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EXPERT SYSTEM FOR DETERMINING STRATEGIC DIRECTIONS FOR ENSURING THE STABLE FUNCTIONING OF AGRICULTURAL ENTERPRISES AND RURAL AREAS

Illia Chikov[1], Denys Titov[2]

Abstract. The *purpose* of the article is to develop an expert system that defines strategic directions to ensure the stable functioning of agro-industrial enterprises and rural areas. The system aims to formalise the selection of optimal development strategies for agro-industrial enterprises by taking into account their competitiveness, innovative potential, and life cycle stage, as well as for rural areas by taking into account the financial capacity of communities (hromadas), in order to increase their adaptability to changes in operating market conditions. *Methodology.* The expert system for agribusiness enterprises is predicated on three interconnected matrices: The acronyms "C/LC", "IP/LC" and "C/IP" are utilised to facilitate the systematisation of strategic choices based on competitive positions, innovative capabilities and life cycle stages. In rural areas, the DEA method is employed for comparative analysis of the operating environment. This method utilises the principles of linear programming to assess the effectiveness of community (hromada) management. *Results.* An expert system was developed that combines three strategic matrices for agricultural enterprises ("C/LC", "IP/LC", "C/IP") and a typology of hromada's financial capacity. A total of 33 strategies for agribusiness enterprises and 10 strategies for amalgamated hromadas were proposed. For agribusiness enterprises, the matrices facilitate the formalisation of strategy selection based on the life cycle, level of competitiveness and innovative potential. Four levels of fiscal dependence were identified for AHs, which determine the adaptive development portfolio. Testing the system with five enterprises and hromadas in Vinnytsia confirmed its effectiveness, providing accurate diagnostics, sound strategising and increased adaptability to external challenges. This development enables a shift from fragmented management to a comprehensive strategic development model, both within the agribusiness sector and at the local government level. *Practical implications.* The expert system increases the accuracy of strategic decisions, reduces the risk of incorrect planning and enables the hromada to respond proactively to external challenges. Testing the model in the Vinnytsia region confirmed its ability to adapt to local socioeconomic realities, thereby ensuring comprehensive development management. *Value/Originality.* The study's scientific novelty lies in the development of an integrated expert system for strategic management. This system combines three analytical matrices – "C/LC", "IP/LC" and "C/IP" – for the first time, enabling the simultaneous evaluation of the life cycle, innovation potential and competitiveness of agricultural enterprises. This approach enables the flexible selection of innovative and competitive strategies in line with the dynamics of internal and external factors. Additionally, the novelty lies in the construction of a typological model of the strategic development of rural areas. This model provides an opportunity to classify communities (hromadas) according to their level of financial self-sufficiency and to formalise the selection of relevant management strategies. The proposed toolkit enables a shift from reactive to proactive management in both agrarian business and local development management.

Keywords: expert system, agro-industrial complex, strategic management, innovation potential, enterprise competitiveness, life cycle, hromada financial capacity, matrix analysis, rural areas, DEA efficiency analysis.

JEL Classification: O13, Q12, Q13, R11, C61

[1] Vinnytsia National Agrarian University, Ukraine *(corresponding author)*
E-mail: ilya95chikov@gmail.com
ORCID: https://orcid.org/0000-0002-2128-5506
Web of Science ResearcherID: T-3922-2018
[2] Vinnytsia National Agrarian University, Ukraine
E-mail: titovden8@gmail.com
ORCID: https://orcid.org/0000-0002-0112-6663
Web of Science ResearcherID: T-3882-2018

1. Introduction

In today's world, where technological progress is relentlessly transforming management processes, expert systems are becoming increasingly important as decision-support tools. They are particularly relevant to Ukraine's agro-industrial complex (AIC), a sector which plays a pivotal role in the national economy, but which also faces numerous challenges including market instability, climate fluctuations and the urgent need for modernisation.

The agro-industrial complex is defined as a term encompassing sectors involved in the production, processing, and distribution of agricultural products. Its distinguishing characteristic is its close interconnection with natural processes, resulting in a considerable degree of reliance on external factors such as climatic conditions and geographical zones. Furthermore, AIC enterprises are distinguished by the complexity of the data they generate, encompassing financial indicators, technological parameters, market conditions, and environmental standards. The aforementioned factors give rise to a requirement for tools that are capable of integrating and processing such heterogeneous information to support managerial decision-making.

As management decisions become increasingly multidimensional, the use of intelligent information systems capable of deep data analysis and providing decision support based on accumulated knowledge is becoming necessary (Sytnyk et al., 2022). In such circumstances, integrating expert systems into the management process at agro-industrial enterprises is crucial, as it enables the swift determination of development strategies and the adaptation of production processes to new conditions.

This article focuses on developing an expert system for formulating strategies that ensure the stable operation of agricultural enterprises and the development of rural areas. The study focuses on innovative management approaches that promote the economic sustainability and competitiveness of Ukraine's agricultural sector. Vinnytsia National Agrarian University conducts relevant research within the framework of the scientific topic: "Development of mechanisms for increasing the competitiveness of enterprises of the AIC and ensuring energy independence of rural areas through the intensification of biofuel production" (state registration number 0124U000340).

Literature review. The strategic management of the development of agro-industrial complex enterprises and rural areas in an unstable external environment is a subject that has been the focus of considerable attention in modern scientific literature. A substantial degree of attention is allocated to the establishment of adaptive strategies, the execution of innovations, the process of digital transformation, the management of risk, and the development of expert systems that facilitate effective management decision-making.

