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INTEGRATIVE OPPORTUNITIES OF NATIONAL ECONOMIES

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The collective monograph is devoted to the study of modern approaches to the integrative capabilities of the national economy of the country. The presented material covers the issues of the development of scientific and technological cooperation between the EU countries and Ukraine in the context of its post-war recovery, integration strategies in the context of global challenges, inclusive project management capabilities in the development of the national economy, the development of a culture of dignity as a psychological architecture of the integration of national economies, as well as the role of the grain product cluster as a factor in ensuring food security in the context of global integration challenges. The monograph demonstrates the interaction of theoretical principles and applied solutions, reflecting the current issues of the development of integration as one of the main principles of building a modern successful economy. The work summarizes the tools that contribute to the formation of a new integration paradigm based on the combination of economics, culture, management and aimed at countering global challenges.
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ABSTRACT

The collective monograph focuses on the study of the special conditions of modern scientific and technological cooperation of countries, theoretical and methodological substantiation and development of practical recommendations for the formation of effective integration strategies of national economies, the study of inclusive project management as a tool for the transformation of the national economy, the definition of the concept of a culture of dignity as a new psychological architecture of the integration of national economies in the global world, as well as the problem of growth rates and the peculiarities of the functioning of enterprises of the country's grain product cluster in the conditions of modern global challenges. The presented materials cover the tasks of: analysis of the main advantages and problems that contribute to effective scientific and technological cooperation between European countries and Ukraine, calculation of a multifactor model of the impact of this cooperation on the economic development of Ukraine; development of the author's concept of multidimensional adaptive integration, which integrates the theoretical constructs of resilience, strategic autonomy and security integration; research into the methodological foundations of inclusiveness in project management and analysis of international experience and assessment of the relationship between inclusive practices and innovative capacity using the example of countries; proving that dignity ceases to be an ethical "decor" of economic processes and becomes their foundation in modern conditions; proving the priority of the grain product cluster in meeting needs within the country and for increasing exports in the face of modern challenges. The monograph is aimed at systematizing the experience of countries, which ensures increased efficiency in the implementation of integration processes in various sectors of the national economy.

The first section identifies features and develops recommendations for improving scientific and technological cooperation between the EU and Ukraine in the context of its post-war recovery. It is shown that such aspects as the creation of a single monetary union, political union, social aspects of integration, changes in the competitive environment, technological innovations, and intercultural differences are of particular importance for the EU's strategic decisions. It is proven that for Ukraine, which is a fairly young state that is fighting for the right to be recognized as an equal member of global scientific and technological cooperation, especially in the conditions of its post-war recovery, it is the consolidation of industries, the process of integration and enlargement, and the creation of strategic alliances that are a relevant response to global challenges. The presented results can be taken into account when developing scientific and technical cooperation programs.

In the second section, a methodological toolkit for assessing the adaptive potential of integration associations is developed, which includes the Adaptability Index, indicators of institutional flexibility, resource availability, and technical potential for crisis response. The mechanisms of response of leading integration associations to global shocks of various nature were studied, a comparative analysis of adaptive strategies of the EU, ASEAN and the Eurasian Economic Union was carried out, the presence of significant economic effects of the transformation of integration strategies was substantiated, and alternative trajectories of

the evolution of integration processes were identified based on scenario forecasting with a horizon of up to 2030. Practical recommendations were formulated for optimizing integration strategies in the context of the transformation of the global security architecture.

The third section confirms the hypothesis of the positive impact of inclusive governance on human capital development, economic sustainability and innovative growth. The constructed regression model demonstrated a high level of correlation between the inclusion index, human development and innovation index, as well as the multiplicative effect of social diversity. Four approaches to inclusive project management are systematized (socially oriented, institutional, innovative, gender-inclusive). Practical recommendations are developed taking into account international standards and Ukrainian realities, barriers are identified and directions for further research are outlined. The fourth section proves that the digitalization of governance and the growth of the role of algorithms create new risks of the "illusion of technological neutrality", which can level the human dimension of integration. The culture of dignity is proposed as a compass that can ensure a balance between innovation and ethics, technocratic efficiency and humanity. Special attention is paid to historical and cultural factors that influence the formation of trust between nations. A vision of integration processes is proposed not as a technocratic construct, but as a "living organism", in which morality and psychology play a key role. This allows for a broader interpretation of economic phenomena through the prism of humanistic methodology.

The fifth section confirms that the development of models and mechanisms of the grain product cluster for the modernization of agricultural sectors, the processing industry, the selection of methods and tools that contribute to increasing the susceptibility of agribusiness to innovative development, requires appropriate theoretical and methodological support, taking into account the specifics of production in each industry. It is proven that, despite the activation of integration processes in grain product clusters, there is inefficiency in the functioning and collapse of a number of such formations. Practical recommendations are given on generalizing and systematizing the experience of using the mechanism for implementing projects for the formation and development of a grain product cluster by both national and foreign companies that have achieved high results in this area. The summarized results of the monograph can be used in the development of scientific and technical cooperation programs between the EU and Ukraine, optimizing integration strategies in the context of the transformation of the global security architecture, determining the impact of inclusive management on the development of human capital, economic sustainability and innovative growth, interpreting the economic phenomenon through the prism of a humanistic methodology, as well as grain product cluster development programs in countries around the world. The materials of the publication constitute a scientific contribution to the development of the economic theory of integration in the context of modern global challenges.

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CIRCLE OF READERS AND SCOPE OF APPLICATION

The monograph is intended for scientists, teachers, postgraduate students and researchers working in the field of integration of national economies in the face of global challenges. It can also be useful for practicing economists involved in the development and implementation of economic models of integration taking into account modern factors of development of countries.

The publication considers integration not as a static discipline, but as a process of continuous development, in which the latest technological, cultural and economic innovations are combined with analytical thinking and responsibility for the quality of decisions made and programs developed.

INTRODUCTION

Modern integration processes are in a state of deep renewal and adaptation to the requirements of modern global challenges. Today, new aspects of economic, managerial, cultural, and technological development are becoming relevant. Thus, radical economic and political changes in the modern world, the removal of many trade barriers have led to the creation of special conditions for scientific and technological cooperation between countries, which has forced them to reconsider their development strategies and organizational structures. This, in turn, requires theoretical and methodological substantiation and the development of practical recommendations for the formation of effective integration strategies of national economies in the context of modern global challenges. The role of inclusive governance as a tool for the transformation of the national economy is also growing. The concept of a culture of dignity is being formed as a new psychological architecture for the integration of national economies in the global world, which, unlike traditional approaches that focus on institutional mechanisms or economic indicators, integrates three dimensions: behavioral economics, philosophy, and psychology. In addition, given the complexity of socio-economic conditions, one of the most sought-after sectors in the agro-industrial sector is the grain product cluster, which requires the unification of the efforts of all agro-industrial complex entities, coordination of activities and a targeted focus on achieving a high final result, and one of the triggers for solving this problem is the integration of commodity producers, which allows combining all links of the reproductive cycle in the technological chain "production of raw materials – production of finished products" in a single complex.

The subject of the collective monograph is the study of the special conditions of modern scientific and technological cooperation of countries, theoretical and methodological justification and development of practical recommendations for the formation of effective integration strategies of national economies, the study of inclusive project management as a tool for the transformation of the national economy, the definition of the concept of a culture of dignity as a new psychological architecture of the integration of national economies in the global world, as well as the issue of growth rates and the peculiarities of the functioning of enterprises of the country's grain product cluster in the conditions of modern global challenges. The presented materials cover the tasks of analyzing the main advantages and problems that contribute to effective scientific and technological cooperation between European countries and Ukraine, and calculating a multifactor model of the impact of this cooperation on the economic development of Ukraine; developing the author's concept of multidimensional adaptive integration, which integrates the theoretical constructs of resilience, strategic autonomy and security integration; research into the methodological foundations of inclusiveness in project management and analysis of international experience and assessment of the relationship between inclusive practices and innovative capacity using the example of countries; proving that dignity ceases to be an ethical "decor" of economic processes and becomes their foundation in modern conditions; proving the priority of the grain product cluster in meeting needs within the country and for increasing exports in the face of modern challenges. The monograph is aimed at systematizing the

experience of countries, which ensures increased efficiency in the implementation of integration processes in various sectors of the national economy.

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The second section develops a methodological toolkit for assessing the adaptive potential of integration associations, including the Adaptability Index, indicators of institutional flexibility, resource availability and technical potential for crisis response. The mechanisms of response of leading integration associations to global shocks of various nature are studied, a comparative analysis of the adaptive strategies of the EU, ASEAN and the Eurasian Economic Union is carried out, the presence of significant economic effects of the transformation of integration strategies is substantiated, and alternative trajectories of the evolution of integration processes are identified based on scenario forecasting with a horizon of up to 2030. Practical recommendations are formulated for optimizing integration strategies in the context of the transformation of the global security architecture. The third section confirms the hypothesis of the positive impact of inclusive governance on the development of human capital, economic sustainability and innovative growth. The constructed regression model demonstrated a high level of correlation between the inclusion index, human development and innovation index, as well as the multiplicative effect of social diversity. Four approaches to inclusive project management are systematized (socially oriented, institutional, innovative, gender-inclusive). Practical recommendations are developed taking into account international standards and Ukrainian realities, barriers are identified and directions for further research are outlined. The fourth section proves that the digitalization of management and the growth of the role of algorithms create new risks of the "illusion of technology neutrality" that can level the human dimension of integration. The culture of dignity is proposed as a compass that can ensure a balance between innovation and ethics, technocratic efficiency and humanity. Special attention is paid to historical and cultural factors that influence the formation of trust between nations. The vision of integration processes is proposed not as a technocratic construct, but as a "living organism", in which morality and psychology play a key role. This allows for a broader interpretation of economic phenomena through the prism of humanistic methodology.

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inefficiency in the functioning and collapse of a number of such formations. Practical recommendations are given on the generalization and systematization of the experience of using the mechanism for implementing projects for the formation and development of a grain product cluster by both national and foreign companies that have achieved high results in this area.

The methodological basis of the monograph is based on the synthesis of modeling, numerical optimization, statistical analytics, and practical validation. The developed approaches form a closed loop from measurements to decision-making. First, data collection and cleaning take place, then parameter identification and model construction, then optimization of modes and formation of control algorithms, and then testing and correction of solutions taking into account feedback. Such logic allows to adapt the results to the constraints of the production environment and maintain the reproducibility of effects when changing external conditions. Along with the advantages, implementation barriers are also recognized. These include limited funding, heterogeneity of economic development of countries, uneven digital readiness, the need to harmonize with current safety and health standards, issues of cyber security and data integrity. Practical steps to overcome these barriers include phased pilot implementations in selected areas, integration of new methods into existing management systems, and the creation of procedures for quality control of modeling and verification of results. Such a pragmatic approach increases confidence in the proposed solutions and reduces the time to obtain a measurable effect.

The practical significance of the presented developments lies in the possibility of their gradual integration into economic development programs aimed at overcoming global challenges. The materials of the monograph can be used as a methodological basis for economists and specialists in economic integration who are responsible for the development of relevant programs in their countries.

The content of the subsequent sections specifies the above principles at the level of models, algorithms and applied results. The proposed approach harmonizes the processes and systems of integration management through a combination of synthesis, modeling and optimization, which corresponds to the stated issues of the monograph.

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1 DEVELOPMENT OF SCIENTIFIC AND TECHNOLOGICAL COOPERATION BETWEEN EU COUNTRIES AND UKRAINE IN THE CONDITIONS OF ITS POST–WAR RECONSTRUCTION

ABSTRACT

In recent years, significant progress has been made in risk management. Moreover, along with risk management, new concepts have been introduced: risk management, risk economics, risk engineering, risk administration and risk production; a new, basic, general and professional criterion for dividing risks (into economic, engineering, administrative and production) has been established; the interpretation of the elements of risk content has been clarified: certainty and uncertainty, in particular, their minimum and maximum values.

However, most scientists consider the idea of the existence of such two forms of them — complete certainty and complete uncertainty — to be erroneous. Eliminating illusory management practices is necessary to increase the effectiveness of organizational decisions. In conditions of complete certainty, managers may mistakenly believe that all processes are predictable, which leads to excessive bureaucratization. In conditions of complete uncertainty, the illusion of control contributes to making impulsive decisions without relying on analytics and scenarios of events. The elimination of such illusions allows to form adaptive strategies and respond more effectively to changes in the external environment. Therefore, this section has proven the absence of complete certainty and complete uncertainty both outside and inside the risk. For the first time, the widespread idea of the existence of complete certainty and complete uncertainty has been refuted.

The results obtained will deepen our understanding of the essence and content of risk, risk management and risk governance in general, and will increase the efficiency of managing enterprises and organizations in the face of risks by eliminating unnecessary activity in the face of non-existent so-called "complete certainty" and "complete uncertainty". Such results will allow to concentrate attention and resources on the real subject of risk management — only on risk.

KEYWORDS

Risk, complete certainty, complete uncertainty, management, illusory management practice.

1.1 THEORETICAL PRINCIPLES OF UNDERSTANDING AND PRACTICE OF APPLYING RISK MANAGEMENT

It is known that the activity of mankind in the conditions of risks has always been in the past, is now, and in the future, post-industrial, entrepreneurial era will only grow. It is necessary to state with pleasure

that to date, knowledge about risks and management in their conditions have achieved significant success, including with the participation of the authors of this article. Thus, the following have been newly defined: the stages of their development, methods of management in the conditions of risks, the essence, the content of risk — as the unity of two basic elements (uncertainty and certainty); the concept of "risk management" has been clarified — as a composition of new concepts "risk economics", "risk engineering", "risk administration"; a new concept of "risk management" was introduced — as a composition of risk management and risk production and as "management under risk conditions" instead of the erroneous one — "risk management" [1, 2]. The need to increase the effectiveness of risk management was also proven, primarily by establishing a new, basic, general and professional criterion for dividing types of risks into economic, engineering, administrative and production. The interpretation of risk as a unity of two main elements: certainty and uncertainty was also clarified. However, the authors believe that among the types of certainty and uncertainty, the idea of the existence of complete certainty and complete uncertainty (inside the risk) is erroneous? Therefore, the very formulation and solution of this problem becomes an exceptionally relevant problem of risk management.

The authors of this section conducted a scrupulous and capacious analysis of a significant number of literary sources on the basic concepts of risk management [3–6]. It shows that there are various interpretations of the concepts of risk, certainty, uncertainty, complete and incomplete certainty, complete and incomplete uncertainty.

But the main result of the analysis is the conclusion that the literature assumes the existence of three different separate phenomena: risks, complete certainty and complete uncertainty. The authors of the article consider the idea of the existence of complete certainty and complete uncertainty (inside the risk) to be a mistake. Let's give a few quotes that clearly illustrate this mistake.

Thus, in [4] it is stated: "Complete uncertainty is a type of uncertainty characterized by close to zero predictability of events. In conditions of complete uncertainty, economic entities are completely unable to predict in any way both the prospects of their own development and the market as a whole... Complete certainty is characterized by a predictability of an event close to 1 and allows economic entities to predict not only their strategy in the market, but also its development trends with a 100 percent probability". But an enterprise is a phenomenon created by man, and therefore there can be neither complete certainty, nor the absence of fluctuations in the magnitude of results, nor can there be complete uncertainty (this follows from the risk principle).

A similar point of view is present in [7–9]. Here the author is sure that "... one can talk about the conditions of certainty, risk, and uncertainty in decision-making". That is, it is also asserted that certainty and uncertainty exist separately, outside of risk. At the same time, it follows from the whole context that here we are also talking about complete certainty and uncertainty.

Analysis of recent research and publications as a whole shows that the most important unresolved component of the problem. In contrast, the authors of this study, based on their personal many years of experience in researching risks as a subject of risk management, or more precisely, as a subject of all risk management as a whole, put forward a hypothesis about the lack of complete certainty and complete uncertainty in general in the phenomena created by mankind.

