. Resolutions of the Conference of Ministers of the Council of Europe responsible for spatial/regional planning (CEMAT). Practice of the Centre of Expertise on Good Governance of the Council of Europe
European integration process of territorial development management	Synchronisation and harmonisation of regional development and territorial cohesion policies
The object of territorial development management policy	Features of uneven development of territories, functional types of territories based on common interests with jurisdiction beyond administrative-territorial units in the system of regional development management and territorial cohesion policy
Prioritising political goals of territorial development management	The management process of policy development for determining priorities for interstate management of European integration based on the identification of challenges and the formulation of territorial development objectives
Principles of functioning and improvement of territorial development management	Multilateralism and good governance, multilevel governance and partnership. Improvement through the creation of databases on standards, tools, best practices and research on territorial development management
Integrated territorial investments	Financial instruments aimed at harmonious and balanced socio-economic development of various functional types of territories
Territorial development management	Includes: intergovernmental administration, national administration and public administration (regional and local) administration
Public management of territorial development	System of regional and local development management by functional types of territories, its synchronisation and harmonisation with the interstate and national levels of regional development management
Ecosystem approach in territorial development management	Identification of territorial development management systems in the context of the activities of government bodies at all levels, institutions, specialised organisations that are subjects and participants in the implementation of regional development and territorial cohesion policies
Public management toolkit for territorial development	A set of tools of the European integration mechanism of public management of territorial development, namely: methods of achieving political goals, management decisions, financial instruments, databases, best practices, regulatory legal acts, administrative agreements, etc.
Strategic planning for the development of functional types of territories	Development of mechanisms to support the development of functional types of territories at the local and regional levels of government for the implementation of public spheres of socio-economic and harmonious development of territories, taking into account the various features of territorial development. Formation of the three-level organisation of power "functional community – functional region – functional state", functioning of the territorial model of territorial development management
Conducting scientific research on territorial development management	The process of obtaining new data on the implementation of priorities for the European integration development of territories for the assessment and monitoring of the achievement of results of regional development and territorial cohesion policy
Laboratory modelling of territorial development	Introduction of management solutions and methods for simulation, analysis and forecasting of socio-economic processes of development of functional types of territories

Source: developed by the authors based on E. Syromolot & N. Gavkalova (2025)

Studying the functioning of the European integration mechanism of public management of territorial development will allow representatives of state authorities and local governments of Ukraine to acquire modern knowledge, skills, and competencies in the field of implementing the territorial cohesion policy of the European Union, namely, studying the essence of interstate and public management of territorial development, understanding the content of the European integration process of synchronisation and harmonisation of regional development and territorial cohesion policies, using the knowledge gained to create and strategically plan the development of functional types of territories based on good governance and multi-level governance, and developing tools for the support and development. It is necessary to reveal some aspects of the functioning of the components of the European integration mechanism of public management of territorial development. The problematic issues of the development of European integration are the focus of attention of many Ukrainian scientists. However, the transition of the state policy of regional development of Ukraine to the essence of the functioning of the policy of territorial cohesion of the European Union remains not yet sufficiently covered. This issue is of a general and directed disciplinary nature from the point of view of understanding the essence of European integration policy, and does not have a focus on determining the territorial impact on the development of effective policies and instruments for the development of territories. Meanwhile, there are expert analytical materials on the issues of regional development of Ukraine, raising these issues, but such materials do not provide a holistic view of the methods of developing and functioning of the policy of territorial cohesion.

Steps towards Ukraine's approximation to the standards of European policy in the domain of regional development are being formed in compliance with the recommendations of the European Commission's reports on the progress made by Ukraine in implementing the EU acquis (Chapters of the acquis EU, n.d.), among which the key one is Acquis 22. Regional policy and coordination of structural instruments of Cluster 5: Resources, agriculture and cohesion, which is an important component in the field of monitoring and evaluation of Ukraine's regional policy in the context of addressing the European integration challenge of Ukraine's regional development, namely the unpreparedness of the regional development management system for EU procedures and best practices (Resolution of the Cabinet of Ministers of Ukraine No. 695, 2025).

A vital focus of the development of territories in the EU is the prioritisation of European integration policy in the context of ensuring the development of functional types of territories that go beyond the existing administrative-territorial borders and directly influence the formation of the content of the EU territorial cohesion policy as the main investment policy of interstate management of European integration aimed at overcoming obstacles to the socio-economic development of territories (Integrated territorial investments…, 2019). A critical aspect of assessing the territorial impact and formulating directions for strategic planning of regional development of Ukraine in the context of implementing the provisions of the Association Agreement between Ukraine and the EU and monitoring the implementation of Ukraine's European integration policy are the reports of the European Commission on Ukraine's implementation of pre-accession obligations of the EU acquis, which determine European integration priorities and tasks for Ukraine's regional policy and provide up-to-date information on methods for developing regional development policy.

The Commission staff working document (2024) defines the primary understanding of EU regional policy as EU cohesion policy, which is the main instrument for reducing regional inequalities and investing in sustainable and inclusive socio-economic development. This approach coincides with the conclusions of the report that the State Strategy for Regional Development 2021-2027 should have specific practical steps that are provided with the necessary resources to develop the potential of territorial communities and regions through establishing links with European groups of territorial cooperation for integrated territorial management, participation in Interreg cooperation programmes, with focus on using the experience of implementing EU cohesion policy and practices of multi-level governance, programming, financial provision, project management at the local and regional levels of Ukraine.

The identification of three levels in the territorial development management system, namely intergovernmental management, national (state) management and public (regional and local) levels, is a comprehensive step in the justification of public territorial development management as a new theory of managing functional types of territories within the framework of the European integration process of synchronisation and harmonisation of regional development policies of Ukraine and territorial cohesion of the European Union with special emphasis on the geographical uniqueness and functioning of new subjects of regional development policy. The European experience of managing functional types of territories requires new applied thematic studies and timely examination and monitoring of the existing and new source base of the functioning of the territorial cohesion policy of the European Union.

Development of policy toolkit to support the development of functional types of territories

The use of an interdisciplinary approach in conducting research on the European territorial cohesion policy will allow studying its various aspects, which will ensure the effectiveness of the implementation of regional development policies at the local and regional levels of Ukraine through the application of the European integration mechanism of public management of territorial development and the creation of tools to support functional types of territories, which are modern drivers of balanced and harmonious development of the territories of the European Union. The latest priority in the regional policy of Ukraine remains the European integration task of developing functional types of territories, which are influential European integration actors in the field of forming and improving the EU territorial cohesion policy, and are participants in multiannual EU programmes.