As Aleksin H. (2016) emphasises, it is vital to consider the enterprise's life cycle stage when devising a financial strategy, thus enabling adaptation to external changes and increasing financial stability. The author emphasises the importance of information transparency for reducing the cost of capital and improving access to financing. In this context, the ideas of Khomenko O. (2015) are complementary, insofar as he considers the matrix approach to be a universal tool for strategic analysis. The author proposes a classification of development strategies according to the stages of the life cycle, which serves to strengthen the analytical basis for making strategic decisions in a changing environment.

Kysh L. (2019) provides a more in-depth analysis of strategic management as a tool for ensuring sustainable development, focusing on the construction of strategic maps and the importance of strategic diagnostics. Vasylyha S. (2020) emphasises the role of adaptability and a focus on long-term goals, underscoring the necessity for a systematic approach to the consideration of market dynamics in the selection of a strategic direction.

A similar position is held by Yarmak M. (2017), who adapts the ADL/LC matrix model to the needs of agricultural enterprises. His approach is characterised by its ability to encompass both the phase of enterprise development and the level of strategic competitiveness. This is a particularly salient feature in conditions of high turbulence in the industry. This finding aligns with the theoretical framework proposed by Zheludenko K. (2021), who conceptualises the system of competitiveness strategies as a multi-level structure. This multi-level structure is predicated on the coordination of corporate, functional and operational strategies with the resource potential of the enterprise.

The issue of risk management is accorded particular attention. Accordingly, Nitsenko V. et al. (2025) propose an entropic approach to risk assessment in agribusiness logistics processes, which enterprises may utilise in order to ensure adaptability to environmental changes. Furthermore, the authors emphasise the necessity to align domestic legislation with international standards, with a view to enhancing the investment attractiveness of the industry. In the same context, Kaletnik G., Lutkovska S. (2020) emphasise the importance of innovative environmental strategies that contribute to both economic growth and environmental sustainability. They highlight the importance of developing groundbreaking strategies that are based on a scientifically sound mission, a clear business model, and a portfolio of innovative projects.

Honcharuk I. et al. (2024) made a significant contribution to the study of the sustainable development of Ukraine's agricultural sector. They highlight the potential of bioorganic technologies, particularly digestate use, as a strategy to increase enterprises' economic and environmental sustainability. These technological innovations address the challenges of the European Green Deal and strengthen the strategic autonomy of agricultural enterprises.

The integration of digital technologies into management strategies is analysed in the work of Lutkovska S. et al. (2024), which focuses on the implementation of smart solutions in cluster agricultural structures. The authors emphasise the importance of technologies such as blockchain, quantum computing and big data systems in creating efficient and sustainable management systems.

Ostrovska H. et al. (2021) study the formation of intellectual entrepreneurship based on digital transformation and take a similar position. Their conclusions regarding the significance of intellectual potential, human capital and digital proficiency in developing a strategic vision are closely linked to the notion of creating expert systems for strategic management.

In the work of Shichao Chang (2020), a formalised approach to assessing the innovative potential of an enterprise is proposed, which is based on the systemic integration of various types of potential (human resources, scientific and technical, managerial, etc.). This approach is predicated on the principle of objectivity in expert assessments, and its efficacy is demonstrated by its effective implementation within the framework of support systems for the strategic management of agricultural enterprises.

The organisational and economic mechanisms through which rural hromadas may develop are explored in the works of Trusova N. et al. (2022). In this study, the main factors and criteria for internal integration and the growth of financial capacity in rural hromadas are identified. It is contended by the aforementioned parties that the program-target method facilitates the deliberate structuring of local self-government bodies and the establishment of relationships with interested business entities with a view to stimulating economic growth in rural areas.

Tomashuk I. (2020) proposes new approaches to rural development in Ukraine under decentralisation and changes in state regional policy. He emphasises that the organisational and economic mechanism of rural hromada development, considered through three components (the effectiveness of financial and budgetary support, the efficiency of resource use, and the potential for economic growth), is capable of forming a functional basis and achieving resource self-sufficiency in order to modernise the infrastructure of rural settlement networks and foster co-operation with the business environment.

Shebeshten Y. (2022) examines the components of rural development, identifying the main structural elements of rural area development: hromadas, local businesses, and civil society. The author substantiates their interconnection, which is realised through decentralisation reform, and explores the main conditions for the effective functioning of rural areas. These include creating a barrier-free environment within rural territories, transforming rural areas in line with the goals of the European Green Deal, and improving rural infrastructure.

Ostapenko M. (2024) studies socio-economic challenges to rural development, examining European Union practices aimed at supporting sustainable rural development, including the LEADER initiative and the Common Agricultural Policy. Particular attention is paid to issues such as boosting employment, improving infrastructure and supporting local hromadas.

The tasks and principles of sustainable rural development in Ukraine under wartime conditions are outlined by Tsvihun I. (2024), who highlights key principles of sustainable development, including ensuring social equity, economic resilience, and environmental safety. The main tasks involve supporting local hromadas, restoring infrastructure, preserving the natural environment and boosting civic engagement. Particular attention is given to attracting international aid, developing local self-government and encouraging public initiatives.

A review of scientific sources indicates an increasing focus on a comprehensive strategic approach in the management of agribusiness enterprises, taking into account life cycle factors, innovation potential, environmental challenges, digitalisation and risk management. The development of an expert system of strategic management in such conditions necessitates the integration of multi-level approaches and an interdisciplinary vision, a notion that is corroborated by contemporary scientific thought. At the same time, analysis of literary sources shows that there is a high level of scientific interest in the strategic management of agribusiness enterprises in a changing environment. However, the lack of a single methodological platform for integrating strategic analysis, digital technologies and decision support tools remains a common challenge. Modern approaches are often fragmented and based on partial models, or focused on large enterprises. Small and medium-sized agricultural producers remain outside the scope of adapted strategy tools. Additionally, there is a lack of unified approaches to formalising knowledge and assessing innovative and adaptive potential in dynamic conditions. This necessitates the creation of an expert

system that can combine strategic planning, risk assessment and the environmental and institutional components of management, while taking into account the specifics of Ukraine's agricultural sector.