1.2 RESEARCH METHODOLOGY

To achieve the aim, the following methodological approach will be followed in the study:

— the meaning of the risk principle is revealed;

— the absence of complete certainty and complete uncertainty outside the risk is proven;

— the absence of complete certainty and complete uncertainty within the risk is proven.

When solving the first problem, which was to establish the risk principle, the authors drew attention to the fact that risks are an integral part of any human activity. This is due to the fact that every phenomenon that arises as a result of human activity always carries a certain risk. Risks have accompanied humanity at all times, since the beginning of the development of civilization, and will remain an important component of our existence in the future. Any phenomenon created by humanity cannot exist without risk, and at the same time there is no risk without a phenomenon. In other words, these two concepts are inseparable.

The principle of inseparability of risk and phenomenon emphasizes: if there is a phenomenon, then it is necessarily accompanied by risk. This applies not only to complex technical or innovative processes, but also to everyday actions. For example, the invention of the car brought with it the risks of road accidents, and the development of digital technologies gave rise to the risks of cyber threats. At the same time, if there is no risk, this means that the phenomenon to which this risk is associated also does not exist. This dependence is explained by the fact that risk is not just a random component, but a natural property of any phenomenon that arises as a result of human activity.

Given this inseparability, a logical question arises: how exactly is risk related to the concepts of certainty and uncertainty? It is especially important to explore these relationships in cases of absolute certainty and absolute uncertainty. After all, it is these extremes that are most often used as theoretical concepts for analyzing complex situations. The answer to this question became the basis for solving the second problem.

The second task was to prove that beyond the risk there is neither complete certainty nor complete uncertainty. To do this, the authors relied on the risk principle established during the solution of the first task. According to this principle, if there are risks, then there must be corresponding phenomena. Among these phenomena there may be such extremes as complete certainty and complete uncertainty.

However, let's imagine a situation where there is no risk at all. In this case, there are no corresponding phenomena, since they are always associated with risk. This means that beyond the risk, it is impossible to exist either absolute certainty or absolute uncertainty. This statement is explained by the fact that the phenomena of complete certainty and complete uncertainty are theoretical constructs that exist only in connection with risk. Without risk, these constructs lose their meaning and cannot actually be realized.

This conclusion is important for understanding the nature of risk and its role in shaping human activity. Outside the risk, the world becomes "empty" in terms of certainty or uncertainty, because their presence is possible only in interaction with risk. Therefore, the statement about absolute certainty or absolute uncertainty in a world where there are no risks makes no sense.

Additionally, the authors considered the question of whether phenomena of complete certainty or complete uncertainty can exist in the risk itself. To do this, they turned to the analysis of the content of risk,

which consists of two main elements — certainty and uncertainty. This means that risk by its nature is a simultaneous combination of these two components.

From the content of risk, it follows that if risk exists, then both of its components must necessarily exist: certainty and uncertainty. This conclusion is based on the concept of "content", which means the set of basic elements of the phenomenon. If even one of these elements disappears, the entire structure of risk collapses. Thus, risk is impossible without the interaction of certainty and uncertainty.

The key point is that none of these elements can completely disappear or become absolute. In other words, certainty cannot be reduced to zero, but it cannot completely replace uncertainty either. Similarly, uncertainty cannot fill the entire risk space, but it cannot be completely absent either. This means that it is impossible to achieve a state of absolute certainty or absolute uncertainty in risk itself.

Risk is a complex phenomenon that is inextricably linked to phenomena created by mankind [10]. Its content is determined by the simultaneous presence of certainty and uncertainty, which cannot exist separately. Outside the risk, neither absolute certainty nor absolute uncertainty is possible, and inside the risk they always coexist in a certain balance. These conclusions emphasize the importance of the risk principle as a key tool for understanding complex processes and phenomena.

The principle of inseparability of risk and phenomenon is a fundamental concept that emphasizes that any phenomenon created by man is always accompanied by a certain degree of risk. This dependence is due to the fact that human activity is always associated with uncertainty, and therefore with the potential for adverse or unpredictable consequences. That is why risk cannot be separated from any human project, discovery or process.

For example, the development of transport technologies, such as cars or airplanes, opened up new opportunities for humanity to move quickly, but at the same time brought with it the risks of accidents, technical malfunctions and security problems. A similar situation is observed in the field of information technology: the creation of computer networks has greatly facilitated the exchange of information, but at the same time the threats of cybercrime have arisen [11]. Even such everyday phenomena as housing construction or agricultural activities involve risks — from possible natural disasters to man-made accidents.

Thus, the established principle of the inseparability of risk and phenomenon is of profound importance for understanding the nature of human activity. It emphasizes that no progress or change can be absolutely safe or completely predictable. Humanity is always left to seek a balance between positive development opportunities and managing potential risks that inevitably arise in the process of creating new phenomena.

The proof of the absence of complete certainty and complete uncertainty outside the risk boundary is based on the principle of the inextricable link between phenomena and risks. Outside the risk boundary, where potential threats or opportunities are not considered, it is impossible to speak of absolute predictability or complete chaos. This is explained by the fact that any phenomenon that is not accompanied by risk actually ceases to exist as a real process or event.

Complete certainty implies the existence of an ideal state in which all factors affecting an event or phenomenon are fully known and controlled. However, in the real world, this is not possible, since there are always unknown variables, even in the simplest situation. For example, even in a stable production process,

unforeseen circumstances may arise, such as equipment breakdowns or external economic changes. The absence of risk here becomes a theoretical abstraction that has no practical meaning. Similarly, complete uncertainty means a state of absolute chaos, where there is no predictability or structure. However, in nature and society, there are always certain patterns and regular relationships that exclude complete chaos. Thus, both complete certainty and complete uncertainty outside the limits of risk become absurd concepts.

Within risk, it is also impossible to achieve a state of absolute certainty or absolute uncertainty. This is explained by the nature of risk itself, which includes the simultaneous interaction of two main components — certainty and uncertainty. It follows from the content of risk that these components are its inseparable components.

Certainty within risk means the presence of partial information about the possible outcomes of an event or process, while uncertainty reflects the inability to predict all possible consequences. None of these components can completely disappear or become absolute. If certainty disappears completely, risk as a phenomenon ceases to exist, since any logical basis for forecasts is lost. On the contrary, if uncertainty disappears, risk also disappears, since all outcomes of the event become predictable.

Thus, neither absolute predictability nor complete chaos are possible even within risk. Risk always functions as a balance between a certain share of certainty and a share of uncertainty, which complement each other.

Effective risk management allows to identify, assess and minimize existing risks by developing response strategies and preventing potential losses. An important tool is the construction of risk forecasting models based on data analysis and the implementation of contingency plans to ensure resilience, in particular supply chains.

The financial sustainability of an organization is characterized by the ability to maintain solvency, ensure continuous operations and meet financial obligations even in crisis conditions. In the logistics sector, this includes cost control, inventory optimization, and management of receivables and payables.

Risk management in this context helps to form financial reserves to cover unforeseen costs, maintain flexibility in financial flows and avoid significant losses from logistics failures. For example, the use of insurance mechanisms or hedging currency risks are practices that support the financial sustainability of logistics operations.

The readiness of a logistics system to develop lies in the ability to quickly adapt to market changes, introduce new technologies and management methods. The assessment of such readiness includes an analysis of financial indicators, organizational flexibility and risk management strategy.

Risk management in this context contributes to effective planning of the expansion of logistics capacities, development of scenarios for adaptation to changes and reduction of the probability of failures during the implementation of innovations. In addition, it allows to avoid overspending of resources and to increase the overall efficiency of management, in particular logistics.

The object of the study is to assess the financial stability and readiness of logistics activities in organizations for development. The proposed two-component methodological approach makes it possible to optimize the assessment of the readiness of organizations for development based on determining a sufficient level of investment, on the one hand, and a balanced level of activity costs, on the other. Thus,

for the first component, it is proposed to use an integral indicator of investment adequacy, the calculation method of which is based on combining the dependencies between the volumes of capital investments and other resource parameters of the activities of enterprises (depreciation deductions, long-term loan capital, non-current assets, equity, etc.). The second component reflects the ratio of material and other operating costs to the total income of logistics activities in organizations.

The study was carried out on the example of motor transport enterprises. The proposed methodological approach was tested, which showed low resource capacity of enterprises. The dynamics of the integral indicator of investment adequacy showed that in general for enterprises engaged in road freight transportation, its level is significantly lower than the normative value, which is equal to 3. Its value on average fluctuated at the level of 1.2–1.7, that is, it was in the range of the absence or limited resources for economic development. This indicates the dominance of survival strategies, not development, among motor transport enterprises, and weak state policy, which does not stimulate investment activity in a legal transparent environment.

The results obtained can be used both at the level of individual logistics organizations and organizational networks, and for an aggregated assessment of the industry as a whole. An additional advantage of the developed two-component methodological approach to assessing the state and readiness of an enterprise for development is the possibility of using different components for each component, differentiating their importance in an integrated assessment, and adjusting target ranges.

As a result of the study, several possible strategies for managing the development of logistics activities in organizations were identified, such as a reserve management strategy, an asset diversification strategy, a profit reinvestment strategy, a strategy for optimizing liabilities and obligations, a risk-oriented liquidity management strategy, and an active liquidity management strategy.

1.3 ASSESSMENT OF SUSTAINABILITY AND READINESS OF LOGISTICS ACTIVITIES IN ORGANIZATIONS FOR DEVELOPMENT: PROBLEMS AND SOLUTIONS

The difficult period of adaptation to modern conditions and requirements for the transport sector will accelerate the processes of transition to a new level of competition in the freight transportation market. Digital transformation is accelerating, consumer preferences are changing, new business models are being introduced [1]. In the future, the competitive environment will be determined by technological modernization, in fact, the restart of infrastructure in general, and transport in particular.

Most organizations have weak financial stability. Despite overcoming the ongoing crisis of unprofitability of motor transport enterprises in the freight transportation market, their profitability remains low, which does not allow forming enough capital to finance development [2].

This situation has led to the emergence of economic and social problems: aggravation of the deficit of working capital; low level of competitiveness and attractiveness for foreign investment; lack of effective policies aimed at stimulating the growth of financial resources; insufficient level of financial potential and economic base.

The negative impact of the ongoing processes has significantly increased the requirements for ensuring the sustainability of commodity supply chains, and in this market the processes of logistics optimization, mergers and acquisitions of transport companies have intensified. A growing trend is the development of e-commerce, wh ich stimulates the control of transport and logistics companies at all links of the supply chain — manufacturer, warehouse, sales centers [3–5]. Increasing investments in modern technologies of logistics supply chains is considered as a tool for improving the quality of transport services, reducing operating costs, and reducing environmental impact.

European initiatives on transport development strategies are supported by large-scale financial resources and various financial instruments for the restoration of the transport sector. The budget of the relevant funds for these purposes is estimated at over 1.8 trillion euros. This further emphasizes the conclusions of this study that the success of the transport sector development critically depends on a consistent state incentive policy, supported by the formation of powerful financial funds and instruments [6–8].

The priority innovative direction of the transport industry development is its digitalization. Accordingly, investments in the implementation of digital technologies in the business processes of transport enterprises will become increasingly important to ensure the maintenance of competitive positions in the market. At the same time, there is a wide range of digital technologies and tools, and their application depends on the type and functional area of logistics activities in organizations. In general, two main models of their activity can be distinguished:

1) organizations that provide goods transportation services;

2) organizations that manage a fleet and provide rental or outsourcing services.

For the first type of organizations, the priority areas of investment in digital technologies are digital tools that allow real-time receipt of data on the delivery of goods, possible obstacles and delays, etc. Such technologies are needed for a quick and timely response to possible problems or changes in the needs of service consumers to avoid delays and unplanned expenses.

For organizations of the second type, investments in digital solutions for monitoring the condition of their vehicles, their intended use, location, etc. are a priority. Such investments are necessary both for control and for the ability to meet modern standards of safety and environmental friendliness of the use of road transport.

Scientific research on the topic under study is important because the economic development of organizations cannot be achieved without innovative development. Low efficiency of spending on technological innovations does not provide opportunities for development. Therefore, it is necessary to take into account not only equipment and technology, but also the organization of the production process. The introduction of innovations requires an increase in sources of capital investment, the expansion of which is impossible without the use of state innovation policy instruments: public-private partnership programs, technological development, and preferential taxation [7, 8].

The current task is to develop a methodological approach to assessing the readiness of organizations for development and recommendations for expanding investment opportunities. The results of such studies are needed in practice, because they are determined by the need for organizations to update fixed assets, the need to transition to modern technologies, the introduction of innovative products and the growth of demand for qualitatively new transport services.

1.4 SCIENTOMETRIC ANALYSIS OF EXISTING PUBLICATIONS ON THE DEVELOPMENT OF METHODOLOGICAL APPROACHES TO ASSESSING THE SUSTAINABILITY AND DEVELOPMENT OF ORGANIZATIONS

International experts note that the development of sustainable transport infrastructure will be based on four dimensions of sustainability: environmental (climate change resilience), social (inclusiveness), institutional (technological development) and economic (productivity and flexibility) [9]. According to their estimates, by 2040 the need for investment in transport infrastructure will amount to up to 2 trillion USD. This is considered a "golden era" of transport infrastructure.

Among the main trends that will determine the development of transport in the EU countries for 2021–2024, the following are highlighted [10]:

1) prioritizing the transition to alternative fuels;

2) ensuring competition in the aviation industry;

3) a modal-neutral approach that promotes sustainable transport development;

4) green financing to increase the sustainability of the EU transport sector.

It should be noted that the current action plan for the implementation of the Transport Strategy provides for the development of multimodal transport technologies and infrastructure complexes to ensure interaction between different modes of transport. And, in particular, paragraph 21 of the plan provides for the partial reorientation of road freight transport to rail and inland waterway transport [11].

In general, the trend in the development of intermodal and multimodal transport also determines the priority for road transport enterprises to invest in projects that will allow them to quickly adapt and integrate into such technologies. The objective priority for investing in development is projects to prepare for the transition to renewable fuels through the renewal of the transport fleet and ensuring compliance with new environmental standards.

The complexity and multifaceted nature of economic development determine the presence of a wide range of scientific interpretations and understandings of such development, for the disclosure of which various algorithms and methods of its assessment are developed and applied. Domestic and foreign researchers use various methodological approaches to assess the financial condition of enterprises, their readiness to implement various strategies of economic development. Thus, the author of the work [12], systematizing methodological approaches to enterprise development, distinguishes the following types: innovative, economic, strategic, marketing and competitive. The author concludes that each of the above approaches or their combination has its own advantages for application, but at the same time reflects only a separate specific effect associated with the development of the enterprise. But the effectiveness of their application will depend primarily on the readiness to implement development strategies on an alternative basis and adapt to new operating conditions. This occurs under the influence of internal and external changes, which complicates the process of assessing the readiness of enterprises for development.

Considering the functioning and development of an enterprise through the prism of competitiveness, methodological approaches are developed to assess the level of such competitiveness. Thus, some researchers note that the competitiveness of an enterprise depends on many factors: technical and technological, organizational and managerial, financial and economic, socio-psychological, natural and geograph-

ical, transport, environmental, industry and market. Therefore, competitiveness cannot be measured by a single statistical indicator [13]. Accordingly, the authors' approach to the need to apply different assessment methods, which are systematized according to two criteria: the degree of objectivity/subjectivity and the type of assessment (quantitative and qualitative), is justified. They thus distinguish 4 groups of methods for assessing competitiveness: objective-quantitative (calculated and calculated-graphic), objective-qualitative (models of structural and strategic analysis), subjective-qualitative and subjective-quantitative.