Part of the Commission staff working document (2023) is devoted to the development of functional

types of territories. Focusing on the three-level system of strategic planning organisation, namely: "state-region-community", an assessment is given of the direction of the state regional policy of Ukraine in defining four functional types of territories:3 territories of renewal; – regional growth poles; – territories with special conditions for development; and territories of sustainable development, and a recommendation is made on the need to coordinate actions with the EU regional policy, including with the NUTS territorial classification (Nomenclature of Territorial Units for Statistics).

Recommendations for achieving administrative capacity through initiating the creation of an official coordination system in Ukraine to prepare for effective programming and management of EU funds with the participation of regional and local authorities of Ukraine will be an effective step in implementing practical management actions at the local and regional levels of government based on the study of European (Fig. 1) and Ukrainian practices of creating functional types of territories. It will be the basis for the formation of a new territorial model of a three-level organisation of government "functional community – functional region – functional state", proposed by E.A. Syromolot, which is not limited to the 4 functional types of territories identified in the state regional policy of Ukraine and creates conditions for the introduction of innovative experimental management of regional development and is provided with the necessary level of knowledge of the identified European integration mechanism of public management of territorial development (Table 1).

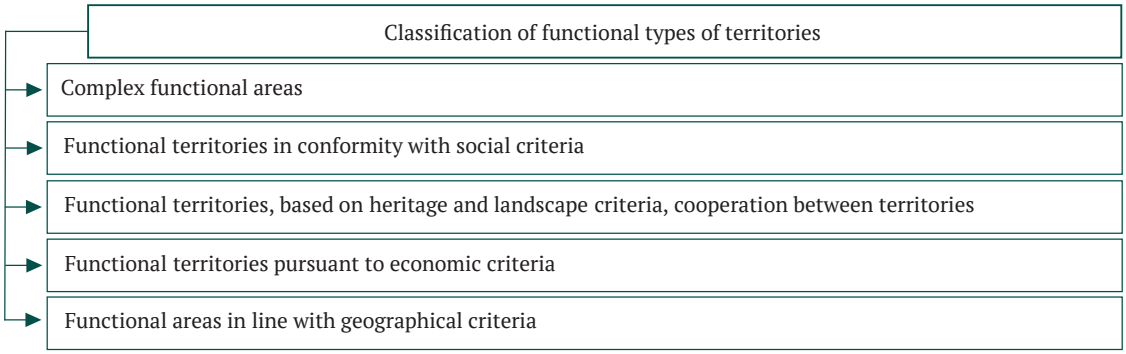

Figure 1. Classification of functional types of territories

Source: compiled by the authors based on the source Functional areas in the EU (n.d.)

The implementation of tasks to create functional types of territories in the city of Kharkiv and the Kharkiv Region is based on the experience gained. It requires standardisation and is the basis for implementing thematic actions, which are the basic management steps for forming the territorial cohesion policy of the European Union and forming the concept of developing a "functional community" and "functional region" in the city of Kharkiv and the Kharkiv Region (Fig. 2). The next step was to propose an experimental model of management of the development of functional types of territories in the city of Kharkiv and communities of the Kharkiv Region, as "functional communities" and "functional region", taking into account the existing experience of developing functional types of territories in the Slobozhanshchyna Region and an analysis of Ukrainian and European experience (Fig. 3).

Figure 2. Thematic actions for the development of functional types of territories in the city of Kharkiv and Kharkiv Region

Source: developed by the authors

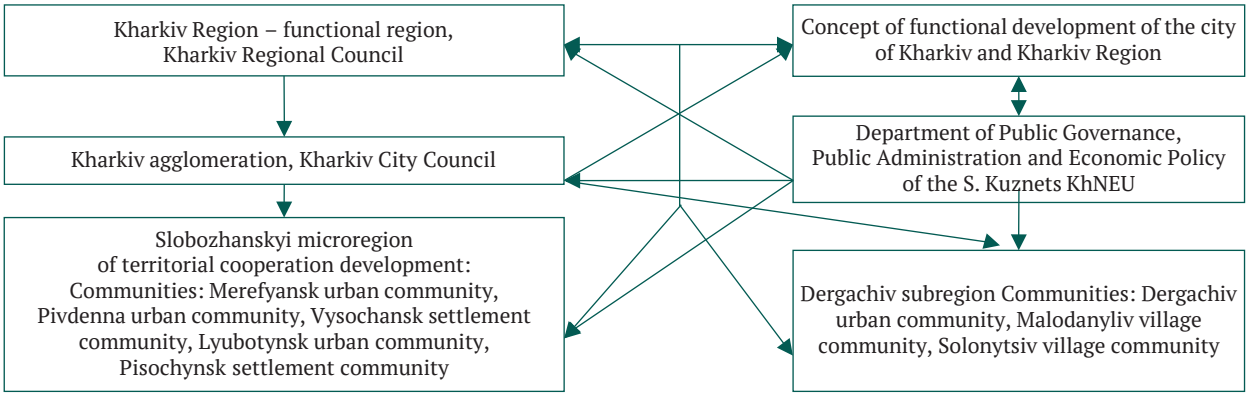

Figure 3. Experimental model of development management by functional types of territories in the city of Kharkiv and Kharkiv Region

Source: developed by the authors

As for the third level of governance, the "functional state", the following characteristics should be noted. Among the recommendations provided by the European Commission is a proposal to organise coordination with responsible stakeholders on the implementation of the State Strategy for Regional Development of Ukraine and its coordination with the process of recovery and reconstruction of the development of territories affected by the war, both at the level of Ministries and with the participation of representatives of local and regional authorities of Ukraine. There are also recommendations on the dissemination of information about Interreg programmes in Ukraine, among local and regional authorities to support the development of projects with possible new beneficiaries from Ukraine. In 2025, the Cabinet of Ministers of Ukraine established the Coordination Centre for Regional Restoration (Resolution of the Cabinet of Ministers of Ukraine No. 776, 2025) as a critical institutional body for coordinating the restoration of the regions of Ukraine. At the same time, it should be determined that the issues of monitoring and evaluating regional development from the point of view of approaching the standards of the EU territorial cohesion policy remain unresolved, complex and require the development of new organisational mechanisms for the territorial impact of the priorities of the European Union territorial agenda on the strategic planning of the development of the territories of communities and regions of Ukraine through the introduction of European practice of conducting experiments in the field of regional development management (Recommendations for policy..., 2022) and the implementation of the vision of the development of regions as living laboratories of European integration (EU border regions..., n.d.).