2. Expert System for Determining Strategic Directions to Ensure the Stable Functioning of Agro-Industrial Enterprises

Despite their high natural resource potential, most agricultural enterprises demonstrate uneven development dynamics, unstable competitiveness, and a weak ability to innovate systemically (Chikov et al., 2022). In this context, ensuring the strategic stability of enterprises' operations becomes particularly important, which requires the introduction of adaptive tools for managerial decision-making.

One such tool is the expert system for strategic support, which can formalise and systematise the selection of strategies based on the enterprise's interrelated characteristics. Due to the cyclical nature of the agro-industrial sector, its technological inertia and its dependence on foreign economic factors, traditional strategic planning methods do not always offer sufficient flexibility (Chikov et al., 2023). This highlights the need to develop a hybrid system for strategic support that considers the enterprise's internal resources and external environment in the context of life cycle, innovation potential, and competitiveness (Okhota et al., 2024a).

Taking into account the above, in order to ensure the possibility of formalising the strategic choice, it is proposed to build an expert system on the basis of three interrelated matrices:

The "C/LC" matrix allows comparing the level of competitiveness with the phase of the life cycle and helps define a typical competitive strategy. This is crucial to avoid erroneous management decisions, particularly the implementation of aggressive expansion during the recession phase.

The "IP/LC" matrix focuses on the type and scale of innovations an enterprise can implement, taking into account its innovation potential and development stage. It enables the assessment of acceptable risk levels and supports the choice between product and process innovations, as well as forecasting implementation effectiveness.

The "C/IP" matrix synthesises two key long-term success factors for enterprises: the ability to compete and the capacity to innovate. This matrix is particularly useful for enterprises at a strategic crossroads, such as those with high innovation potential that has yet to be converted into a competitive advantage, or those that are highly competitive but have limited innovation capacity.

The initial strategy matrix to be examined is the "C/LC" strategy matrix. The "C/LC" matrix of selection and justification of competitive strategies is built on the basis of the level of competitiveness (Y-axis) and stages of the life cycle of the enterprise (X-axis). The amalgamation of these parameters constitutes a matrix for the selection of competitive strategies, predicated on the enterprise's positioning along the developmental trajectory of economic entities (see Table 1).

The "C/LC" strategy matrix enables you to analyse the portfolio of agricultural enterprises' strategies in the context of the stages of their life cycle. This provides complete information on the efficiency of business entities' operations and the effectiveness of strategic decisions implemented at previous stages of development. The identification of issues impacting the functionality of enterprises, alongside the exploration of avenues for their advancement, is facilitated. Furthermore, the implementation of a meticulous management strategy for the portfolio of strategies is undertaken, with the objective of optimising the outcomes derived from the utilisation of the prevailing resource capacity.

The combination of potential levels of competitiveness and the stages of the life cycle of agricultural enterprises form twelve quadrants of strategies, which are the most optimal for each individual competitive situation (see Table 2).

In contemporary conditions, the primary task of agricultural enterprises is to surpass competitors in the development of new products, technologies, cost reduction and improvement of logistics (Nitsenko et al., 2025). Concurrently, the strategic objectives

Table 1
"C/LC" matrix of competitive strategies of agrarian enterprises

High (H)	**Quadrant 3 Q3**	**Quadrant 6 Q6**	**Quadrant 9 Q9**	**Quadrant 12 Q12**
Medium (M)	**Quadrant 2 Q2**	**Quadrant 5 Q5**	**Quadrant 8 Q8**	**Quadrant 11 Q11**
Low (L)	**Quadrant 1 Q1**	**Quadrant 4 Q4**	**Quadrant 7 Q7**	**Quadrant 10 Q10**
Y / X	Emergence	Growth	Maturity	Decline

Source: authors' development

Table 2
Economic content of competitive strategies of agricultural enterprises according to the "C/LC" matrix

"C/LC" matrix quadrants	Competitive strategy	Strategy description
Q1	Organic Growth Strategy	Market presence expansion, business and product development
Q2	Gradual Development	Maintaining existing growth rates and building economic potential to move to a higher development stage
Q3	Rapid Growth	Scaling up production, profits, and market share with existing products
Q4	Focus Strategy	Cost reduction to retain market share
Q5	Intensification Strategy	Increasing sales and market share within the current business model
Q6	Leadership Strategy	Seeking new solutions and markets to strengthen competitiveness
Q7	Change Strategy	Adapting to market conditions and consumer demands, optimising operations, changing the target audience
Q8	Growth Strategy	Scaling enterprise operations, entering new markets, and active investment
Q9	Preservation Strategy	Maintaining leadership, monitoring consumer behaviour, and profitable investing
Q10	Cost Minimization	Saving resources, maintaining production, and preparing for recovery
	Crisis Management	Sustaining minimal viability and gradual recovery from crisis
	Short-Term Revenue Maximisation	Exploiting current advantages to generate profit before potential liquidation
	Downsizing	Restructuring or phasing out unpromising business areas
	Liquidation	Shutting down or restructuring the enterprise with maximum benefit for owners
Q11	Divestiture Strategy	Selling off inefficient assets and seeking new technologies
	Rehabilitation Measures (Financial Sanation)	Restoring profitability and attracting investment to avoid bankruptcy
Q12	Turnaround Strategy	Abandoning unprofitable directions, reducing costs, and focusing on efficiency
	Recovery	Growth in production and profits, return to active development

Source: authors' development

and potential of the enterprise are subject to change due to the influence of the external environment and internal flexibility (Chikov et al., 2023). Consequently, approaches to the utilisation of innovation potential exhibit variation across the various stages of the life cycle, with the objective of minimising external risks and optimising the efficient use of resources (Pidvalna, 2022).