Different methods have their advantages and disadvantages, and accordingly, their application must correspond to the goals and possibilities of their effective use. Difficulties arise due to the fact that some assessment methods require complex algorithms for calculating performance indicators, and hence more costs for their application. Other methods are less complex, but also with a lower probability of accuracy and validity of their results. This complicates the choice of the optimal method.

Often, the development of an enterprise is considered in the context of assessing its potential. The implementation of this approach is based on the application of various methods for assessing such potential, which, in turn, is also considered by its individual types, in particular: innovative, investment, technological, competitive, marketing, labor, etc.

In the work [14], the author singled out the following principles for assessing the potential for economic development of an enterprise:

1) determining the key properties of the enterprise;

2) considering the potential for economic development of an enterprise as a set of its properties;

3) identifying a criterion functional property;

4) identifying the controllable basic properties of both the enterprise and its components;

5) identifying the uncontrollable basic properties of the enterprise and its components;

6) taking into account external environmental factors;

7) organizing the process of searching for reserves for the enterprise's economic development.

Despite the rather broad interpretation of these principles, they show the systematicity and complexity of the enterprise's potential and, accordingly, methodological approaches and tools for its assessment.

The author also emphasizes the need to use three levels of potential assessment indicators: partial, general, generalizing. Partial will characterize the possibilities of improving the basic properties of the enterprise (in particular, consumer properties of products or services). General will characterize key properties (in particular, financial results, sales volumes, etc.). Generalizing will characterize the criterion properties of the enterprise (for example, its market value).

The author's grouping of methods for assessing the potential of economic development of enterprises includes: the use of individual indicators or their combination; quantitative and qualitative assessment; absolute and comparative assessments; different levels of the hierarchy of assessment indicators, etc. Such diversity opens up wide possibilities for finding effective tools and indicators for assessing the current state or potential of the enterprise at the appropriate stage of its development. But the issue of determining the optimal methodology remains unresolved due to the fact that excessive overload can blur the accuracy and validity of the results of their application when making management decisions regarding strategic and tactical tasks of enterprise development.

In the context of assessing the potential of enterprises, traditional methods are to determine the effectiveness and feasibility of investments, investment projects for individual enterprises. In particular, this involves assessing the payback period of investments, the level of net present value, investment profitability, and systematization of risks for the relevant industry or market of goods/services. Undoubtedly, assessing the effectiveness of investments is critically important for the development of an enterprise, but it is advisable to apply it to specific investments, relevant target goods, services, and markets. The problem remains that such methods should be preceded by an integrated assessment of the state and readiness of the enterprise for development. But investments should serve as the basic criterion and indicator for conducting such assessments.

A number of studies are aimed at developing methodological tools for assessing the state and potential of development, which take into account industry specifics and aspects of the functioning of business entities. In particular, such an approach is disclosed in the works: [15] on the development of agricultural enterprises, [16] on the development and livelihoods of food industry enterprises, etc. There is no single methodological approach to assessing the development of motor transport enterprises, so this issue remains relevant.

In general, it should be noted that the development of methodological approaches to assessing various aspects of the activities and development of enterprises is carried out in accordance with the theoretical basis of the issues under study. And, accordingly, the application of existing and new criteria, indicators, characteristics should be adapted to management tasks, the existing information base for the use of such methodological approaches and tools.

Most researchers justify the need to combine different assessment methods that will provide an acceptable level of validity of conclusions and recommendations regarding the analysis of the current and potential state of development of the enterprise, but this issue remains unresolved.

All this allows to argue that it is advisable to conduct a study dedicated to optimizing the assessment of the readiness of enterprises for development based on the development of a two-component methodological approach that takes into account investment adequacy and material costs. This methodological approach determines the logic of monitoring the sustainability of motor transport enterprises based on the consistency of key economic indicators with the level of investment and achievement of target parameters of structural cost balance. The advantage of this methodological approach is the possibility of using different components for each component, the possibility of adjusting target ranges and establishing different specific weights in the integral assessment [17].

1.5 RESULTS OF THE DEVELOPMENT OF A METHODOLOGICAL APPROACH FOR ASSESSING THE SUSTAINABILITY AND DEVELOPMENT OF ORGANIZATIONS

The aim of the study is to optimize the assessment of the readiness of road transport enterprises for economic development based on a two-component methodological approach. This will make it possible to investigate the level of investment adequacy and balance of the enterprise's costs, as well as develop recommendations for solving existing problems and outlining strategies for further development.

To achieve the aim, the following objectives were set:

— to propose a methodological approach to assessing the readiness of enterprises for development based on the calculation of an integral indicator of investment adequacy and the level of material costs;

— to test the proposed two-component approach to assessing the state and readiness of enterprises for development;

— to develop strategies for managing the development of enterprises.

The object of the study is to assess the financial sustainability and readiness of road transport enterprises for development. Enterprises engaged in freight transportation chronically lack working capital, which increases risks for current activities and blocks investment opportunities in their development strategies. Thus, in general, net working capital for such enterprises has been negative for the last 10 years, which requires the introduction of modern instruments for financing their activities, which will be accessible and effective [18].

The imbalance in the financing model of motor transport enterprises is further exacerbated by the dominance of material intensity of cost price and operating costs. The share of material costs and services takes up about 80% of all operating costs of the enterprise, which forms a dependence on working capital and the settlement system at enterprises. But the problem of settlements for the provided services for cargo transportation is acute for the studied industry enterprises, whose current assets consist of accounts receivable on average by 2/3. About 20% is accumulated in inventories, highly liquid assets are quite limited [18]. Such a cost structure requires additional working capital to pay VAT and excise duties when making material costs, although it reduces the real burden of value added tax. At the same time, it increases the dependence of enterprises on the level of tax burden by direct taxes — on profit, on property, on the payroll.

The study used methods of generalization (to systematize modern mechanisms for the formation and implementation of economic development), statistical observations (to structure data on the financial activities of motor transport enterprises in Ukraine), a systematic approach (to study the principles of implementing economic development), and the method of expert assessments (to determine the criteria for the economic development of motor transport enterprises and internal indicators of the effectiveness of their activities).

The proposed methodological approach to assessing the state and readiness of motor transport enterprises for development consists, on the one hand, in determining a sufficient level of investment for development, and on the other, a balanced level of activity costs. To take into account the first component, it is proposed to use an integral indicator of investment adequacy, compliance with the minimum regulatory level of which will confirm the accumulation of a sufficient and sustainable level of investment at the enterprise. The components of the integral indicator of investment adequacy are the ratio of capital investments with such parameters as: depreciation, long-term loan capital, non-current assets and equity. The normative minimum level of the integral indicator of investment adequacy of the enterprise will depend on the specified parameters of its components, which allows for multivariate calculations. The proposed integral indicator can be used both at the level of individual enterprises and for an aggregated assessment of the industry as a whole. Taking into account the second component involves determining the level of material costs as the ratio of material and other operating costs to the total amount of income from all types of activity at the enterprise.

1.6 RESULTS OF RESEARCH ON THE USE OF THE PROPOSED METHODOLOGICAL APPROACH BASED ON A TWO–COMPONENT MODEL

The methodological approach to assessing the state and readiness of motor transport enterprises for development consists in determining two components: a sufficient level of investment for development and a balanced level of activity costs.

Definition of the integral indicator of investment adequacy.

The integral indicator of investment adequacy is calculated as follows:

$$IS_t = \sum_{i=1}^{n} \frac{CI_t}{SD_{it}} \cdot P_{it} + \sum_{j=1}^{m} \frac{SD_{jt}}{CI_t} \cdot P_{jt}, \quad (1.1)$$

where IS_t – integral indicator of investment adequacy in the t-th period; CI_t – capital investment in the t-period; P_{it} – weight of the i-th type of resource for the integral indicator of investment adequacy for development in the t-th period; $i = 1, 2, ..., n$; SD_{it} – indicators of the i-th type of development resources in the t-th period; SD_{jt} – indicators of the j-th type of development resources in the t-th period; P_{jt} – weight of the j-th type of resource for the integral indicator of investment adequacy for development in the t-th period; $j = 1, 2, .., m$.

One of the options for the normative level of the integral indicator of investment adequacy is given in **Table 1.1**.

Table 1.1 Normative level of the integral indicator of investment adequacy

Components of the integral indicator of investment adequacy	Calculation of indicators	Minimum level	Weight	Contribution to the integrated indicator
1	2	3	4	5 (gr.3*gr.4)
Depreciation adequacy	Ratio of capital investments to depreciation deductions	2.5	0.25	0.625
Adequacy of long-term loan capital	Ratio of capital investments to long-term debt capital	4	0.25	1.0
Production adequacy	Ratio of non-current assets to capital investments	3.5	0.25	0.875
Equity adequacy	Ratio of equity to capital investments	2	0.25	0.5
Integral indicator of investment adequacy	–	–	1	3.0

Source: compiled by the authors

The first component of the integral indicator of investment adequacy allows to assess depreciation adequacy through the ratio of the annual volumes of capital investments of the enterprise and the volumes

of depreciation deductions. The target minimum level for this ratio is set at 2.5, based on the logic of the formation of its components. Thus, depreciation deductions show only the actual level of wear and tear of existing means of production (fixed assets) formed in previous years. Accordingly, capital investments at the level of depreciation deductions will not ensure even a simple reproduction of fixed assets. Especially in conditions of their fairly rapid depreciation, both moral and technological, and physical.

Therefore, capital investments should not be less than 2.5 times higher than the annual volumes of depreciation deductions. There are certain risks for enterprises that have practically worn out fixed assets and, accordingly, minimal depreciation deductions. This can lead to a wide range of values for this component. This feature is generally inherent in indicators that reflect the ratio between different financial and economic indicators of the activities of enterprises. Therefore, it is advisable to use limit levels of the ratio, in particular, if they exceed 3–4 times the minimum target standard, then such a three-fold minimum is applied, and not the actual result.

The second component of the integral assessment allows to assess the adequacy of long-term loan capital through the ratio of annual volumes of capital investments and accumulated long-term liabilities of the enterprise. Similarly to the previous ratio, capital investments should exceed such liabilities several times, which will indicate an active investment strategy aimed at the economic development of the enterprise.

The next component of the integral assessment is aimed at determining production adequacy through the ratio of the cost of non-current assets and capital investments. The inverse ratio is used here, since this allows to apply comparable weighted rates and target standards. The proposed target standard may be a 2–4-fold excess of assets over capital investments and will depend on the need for fixed assets for the production of goods or the provision of services. Thus, for motor transport enterprises, especially medium and large ones, the presence of a modern transport fleet and its renewal is a critically important condition for maintaining competitiveness, market positions and implementing development strategies.

The next component of the integral assessment is the adequacy of equity, which is assessed through the ratio of equity and capital investments. Similarly to the previous ratio, compliance with the parameters of financial autonomy requires an adequate level of equity. Accordingly, a multiple excess of equity over capital investments is acceptable.

In general, the use of different regulatory limits allows for multivariate calculations and evaluation of results in accordance with the goals and strategies of economic development of enterprises.

To calculate the integral indicator of investment adequacy, the same specific weight of its individual components (ratio) was used, i.e. each of them was 25% (0.25). At the same time, different specific weights can be used for research, as well as expanding the components of the integral indicator. Four components of the integral indicator were used. Accordingly, the minimum normative value of the integral indicator of investment adequacy is 3. And the higher the value of this indicator, the better the potential of the enterprise to implement its economic development strategy, and therefore, a more effective mechanism for managing its economic development is used.

In this case, it seems appropriate to supplement the minimum target level with a sufficient level, in particular, which will be twice as high as the minimum. Conceptually, this is shown in **Fig. 1.1**.

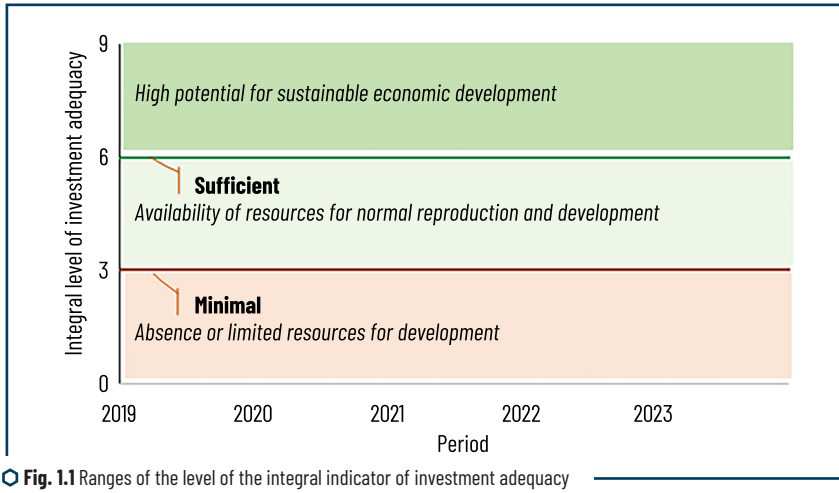

Fig. 1.1 Ranges of the level of the integral indicator of investment adequacy

Source: developed by the authors

This will allow to obtain three ranges for the integral indicator:

1) less than the minimum level – the actual value in this range will indicate the absence or significant limitation of resources for development at the enterprise;

2) between the minimum and sufficient levels – the actual value in this range will demonstrate the availability of resources for normal reproduction and development of the enterprise;

3) above the sufficient level – the actual value in this range will demonstrate a high potential for sustainable development of the enterprise.

Determining the level of material costs.

Taking into account the second component of the methodological approach to assessing the state and readiness of enterprises for development involves determining the level of material costs, the calculation of which is proposed to be carried out as follows:

$$CL_t = \frac{MC_t + OC_t}{I_t} \cdot 100\%, \quad (1.2)$$

where CL_t – level of material costs in the t-th period; MC_t – volume of material costs and costs for payment of services used in production in the t-th period; OC_t – volume of other operating expenses in the t-th period; I_t – total amount of income from all types of activities in the t-th period.

Thus, the level of material cost is the ratio of material and other operating expenses to the total amount of income of the enterprise. As with the first component, it is possible to apply only the minimum target standard or to apply several ranges (**Fig. 1.2**).

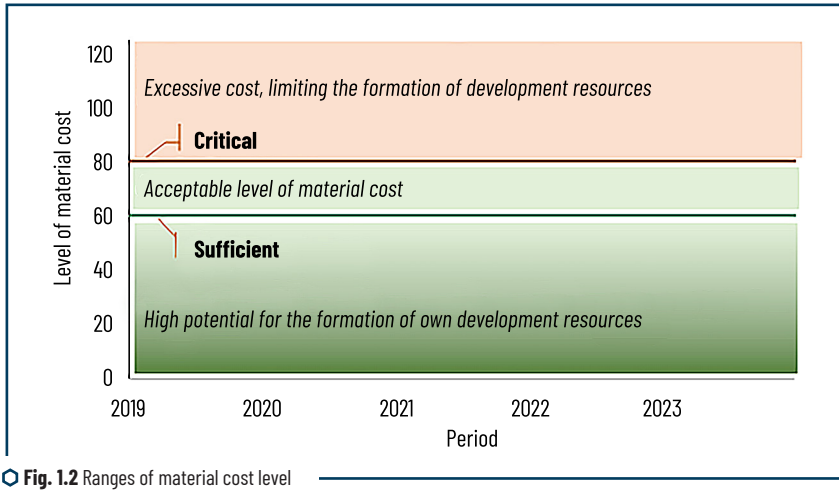

Fig. 1.2 Ranges of material cost level

Source: developed by the authors

So, actual values of the material cost level less than 50% will indicate the presence of a high potential for the formation of the enterprise's own development resources. Values at the level of 50–75% will indicate an acceptable level of material cost, and above 75% will mean a critical level and excessive cost, which limits the formation of sufficient development resources at the enterprise.