It should be noted that there is no practice of functioning of permanent organisational formats at the central level of government in Ukraine that would deal with issues of coordination of the development of territorial and cross-border cooperation, while various advisory and consultative, coordination councils, interdepartmental commissions, etc. functioned at different stages of development of regional policy of Ukraine. From the point of view of good practices in developing state policy in the field of Euroregion development in the period from 2002 to 2010, it is worth noting the activities of the Interdepartmental Commission on the Development of Cross-Border Cooperation and Euroregions established in 2002 (Resolution of the Cabinet of Ministers of Ukraine No. N 587, 2002), the activities of the Consultative and Advisory Council on the Development of Euroregions and Cross-Border Cooperation under the Ministry of Regional Development and Construction, and the establishment of the Assembly of Ukrainian Border Regions and Euroregions in 2010 (Ukraine's European integration process, 2010). This experience in developing policy in the field of Euroregion development and cross-border cooperation, as an example of good governance and multilateral cooperation, should be used to implement the experience of developing the territorial cohesion policy of the European Union at the local and regional levels of government of Ukraine. It is worth mentioning the importance of reports on the implementation of the territorial cohesion policy of the European Union. These reports are seen as a process of preparing analytical documents with the data obtained for monitoring and evaluating the harmonious and balanced development of the EU territory over a three-year reporting period pursuant to the provisions of the Treaty on the Functioning of the EU and improving the vision of priorities, goals, objectives, and results as a process of developing a policy for the development of territorial cooperation for the new reporting period on the principles of multilateralism and good governance.

An analytical report by the European Territorial Development Observatory (Böhme *et al.*, 2024) characterised the use of territorial cohesion policy at national, regional and local levels in the European Union countries as facing certain difficulties due to its complexity, low visibility and competition with other policy priorities, which makes it difficult for stakeholders to fully understand and prioritise. To improve the processes of reflecting in the regional development strategies of Ukraine the practice of developing and operating the EU territorial cohesion policy, European experience should be used. This could encompass the operation of the Coordination Network of Cross-Border Points (About the Border Focal Point Network, n.d.) to create a Coordination Network of Territorial Cohesion Centres as an online network of professional experts to discuss with stakeholders relevant issues of the development of territorial cooperation. The inclusion of European experts in this

network will allow directing cooperation with Ukrainian experts in the field of synchronisation and harmonisation of actions to improve the functioning of the EU territorial cohesion policy and the regional development of Ukraine as a modern process of interstate management of European integration between Ukraine and the EU. An integral factor in the success of the proposed process of convergence of management systems for regional development policies of Ukraine and territorial cohesion of the EU is the organisation of multilateral cooperation with leading European organisations whose field of activity is the development of territories. It was determined by the Ukrainian mission to the EU as a priority for Ukraine's European integration. It also required the implementation of experiments in the field of management of regional development of Ukraine in the context of modelling the strategic development of functional types of territories based on identifying the features of the development and functioning of management bodies grounded on the principles of multilateralism and good governance and assessing the effectiveness of achieving the implementation of certain political priorities.

The interdisciplinary and ecosystem approach to studying European policy is used from the point of view of studying the territorial impact of the source base of regulatory and legal documents, the creation of which is the result of cooperation between scientists, practitioners, and politicians whose field of activity is various aspects of regional development and territorial cohesion. E. Syromolot & N. Gavkalova (2025) defined functional types of territories as an object of public management of territorial development, which made it possible to study modern processes of decentralisation of interstate management of European integration from the point of view of the formation of new subjects of regional policy. These subjects are formed on the basis of functional ties of territories, which go beyond the existing administrative-territorial units of the EU member states. Discussion of the components of the European integration mechanism of public management of territorial development: research on the role of scientific ideas for the restoration of the development of territories of communities and regions of Ukraine through economic development and overcoming inequalities, obstacles, interregional disparities and asymmetries as components of European integration processes to ensure harmonious and balanced development and improve the European integration mechanism of public management of territorial development was disclosed within the framework of the Conference of the International Scientific Conference "Economic Development and the Legacy of Semen Kuznets" in 2024.

The scientific heritage of S. Kuznets as a pivotal part of the innovation ecosystem of the S. Kuznets Kharkiv National Economic University, which exerts influence on the functioning of important components of the innovation ecosystem of the S. Kuznets Kharkiv National Economic University, namely on cooperation with European organisations and embassies, and arranging cooperation with international universities, in the context of the renewal of the regional development of Ukraine, was presented by E. Syromolot & N. Gavkalova (2025). The annual Conference on the Scientific Heritage of S. Kuznets is a crucial determinant in the formation of the Kharkiv Region as a functional region and contributes to the approximation of the regional policy management system of Ukraine to the standards and best practices of the EU territorial cohesion policy in the context of the priority of developing functional types of territories and forming a three-level organisation of power "functional community – functional region – functional state".

Functional types of territories as an object of public management of territorial development

The Territorial Agenda 2030, which complements the EU's territorial cohesion policy, focuses on two main objectives for territorial development, namely achieving a Fair Europe through the implementation of three priorities: achieving the status of a balanced Europe, developing functional regions, ensuring integration across borders, and achieving the goal of building a green Europe by ensuring a healthy environment, implementing a circular economy, and sustainable connectivity (Territorial Agenda 2030, 2020). The essential characteristics of the defined priority of the development of the functional region Territorial Agenda 2030 are the identification as engines of regional growth that go beyond the administrative borders to organise cooperation with other regions, cities and towns, using an integrated multi-level partnership involving people from different levels of government, in particular local and regional, as well as different political sectors and social groups, which makes functional types of territories the object of public management of territorial development, and provides for the implementation of thematic actions in the field of management of the development of functional types of territories (Fig. 4).