It is vital to consider the considerable impact of the various stages of the life cycle of enterprises on their vector of innovative development, particularly in relation to the management of innovation potential. In light of this, we propose the "IP/LC" matrix of selection by agricultural enterprises of the type of innovation of the project (see Table 3).

The matrix has been developed to facilitate the selection of the vector of innovation-driven development for agrarian enterprises. This is based on the current level of innovation potential (Y-axis) and the enterprise's stage of the life cycle (X-axis). The degree of project radicality is identified based on the defined quadrants of the "IP/LC" matrix. This is considered most optimal for implementation by agrarian enterprises at a specific stage of their life cycle (see Table 4).

Thus, at the inception stage, agricultural enterprises typically exhibit low to medium innovation potential, focusing on moderate development initiatives such as upgrading basic equipment, improving product quality and implementing modern management practices.

Table 3
"IP/LC" matrix of choice by agricultural enterprises of the type of innovation of the project

High (H)	**Quadrant 3 P3**	**Quadrant 6 P6**	**Quadrant 9 P9**	**Quadrant 12 P12**
Medium (M)	**Quadrant 2 P2**	**Quadrant 5 P5**	**Quadrant 8 P8**	**Quadrant 11 P11**
Low (L)	**Quadrant 1 P1**	**Quadrant 4 P4**	**Quadrant 7 P7**	**Quadrant 10 P10**
Y / X	Emergence	Growth	Maturity	Decline

Source: authors' development

Table 4

Characteristics of types of project innovation according to the radicality of changes in agricultural enterprises according to the "IP/LC" matrix

Vector of innovation development	"IP/LC" matrix quadrants	Innovation project level range	Innovation characteristics by enterprise life cycle stage
Adaptive Strategy	P1	0–2*	The formation of innovative ideas for introducing new technologies or business organisation models.
	P2	1–3*	
	P3	3–4*	Innovations in process, product and marketing aimed at effectively promoting products.
Offensive, Defensive Strategy	P4	1–4*	Technological and non-technological innovations are aimed at securing and strengthening market positions.
	P5	4–6*	
	P6	6–7*	
	P7	6–7*	Technological, organisational and marketing innovations are aimed at increasing profits and strengthening the market.
	P8	3–5*	
	P9	4–6*	
Cut-Off (Freezing) Strategy	P10	1–3*	Focus on technological and organisational innovations aimed at reducing costs and generating ideas.
	P11	2–3*	
	P12	3–4*	The formation of new, innovative ideas and organisational and marketing decisions regarding asset realisation and loss minimisation.

Note: *authors' proposal for the distribution of the level of radicality of innovative projects of agricultural enterprises in relation to their life cycle stages

Source: authors' development

The innovation activity of enterprises at this stage is aimed at generating innovations of the zero to fourth order.

During the growth and maturity stages, enterprises with sufficient innovation potential implement either offensive or defensive strategies. Offensive strategies focus on achieving leadership through the creation of new products, achieving fourth- to seventh-order innovations depending on potential. These strategies are mainly implemented by powerful agricultural holdings that use biotechnology and innovative agricultural systems to achieve waste-free production.

Defence strategies are aimed at maintaining the achieved positions through scientific developments, market analysis, and environmental diagnostics. The implementation of innovations of the fourth or sixth order is observed, yet these are accompanied by a greater demand for resources and are predicated on the principle of "moving one step behind".

In the context of the recession stage, enterprises are confronted with a decision between two scenarios. The initial strategy entails the reduction or liquidation of unprofitable areas, the divestiture of obsolete assets, and the cessation of unprofitable products from production (strategies of "separation" and "reversal" in the C/LC matrix). The second is a wait-and-see strategy. The present study explores the phenomenon of "freezing" innovations, the implementation of remediation measures, and the pursuit of external financing. At this particular stage, innovation is constrained to the third or fourth order as a consequence of the paucity of resources.

The degree of radicality of the implementation of innovative projects by agricultural enterprises is given in Table 5.

In order to realise its competitive advantages and achieve high flexibility in the functioning of business processes, introduce innovative methods of manufacturing high-quality products at minimal cost, form an effective enterprise management system capable of responding quickly to changes in the external and internal environment, etc., the enterprise must ensure the full use of all internal resources (basic, competitive, strategic) by filling them and filling the production system with innovative content (Perehuda, 2022).

It is therefore concluded that agricultural enterprises can most fully and effectively realise competitive advantages and increase their competitiveness only through the selection and effective implementation of the optimal innovative strategy for the development of competitive advantages. Consequently, the subsequent proposal for deliberation is the "C/IP" matrix of selection and justification of innovative strategies for enhancing the competitiveness of agricultural enterprises (see Table 6).

The matrix is formed on the basis of nine quadrants of strategic alternatives, combining the level of competitiveness (Y-axis) with the innovation potential of agricultural enterprises (X-axis) (see Table 7).

In consideration of the cyclical character of the process of functioning of agricultural enterprises, the result of the process of developing a portfolio of strategies should be a single strategic plan, which provides for a general idea of the development of the enterprise in the short, medium and long term. The above-proposed matrices for choosing strategies for increasing the competitiveness of agricultural enterprises enable the determination of possible alternative options for the functioning of economic

Table 5
Gradation of radical implementation of innovative projects by agricultural enterprises

No.	Order of innovation by degree of radicalism	Brief description
1	Zero-Order Innovations	These are targeted changes that maintain and update the existing functions of the production system or its components.
2	First-Order Innovations	This involves simple targeted renewal while preserving the functions of the production system or its components. For example, this could involve market expansion.
3	Second-Order Innovations	Basic organisational changes, such as splitting the marketing department into market research and sales promotion units.
4	Third-Order Innovations	Adapting production processes to innovation-driven changes to improve product output.
5	Fourth-Order Innovations	A basic qualitative change that exceeds the boundaries of simple adaptive modifications.
6	Fifth-Order Innovations	While most or all of the production system's functional characteristics change, the core structural concept remains intact.
7	Sixth-Order Innovations	A qualitative change in the functional characteristics of the production system or its components, whereby the original concept is altered but the functional principle remains unchanged.
8	Seventh-Order Innovations	A fundamental change in the functional characteristics of the production system or its components.