The information base for calculating the material cost level is the data of the report on the financial results of the enterprises [19]. Sources of input data for applying the proposed methodological approach to assessing the state and readiness of enterprises for development are given in **Table 1.2**.

Table 1.2 Input data for assessing the state and readiness of enterprises for development

No.	Indicator	Reporting form	Line code
1	2	3	4
1	Integral indicator of investment adequacy		
1.1	Capital investments	Notes to the reporting	–
1.2	Depreciation and amortization	Financial statement (form 2)	2515
1.3	Profit before tax		2290/2295
1.4	Non-current assets	Company balance sheet	1095
1.5	Equity		1495
1.6	Long-term debt capital		1595

Continuation of Table 1.2

1	2	3	4
2	Level of material costs		
2.1	Material costs and costs of services	Financial statement (form 2)	2500
2.2	Other operating expenses		2520
2.3	Net income from sales of products (goods, works, services)		2000
2.4	Other income from operating activities		2105, 2110, 2111, 2112, 2120, 2121, 2130, 2180
2.5	Income from financial activities		2200, 2220
2.6	Other income		2240

Source: compiled by the authors

A certain problem for assessing the state and readiness of enterprises for economic development for external experts and researchers is the rather veiled data on investments in general, and capital investments in particular, in the financial statements of enterprises. On the one hand, such data are quite confidential and require proper protection of commercial interests.

1.7 TESTING THE PROPOSED TWO–COMPONENT METHODOLOGICAL APPROACH TO ASSESSING THE READINESS OF ORGANIZATIONS FOR DEVELOPMENT

The testing of the methodological approach showed low resource capacity of the studied enterprises.

Thus, the dynamics of the integral indicator of investment adequacy showed that in general for enterprises engaged in road freight transportation, its level is significantly lower than the target normative value.

In particular, in 2013 it was 2.1 points with a minimum level of 3 points. And during 2015—2023 its value on average ranged from 1.2 to 1.7, that is, it was in the range of absence or limited resources for economic development [18]. This confirms the widespread practice of domestic enterprises in general to rely on internal resources for financing investments. In particular, in 2020, only 6.6% of capital investments in the economy as a whole were financed by bank loans and other loans [18].

The calculation of the second component of assessing the state and readiness of enterprises for development based on aggregated data for freight road transportation enterprises in Ukraine showed the following. The overall level of material costs of the specified type of economic activity is quite moderate and during 2013—2023 did not exceed 40% [18]. This confirms the presence of the potential for ensuring the efficiency and profitability of providing freight transportation services by road transport. At the same time, the application of the developed approach to the reporting of individual motor transport enterprises showed results that differ from industry-wide calculations.

The calculations were carried out using data from three motor transport enterprises from different regions of Ukraine and with different potential: Kyiv Production Company Rapid, PJSC ATP 11263, Dnipro, PJSC Chernihiv Motor Transport Enterprise 17462. The calculation of the integral indicator of investment adequacy showed that during 2018–2023 the studied enterprises did not reach the target regulatory level (**Table 1.3**).

Table 1.3 Average level of indicators for assessing the state and readiness for development for individual enterprises during 2018–2023

Indicators / enterprises	Value
Integral indicator of investment adequacy	Standard level > 3
PJSC "Kyiv Production Company "Rapid", Kyiv	2.4
PJSC "Chernihiv Motor Transport Enterprise 17462"	2.0
PJSC "ATP 11263", Dnipro	2.7
Level of material costs of the enterprise's activities	Standard level < 60
PJSC "Kyiv Production Company "Rapid", Kyiv	63.9
PJSC "Chernihiv Motor Transport Enterprise 17462"	54.5
PJSC "ATP 11263", Dnipro	74.3

Source: compiled by the authors based on enterprise reporting [19]

In addition, more powerful enterprises from Kyiv and Dnipro generally have a higher level of the investment adequacy indicator, which confirms the feasibility of building potential and investment opportunities. Analysis of the integral indicator of investment adequacy by individual components in the context of the studied enterprises shows significant differences in their business models and ability to implement development strategies (**Table 1.4**).

Table 1.4 Assessment of compliance with the regulatory level of individual components of the integral indicator of investment adequacy for individual enterprises during 2018–2023

Indicators / enterprises	Depreciation adequacy	Long-term debt capital adequacy	Production adequacy	Equity adequacy
Standard level	> 2.5	> 4	> 3.5	> 2
PJSC "Kyiv Production Company "Rapid", Kyiv	4.79	2.24	1.36	0.91
PJSC "Chernihiv Motor Transport Enterprise 17462"	1.23	2.13	5.03	3.41
PJSC "ATP 11263", Dnipro	0.98	0.40	5.47	3.68

Source: compiled by the authors based on enterprise reporting [19]

So, PJSC "Kyiv Production Company "Rapid" in 2018–2023 has a high level of depreciation adequacy, which was achieved primarily due to active investment activity. The enterprise, while maintaining a

traditionally low share of depreciation deductions in the structure of operating expenses for the industry, directs resources to capital investments that are several times higher than the annual depreciation of fixed assets. The enterprise also uses long-term loan resources more actively, although their volumes are somewhat lower than capital investments.

The greatest influence on the formation of the integral indicator of investment adequacy for PJSC "Chernihiv Motor Transport Enterprise 17462" and PJSC "ATP 11263" was production adequacy and equity adequacy. In particular, during the period under study, these indicators exceeded the target standard. Probably, enterprises are serious about maintaining an appropriate level of financial autonomy and minimizing risks associated with obligations to creditors.

Analysis of financial statements of transport enterprises showed that most of them do not provide open data on their capital investments, which complicates the analysis of their activities by external experts. Therefore, their investment activity can be evidenced by data on the renewal of fixed assets, cash flows from investment and financial activities, etc.

For PJSC "Chernihiv Motor Transport Enterprise 17462", the results of assessments of the integral indicator of investment adequacy by components are largely comparable with the studied enterprise from the city of Dnipro. In general, it should be noted that an important aspect of applying the developed methodological approach is a sufficient information base, primarily regarding the volumes of capital investments or another aggregate indicator of investment volumes.

The assessment of the studied enterprises showed that the problem of excessive cost is quite relevant. Thus, the level of material costs for enterprises is almost twice as high as that calculated for the freight road transportation industry as a whole. In particular, for PJSC "ATP 11263" it is almost 75%, that is, the costs of fuel, spare parts and other material costs make up almost 3/4 of the total revenue of the enterprise. The minimum target standard of the level of material costs is not observed for PJSC "Kyiv Production Company "Rapid". And only PJSC "Chernihiv Motor Transport Enterprise 17462" has a level of material costs lower than 60%, but also significantly exceeds the average industry level.

Calculation of the integral indicator of investment adequacy and the level of material costs for individual ATPs confirms the conclusions obtained about their weak investment readiness to implement ambitious strategies of economic development in the freight transportation market. This increases the risks of further technological lag of enterprises in the industry, the preservation of non-equivalent exchange and pressure of the transport sector on all other related sectors of the economy and markets, and the limitation of the resource base for the formation of budgets at various levels.

DISCUSSION OF THE RESULTS OF IMPLEMENTING A TWO-COMPONENT METHODOLOGICAL APPROACH TO ASSESSING THE READINESS OF ORGANIZATIONS FOR DEVELOPMENT

A methodological approach to assessing the sustainability of organizations based on a two-component assessment is substantiated, which consists, on the one hand, in determining a sufficient level of investment for development, and on the other, a balanced level of activity costs.

For the first component (2.1), it is proposed to use an integral indicator of investment adequacy. The methodology for its calculation is based on combining the dependencies between the volumes of capital investments and other parameters of activity (depreciation deductions, long-term loan capital, non-current assets, equity, etc.). The normative minimum level of the integral indicator of investment adequacy will depend on the specified parameters of its components, which allows for multivariate calculations. One of the options for the normative level of the integral indicator is given in **Table 1.1**. The calculation was carried production adequacy, adequacy of equity. Under these conditions, the integral indicator of investment adequacy is determined at the level of 3.0. The ranges of the level of the integral indicator of investment adequacy are proposed: minimum, sufficient, high (**Fig. 1.1**).

The second component (2.2) reflects the ratio of material and other operating costs to the total income of the enterprise. It is possible to apply the minimum (critical) target standard, which is set at 60%, or to apply several ranges (**Fig. 1.2**): sufficient, acceptable, critical.

An assessment of the dynamics of volumes and the level of material costs for freight road transportation enterprises in Ukraine was carried out, based on the results of which it can be concluded that during 2013–2023 the level of material costs did not exceed 40%. This confirms the potential for ensuring the efficiency and profitability of providing freight transportation services by road. At the same time, the application of the developed approach to reporting by individual road transport enterprises showed results that differ from industry-wide calculations.

The sustainability of road transport enterprises was monitored based on the consistency of key economic indicators with the level of investment and the achievement of target parameters of the structural balance of its costs. It was found that the majority of road transport enterprises have weak financial stability.

Three road transport enterprises from different regions of Ukraine and with different potential were selected for the study: PJSC "Kyiv Production Company "Rapid", Kyiv, PJSC "ATP 11263", Dnipro, PJSC "Chernihiv Road Transport Enterprise 17462".

Testing of the proposed two-component assessment of the state and readiness of enterprises for development showed their low resource capacity and the presence of the problem of excessive cost (**Table 1.3**). Thus, the level of material costs for enterprises is almost twice as high as that calculated for the freight road transportation industry as a whole. The assessment of compliance with the regulatory level of individual components of the integral indicator of investment adequacy for the studied motor transport enterprises in 2018–2023 is presented in **Table 1.4**.

The dynamics of the integral indicator of investment adequacy showed that, in general, for enterprises engaged in road freight transportation, its level is significantly lower than the normative value. This indicates the dominance of survival strategies among enterprises, rather than development, and weak state policy that does not stimulate active investment in a legal transparent environment.

It is proposed to take into account the developed approach in the implementation of state support for enterprises that actively invest, increase legal turnover, income and labor costs. Benefits can be introduced for enterprises that have higher than the normative values of the developed indicators and will adhere to such conditions for a long period. In particular, if they are fulfilled for three or more years, such enterprises may be exempted from paying income tax if they are invested in development.

The developed two-component methodological approach makes it possible to optimize the assessment of the readiness of motor transport enterprises for economic development. Based on the interpretation of economic development as a transition to a new qualitative state and new possibilities for the functioning of the enterprise, the basis for its implementation is a sufficient level of investment and the availability of sources of their financing. And the necessary result of the success of such investments should be a more balanced structure of operating costs, which will confirm the systematicity, long-term nature and durability of changes.

The development of research using the proposed methodological approach is that its use will allow rationalizing the mechanism of economic development management and more clearly identifying the correspondence of current and projected performance indicators of both domestic and foreign enterprises to their development goals.

The limitations of the developed methodological approach include the impossibility of including profitability as the main internal resource for financing the development of the enterprise in the integrated assessment of the adequacy of profitability. This component quite organically corresponds to the task of assessing the integral indicator of investment adequacy. But its practical application is complicated by possible losses of the enterprise or minimum profit values. This is a fairly typical situation for many motor transport enterprises, which will actually lead to excessive values of this ratio and distortion of the results obtained. Therefore, its application requires the availability of adequate data on the profit of enterprises and their proper calibration.

The disadvantages include the fact that the problem for assessing the readiness of enterprises for development for external experts is the rather veiled data on investments in general and capital investments in particular in financial statements.

STRATEGICALLY–ORIENTED MANAGEMENT OF ORGANIZATIONAL DEVELOPMENT

Strategically-oriented management of organizational development is a scientifically substantiated influence of management on the socio-economic development of an organization, which ensures long-term, sustainable growth of the results of production and commercial activities. The development management system consists of interconnected subsystems: production, technological, financial, innovation, communication, structural and organizational, marketing, personnel, legal support, economic, socio-psychological, motivational subsystems [20].

The main tools of strategically-oriented management of development in order to achieve the main target benchmarks are the development and implementation of appropriate strategies. Organizations that have a strategy and implement strategically-oriented management of activities always have the opportunity to act consistently and systematically both in the internal environment and in the conditions of a changing external environment, which increases the likelihood of achieving the set goals for further development.

Let's consider the strategies that can be implemented by an organization to ensure financial stability and optimize resources:

1. The reserve management strategy involves an active process of accumulating and managing financial reserves to ensure financial stability its obligations. The main provisions are presented in **Fig. 1.3**.

2. The asset diversification strategy consists of distributing investments between different asset classes in order to reduce risk and ensure greater liquidity. The main provisions are presented in **Fig. 1.4**.

3. The profit reinvestment strategy involves the redistribution of profit received from activities in order to maintain or increase the organization's liquid assets. The main goal is to use the cash that the enterprise already has to generate additional profit. The main provisions of this strategy are presented in **Fig. 1.5**.

4. The strategy of optimizing liabilities and obligations is aimed at balancing the structure of the organization's liabilities and assets in order to ensure an optimal balance between the liquidity of assets and their financial stability. This strategy can help reduce financial costs, increase profitability and improve financial risk management. The main provisions of the strategy are presented in **Fig. 1.6**.

5. The risk-based liquidity management strategy emphasizes control over risks associated with liquidity, in particular ensuring financial stability in a changing financial environment, and helps manage the liquidity of assets in conditions of increasing risk. The main provisions of the strategy are presented in **Fig. 1.7**.

6. The strategy of active asset liquidity management involves active investment and management of liquid assets to ensure maximum efficiency and profitability, as well as optimization of the organization's risk. The main provisions of the strategy are presented.