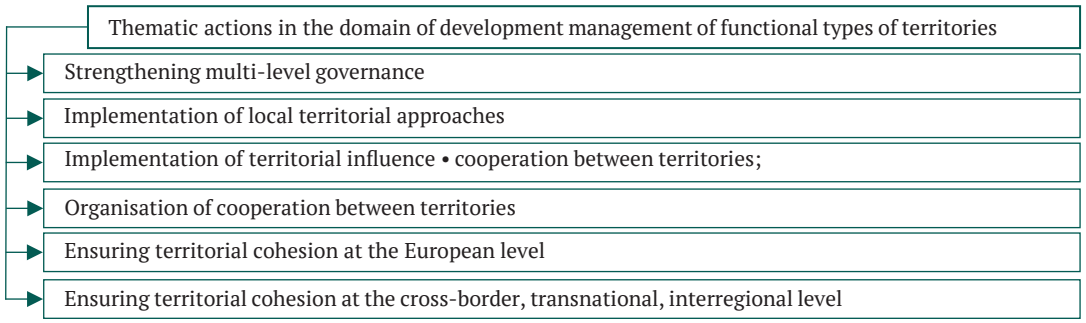

Figure 4. Thematic actions in the field of development management of functional types of territories
Source: developed by the authors

An essential tool for developing territorial cohesion policy, the sphere of public management of territorial development and strategic planning of the development of various types of territories is the implementation of thematic pilot actions initiated by the Territorial Agenda until 2020 to develop priorities for aligning the development of regions with specific needs (Delivery of services…, 2024) and demonstrating and disseminating best practices of innovative management solutions in the field of service provision to address identified territorial challenges and overcome uneven development of territories. A significant step in the institutional development of functional types of territories is the development of a methodology for the functioning as subjects of regional development and territorial cohesion policy in territories that are located outside the administrative-territorial units of EU member states, have common functional connections and development features, are beneficiaries of multiannual programmes for the development of European territorial cooperation, which are financed from the EU structural funds, being a demonstration of the functioning as an object of public administration in the national system of regional development management and interstate management of European integration.

The methodological toolkit for improving the processes of management, coordination, planning, and implementation in different jurisdictions of functional types of territories developed by the Joint Research Centre, the Directorate-General for Regional Development of the European Commission and the World Bank, includes practical recommendations for local and regional authorities to develop integrated strategies, identify flagship projects, improve participation, strengthen urban-rural links, promote cross-sectoral integration, mobilise funding and improve monitoring and evaluation processes at the level of functional territories, which is an example of improving the European integration mechanism of public management of the development of EU territories and demonstrating the best practice of developing European territorial cooperation for its dissemination within the framework of the implementation of the state policy of regional development of Ukraine (Functional areas in the EU, n.d.).

The modern principles of the state regional policy of Ukraine are formed, including on the processes of formulation and identification of functional types of territories as objects of public management of territorial development. These principles are formed through the creation of a system of support for the development through the implementation of regional development programmes and projects in these territories, monitoring, and evaluation of socio-economic processes and results of socio-economic development, including functional types of territories (Law of Ukraine No. 156-VIII, 2015). Therefore, the definition of functional types of territories as an object of public management of territorial development and a subject of development of regional development policies of Ukraine from the point of view of synchronisation and harmonisation with the territorial cohesion policy of the EU is a relevant managerial action within the framework of improving the European integration mechanism of interstate management of European integration between Ukraine and the EU, and its practical implementation at the local and regional levels of government of Ukraine.

Laboratory modelling of territorial development to obtain new data for regional policy

Functional types of territories become a source of creating new regional development databases based on the identified features of territorial development and identified functional ties, on the basis of which projects are formed to attract integrated territorial investments, as a basic financial instrument of the EU territorial cohesion policy. The assessment of the implementation of regional development and European integration of Ukraine for the reporting period 2021-2023 conducted by the Ministry of Community and Territorial Development of Ukraine indicates a lack of progress in determining the list of functional types of territories and the creation by executive authorities and local self-government bodies of special mechanisms and tools to support these territories for the effective participation of communities and regions in EU financial instruments and structural funds that are available to Ukraine as a candidate country for EU membership (Report on the results…, n.d.).

The complexity of the defined task of regional development of Ukraine regarding the development of functional types of territories lies in the plane of determining the relevance of the introduction of a systemic and innovative approach, which provided for conducting experiments in the regional development management system, introducing into local regional development strategies a strategic goal for the development of functional types of territories and conducting laboratory modelling of the development based on the implementation of the best European practices for the development of territorial cooperation. Modern European practice of territorial development recognises cross-border regions as living laboratories of European integration, acknowledging the practice of creating Euroregions as the beginning of the organisation of territorial integration of EU border regions, which cover 40% of the territory and 30% of the EU population (EU border regions…, n.d.).

The practice of creating living laboratories has not yet gained any development in Ukraine, while in the EU, such laboratories have become a political tool for carrying out real experiments, where innovative solutions for the development of territories are created in partnership between local administrations, enterprises, and citizens (Nesti, 2017). A similar opinion was held by T. Santonen (2020), who characterises living laboratories as a multi-faceted approach of participants and development entities to the implementation of open innovations, focused on the user, for the joint creation and testing of new solutions in real conditions at different stages of the innovation process using various research, development and testing methods using a systematic methodology. The Living Lab development strategy is based on the concept of Open Innovation 2.0 (n.d.), as an integrated system of multilateral cooperation, guided by the realisation that the problems faced by countries and societies are too big to be solved separately, and that a new approach is needed in creating a four-fold spiral of cooperation on innovation development at the level of government, industry, academia and citizens, to collaborate, exchange ideas, knowledge, resources, innovations to achieve harmonious and balanced development.

The Living Lab concept is based on dynamic, open innovation ecosystems where research and innovation take

place in real policy sectors, rather than in isolated laboratories, and new solutions are not only innovative but also based on the real needs of citizens and end users. This approach makes Living Labs particularly effective in solving current problems and complex societal challenges (Living Labs, n.d.). Modern management tasks for the development of mechanisms to support functional types of territories in the regional development management system of Ukraine should be based on obtaining new data for strategic planning of socio-economic development of territories of communities and regions, related to the significant features of the development of functional types of territories, as those that go beyond the boundaries of existing administrative-territorial units of communities and regions and have identified functional spaces and connections, on which the development of integrated territorial investments and strategic planning of new socio-economic formations is based, as a new territorial model of attracting investments for the development of communities and regions of Ukraine (Functional areas in the EU, n.d.).