Source: authors' development

Table 6
"C/IP" matrix for choosing innovative strategies to increase the competitiveness of agricultural enterprises

High (H)	**Quadrant 7 K7**	**Quadrant 8 K8**	**Quadrant 9 K9**
Medium (M)	**Quadrant 4 K4**	**Quadrant 5 K5**	**Quadrant 6 K6**
Low (L)	**Quadrant 1 K1**	**Quadrant 2 K2**	**Quadrant 3 K3**
Y / X	Low (L)	Medium (M)	High (H)

Source: authors' development

entities, based on the dynamics of their positions on the life development curve.

In accordance with the aforementioned matrices, which delineate the tools for the selection of strategies designed to enhance the competitiveness of agricultural enterprises, the dynamics of the portfolio of strategies employed by the enterprises under study in the Vinnytsia region during the period 2017-2023 will be determined (see Table 8).

As demonstrated in Figure 1, the generalised system of quadrants of the proposed matrices indicates that the studied agricultural enterprises have a medium-high potential for transformations on an innovative basis as of 2023. Consequently, in 2021, PJSC Dashkivtsi and the AE IRYNA-O.T. operated within the framework of Strategy Q2, which concentrated on the stable enhancement of enterprise potential without fundamental changes in their operational activities. This approach was justified in conditions of market unpredictability and external uncertainty, as it maintained operational levels and ensured a smooth transition to more advanced stages of development. However, in light of changes to the external economic environment, more ambitious strategies are proposed for 2022, specifically Q3 and Q5. These represent an "Intensification Strategy", which is aimed at actively increasing production and expanding market presence through the use of existing products and resources. This provides enterprises with an opportunity to reach a new level and adapt more rapidly to market shifts.

In this regard, the selection of innovation strategies P3 and P4 appears rational, as these approaches underscore the necessity for adaptation to evolving market conditions and technological advancements. It is evident that the enterprise's growth and the strengthening of its market positions are both supported by this initiative. It is evident that strategies such as K6, K8 and K9 underscore the significance of incorporating innovation into the enterprise development strategy. To remain competitive, enterprises must focus their efforts on improving technological processes, expanding capabilities and exploring new markets by implementing innovations.

By 2022, Agricultural Complex "Zelena Dolyna" and LLC Selyshchanske will need to modernise their strategy. Transitioning to Q6 or Q7 strategies, which focus on actively searching for new markets, technologies and solutions, is a logical step for these enterprises, as this is critical for maintaining competitiveness and long-term

Table 7

Economic content of innovative strategies for increasing competitiveness of agricultural enterprises of the "C/IP" matrix

"C/IP" matrix quadrants	Innovation strategy	Strategy description
K1	Traditional Strategy	Improving the quality of existing products without technological changes; possible innovations in services.
K2	Residual Strategy	Maintaining market position with known products; partial upgrades based on previous developments.
K3	Opportunistic Strategy	A strategy based on the product of the market leader, with minimal R&D expenses and the risk of losing a competitive advantage.
K4	Niche Strategy	Rapid market entry using traditional methods to compete for market share.
K5	Strategy of Anticipating Change	Market monitoring with the aim of improving products and expanding modifications and technological solutions.
K6	Imitation Strategy (Licensing Strategy)	Copying or licensing leader technologies with minimal R&D investment.
K7	Defensive Strategy	Adapting to competitors' actions by adopting new technologies and entering new markets is often linked with licensing.
K8	Passive-Offensive Strategy	Analysing the achievements of leaders and implementing the results in patented products.
K9	Active-Offensive Strategy	Accumulating resources in order to achieve innovation leadership involves taking on significant risks and making substantial R&D investments.

Source: authors' development

Table 8

Hybrid system of the portfolio of strategies for increasing the competitiveness of agricultural enterprises of the Vinnytsia Oblast, 2017-2023

Strategy matrices	Year						
	2017	2018	2019	2020	2021	2022	2023
PJSC Dashkivtsi							
"C/LC"	Q3	Q7	Q5	Q8	Q8	Q11	Q2
"IP/LC"	P3	P7	P6	P6	P6	P12	P3
"C/IP"	K9	K1	K6	K6	K6	K6	K6
Agricultural complex "Zelena Dolyna"							
"C/LC"	Q8	Q6	Q8	Q8	Q5	Q7	Q5
"IP/LC"	P7	P6	P9	P9	P5	P8	P6
"C/IP"	K4	K9	K6	K6	K5	K2	K6
AE YAVIR							
"C/LC"	Q8	Q6	Q5	Q5	Q4	Q1	Q5
"IP/LC"	P7	P6	P4	P4	P10	P1	P5
"C/IP"	K1	K9	K4	K4	K4	K4	K5
AE IRYNA-O.T.							
"C/LC"	Q2	Q5	Q5	Q5	Q4	Q5	Q2
"IP/LC"	P3	P6	P6	P6	P12	P6	P3
"C/IP"	K6	K6	K6	K6	K3	K6	K6
LLC Selyshchanske							
"C/LC"	Q6	Q8	Q5	Q4	Q2	Q8	Q5
"IP/LC"	P6	P9	P6	P12	P3	P9	P6
"C/IP"	K9	K6	K6	K6	K6	K6	K6

Source: authors' development

growth. In order to maintain their leadership positions in the face of constant market changes, the enterprises must invest in new technologies and shift to more adaptive business models.