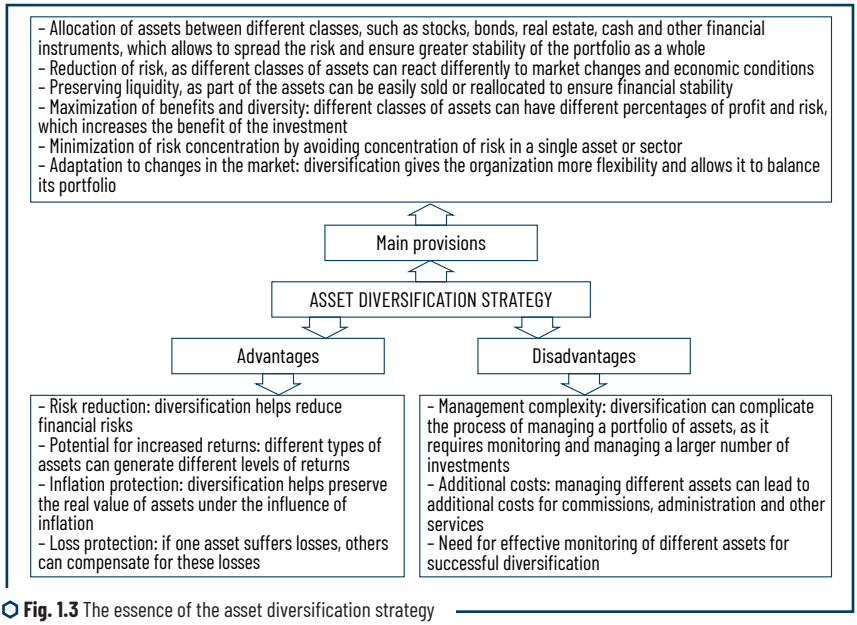

Fig. 1.3 The essence of the asset diversification strategy

Source: compiled by the authors

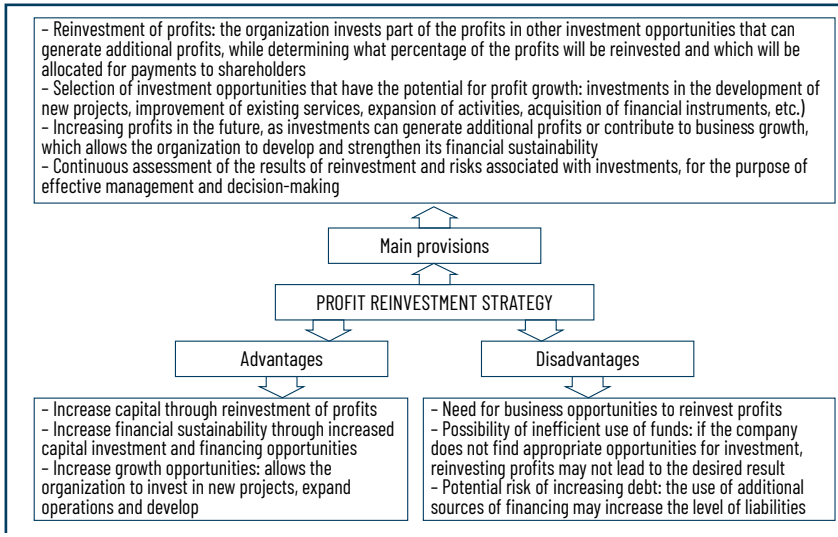

Fig. 1.4 The essence of the profit reinvestment strategy

Source: compiled by the authors

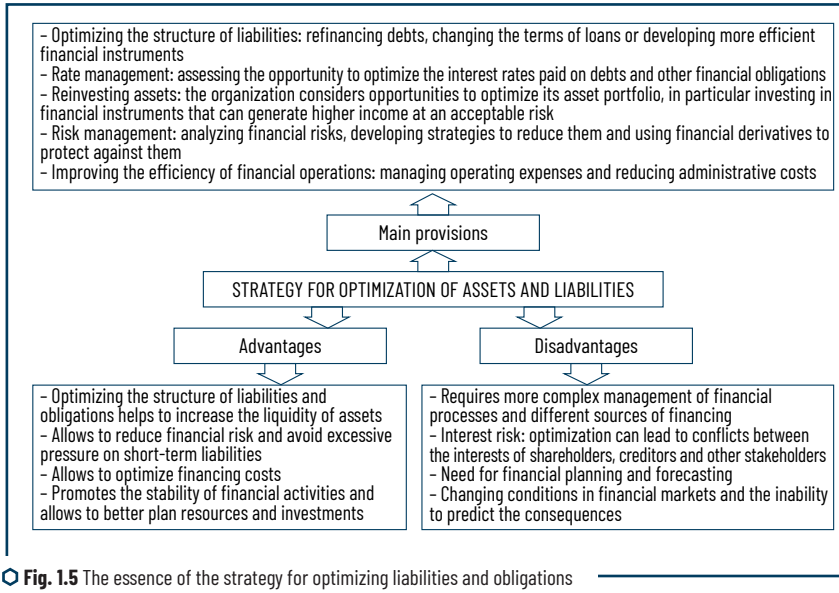

Fig. 1.5 The essence of the strategy for optimizing liabilities and obligations

Source: compiled by the authors

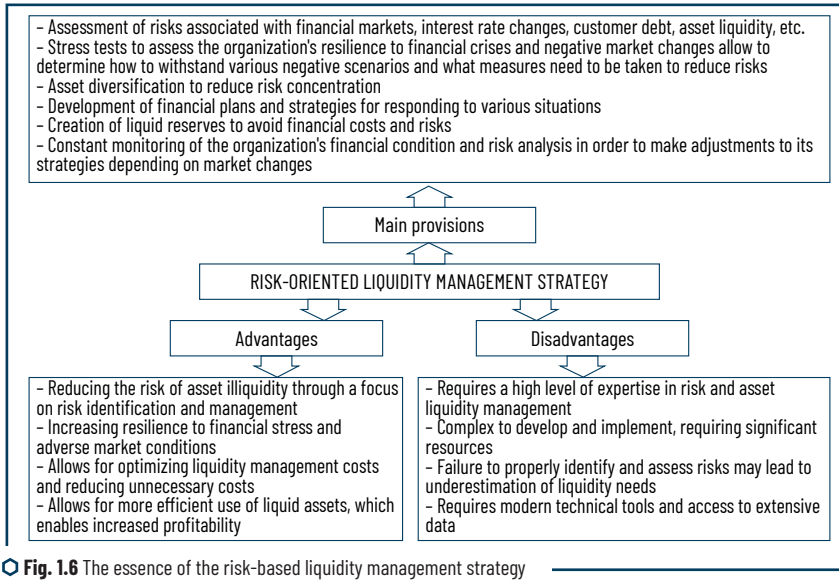

Fig. 1.6 The essence of the risk-based liquidity management strategy

Source: compiled by the authors

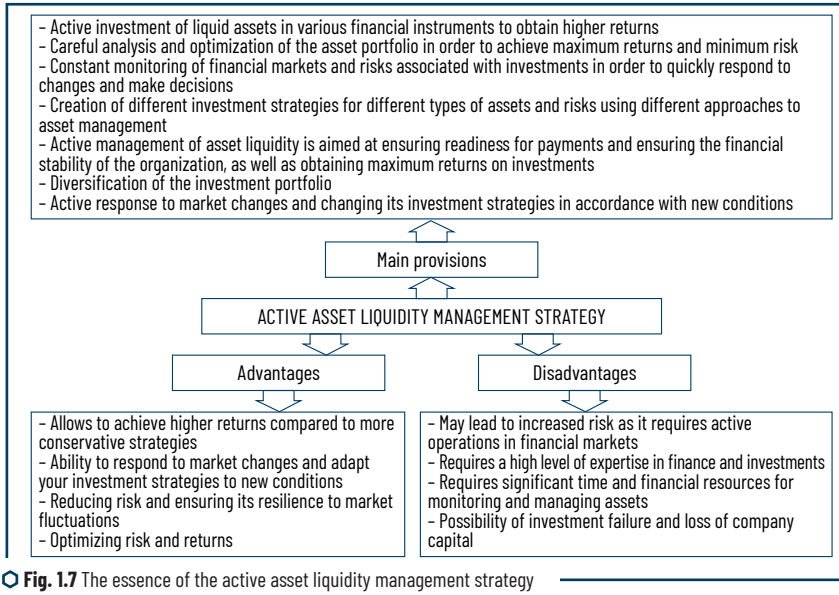

Fig. 1.7 The essence of the active asset liquidity management strategy

Source: compiled by the authors

The study determined that the implementation of combined strategies can be a key factor in achieving financial stability and ensuring the development of organizations. The need for further improvement of resource management strategies, careful monitoring and risk management, as well as the development of the ability to adapt different strategies to the unique conditions and needs of their activities is important.

To further strengthen financial stability and maintain competitiveness, it is worth considering opportunities for the implementation and improvement of innovative strategies. The emphasis on the implementation of advanced technologies can not only provide an advantage in the market, but also help solve possible challenges and make any organization less vulnerable to fluctuations in the external environment. The key drivers of success and sustainable development in the future may be the expansion of markets and the ability to implement innovations.

As a result of the study, a two-component methodological approach was developed, which makes it possible to optimize the assessment of the readiness of enterprises for development based on the calculation of the integral indicator of investment adequacy and the level of material cost. The integral indicator of investment adequacy was calculated based on the comparison of depreciation charges, equity, long-term loan capital, non-current assets with the size of capital investments. The level of material cost was determined based on the comparison of material and other operating costs with the income of the enterprise.

The proposed methodological approach was tested, which showed the low resource capacity of enterprises. The dynamics of the integral indicator of investment adequacy showed that in general for enterprises engaged in road freight transportation, its level is significantly lower than the normative value. This indicates the dominance of survival strategies, not development, among motor transport enterprises, and weak state policy, which does not stimulate investment activity in the legal environment. The advantage of the developed methodological approach is the possibility of using different components for each component, setting different weights in the integral assessment, and the possibility of adjusting target ranges.

Strategies for managing the development of the organization have been developed: a reserve management strategy, an asset diversification strategy, a profit reinvestment strategy, a strategy for optimizing liabilities and obligations, a risk-oriented liquidity management strategy, and an active liquidity management strategy. The implementation of combined strategies can be a key factor in achieving financial stability, optimal risk management, and the possibility of further development of organizations.

The destabilization of the geopolitical, socio-economic and security situation in the world has exacerbated the issue of sustainable development of regional economies and deepening their interaction. Ensuring the growth of the national economy as a whole and individual regions in particular makes the search for mechanisms aimed specifically at internal sources relevant. Spatial development is gaining particular importance due to the increasing role of transport infrastructure in ensuring the economic growth of regions.

The socio-economic heterogeneity of regional systems plays a decisive role in the formation of mechanisms for ensuring economic growth, which determines the diversity and contradictions of the effects of transport infrastructure on them. This is expressed in the fact that similar infrastructure facilities in different regions can have different organizational and economic effects. Thus, the appearance of a road can

lead to the acceleration of material flows, thereby contributing to the development of the region's economy, and on the other hand, can stimulate an accelerated outflow of population. At the same time, the principles of managing social development and economic growth of regions obtained in practice do not allow to take into account the functional diversity and inconsistency of the effects of transport infrastructure and thereby complicate the search for effective mechanisms for ensuring regional development. growth based on the development of transport infrastructure.

Therefore, the study focuses on the actualization of the need to introduce innovative mechanisms into the economy of regions by determining the conditions necessary and sufficient for the implementation of the role of transport infrastructure as one of the sources of sustainable economic growth. In this regard, the knowledge of the essence and patterns of the mutual influence of transport and regional economic development is of great theoretical and practical interest.

1.8 CONDITIONS AND FEATURES OF ENSURING ECONOMIC GROWTH OF TRANSPORT INFRASTRUCTURE

At the beginning of our study, the task is to understand the conditions that allow transport infrastructure to be interconnected with regional economic systems, and to formulate a general concept of improving mechanisms for ensuring economic growth of regions based on the development of transport infrastructure.

It should be noted that one of the conditions, in particular, is the need to take into account the stability of the inflationary or recessionary gap in which various regional territorial entities are located. The state when prices in some regions exceed the equilibrium, and aggregate demand consistently lags behind supply, is accompanied in other regions by a state when prices are lower than the equilibrium, and demand is constantly not satisfied.

The difference in conditions also requires different mechanisms for activating economic growth. The main mechanism for stimulating growth in regions with insufficient supply is the stimulation of aggregate demand. It is characteristic of such regions that infrastructure development is carried out by private agents.

As an example, it is possible to cite the process of formation in the transport infrastructure of the function of ensuring the movement and distribution of goods (associated with the development of logistics and trade). Successful resolution of issues of stimulating growth on the basis of this mechanism in individual regions has initiated interest in it as a basis for regional development [1]. However, this mechanism, as a national practice of managing regional development, cannot always ensure the growth and development of the entire complex of regional economic systems.

The main feature of regions in the inflationary gap is that stimulating demand negatively affects their economic system, since demand already exceeds supply. Such regions need targeted state investments, including for the development of transport infrastructure. The main mechanisms here should be aimed at expanding the capabilities of regional industrial production, taking into account the established industry specifics and stimulating interregional industrial cooperation.

In addition to the above-mentioned features of infrastructure development in different regions, one should not lose sight of the implementation of state interests in general. An important factor in the formation of an economically integrated space is the transport infrastructure, which provides living conditions and economic activity in the regions, contributes to the creation of a favorable investment environment and is a condition for the expansion of industrial and social structures. The formation of economic integrity and the establishment of regular interactions mean the strengthening of interdependence and the development of interregional production interactions.

Thus, it can be noted that the dynamics of the development of transport infrastructure in some regions and the parameters of the economic situation in other regions are mutually determining (the situation in each region depends on decisions and events in other regions). At the same time, it is not possible to forget about the internal property of regional economic systems, namely the possibility of mutually beneficial exchange. And here the development of transport infrastructure expands the possibilities of beneficial interaction for all regions through the formation of a single economic space and the deepening of interregional cooperation.

In addition to the tasks of the global and national division of labor and the state task of connecting the country's territory, there are tasks of lower territorial levels. In this context, the development of transport infrastructure should be linked to the economic level of the regional system, the goals set for it, the scale of the existing and prospective production potential. During periods of crisis and post-crisis stages of development, the need for state participation in economic regulation increases sharply, since the state is the only agent capable of focusing on systemic goals under any circumstances. By implementing infrastructure projects and ensuring the integrity of the territory, the state contributes to reducing uncertainty and lays the basic foundation for overcoming crisis phenomena.

Next, it is possible to highlight the following essential condition that must be taken into account when forming mechanisms for activating regional growth. It consists in the mutual influence of economic systems of different levels and different regions, which can manifest itself in the interregional movement of population, resources, and investments. Thus, when implementing some regulatory influences in the field of transport infrastructure, it is necessary to take into account both internal and interregional flows of population and investment. In particular, the construction of highways in remote and depressed areas of the country is often accompanied by an outflow of population. That is, measures to develop transport infrastructure to achieve the goal of its attraction and consolidation should be accompanied by additional solutions that could stimulate such effects.

In addition to taking into account the conditions of regional economic systems and the specifics of interregional cooperation, another necessary condition for activating regional growth through the development of transport infrastructure is the inclusion of the regional aspect in the system of public administration. Studies show that the effectiveness of the same measure can be assessed differently by different agents. That is, the effectiveness of measures cannot be assessed according to conditional principles. For example, the construction of a relevant infrastructure facility may have a negative commercial effect, but a positive budgetary effect, for example, in the case when the city (regional) authorities decide to introduce a fee for the passage of commercial transport. Otherwise, the construction of a highway may

require the demolition of some industrial building, but it can increase the transport accessibility and attractiveness of the territory for the population, stimulate the organization of new service enterprises along the route (public catering, car workshops), which can lead to an increase in the standard of living, income, population, land value and an increase in tax revenues. Thus, with negative effects for one entity, there are positive effects for others, including for local (regional) authorities. This indicates the importance of harmonizing different opinions and interests in planning and organizing the development of transport infrastructure. Therefore, it is advisable to involve regional and local administrations, as well as the local community, in assessing the effectiveness of measures and developing mechanisms for their implementation.

Thus, for the effective organization of transport infrastructure and improving the mechanisms for managing its impact on the economic development of regions, it is necessary to take into account all the above conditions, they are reflected in **Fig. 1.8**.

Thus, solving the above tasks allows ensuring the effectiveness of management mechanisms and the applicability of this toolkit for any regional territorial entities. A natural consequence of the existence of various connections and the complexity of the subject of research is the diversity of approaches to assessing the role of transport infrastructure and to the formation of mechanisms for ensuring economic growth of regions based on the development of transport infrastructure.

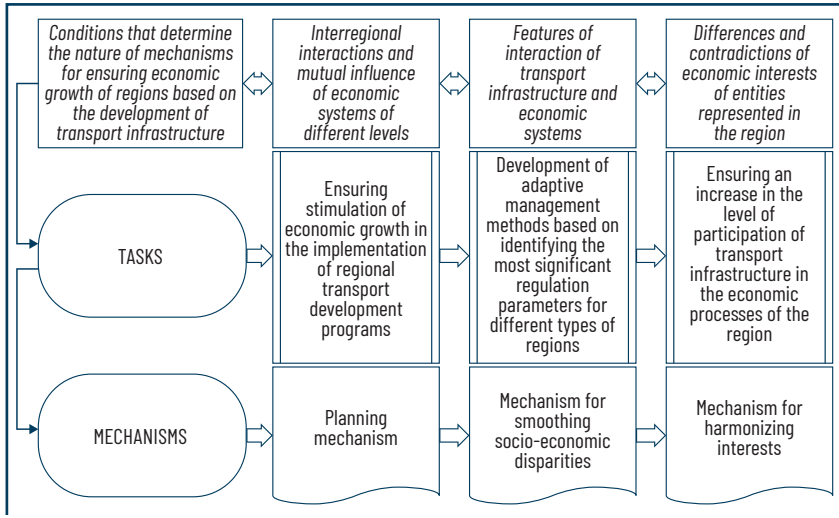

Fig. 1.8 General concept of improving mechanisms for ensuring economic growth of regions based on the development of transport infrastructure

Source: [2–4]

At the next stage of the study, it should be noted that the complexity of the transport infrastructure system, the multidirectional impact on both the economic and social systems determined a wide range of

tools for forming mechanisms for ensuring regional growth based on the development of transport infrastructure. Having studied and generalized international experience, a systematization of methodological approaches and methods for forming mechanisms for the development of transport infrastructure was obtained (**Table 1.5**).