Taking into account the European experience, the urgent task of strategic planning of regional development in the context of updating the regional policy of Ukraine to ensure the assessment and monitoring of socio-economic processes occurring in functional types of territories, has been identified as the urgent task of developing new statistical data for identifying new types of territories on the basis of which local governments of Ukraine will develop mechanisms for supporting new types of territories at the local and regional levels of Ukraine in programmes for the comprehensive restoration of the socio-economic development of communities and regions. Considering the recommendations of the Council of Europe on the development of strengthening good democratic governance and resilience in Ukraine (Strengthening good democratic..., n.d.) and the Plan for the restoration of local self-government from the consequences of the war (Recommendations for policy..., 2022), the Living Laboratory for the Development of Territories of Slobozhanshchyna was created for laboratory modelling and creation of databases of the development of functional types of territories at the local and regional levels, which will ensure the effectiveness of the implementation of the specified tasks for the renewal of the regional development of Ukraine. It was proposed to create a Living Laboratory for the Development of Territories of Slobozhanshchyna as a component of the innovation ecosystem of the Department of Public Governance, Public Administration and Economic Policy of the S. Kuznets KhNEU to obtain primary information to identify the functional ties of the territories of communities of Slobozhanshchyna (Fig. 5).

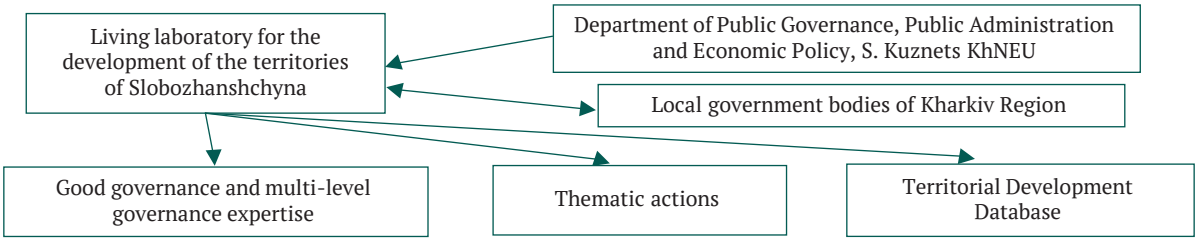

Figure 5. Living laboratory model development of the territories of Slobozhanshchyna

Source: developed by the authors

The pillar for the functioning of the Living Laboratory for the Development of Territories of Slobozhanshchyna, the creation of which was supported by the leadership of the S. Kuznets KhNEU and the Association of European Border Regions, will be the identification of existing functional ties with the communities of Kharkiv and Kharkiv Region in the field of regional development and the training of future specialists for civil service and service in local government bodies by the Department of Public Governance, Public Administration and Economic Policy of the S. Kuznets KhNEU.

DISCUSSION

The use of the methods of forming the EU territorial cohesion policy in the development of regional development policies of Ukraine at the local and regional levels of government of Ukraine, as a priority of the European integration of Ukraine, requires conducting new comprehensive research and implementing management decisions based on innovative approaches and experimental management of regional development where functional types of territories are considered as objects of management and interdisciplinary research, conducting a study of the identified components of the European integration mechanism of public management of territorial development. This mechanism was formed on the institutional principles of ensuring the cohesion of territories with special needs in the process of creating, developing and expanding the EU, which is an essential European integration task of regional policy for the formation of a new territorial model of participation of local governments of Ukraine in EU programmes and projects financed from the EU structural funds.

The analysis of the conducted scientific research indicates that scientists have covered various relevant areas of Ukraine's European integration. Nevertheless, the issue of the impact of the EU territorial cohesion policy from the point of view of using the methods of its formation on the process of strategic planning of regional development at the local and regional levels of Ukraine remains unexplained. This causes strategic uncertainty on the part of local governments of Ukraine in using modern practices for the development of European territorial cooperation (Khymynets *et al.*, 2022), which affects the perception of the need to develop a modern territorial model of territorial cooperation of communities close to the best practices for the development of functional types of EU territories, which are formed as new influential subjects of regional development and strategic planning, provided with the

necessary program and financial instruments for support and development.

P. Logvinov *et al*. (2025) considered the experience of the Carpathian Euroregion, which includes Ukrainian border regions, as a practical example of coordination with the priorities of the EU cohesion policy and the best model for sustainable and integrated development of the territories of communities and regions of Ukraine based on a detailed and meaningful description of the implementation of the policy of balanced and harmonious development of the territories of the European Union. The conclusions of this article coincide with the proposed vision of the development of the Carpathian Euroregion as an experimental and evolutionary laboratory of the processes of European integration of multifactor administrative and territorial entities, the reflection of the development of Euroregional formats in the national strategy for the development of cross-border cooperation of Ukraine for the period 2025-2030, the determined importance of the macro-regional strategy for the Carpathian region as a coordination tool for the development of infrastructure projects, the implementation of innovative models of the use of renewable energy sources and the preservation of the cultural and natural heritage of the region.

Meanwhile, the study determines that the Carpathian Euroregion experiences a deficit of institutional efficiency in using the opportunities of cross-border cooperation for socio-economic progress in border regions. It characterises the need to implement management actions to strengthen the coordination activities of the members of the Carpathian Euroregion, identifying it, including as a subject of regional policy in Ukraine and a participant in the development of regional development strategies and the state program for the development of cross-border cooperation in Ukraine based on the experience of developing the territorial cohesion policy of the European Union. C. Patrascu (2023) characterises the integral role and impact of cohesion policy on all European regions, through the creation of local strategies in the context of the EU renewal of the social market economy model through green and digital transition strategies to overcome challenges in the development of territories, including negative demographic trends and the growing shortage of skilled labour, considering cohesion policy as the main instrument of EU development, with a crucial mission – improving the quality of life and reducing inequalities in European regions, involving and consulting numerous partners and stakeholders.

The study focuses on the existing territorial instruments of the EU territorial cohesion policy, namely: community-led local development (CLLD) and integrated territorial investments (ITI), which are aimed both at interacting with communities and at building integrated multilateral financing. It is these tools that need to be applied in the practice of strategic planning for the development of functional types of territories in Ukraine, based on the identification of modern challenges and opportunities for the development of territories of communities and regions of Ukraine in conformity with the sustainable practice of developing European territorial cooperation and implementing management actions to renew the regional development of Ukraine. A. Ciffolilli *et al*. (2024) presented a thematic study of indicators of the use of EU cohesion policy funds in 2014-2020 from the EU structural funds of various operational programmes in six EU Member States regarding the ability to adapt EU cohesion policy at the national and regional levels of strategic planning, identifying a typical model of absorption and territorial impact of EU cohesion policy at the local and regional levels of European integration of territories, through the ability of public management entities for the development of territories to make better management decisions in the field of balanced and harmonious development. The peculiarity of the study is the fact that it was prepared in accordance with the request of the European Parliament Committee on Regional Development, and it formulates proposals for the EU countries at the level of the countries to simplify the rules and procedures for the use of the instruments of the European Union cohesion policy by promoting the participation of the EU Member States in the development of the policy and adapting the policy to specific needs, reducing uncertainty regarding the application of its key principles and compliance with its requirements, promoting learning and the exchange of good practices.