Innovation strategies P6 and P7 are crucial for such enterprises as they emphasise integrating new technologies into existing processes. Additionally, strategic directions K6, K8 and K9 enable a focus on utilising well-established technologies and studying industry leaders to minimise risks and create favourable conditions for strategic changes. This enables enterprises to leverage their innovation

potential to ensure steady growth and maintain their competitiveness.

In the case of AE IRYNA-O.T., in view of the evolving market conditions, it is recommended that a transition to a more ambitious strategy, designated Q6 or Q7, be effected in 2022. These strategies will enable the enterprise to focus on entering new markets and investing in innovative technologies, which will strengthen its competitiveness. The selection of strategy P5 underscores the significance of proactively enhancing business processes and refining marketing strategies to optimise business efficiency.

Strategies K5, K8 and K3 – collectively known as the "Opportunistic Strategy" – encourage enterprises to adopt a flexible approach, focusing on opportunities arising from market changes and preparing for adaptation. These strategies enable risk reduction and adjustment to new opportunities through innovative solutions and changes in the external environment.

Thus, using the described hybrid expert system to evaluate and develop strategies for agrarian enterprises is an extremely effective way to adapt to changing economic and technological conditions. This system combines various approaches to data processing and analysis to provide comprehensive forecasts for the strategic development of enterprises, taking into account numerous variable factors, from technological innovations to market conditions.

3. Expert System for Identifying Strategic Directions to Ensure the Sustainable Functioning of Rural Areas

Over recent decades, rural areas of Ukraine have faced multifaceted challenges, including depopulation, deteriorating infrastructure, environmental degradation, loss of labour potential and insufficient adaptability to market changes. These issues are not only a consequence of the post-Soviet transformational crisis, but also the result of structural imbalances between urban and rural development, a lack of institutional state support, and the limited financial capacity of local communities (Dotsiuk et al., 2024). At the same time, however, decentralisation has created a new window of opportunity. Hromadas have gained the tools for self-governance, as well as full responsibility for outcomes.

The absence of systematic approaches to strategic planning, the fragmented use of data, poor-quality analytics and the dominance of manual budget management all limit the capacity of hromadas to respond to and anticipate challenges. Furthermore, traditional planning methods frequently fail to consider the rapidly evolving external environment, including climate change, macroeconomic instability, labour migration, military threats and regional conflicts. In this context, there is an increasing demand for a new generation of management tools that focus on systemic thinking, adaptability and supporting digital decision-making (Cheremisina et al., 2022).

In this context, the development of an adaptive expert system that can support strategic decision-making by integrating interdisciplinary knowledge, empirical data and scenario analysis becomes particularly relevant. This is not merely a formal platform or a database. The module has been designed to function as an "intelligent analytical module", incorporating both objective rural hromada functioning parameters (economic, financial, social, environmental) and subjective governance factors. The latter include institutional capacity, leadership, strategic vision, and citizen engagement in decision-making processes.

A new-generation expert system should be based on the following principles (Vdovenko et al., 2021; Titov, 2021; Okhota et al., 2024b):

– Dynamic governance, which accounts for environmental variability and allows for timely adjustment of strategies;
– comprehensive diagnostics that encompass all subsystems of hromada life (demographic, financial, infrastructure, education, healthcare, and environmental);
– indicative planning, grounded in scenario-based modeling of potential development trajectories;
– digital openness, ensuring maximum transparency of processes and public access to analytical results;
– knowledge integration, combining scientific approaches, local experience, and international best practices in territorial management.

The key task of such a system is to identify risk zones and windows of opportunity in a timely manner, enabling proactive rather than reactive decision-making. For instance, if a hromada's fiscal capacity is decreasing, the system can recommend a combination of financial mobilisation strategies, income diversification and partnership engagement. The focus would be on assessing the dependency of general fund expenditure on fiscal returns and transfer support.

Thus, the expert system should be used as a tool to enhance the capacity of rural areas, enabling a shift from tactical management to strategic development. Using it ensures that decisions are justified, that tasks are prioritised transparently, that the risk of inefficient resource allocation is reduced, as well as increasing trust in governance processes among community residents.

The development of the financial capacity of amalgamated hromadas (AHs) is essential for the successful implementation of decentralisation reform in Ukraine. As the country transitions to a new model of territorial development management, there is an objective need to create effective strategic planning tools that allow AH budgets to adapt to constant changes in the macroeconomic and institutional

environment. One such tool is an expert decision support system that can formalise the relationship between the factor attribute (Y) and the result attributes (K) and (X).

The essence of this approach lies in identifying the structural dependency between the hromada's internal revenue-generating potential (K), external financial support (X) and its ability to fulfil its function of providing for the basic needs of the population (Y). This approach enables bottlenecks in community functioning to be identified, fiscal risk zones to be determined, and individualised development strategies to be formed that take into account both quantitative parameters and a qualitative assessment of the effectiveness of management decisions.

The level of financial self-sufficiency of the hromada, its ability to provide basic services, implement infrastructure projects and maintain social resilience is determined by the interaction of these three parameters (K, X and Y). The proposed ten development strategies for AHs therefore serve as an instrument of adaptation to existing conditions, enabling communities to select the most suitable management approach based on their current revenue and expenditure structure.

The table below summarises each strategy, with emphasis on its objective and key implementation instruments:

The presented strategies are not mutually exclusive. On the contrary, they should be combined within an integrated strategic portfolio that considers the hromada's specific characteristics, life cycle stage, current challenges and long-term development goals. For instance, a hromada with a strong financial position could implement strategies for investment growth, digital transformation and social efficiency, whereas a hromada with limited budgetary stability might prioritise fiscal mobilisation, collaboration with other hromadas and transfer management.