● **Table 1.5** Systematization of methodological approaches and methods for forming mechanisms for the development of transport infrastructure

Main aspects of the methodology	Development of management mechanisms	Advantages of approaches	Disadvantages of approaches
Descriptive approach — Technocratic method			
Analysis of the state and technical parameters of transport networks	Organization of interaction between modes of transport, harmonization of network operation	Systematization of transport activities	Complexity of comparison and quantification
Descriptive approach — Economic and geographical method			
Description, assessment of quantitative indicators proceed from economic sense	Regulation of the provision of infrastructure facilities in various territories	Comparison possibilities (ranking, assessment of dynamics)	Lack of consideration of spatial characteristics
Economic and analytical approach — Balance method			
Transport is considered as one of the branches of the economy through cost indicators	Improving the planning of the distribution of costs for the development of transport infrastructure	Depth of assessments and ideas about the parameters of the interconnections of industries	Laboriousness; the balanced scenario does not seem realistic enough
Economic and analytical approach — Capital method			
Cost and quantitative assessments of transport infrastructure as a capital resource	Regulation of interregional interactions on the use of transport infrastructure	Assessment of the role of transport in comparison with other resources (labor and capital)	Complexity of modeling spatial aspects
Economic and analytical approach — Investment method			
Cost assessments of transport infrastructure as an investment, providing for the return of invested funds	Organization of principles of joint financing of transport infrastructure development	Possibility of assessing the time horizon of the implementation of the Transport Infrastructure Development Project; the effectiveness of transport infrastructure development for individual companies	Contradictions between the guidelines for increasing the efficiency (return) of investments and stimulating regional development processes

Source: [5-7]

Therefore, it is possible to conclude that there are theoretical premises that are the basis for further research and analysis. Initially, it is assumed that the territorial location and economic significance of transport infrastructure are extremely heterogeneous, the level of its development differs significantly between regions. This necessitates the structuring of regions according to the ratio of economic characteristics and transport infrastructure indicators.

Therefore, for an adequate analysis and assessment of the impact of transport infrastructure on economic growth and, ultimately, for the formation of adaptive management methods, it is necessary to take into account the spatial structure in order to correctly understand the scale, nature of the inclusion of transport infrastructure in the regional economic system, the level of interregional connections. that it provides. On the other hand, it is important to take into account the main characteristics of the economic system within which the analysis of transport infrastructure takes place.

The essence of the analysis in this approach is not limited to the study of individual aspects of transport infrastructure or the economic environment. Spatial prerequisites for the formation and support of economic interactions have been identified, which, together with the assessment of the main parameters of the economic system, allows to put forward adequate hypotheses regarding the determination of the main factors and conditions of the economic development of the region and further determine the mechanisms by which this development can be carried out. Thus, the conditions considered above that allow transport infrastructure to be interconnected with regional economic systems and methodological approaches and methods for forming mechanisms for the development of transport infrastructure make it relevant to improve the mechanisms for implementing management functions presented in **Fig. 1.9**. Let's consider it an important scientific and managerial task to determine the parameters and conditions for the functioning of transport infrastructure necessary to stimulate the growth and development of a specific regional economic system. Thus, a fundamental basis is formed for the implementation of these mechanisms in practice, since the required state of transport infrastructure significantly depends on the current structure of the economy.

1.9 TRANSPORT INFRASTRUCTURE DEVELOPMENT PLANNING MECHANISM

To increase management efficiency, it is necessary to create and develop an information and analytical system for managing the implementation of programs at different levels [8]. The main tasks of such a system are: registration of analytical information in various forms (in terms of basic indicators; planned indicators, territories, etc.); design of transport development programs both in territorial and temporal terms with a breakdown into objects, nodes, directions and corridors with their current and prospective characteristics.

Such a large-scale and intensive process of forming programs in the system of public administration and local self-government was designed to solve problems related to determining the goals of regional and local authorities in terms of stimulating the economy and ensuring the focus of the territorial development process. However, it is worth saying that this mechanism is not completely perfect, since the formally

approved requirements for ensuring territorial development were not properly supported by an understanding of the nature of the impact of transport infrastructure on the economic growth of individual territories, ways to enhance growth through transport infrastructure. One way to overcome such planning difficulties is to transfer planning goals from higher-level programs. In general, this approach corresponds to the established practice of setting management tasks from top to bottom.

It should be noted that the transformation of the principles of public administration will allow to increase awareness of significant interrelationships and develop mechanisms that will have a tangible impact on the development of territories. This will make it possible to increase the degree of compliance of the planned process of state and local administration with the goal of regional growth. It should be expected that the priority of the principle of territorial development will contribute to the most complete achievement of the goal of activating regional growth. At the same time, the system of indicators that will reflect the stages and levels of achieving the goal needs to be improved. The relevance of such improvement is dictated by the need to monitor the process of stimulating growth through the development of transport infrastructure, as well as the need for an objective assessment of the existing reality and options for territorial development.

The principle of purposefulness in application to planning activities for the development of territories provides that for territories with different characteristics a set of special actions or measures will be developed that will increase the efficiency of transport infrastructure as a source of growth. Efficiency here should be understood as the most close to the goal of economic growth of the territory through the use of material, labor and energy resources of the transport industry.

No less important is the group of principles related to an adequate description of existing socio-economic systems and the study of the features and patterns of their development, which provides for the strengthening of the regional vector and the systematization of knowledge about the genesis of socio-economic systems of various types. A substantial and meaningful understanding of the trends in the development of socio-economic systems, obtaining reliable ideas about their reactions to external influences is the most important condition for the implementation of the scientific principle in the process of territorial development planning. Based on reliable data, it is possible to develop measures that will be effective in different conditions for different regions. This ensures the implementation of the principle of reality. In the absence of scientific research of systemic reactions, it is impossible to develop effective mechanisms for improving socio-economic systems, it is impossible to determine the level of resource provision that can lead to solving problems. The choice of methods according to any other principle, such as the introduction of best practices, does not remove the question of understanding and assessing the consequences of implementing certain decisions. At the same time, the implementation of the principle of connection with the socio-economic life of the territory is not achieved, as indicated in the source [9]. Only under the condition of a meaningful analysis of the conditions for the development of regional economic systems and their connections with the transport infrastructure is it possible to select and develop such managerial influences that can significantly affect the system in a certain direction [10], which makes it possible to successfully implement the planned function of managing the development of transport infrastructure.

Another group can be those principles that contribute to the formation of the sustainability of the planning process for the development of organizational and economic relations of transport infrastructure. These include the principles of continuity and flexibility. Continuity should be understood as the ability of the management system at any time to determine the development process with varying degrees of success. It is obvious that in conditions of crisis, with changes in national and/or international macroeconomic trends, with changes in priorities and key principles of national policy, manageability and predictability may decrease, which requires a new scientific understanding and coordination with reality. Reproducing this stage in new, changed conditions and developing actions corresponding to the prevailing circumstances will be an expression of the principle of continuity. The flexibility of the public administration planning process is expressed in the ability to perceive and take into account such transformations in the current and subsequent planning cycles.

Therefore, it is possible to conclude that when implementing the priority of territorial development, it is necessary to deepen the established programs for the development of transport infrastructure through objective assessments of connections with socio-economic systems of different levels [11].

1.10 MECHANISM FOR SMOOTHING SOCIO–ECONOMIC DISPARITIES IN THE DEVELOPMENT

Earlier in our study, the need to perceive regional economic systems as complex and heterogeneous elements of the national system, in which multidirectional trends can operate, was substantiated. The features of economies in conditions of inflationary and recessionary gaps were highlighted. The essence of this division is that different properties of economic systems imply different mechanisms for activating economic growth. Since the territories of the recessionary gap are characterized by a state of overproduction, the main vector of approaching the equilibrium state is determined by economic theory to stimulate demand. Unlike recessionary territories, territories in the inflationary gap have a price level below the equilibrium, which hinders production processes, which ultimately leads to a significant excess of demand over supply. Therefore, the use of mechanisms for stimulating demand turns out to be detrimental for such territories due to the intensification of negative trends and an increase in deviations from the equilibrium state. It was also proven that this property of economies is systemic and affects not only the sphere of transport infrastructure.

For this reason, the formation of mechanisms for stimulating economic growth through the development of transport infrastructure should be adapted to the current situation in the regions. Such unevenness of the national economy makes it necessary to develop mechanisms that would improve the proportions of regional development and reduce gaps.

Based on the study of the conditions of economic growth in regions of the inflationary gap, it is possible to conclude that it is necessary to take into account important organizational conditions to ensure economic growth. Based on this, let's highlight the main groups of measures and areas of improvement for stimulating the economic growth of regional territorial entities in the inflationary gap through the development of transport infrastructure, in particular:

1. Stimulating the organization of primary processing of the flow of raw materials with coordination between private and regional business entities at the highest level of management; state support for industrial and infrastructure development. Mechanisms for harmonizing industry interests and interests of regional and local development in the formation of transport infrastructure:

— legislative registration of incentives for the creation of industrial transport networks taking into account the potential for regional growth; financial support for transport infrastructure development projects; control over targeted spending of funds; coordination of national-level interests in industrial development and regional-level interests in economic growth;

— development of transport infrastructure projects to ensure regional growth; financing; control over the technological and technical level of transport infrastructure project implementation; implementation of measures invested in stimulating industrial development;

— development of transport infrastructure projects at the regional level to ensure regional growth; interregional cooperation in the formation of transport infrastructure development projects; organization and implementation of a transport infrastructure development project; development of measures to stimulate the development of industry on the basis of the created infrastructure.

2. Stimulation of the production of final demand products, organizational work by local and regional administrations, production associations. Mechanism for the development of public transport infrastructure networks based on state funding:

— legislative provision of opportunities for interregional cooperation on infrastructure and industry development; financial support for transport infrastructure development projects; control over targeted spending of funds;

— development of transport infrastructure projects to ensure regional growth; organization and implementation of a transport infrastructure development project; development of measures to stimulate economic growth on the basis of the created infrastructure.

3. Purposeful formation of territorial and economic relations for the organization of production. Creation of conditions for attracting flows of technological transfers from highly developed regions. Mechanisms for preserving transport infrastructure and increasing its level of improvement and quality. At the initial stage, the construction of better roads and the organization of roadside service. Involvement of the most convenient places in economic turnover:

— financial support for projects to improve the existing transport infrastructure system; control over targeted spending;

— development of the regional level and financial support for projects to improve the existing transport infrastructure system; organization and implementation of projects to improve transport infrastructure; development of measures to stimulate economic growth based on the infrastructure being created.

Thus, it is possible to conclude that most regions have significant potential for significant economic growth. However, its implementation is associated with the implementation of a set of measures, and specialized for different groups of regions. Therefore, the next step is to develop mechanisms that ensure the most complete consideration of the interests of local communities in the growth of the local economy. The importance of developing a coordination mechanism is due to the fact that it is also necessary to ensure

that national interests and the interests of individual manufacturing companies and industries are taken into account.

MECHANISM FOR HARMONIZING INTERESTS IN THE TRANSPORT INFRASTRUCTURE DEVELOPMENT SYSTEM

Transport infrastructure projects, oriented towards end-use, implement social functions and ensure the expansion of consumer demand. Thus, the involvement of local private entities in investment activities in the transport construction sector will contribute to the mitigation of the recessionary gap. The functioning of the mechanism for harmonizing the interests of stakeholders should be aimed at harmonizing two blocks of issues:

BLOCK I. This block is related to the conditions of investment activities, in particular, specific measures for the construction of transport infrastructure facilities should be determined (quantitative measurement of the expected length of roads of a certain class, special structures, etc.). On the other hand, these measures should be reflected in the financing part. Determine the terms and stages of direct implementation of infrastructure construction measures. Implementation of the project by a private agent with the involvement of its investment potential can contribute to increased savings due to more economical use of materials and increased labor productivity. During the implementation and upon completion of construction, the state's efforts should be aimed at monitoring the planned passage of construction stages and achieving the required level of quality of infrastructure formation. This is necessary because the private investor will focus on the fastest and most economical solution, which, in turn, may lead to disruption of a number of technological operations and a general decrease in the quality of facilities, and this is designed to make state control impossible at this stage.

BLOCK II. Determining the conditions for the return of investment to private agents. Here, the state as a stakeholder formalizes its interests in creating the prerequisites for socio-economic development. And, accordingly, the more significant the external positive effects of creating a transport infrastructure project, the higher the concession payments can be. To implement such impulses, taking into account the specifics of the territories, transport construction should be accompanied by measures to improve the urban environment, expand development and increase the accessibility and availability of transport infrastructure. To this end, organizations implementing an infrastructure project should interact with local authorities on issues of increasing the significance of the transport facility in social terms.

At the end of our study, it is possible to determine the positive effects of the practical implementation of improved mechanisms for ensuring economic growth of regions based on the development of transport infrastructure:

— change in the ratio of the number of enterprises in the regional center and in the rest of the region (reduction of concentration in the capital);

— increase in the number of companies localized in a certain industrial zone on the "periphery" of the region;

— decrease in the specific costs of each enterprise located on the periphery;

– reduction of negative consequences in areas of overconcentration of production while simultaneously reducing it;

– development of production cooperation due to an increase in the number of regional suppliers and contractors;

– increase in the share of meeting the needs of transport construction at the expense of local goods, resources, components;

– increase in industrial production in terms of volume;

– expansion of the range of own products, components, parts, etc., as an element of the country's national security in the field of goods;

– reduction in the physical volume of imports of certain categories of industrial goods;

– increase in the labor intensity and depth of raw material processing;

– growth in private investments (public finances) attracted to the production sector;

– increase in the introduction of innovative equipment and technologies.

CONCLUSIONS

Currently, an active scientific search is underway for tools and mechanisms for ensuring economic growth of regions at the expense of the country's internal forces. Transport infrastructure is considered one of the most important engines. The study:

– theoretical provisions were generalized and practical recommendations were developed for ensuring economic growth of regions based on the development of transport infrastructure;

– the main theoretical concepts of the role of transport infrastructure as a source of regional growth and development were considered and the conditions that must be taken into account for the formation of effective mechanisms for ensuring economic growth of regions based on the development of transport infrastructure were identified and described: the need to take into account the mutual influence of economic systems at different levels; the need to analyze the interrelationships of transport infrastructure and the regional economic system; the need to coordinate the interests of various agents (stakeholders) represented in the region;

– an analysis and generalization of existing approaches to the formation of mechanisms for ensuring growth based on the development of the transport infrastructure of the system was carried out and it was established that they mainly take into account to a small extent the participation and nature of the prevailing organizational and economic relations of the transport infrastructure and the local economic system.

The above-described conditions, in combination with the tasks set and their solution, allowed to improve and form a number of mechanisms that took shape in the concept of improving the mechanisms of economic growth of regions based on the development of transport infrastructure.

The proposed mechanisms can serve as the basis for the development of management decisions that will be different in content (attraction of private or public investments in infrastructure projects;

development of industrial transport or transport infrastructure of final demand; development of the distribution functions of transport infrastructure or transport). interactions that provide integration and cooperative interregional production links) for each individual regional or local economic system, but are united by the goal of ensuring economic growth of regions based on the development of transport infrastructure.