At the national and regional levels of adaptation to the territorial cohesion policy, proposals are provided to strengthen administrative capacity, enhance coordination, promote compliance of national and regional legislative initiatives with EU rules and regulations to avoid uncertainties, as well as support the potential of beneficiaries of the territorial cohesion policy. F. Molica *et al*. (2025) presented a new perspective on the process of improving the EU territorial cohesion policy starting with the adoption of the Lisbon Strategy, according to which the resources of the EU structural funds were directed to financing large-scale infrastructure projects and investments in industrial production in less developed regions, but at the next stage, these steps became insufficient to ensure sustainable development, especially in more developed regions, where innovation and human capital played a greater role and there was a need to synchronise the EU cohesion policy with other EU policies, taking into account the EU's transition to a knowledge-based economy, the development of innovation and the implementation of structural reforms, strengthening a more centralised approach to management with stronger national coordination. Researcher V.I. Dudkevych (2021) noted the advantageous geographical location of Ukraine and identifies a strong potential for cooperation between Ukraine and the European Union by analysing the political steps that Ukraine took on the path to membership in the European Union. The statement about the complexity of the process of Ukraine's European integration and the need to create a powerful pro-Ukrainian lobby is undeniable.

The next stage of the implementation of EU cohesion policy, which F. Molica *et al*. (2025) defined as territorialisation, was aimed at overcoming excessive centralisation and building capacity, defining a new role and participation of local and regional authorities in the development and implementation of territorial cohesion policy, based on the creation of individual strategies that reflected the specific needs and strengths of different territories. The third stage – hyper-Lisbonisation – transformed territorial cohesion policy into a flexible and crisis-sensitive tool for the transition from spatially oriented to sectoral allocation of resources, which underwent regulatory adaptations, allowing for the redistribution of more funds and the

reorientation to strategic use to meet the EU's urgent priorities. Pursuant to F. Molica *et al*. (2025), periodisation of EU cohesion policy indicates a crucial process of improving the intergovernmental management of European integration development of territories through the identification of three stages of assessing the parameters of current actions as a factor influencing the functioning and achievement of cohesion policy priorities at the intergovernmental, national and regional levels of EU government, and the focus of attention on the use of financial instruments of the EU structural funds to reduce uneven development of territories and find a better territorial model of socio-economic development of territories.

A. Pegan & M. Lovec (2025) pointed out the importance of creating communication platforms for the development of territorial cohesion policy, paying attention to the growth of political problems that have become more complex, and emphasising the advantages of management practices of creating networks and partnerships of multi-level governance over hierarchical control of strategic development planning of territories. O. Marukhlenko & D. Kuzmenko (2024) characterise the essential characteristics of the EU cohesion policy as a regional, structural and main investment policy of the EU, aimed at increasing the economic and social well-being of EU regions and cities, reducing regional economic, social and regional disparities of European regions. The opinion of the authors of this article coincides with the conclusions of O. Marukhlenko & D. Kuzmenko (2024), who note a fairly high level of regional differentiation by level of development in Ukraine, and the importance of identifying the priorities of the EU cohesion policy as strategic imperatives of the regional development of Ukraine with clearly defined goals, instruments, and conditions for supporting local initiatives, based on the consolidation of state resources and territorial communities, but at the same time, which still remain an undefined mechanism for introducing methods of developing the EU cohesion policy into the strategic planning of the regional development of Ukraine, being an urgent challenge for the European integration of Ukraine.

CONCLUSIONS

The conducted research allowed drawing conclusions about the functioning of the European integration mechanism of public management of territorial development, which describes crucial components of the European Union's territorial cohesion policy, as the main investment and regional policy of the European Union, the study of which is required to strengthen the ability of representatives of local governments of Ukraine to participate in the financial programmes of the European Union. The European integration mechanism allows defining critical drivers for achieving balanced and harmonious development of the European Union in the context of modern transformations of the regional policy management system and the transition to a new territorial model of territorial development management based on the development of functional types of territories as new actors of regional development in the countries of the European Union. An essential result of the implementation of European integration processes and the renewal of regional policy in Ukraine is the creation of a new territorial model for managing the funds of the European Union structural funds, which is founded on the development of functional types of territories as new subjects of regional policy in Ukraine, requiring a transition to experimental management of regional development in Ukraine and laboratory modelling of new socio-economic entities as subjects of regional policy for which it is necessary to develop special mechanisms and tools to support the development.

Given the analysis of the implementation of the state strategy for regional development for 2023, the regional development management system at the local and regional levels is not ready to determine and plan the development of functional types of territories, which complicates both the European integration processes of Ukraine and the creation of a new territorial model for managing the funds of the European Union structural funds with the participation of communities and regions of Ukraine. The study proves that a feature of the transition to a new model of spatial development of territories, within the framework of the identified European integration mechanism, is the direct participation of scientists in the formation, together with local politicians, of new strategies for the development of various types of territories. The boundaries of the mentioned territories go beyond the boundaries of existing administrative-territorial units. Hence, the new geography of territories is shaped by establishing functional territorial ties. These ties are used to create new databases, underpinning strategic planning for the development of functional types of territories and supporting the participation in EU programmes as subjects of regional policy.

Discussion of scenarios for the development of functional types of territories of the Kharkiv Region, namely: the Kharkiv agglomeration, the Slobozhansk microregion for the development of territorial cooperation, the Dergach subregion, was proposed to be held within the framework of the permanent section "School of Public Administration and Project Management" of the International Scientific and Practical Internet Conference "Public Administration: Problems and Prospects" together with representatives of communities, experts of the Association of European Border Regions. It possesses extensive experience, practices, and examples of managing functional types of territories, which are Euroregions, European groups of territorial cooperation. Prospects for further research encompass developing the provisions of the concept of the development of the Kharkiv Region as a functional region and the living laboratory for the development of territories of Slobozhanshchyna. It relates to the framework of the modern European integration process of approximation and the use of experience in devising a policy for the functioning of the European territorial cooperation toolkit and the development of functional types of territories, which are critical components of the European integration mechanism of public management of territorial development.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

REFERENCES

[1] About the Border Focal Point Network. (n.d.). Retrieved from https://futurium.ec.europa.eu/en/border-focal-point-network/news/about-border-focal-point-network.