Determining the fiscal dependency type of an amalgamated hromada enables its current financial capacity to be assessed and the most effective development instruments to be selected. An expert system that considers the relationship between the factor attribute (Y) and the result attributes (K) and (X) can classify hromadas into one of four dependency categories: high, medium, low and critical.

Relevant management strategies have been identified for each of these dependency levels, which can be implemented through appropriate instruments. This matrix enables the hromada's strategic portfolio to be structured according to its financial profile, thereby facilitating targeted management, minimising risk and increasing the effectiveness of budget policy.

The presented typology functions not only as an analytical instrument but also as a practical guideline for local self-government bodies in the development of socio-economic development programs, sustainable growth strategies, or anti-crisis measures. It is imperative to emphasise that a hromada's financial condition is not static; through the implementation of strategies, even hromadas with a critical level of

Table 9

Development strategies for amalgamated territorial communities

No.	Strategy name	Main goal	Key instruments
1	Fiscal Mobilisation	Increase K by activating internal sources	Asset inventory, update of normative monetary valuation (NMV), improved tax discipline
2	Financial Autonomy	Increase the share of own revenues and reduce dependence on X	Support for SMEs, development of self-employment, local employment programs
3	Effective Budget Planning	Optimise Y taking into account the dynamics of K and X	Program-target method, medium-term planning, participatory budgeting
4	Transfer Management	Improve the efficiency of state support (X)	Differentiation of transfers, subsidy audit, grant co-financing
5	Revenue Source Diversification	Reduce the risk of excessive dependence on a single source (K or X)	Property leasing, local fees, public-private partnerships
6	Investment Growth	Strengthen the financial capacity of the community (K) through investment	Industrial parks, processing of agricultural products, support for business incubators
7	Digital Transformation	Reduce administrative costs (Y) and increase the transparency of K and X	E-budgeting, management automation, CRM systems
8	Social Efficiency	Improve the quality of public services through effective management of Y	Social program audits, electronic services in education and healthcare
9	Partnership and Intermunicipal Co-operation	Reduce costs (Y) through co-operation between AHs	Joint facility management, clusters, intermunicipal agreements
10	Financial Resilience in Crisis Conditions	Ensure budget stability in the face of fluctuations in K and X	Reserve fund, scenario planning, indicative forecasting

Source: authors' development

Table 10
Typology of development strategies for amalgamated hromadas based on the level of dependence of factor indicators (Y) and result indicators (K) and (X)

Level of dependence	Strategies	Implementation tools
High	– Investment growth; – financial autonomy; – digital transformation.	Industrial parks, SME development, e-budget systems, CRM platforms
Medium	– Fiscal mobilisation; – effective budget planning; – revenue diversification.	Land valuation updates, business partnerships, participatory budgeting, R&D initiatives
Low	– Transfer management; – social efficiency.	Transfer audits, prioritisation of social expenditures, digital services, network optimisation
Critical	– Partnerships and inter municipal co-operation; – financial resilience in crisis conditions.	Co-operation with other hromadas, reserve funds, scenario planning, crisis management

Source: authors' development

dependency can gradually transition to a medium or high level. This transition increases their budgetary autonomy, investment attractiveness, and managerial capacity.

It is thus proposed that the proposed matrix serves as a core module of the expert system for strategic management, with the capacity to formalise financial diagnostics and to generate well-grounded solutions for the long-term development of each specific amalgamated hromada (AH).

In order to assess management efficiency in rural hromadas in the Vinnytsia Oblast, the Data Envelopment Analysis (DEA) method will be applied. This method is based on the principles of linear programming and the concepts of M.J. Farrell. The efficiency assessment employing the DEA method yielded optimal values for input and output indicators. These values then formed the foundation for managerial decisions regarding the adjustment of inputs or outputs to achieve an efficient operational level for a given hromada. When the DEA method is applied to evaluate the performance of rural hromadas, relevant results are obtained depending on the output variables.

The construction of graphs is predicated on preliminary data pertaining to five selected hromadas in the Vinnytsia Oblast (Ahronomichne, Luka-Meleshkivska, Viitivtsi, Ulaniv, and Olhopil). The following dependencies are observed:

A) The dependency of the result indicator (Y) (general fund expenditures) on the influence of factor variables: fiscal return of the hromada's territory (K) and official transfers (X).

B) The dependency of the effective characteristic (Y) (general fund revenues) on the influence of factor factors: fiscal return of the hromada territory (K) and local taxes and fees (X).

The Farrell method was utilised to conduct a comprehensive analysis, thereby facilitating the construction of a graph that elucidates the efficiency level of hromada functioning in relation to the selected factors. It is therefore possible to compile Table 11, which provides recommendations for the formation of further strategies for each hromada, depending on the zone it occupies according to the analysis.

The proposed typology demonstrates that even within a single region, hromadas may have fun damentally different initial conditions, levels of fiscal