USE OF ARTIFICIAL INTELLIGENCE

The authors of this study state that AI tools were not used as a replacement for critical thinking, expertise, and human evaluation.

During the preparation of this work, the authors used Chat GPT (Chat GPT 5.1) for purely mechanical work, editorial assistance: stylistic improvement, grammar, spelling, and translation of sources/references.

The authors carried out a full check of all materials obtained with the participation of AI by: comparing each fragment with primary sources and current scientific literature; manually clarifying terms, definitions, and content in accordance with the research methodology; verifying statistical data, facts, international examples, and regulatory references; ensuring compliance with academic standards, research logic, and the requirements of the target publication.

The use of AI tools did not affect the scientific results, empirical conclusions, statistical models, and research position of the authors.

All key findings, conceptual models, methodological positions and recommendations of the study are formulated solely by the authors and reflect their own scientific position.

After using this tool/service, the authors reviewed and edited the content of the work and bear full responsibility for the content of the published article.

CONFLICT OF INTEREST

There is no conflict of interest. The authors declare that they have no financial, academic, personal or other conflicts of interest that could influence the content, results or interpretation of this study.

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2 INTEGRATION STRATEGIES IN THE CONTEXT OF GLOBAL CHALLENGES

ABSTRACT

This study is devoted to the development of a system of anti-crisis management of transport enterprises to ensure their effective functioning in modern economic conditions.

The state of the transport industry of Ukraine was studied, where the following indicators were analyzed: the number of operating business entities, the number of employees, the volume of products sold (goods, services), the level of profitability of enterprises. It was determined that most of the analyzed indicators are decreasing in dynamics, which is primarily due to the consequences of military aggression against Ukraine. The main problems that hinder the development of the transport industry of Ukraine were identified. The prerequisites for the emergence of crisis phenomena in the activities of transport enterprises were studied – internal and external factors that can lead an enterprise to a crisis were identified.

The need for the implementation of anti-crisis management to overcome crisis phenomena in the activities of transport enterprises was substantiated. A system of anti-crisis management is proposed, which is represented by four main consecutive stages: diagnostics of the state of the enterprise, formation of an anti-crisis strategy and program, application of anti-crisis methods and measures and assessment of the effectiveness of the proposed methods and measures. Each component of this system is disclosed in detail.

It is found that the crisis caused by war is a special type of crisis phenomena. A comparison is made between the traditional and "war" crisis at the enterprise. In particular, it is determined that the second is systemic, long-term, carries not only financial losses, but also a threat to people's lives, destruction of infrastructure and loss of assets. This necessitated the adaptation of traditional anti-crisis management to the conditions of the war period. The features of anti-crisis management of transport enterprises during the war period are considered, in particular diagnostics, strategies, methods, measures and performance assessment.

KEYWORDS

Transport industry of Ukraine, military aggression, anti-crisis management, enterprise crisis, state diagnostics, anti-crisis strategy, military crisis, enterprise profitability.

The main goal of anti-crisis management of an enterprise during the war is to minimize the negative economic and social consequences of the enterprise's activities. Given that such a crisis is characterized

by an acute shortage of time to respond and a limitation on the terms of overcoming the crisis, the main task of anti-crisis management is to make decisions promptly and with the least risk, which would make it possible to achieve the desired result with minimal additional efforts and minimal negative consequences.

At the initial stages of the war, such a desired result is to ensure the uninterrupted operation of the enterprise and its survival in new war conditions. At this time, it is important to respond quickly to changes, ensuring the safety of employees and the stability of production and supply of products. As the war progresses, the priorities of anti-crisis management may change. The task of ensuring the survival of the enterprise turns into adaptation and adjustment of functioning in war conditions.

It is clear that the impact of war on enterprises is different and anti-crisis management requires an individual approach. However, in all cases, the main principles of anti-crisis management in wartime remain efficiency, risk minimization and priority of ensuring the uninterrupted operation of the enterprise.

Thus, in times of war, especially in the first "period of shock", all decisions must be made very quickly, since the situation changes every day and in such a case, untimely response can be costly for the enterprise. In this case, increasing the speed of making anti-crisis decisions in war conditions involves reducing the levels of management, a limit on the approval of decisions, within which decisions can be made without the approval of a senior manager, or decentralization, so that decisions are made not only from the top down, but also on missions, for the rapid resolution of local problems. As one of the managers whose business survived the first stages of the war notes: "It is better to make a mistake quickly than to think long".

The main goal of anti-crisis diagnostics in wartime is to identify the impact of war on the activities of the enterprise: assessing the current situation and identifying the causes of deviations.

2.1 STATE OF THE TRANSPORT INDUSTRY OF UKRAINE AND PREREQUISITES FOR THE EMERGENCE OF CRISIS PHENOMENA IN THE ACTIVITIES OF TRANSPORT ENTERPRISES

Today, transport plays a key role in ensuring the effective functioning of the economy and meeting the needs of society. Transport enterprises ensure the movement of goods, services and people both within the country and at the international level. However, the functioning of transport enterprises in a market economy is influenced by various factors of the external and internal environment. In Ukraine, the conditions of martial law open up new challenges and threats for transport enterprises, which significantly affects the stability and functioning of this industry. The introduction of anti-crisis management in the activities of transport enterprises will make it possible to avoid or reduce the negative impact of crisis phenomena and ensure their sustainable functioning in modern economic conditions.

In order to be able to apply anti-crisis management, it is important to timely identify the symptoms of crisis phenomena and establish the factors that led to the emergence of a crisis situation at the enterprise. To clarify the prerequisites for the emergence of crisis phenomena in the activities of transport enterprises, it is first necessary to examine the current state of the transport industry of Ukraine. The general state of the transport industry in 2022 deteriorated significantly, as evidenced by the following indicators:

1. Number of operating business entities. According to the State Statistics Service [1], the number of operating business entities in the "Transport, warehousing, postal and courier activities" industry began to decline starting in 2020 (**Fig.2.1**).

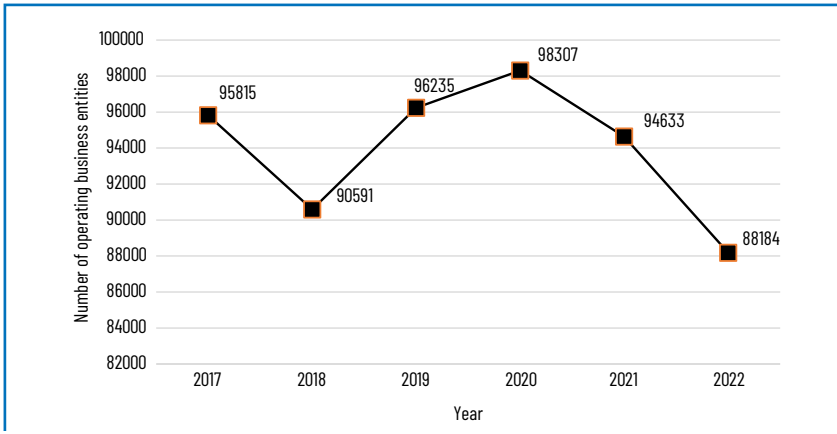

Fig. 2.1 Number of operating economic entities in the transport sector for 2017–2022, units

Source: [1]

2. Number of employees. The number of employees in the transport sector in 2022 decreased by 102,620 people (**Fig. 2.2**) [1]. Due to the consequences of the war, many enterprises were forced to reduce their activities or lose their infrastructure, which led to a decrease in the number of employees.

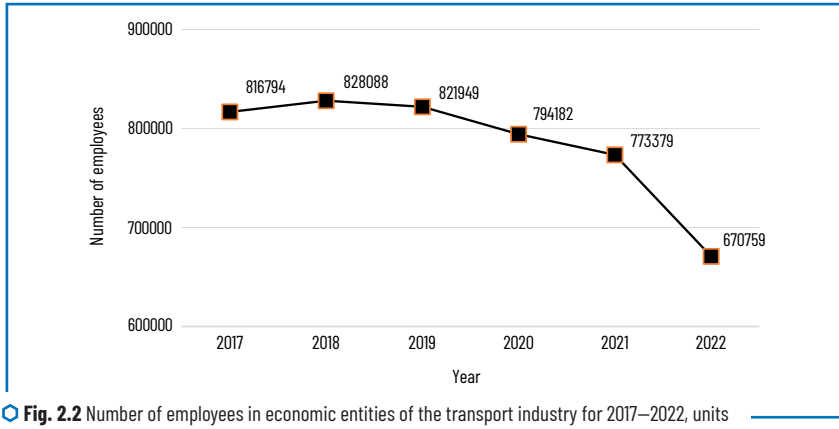

Fig. 2.2 Number of employees in economic entities of the transport industry for 2017–2022, units

Source: [1]

3. Volume of products sold (goods, services). Before the start of the war in 2022, the volume of products sold (goods, services) was constantly increasing, as evidenced by the data (**Fig. 2.3**) [1]. In 2022, the volume of products sold decreased by 112,539,339.3 thousand UAH.

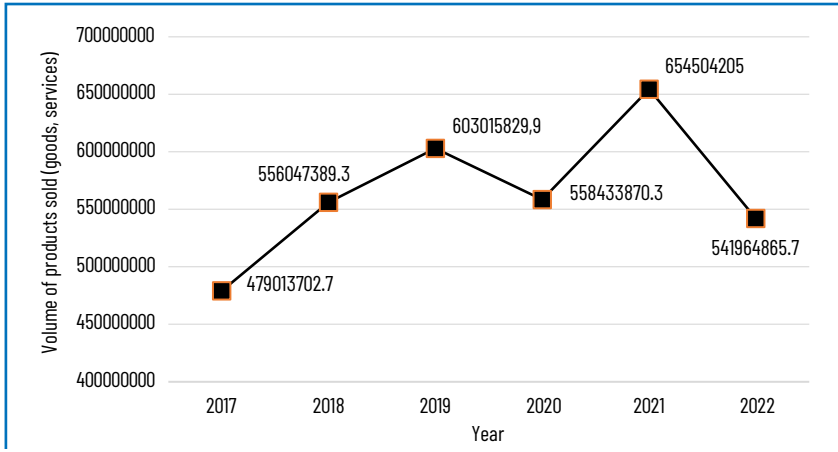

Fig. 2.3 Volume of sales (goods, services) of transport sector entities in 2017–2022, thousand UAH

Source: [1]

4. Level of profitability of enterprises. This indicator indicates how effectively transport enterprises use their resources to generate profit. The overall level of profitability of transport enterprises in Ukraine has always been low, however, in 2022 [1] the industry suffered large-scale losses (**Table 2.1**, **Fig. 2.4**) due to reduced demand, increased costs, currency fluctuations, etc.

Table 2.1 Profitability of transport enterprises in Ukraine in 2017–2022 by their size, %

Year	Overall profitability	Large enterprises	Medium enterprises	Small enterprises	Micro-enterprises
2017	–3.5	–6.7	2.3	–5.2	–14.0
2018	–4.3	–9.3	1.3	2.2	1.3
2019	1.4	–2.2	6.4	2.9	1.7
2020	1.6	2.4	1.9	–0.9	0.6
2021	3.7	4.5	3.6	2.0	2.1
2022	–4.2	–4.1	–5.5	–2.6	–11.9

Source: developed based on data [1]

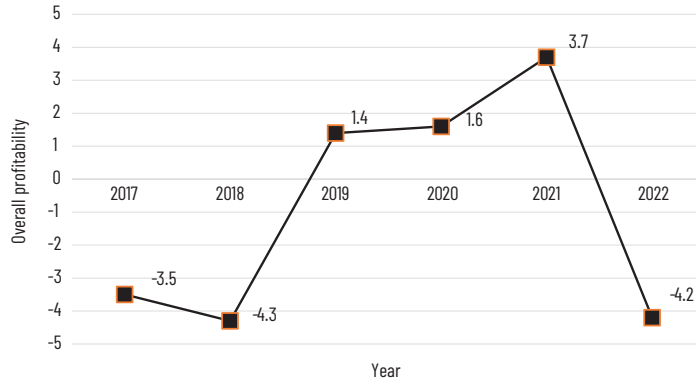

Fig. 2.4 Overall profitability of transport industry enterprises for 2017–2022, %

Source: [1]

The latest survey conducted by Advanter Group [2] at the end of 2023 on general problems that prevent the restoration and development of business shows: the biggest problem of enterprises is uncertainty (**Fig. 2.5**).

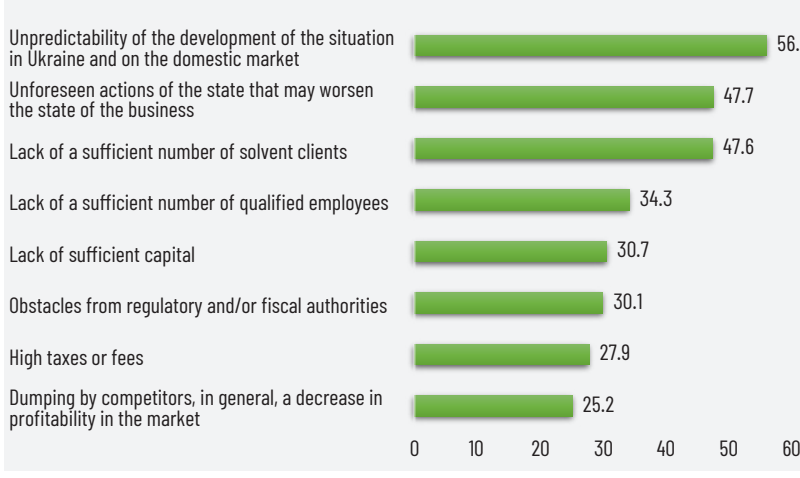

Fig. 2.5 Main problems hindering the restoration and development of business in Ukraine in 2023

Source: [2]

Thus, the general state of the transport industry in Ukraine has declined since 2022. This was undoubtedly a consequence of military aggression against Ukraine. Thus, in particular, the aviation industry suffers the most due to the run ban. However, as can be seen in previous years, most of the analyzed indicators were at a fairly low level. This is due to a number of problems of transport enterprises.

Firstly, this is outdated equipment and infrastructure. A large number of transport enterprises, especially municipally owned, have outdated buses, trams, trolleybuses and other transport, which leads to an increase in maintenance and repair costs, and also reduces the quality of such services.

Secondly, there is a lack of funding and investment in this industry. Many enterprises have limited financial resources, investors have no incentive to invest in the transport sector due to low profitability, and government support is almost non-existent.

Thirdly, high prices for fuel and other resources. Fuel is the main component of costs for many transport enterprises, especially in road transport. The increase in prices for petroleum products, which is especially observed during the war, leads to a significant increase in the cost of refueling cars, buses, minibuses, taxis and other vehicles. Because of this, the transport business has to increase tariffs, for example, for travel, or the prices of its services to compensate for costs, which can lead to a decrease in demand from consumers.

All these problems lead to the emergence of crises and crisis phenomena in the activities of transport enterprises.

According to scientists, solving the problems of transport enterprises can be achieved through the following measures [3]:

— reducing the tax burden or partial compensation for the costs of resource provision for enterprises engaged in international freight transportation;

— lobbying by the state to increase the quota for issuing permits for international transportation for Ukraine;

— carrying out high-quality reconstruction of transport routes to increase the transit attractiveness of Ukraine and reduce the costs of domestic enterprises for the repair of vehicles;

— introducing an anti-crisis management system to effectively counteract the impact of external and internal threats.

Thus, the prerequisites for the emergence of crisis phenomena in transport enterprises of Ukraine are associated with the peculiarities of the functioning of the domestic transport industry and the cumulative effect of a number of negative macroeconomic factors that have accumulated over a long time and whose influence intensified during the period of the full-scale invasion of Ukraine.