[2] Association Agreement Between Ukraine and the EU, on the One Hand, and the European Union, the European Atomic Energy Community and Their Member States, on the Other Hand. (2014, June). Retrieved from https://zakon.rada.gov.ua/laws/show/984_011.

[3] Bartůněk, M., & Marek, P. (2025). Territorial identity of a region: A review of data collection techniques. *Hungarian Geographical Bulletin*, 74(1), 37-55. doi: 10.15201/hungeobull.74.1.3.

[4] Böhme, K., Toptsidou, M., Marinović, P., de Bruijn, M., & Zaucha, J. (2024). *Stocktaking review of the territorial agenda 2030*. Kirchberg: ESPON.

[5] Chapters of the acquis EU. (n.d.). Retrieved from https://enlargement.ec.europa.eu/enlargement-policy/conditions-membership/chapters-acquis_en.

[6] Ciffolilli, A., Pompili, M., Borowczak, A., & Hranilovic M. (2024). *Research for REGI committee – absorption rates of cohesion policy funds*. Brussels: European Parliament. doi: 10.2861/127097.

[7] Commission staff working document. (2023). Retrieved from https://op.europa.eu/en/publication-detail/-/publication/a0f3eaa6-7eee-11ee-99ba-01aa75ed71a1/language-en.

[8] Commission staff working document. (2024). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52024SC0699.

[9] Consolidated Versions of the Treaty on European Union and the Treaty on the Functioning of the European Union. (2016, June). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12016ME%2FTXT.

[10] Delivery of services of general interest in lagging regions and areas with special needs. (2024). Retrieved from https://territorialagenda.eu/wp-content/uploads/Delivery-of-SGI-Policy-Brief-FINAL.pdf.

[11] Dudkevych, V.I. (2021). The process of Ukraine's integration into the European Union in the context of contradictions of internal European development. *Political Life*, 1, 119-124. doi: 10.31558/2519-2949.2021.1.15.

[12] EU border regions: Living labs of European integration. (n.d.). Retrieved from https://futurium.ec.europa.eu/en/border-focal-point-network/library/eu-border-regions-living-labs-european-integration?language=sv.

[13] Functional areas in the EU. (n.d.). Retrieved from https://functionalareas.eu/.

[14] Functional territories for better integrated governance: Towards spatially coordinated development in metropolitan and urban-rural area. (2023). Retrieved from https://urbact.eu/articles/functional-territories-better-integrated-governance-towards-spatially-coordinated.

[15] Integrated territorial investments as an effective tool of the cohesion policy. (2019). Retrieved from https://www.europarl.europa.eu/cmsdata/162823/25032019_CONT_Briefing_ITI_Final.pdf.

[16] Jánošková, K. (2024). Impact of European structural and investment funds on the Slovak economy. In F. Petrovská (Ed.), *EDAMBA 2023: Conference proceedings* (pp. 301-309). Bratislava: University of Economics in Bratislava. doi: 10.53465/EDAMBA.2023.9788022551274.301-309.

[17] Karpa, M., Gavkalova, N., Beliavceva, V., & Hryshyna, V. (2023). Theoretical fundamentals of territorial development strategy. *Public Administration and Law Review*, 2, 28-43. doi: 10.36690/2674-5216-2023-2-28-43.

[18] Khymynets, V.V., Holovka, A.A., Zhalilo, Ya.A., Dvigun, A.O., Lisohor, L.S., Barinova, D.S., & Nesterenko, V.V. (2022). *Economic foundations of promoting community cohesion*. Kyiv: National Institute for Strategic Studies. doi: 10.53679/NISS-analytrep.2022.08.

[19] Kravtsiv, V., & Storonyanska, I. (2025). Regional policy vs spatial shifts of the Ukrainian economy: Searching for answers to current questions. *Visnyk of the National Academy of Sciences of Ukraine*, 3, 29-38. doi: 10.15407/visn2025.03.029.

[20] Kutsmus, N., Prokopchuk, O., & Usiuk, T. (2025). European integration policy and sustainable development: Complementarity of trajectories. *European Journal of Economic and Financial Innovations*, 4(18), 486-498. doi: 10.32750/2025-0440.

[21] Law of Ukraine No. 156-VIII "On the Principles of State Regional Policy". (2015, February). Retrieved from https://zakon.rada.gov.ua/laws/show/156-19#Text.

[22] Living Labs. (n.d.). Retrieved from https://enoll.org/living-labs/.

[23] Logvinov, P., Buriachenko, A., Gaponiuk, M., Petrukha, S., & Siusko, M. (2025). EU cohesion policy and cross-border cooperation: Strategies for sustainable development of the Carpathian region. *International Journal of Organizational Leadership*, 14, 170-189. doi: 10.33844/ijol.2025.60471.

[24] Marukhlenko, O., & Kuzmenko, D. (2024). Cohesion policy in the EU: experience for Ukraine. *European Scientific Journal of Economic and Financial Innovation*, 13, 329-340. doi: 10.32750/2024-0132.

[25] Mogyl, V. (2023). European integration as a promising direction of modernization of Ukraine. *Scientific Works of the Interregional Academy of Personnel Management. Political Science and Public Administration*, 3(63), 78-82. doi: 10.32689/2523-4625-2022-3(63)-11.

[26] Molica, F., de Renzis, A., & Bourdin, S. (2025). From Lisbonisation to Hyper-Lisbonisation: The long goodbye to EU cohesion policy's original goals. *Regional Studies*, 59(1), article number 2540361. doi: 10.1080/00343404.2025.2540361.

[27] Nesti, G. (2017). Living labs: A new tool for co-production? In A. Bisello, D. Vettorato, R. Stephens & P. Elisei (Eds.), *Smart and sustainable planning for cities and regions: Results of SSPCR 2015* (pp. 267-281). Cham: Springer. doi: 10.1007/978-3-319-44899-2_16.