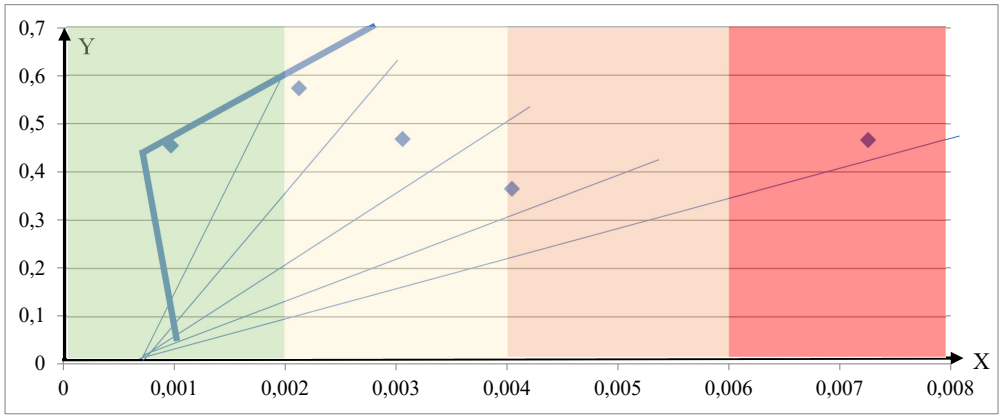

Figure 1. Analysis of the operating environment of rural hromadas under model A

Source: authors' development

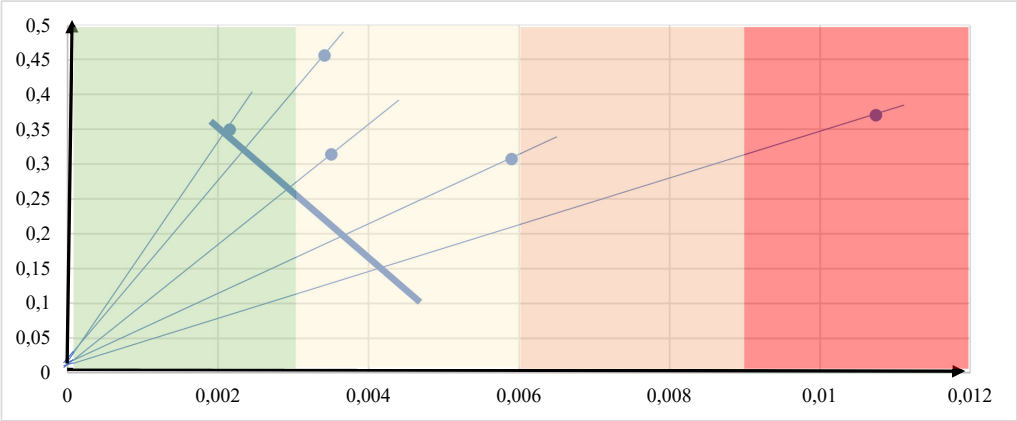

Figure 2. Analysis of the operating environment of rural hromadas under model B

Source: authors' development

Table 11

Approximate typology of strategic approaches to hromada development based on the level of dependence on factor indicators (Y) and outcome indicators (K) and (X) Ahronomichne, Luka-Meleshkivska, Viitivtsi, Ulaniv, and Olhopil

Hromadas	Key objectives	Expected effects
Ulaniv	– Maximising budget revenues through investment activity; – reducing administrative burden and manual management; – gradual exit from transfer dependence and independent strategic planning.	– Growth of the hromada's gross regional product (GRP); – emergence of quality infrastructure; – formation of an independent budget; – increased trust from business and the public.
Luka-Meleshkivska, Olhopil	– Optimisation of existing revenue sources (tax and non-tax); – implementation of rationality and transparency principles in budget allocation; – formation of a multi-channel financial base resilient to shocks.	– Improved budget manageability; – reduction of inefficient expenditures; – expansion of the revenue base; – better financial forecasting.
Viitivtsi	– Ensuring the most effective use of every hryvnia in the budget; – prioritising social sectors within limited resources; – shifting from maintenance to development of basic services.	– Increased effectiveness of social spending; – reduction of chronic deficits; – establishment of a "minimum quality of life standard" in the hromada.
Ahronomichne	– Maintaining basic governance and public service capacity; – mobilisation of external resources and joint resolution of critical issues; – creating mechanisms for crisis response and resilience.	– Avoidance of default and social collapse; – rationalisation of expenditures through co-operation; – foundations for gradual recovery from crisis.

Source: authors' development

capacity, and management priorities. It can thus be concluded that a universal development scenario is non-existent; rather, each amalgamated hromada (AH) is required to formulate its own strategy based on its actual situation, goals, and institutional potential.

The use of such a table in management practice allows:
– Accurately determining the financial and strategic area in which the hromada operates;
– forming realistic expectations from the measures implemented;
– adapting the portfolio of management decisions to current challenges without placing an excessive burden on the budget.

The proposed expert system introduces a new governance paradigm for strategic planning in rural development. This paradigm is based on objective financial indicators, interdisciplinary analysis, and digital decision-support tools. The developed typology of AHs by the level of fiscal dependency allows for the clear identification of management weaknesses, well-founded priority setting, and the adaptation of the strategic portfolio to current challenges.

The system's practical testing using the example of communities in Vinnytsia Oblast confirmed its effectiveness, demonstrating the potential for developing individualised strategies even under challenging socio-economic conditions.

4. Conclusions

The expert system developed for the strategic management of agro-industrial enterprises and

rural areas provides a comprehensive and adaptive approach to addressing the challenges posed by a dynamic economic environment. By integrating three analytical matrices – "C/LC", "IP/LC" and "C/IP" – the system enables agricultural enterprises to develop precise strategies based on their competitiveness, innovation potential and life cycle stage. This approach facilitates the selection of optimal strategies, ensuring adaptability to market changes and enhancing long-term stability. In rural areas, the system uses the DEA method and a financial capacity typology to categorise hromadas and suggest bespoke development strategies, thereby promoting fiscal autonomy and resilience.

Practical testing in the Vinnytsia Oblast demonstrated the effectiveness of the system in diagnosing challenges, formulating strategies and improving the adaptability of enterprises and hromadas. The scientific novelty lies in the integration of multidimensional analytical tools that combine life cycle dynamics, innovation potential and competitiveness in agribusiness, alongside a structured model for rural development. This dual framework shifts management from a reactive to a proactive approach, providing a robust toolkit for achieving sustainable growth in Ukraine's agro-industrial sector and rural hromadas.

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