[28] Olkowska, O. (2023). European structural funds. *Zeszyty Prawnicze Biura Analiz Sejmowych*, 2(78), 186-192. doi: 10.31268/ZPBAS.2023.39.
[29] Open Innovation 2.0. (n.d.). Retrieved from https://ivi.ie/publication/openinnovation2-0/.
[30] Paasi, A., Ferdoush, A., Jones, R., Murphy, A., Agnew, J., Espejo, P., Fall, J., & Peterle, G. (2022). Locating the territoriality of territory in border studies. *Political Geography*, 95, article number 102584. doi: 10.1016/j.polgeo.2021.102584.
[31] Patrascu, C. (2023). Reinforcing convergence in implementing EU's new cohesion policy objective: "Europe closer to citizens". *Bulletin of the Transilvania University of Braşov Series VII: Social Sciences and Law*, 16(65), 53-62. doi: 10.31926/but.ssl.2023.16.65.3.7.
[32] Pegan, A., & Lovec, M. (2025). Public communication and strategic planning: The case of EU cohesion policy. *Journal of European Integration*. doi: 10.1080/07036337.2025.2537360.
[33] Recommendations for policy formulation on the local government recovery plan from the consequences of the war. (2022). Retrieved from https://rm.coe.int/cegg-pad-on-ukraine-recovery-strategy-in-lsg-area-ukr-final/1680aef3fb.
[34] Report on the results of the internal evaluation of the first stage of implementation of the state strategy regional development for 2021-2027 and implementation of the action plan for its implementation for 2021-2023. (n.d.). Retrieved from https://mtu.gov.ua/files/GetFileAttachment_0306_1.pdf.
[35] Resolution of the Cabinet of Ministers of Ukraine No. 695 "On the Approval of the State Strategy for Regional Development for 2021-2027". (2020, August). Retrieved from https://zakon.rada.gov.ua/laws/show/695-2020-%D0%BF#Text.
[36] Resolution of the Cabinet of Ministers of Ukraine No. 776 "On the Establishment of the Coordination Center for Regional Restoration". (2025, June). Retrieved from https://zakon.rada.gov.ua/laws/show/776-2025-%D0%BF#Text.
[37] Resolution of the Cabinet of Ministers of Ukraine No. N 587 "Some Issues of the Development of Cross-Border Cooperation and Euroregions". (2002, April). Retrieved from https://zakon.rada.gov.ua/laws/show/587-2002-%D0%BF#Text.
[38] Santonen, T. (2020). *Living lab business models and services – key findings from product validation in health (ProVaHealth) project*. Vantaa: Laurea Publications.
[39] Soloviova, A., & Fomin, A. (2025). Ukraine and the EU: Prospects and challenges on the road to integration. *Acta de Historia & Politica: Saeculum XXI*, 9, 58-68. doi: 10.26693/ahpsxxi2025.09.058.
[40] Strengthening good democratic governance and resilience in Ukraine. (n.d.). Retrieved from https://www.coe.int/uk/web/kyiv/strengthening-good-democratic-governance-and-resilience-in-ukraine.
[41] Syromolot, E., & Gavkalova, N. (2025). *The some aspects of functioning S. Kuznets KhNUE innovative ecosystem in the conditions of renewal of the regional development of Ukraine*. Retrieved from https://skced2025.hneu.edu.ua/wp-content/uploads/2025/10/Syromolot_-Gavkalova_presentation_-Kuznets.pdf.
[42] Territorial Agenda 2030. (2020). Retrieved from https://territorialagenda.eu/wp-content/uploads/TA2030_summary_jun2021_en.pdf.
[43] Ukraine's European integration process. (2010). Retrieved from https://www.zoda.gov.ua/files/WP_Article_File/original/000010/10454.pdf.
[44] Zalodska, I., Romakhova, O., Lyashenko, P., & Adamenko, T. (2025) Reconfiguration of the administrative-territorial structure of the Kharkiv, Zaporizhzhia and Kherson regions in the post-war period. *Economic and Law*, 3, 112-119. doi: 10.15407/econlaw.2025.03.112.

Деякі аспекти функціонування євроінтеграційного механізму публічного управління розвитком територій

Едуард Сиромолот
Аспірант
Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки, 9А, м. Харків, Україна
https://orcid.org/0009-0006-0118-4237

Наталія Гавкалова
Доктор економічних наук, професор
Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки, 9А, м. Харків, Україна
https://orcid.org/0000-0003-1208-9607

Анотація. Метою статті було дослідити історію формування політики згуртованості Європейського Союзу через ідентифікацію та формулювання євроінтеграційного механізму публічного управління розвитком територій для забезпечення ефективної участі громад та регіонів України у сучасних євроінтеграційних процесах переходу до функціональної територіальності як основи сучасної політики згуртованості ЄС у аспекті її функціональної територіальності та переходу до нової моделі розвитку територій «функціональна громада – функціональний регіон – функціональна держава». Запропоновано кроки зі створення в Україні суб'єктами регіональної політики нової територіальної моделі управління коштами структурних фондів Європейського Союзу, які включають ідентифікацію географічних функціональних зав'язків між суб'єктами регіональної політики, що формують нову територію співробітництва, яка виходить за межи існуючих адміністративно-територіальних одиниць та формує новий суб'єкт формування регіональної політики, а саме функціональний тип територій з формуванням нової бази даних для програмування соціально-економічних процесів розвитку органів місцевого самоврядування відповідно до завдань оновленої державної стратегії регіонального розвитку України. Запропоновано, у відповідності до кращого європейського досвіду бачення регіонів як живої лабораторії розвитку територіального співробітництва, кроки щодо створення живої лабораторії розвитку територій громад Слобожанщини для розробки механізму та інструментів підтримки функціональних типів територій на рівні м. Харкова та Харківської області, а також подальші кроки щодо створення Харківської агломерації, Слобожанського мікрорегіону територіального співробітництва та Дергачівського субрегіону, які були оприлюднені в рамках щорічної Міжнародної наукової конференції «Економічний розвиток і спадщина Семена Кузнеця» у 2024 та у 2025 роках

Ключові слова: територіальна згуртованість; територіальні диспропорції; інтегрована взаємодія; міждержавне управління; удосконалення процесу; громади та регіони

УПРАВЛІННЯ РОЗВИТКОМ
Міжнародний економічний журнал

Том 24, № 4
2025

Відповідальний редактор:
Н. Проскурніна

Підписано до друку 23.12.2026
Формат 60*84/8
Ум. друк. арк. 8,5
Наклад 50 прим.

Видавництво: Харківський національний економічний університет імені Семена Кузнеця
61166, пров. Інженерний, 1-А, м. Харків, Україна
E-mail: info@devma.com.ua
https://devma.com.ua/uk

DEVELOPMENT MANAGEMENT
International Economic Journal

Volume 24, No. 4
2025

Managing Editor:
N. Proskurnina

Signed to the print 23.12.2026
Format 60*84/8
Conventional Printed Sheet 8.5
Circulation 50 copies

Publisher: Simon Kuznets Kharkiv National University of Economics
61166, 1-A Inzhenerny Ln., Kharkiv, Ukraine
E-mail: info@devma.com.ua
https://devma.com.ua/en