That is, the entire set of factors that can lead an enterprise to a crisis can be divided into two groups:

— external — on which the enterprise is unable to influence or its influence is limited;

— internal — arise as a result of the activities of the enterprise itself.

The prerequisites for the emergence of crisis phenomena in the activities of transport enterprises (**Fig. 2.6**) are:

External:

— political instability — low trust in government institutions, uncertainty of the political course, instability of legislation, unpredictable actions of the state, obstacles from regulators;

– economic instability – economic or financial crises, rising inflation, budget deficit, devaluation of the hryvnia, credit restrictions, rising unemployment, high level of taxes;

– currency fluctuations – increasing cost of imported raw materials, materials, equipment;

– low level of demand – decrease in sales volume, necessity of reducing activities, increase in inventories of goods;

– low level of investment attractiveness – limited access to capital, lack of innovation, high level of risk.

Internal:

– equipment wear and tear – increase in maintenance costs, decrease in productivity, risks of accidents and downtime, limited opportunities for development;

– outdated infrastructure – low productivity, increased maintenance and repair costs, limited opportunities for development;

– lack of free funds and financing – risk of insolvency, delayed project development, reduced liquidity, loss of investment opportunities;

– ineffective management – inability to adapt, inability to make quick decisions, loss of potential opportunities, low level of staff motivation;

– personnel problems – low qualifications and skills of employees, lack of motivation, outflow of qualified employees, conflicts in the team, ineffective distribution of duties and responsibilities.

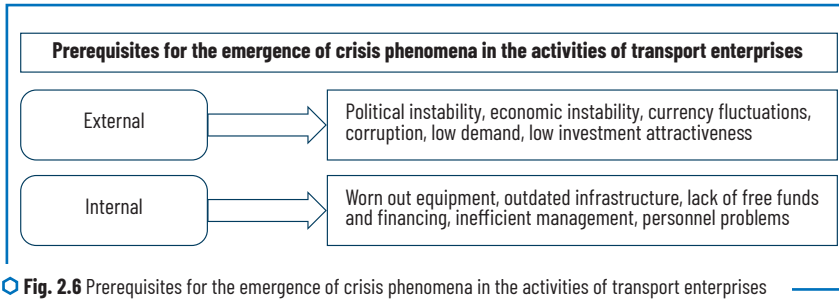

Fig. 2.6 Prerequisites for the emergence of crisis phenomena in the activities of transport enterprises

Source: author's development

2.2 THE SYSTEM OF ANTI-CRISIS MANAGEMENT OF TRANSPORT ENTERPRISES AND ITS COMPONENTS

The development of transport enterprises in Ukraine occurs under the influence of many negative internal and external factors, therefore, predicting and avoiding crisis phenomena and minimizing their consequences is one of the priority tasks.

Overcoming the crisis state of the enterprise requires the comprehensive application of anti-crisis management, the implementation of which will be carried out throughout the entire period of operation

of the enterprise, because the possibility of a crisis occurs at all stages of its development. Elimination of crisis phenomena in the transport industry is possible through the formation and application of the system of anti-crisis management of transport enterprises.

Such a system can be represented by four main stages: diagnostics of the state of the enterprise, formation of an anti-crisis strategy and program, application of anti-crisis methods and measures, assessment of the effectiveness of the proposed methods and measures (**Fig. 2.7**).

Successful problem solving should be preceded by a thorough analysis of the situation. The basis of the anti-crisis management system of the enterprise should be conducting research and identifying weaknesses in the functioning of the enterprise. In order to identify crisis phenomena at the enterprise and prevent bankruptcy in the future, a permanent system of monitoring and diagnostics of the enterprise is necessary. The basis for assessing the factors of the crisis situation is the analysis of the external and internal environment.

Stage I	*Diagnostics*
	Comprehensive analysis of financial and economic condition (liquidity, solvency, profitability indicators); analysis of revenue growth rate, sales profitability, availability of own working capital; analysis of models for assessing the probability of bankruptcy, etc.
Stage II	*Formation of an anti-crisis strategy and program*
	Growth strategies (concentration, integration, diversification), marketing strategy, production strategy, cost minimization strategy, stabilization strategy, financial strategy, restructuring strategy, offensive strategy, harvesting strategy, etc.
Stage III	*Application of anti-crisis methods and measures*
	Methods: autosourcing, benchmarking, regularization, downsizing, restructuring, rehabilitation, etc. *Measures:* cost reduction, marketing activities to increase sales, tax optimization, stopping secondary production, etc.
Stage IV	*Assessment of the effectiveness of the proposed methods and measures*
	Assessment methods: *Economic analysis* – analysis of key financial and economic indicators; *Expert assessments* – qualitative or quantitative assessment of expert opinions; *Comparisons* – comparison of crisis indicators with actual ones

Fig. 2.7 Anti-crisis management system of the enterprise

Source: author's development

The process of anti-crisis diagnostics of the state of enterprises (**Stage I**) includes various methods and tools. First of all, the main performance indicators should be analyzed, such as the growth rate of revenue, profitability of sales, availability of working capital. Factor analysis can be used to study the

impact of various factors on financial results. These indicators allow to track key aspects of the enterprise's activities. Thus, a decline in revenue or a decrease in profitability may indicate problems in management or ineffective sales strategies.

For a comprehensive assessment of the financial and economic condition, indicators should be used that cover various aspects of the enterprise's activities, such as property status, liquidity, profitability, solvency, business activity, logistics, etc. This provides an overall assessment of various aspects of the activities of transport enterprises, which allows identifying problems in the financial sphere of the enterprise.

In addition, enterprises can use various models of assessing the probability of bankruptcy to predict crisis situations in order to prevent possible problems and take timely measures. Such a comprehensive approach to diagnosing the enterprise's activities helps to effectively manage its activities and make informed decisions to ensure sustainable development.

It is worth noting that anti-crisis diagnostics of an enterprise can cover not only the analysis of financial indicators. It should also include checking other important aspects of the enterprise's functioning, such as business processes, organizational structure or HR direction, which will also allow identifying possible weaknesses in the management and functioning of the enterprise.

Along with quantitative methods of financial analysis, it is advisable to use qualitative methods, such as PEST and SWOT analysis. These methods allow to take into account external and internal factors that can affect the activities of the enterprise, and identify opportunities, threats, strengths and weaknesses. The results of these methods can also help in developing strategies, which will only increase the quality of anti-crisis decisions taken.

If deviations are detected during diagnostics that can lead to a crisis state of the enterprise, the next stage is the development of an anti-crisis strategy and program (**Stage II**). This strategy is a set of actions aimed at overcoming crisis phenomena and strengthening the enterprise's position in the market.

An anti-crisis strategy is a specially developed action plan for managing crisis situations in order to overcome crisis phenomena and prevent bankruptcy. The main goals of the anti-crisis strategy should be focused on eliminating the main causes of the crisis by reducing the impact of relevant factors, taking into account the existing limitations of the enterprise. The main goal is to restore financial stability and ensure the stable functioning of the business.

The development of an enterprise's anti-crisis strategy consists of the following stages: analysis of the crisis situation at the enterprise; review of the mission and system of goals; analysis of alternatives and selection of an anti-crisis strategy [4].

The entire set of possible strategies from the point of view of anti-crisis management can be divided into two groups:

1) strategies for ensuring crisis prevention within the framework of preventive anti-crisis management;

2) strategies for ensuring survival in crisis situations and minimizing possible losses.

Strategies for ensuring crisis prevention within the framework of preventive anti-crisis management should be applied at the stage of identifying minor deviations in the enterprise's activities or in the case of preventive actions to prevent future crisis phenomena. Strategies for ensuring survival in crisis situations are applied already during an ongoing crisis at the enterprise.

Table 2.2 lists possible anti-crisis strategies that can be used to overcome a crisis at a certain stage [4–6]. Their diversity allows the enterprise to choose the one that is most appropriate at a certain stage of the organization's development and corresponds to the formed general strategy of the enterprise.

The means of implementing an anti-crisis strategy is the development and implementation of an anti-crisis program. An anti-crisis program is a document that defines the main measures to overcome crisis phenomena at an enterprise. Within one anti-crisis strategy, there may be several anti-crisis programs that include a set of measures to achieve goals. This document may be developed at the level of the entire enterprise or have subprograms for individual divisions and functional services.

The structure of the anti-crisis program should include the following components: a list of planned measures; determination of start and end dates; resources required for implementation; expected results from implementation; responsible persons and executors for each measure.

After the strategy and anti-crisis program are developed, the next step is the direct implementation of anti-crisis methods and measures (**Stage III**). This stage includes the implementation of specific actions aimed at overcoming crisis situations and restoring the stability of the enterprise. The set of anti-crisis measures is unique for each enterprise, as it must take into account various factors, such as the stage of the crisis process, the specifics of the industry, the size of the enterprise, etc.

Table 2.2 Anti-crisis strategies according to the crisis stage of the enterprise

Stages of crisis	Signs of manifestation	Anti-crisis strategies
Strategic crisis	Lack or insufficient development of the strategic management system, shortcomings in marketing activities, decrease in the market value of the enterprise	Organizational, personnel, marketing, investment, crisis prevention, anticipation, cost reduction
Structural crisis	Deterioration of the financial condition of the enterprise, decrease in sources and potential for development, reduction in activity volumes, loss of market share, decrease in the number of personnel	Marketing, production, cost minimization, turnaround, stabilization, diversification, innovation, cost leadership, counteraction, anticipation, concentration, cost reduction
Operational crisis	Decrease in the most important economic indicators, loss of profit of the enterprise	Marketing, cost minimization, turnaround, stabilization, offensive, defense, defensive, counteraction, restructuring, transformation
Liquidity crisis	Increase in the enterprise's debt to creditors, deterioration in the indicators of liquidity and solvency of the enterprise	Financial, cost minimization, restructuring, reduction, harvesting, growth
Insolvency (threat of bankruptcy)	Deficit of liquid funds for the fulfillment of external financial obligations (repayment of debts), production is constrained by a shortage of materials, the period for repayment of receivables increases	Financial, merger, liquidation, reduction, restructuring, exit, survival
Bankruptcy	Initiation of bankruptcy proceedings, excess of obligations over the enterprise's own capital	Liquidation, exit, merger, reorganization

Measures (which are specified in the anti-crisis program) are formed in the form of specific tasks that must be taken. It is worth remembering that for the successful implementation of these measures, it is necessary to determine not only responsible persons, but also specific deadlines, necessary resources and expected results from each measure. Such an approach will help the enterprise effectively achieve its goals.

Anti-crisis methods are approaches to crisis management. They include a wide range of measures. In particular, the methods include: autosourcing, benchmarking, regularization, downsizing, restructuring, rehabilitation, etc. [4].

Anti-crisis measures are actions and steps to overcome the crisis. Measures, in turn, can also be specified in tasks and objectives. All measures should be divided into two categories: measures when symptoms or a "mild" crisis occur; measures in case of acute crisis [4].

When symptoms or a "mild" crisis occur, the following options for anti-crisis measures can be used: reducing or optimizing costs, optimizing the capital structure, improving the quality and competitiveness of products, increasing marketing efficiency, reducing the share of obsolete equipment, optimizing the credit policy of the enterprise, etc.

In case of acute crisis, the following measures can be used: modernization or stopping unprofitable secondary production, implementation of non-production facilities, strict control of all types of alternative costs, reviewing the organizational structure to eliminate unnecessary levels of management, measures to release funds for product improvement, etc.

The final stage of the anti-crisis management system is an assessment of the effectiveness of the implementation of the implemented measures (**Stage IV**). The effectiveness of anti-crisis management of an enterprise consists in the ability to achieve the optimal effect from the implementation of relevant anti-crisis programs while preserving all preferences as much as possible with minimal expenditure of funds and resources.

The criteria for assessing the effectiveness of anti-crisis measures include [7]:

1. *Has a change been achieved in the most important indicators of economic and financial activity and the financial condition of the enterprise during the period of anti-crisis management?* This criterion measures what changes have occurred in the financial indicators of the enterprise after the implementation of anti-crisis measures compared to the initial values.

2. *What is the speed of obtaining positive changes per unit of time?* Measures how quickly positive changes have occurred in the activities of the enterprise after the implementation of anti-crisis measures.

3. *What is the cost-effectiveness of obtaining a positive effect?* This criterion is the ratio between the achieved increase in the results of economic and financial activity and the amount of costs associated with achieving this result.

4. *What is the sufficiency of changes to restore the viability parameters of the enterprise?* This criterion determines how much the achieved changes are sufficient to restore the viability of the enterprise and compares the actually achieved indicators with reference values.

If the measures to overcome the crisis were ineffective, and the crisis continues to develop or the measures taken have not had an adequate effect, the enterprise should return to the starting point of searching for the causes and developing a new program or strategy for overcoming the crisis.

Thus, the general process of anti-crisis management of the enterprise, taking into account the stage of the crisis, can be presented as follows (**Table 2.3**) [4–6].

Table 2.3 Anti-crisis management according to each stage of the crisis at the enterprise

Crisis stage	Diagnostic methods, tools	Recommended anti-crisis management
Strategic crisis	Analysis of the strategic and marketing activities of the enterprise	Review of strategy, restructuring, increase in market value of the enterprise
Structural crisis	Analysis of the production and economic indicators of the enterprise	Normalization of the enterprise's activities: reducing costs, increasing productivity, increasing the economic added value of the enterprise
Operational crisis	Balance sheet analysis, express analysis of the financial condition of the enterprise	Eliminating the causes of the crisis: minimizing losses, increasing the profitability of the enterprise's capital
Liquidity crisis	Analysis of the liquidity, financial stability and solvency of the enterprise	Preventing the development (deepening) of the crisis: finding funds to continue financing activities, directing part of the working capital to repay losses
Insolvency (threat of bankruptcy)	Comprehensive assessment of the enterprise's activities, analysis of equity and solvency	Preventing the initiation of bankruptcy proceedings (settlement): finding liquid funds to fulfill immediate financial obligations, attracting new external financial capital, obtaining a temporary deferral or prolongation of previously received loans
Bankruptcy	Determination of supercritical solvency, analysis of debt security with real assets, assessment of business activity and investment attractiveness of the enterprise	Removing the enterprise from bankruptcy (rehabilitation): partial mobilization of available assets to settle obligations, going through the bankruptcy procedure with minimal losses for the owners of the enterprise

Source: author's development based on [4–6]

Thus, the proposed anti-crisis management system will allow transport enterprises to respond in a timely manner to changes in the economic environment, will help ensure financial stability, and also increase their competitiveness in the transport services market.

The main goal of anti-crisis management of an enterprise during the war is to minimize the negative economic and social consequences of the enterprise's activities. Given that such a crisis is characterized by an acute shortage of time to respond and a limitation on the terms of overcoming the crisis, the main task of anti-crisis management is to make decisions promptly and with the least risk.

2.3 FEATURES OF ANTI–CRISIS MANAGEMENT OF TRANSPORT ENTERPRISES DURING WARTIME

A regular (traditional) crisis at an enterprise most often arises due to various factors, such as economic instability, market instability, internal management problems, etc. Such a crisis is usually characterized by a limited time frame and can be completely overcome with the help of the right management anti-crisis solutions.

In the case of a crisis caused by war, the situation becomes much more complicated and unpredictable. War is a complex and unpredictable factor that significantly affects the activities of all enterprises. Signs of war in the context of enterprise activities include:

— reduction in production capacity;
— possible interruptions in the supply of energy, water, and communications;
— increased risks, including security-related;
— reduced demand for products or services;
— loss of suppliers of raw materials, components, finished products;
— increase in resource prices;
— problems with logistics;
— reduced investment and development;
— loss of personnel (mobilization, migration, reduced motivation).

For transport enterprises, signs of war can have a special impact due to their dependence on the functioning of transport infrastructure and transport safety, namely for them it is possible to include: threat to transport safety, obstacles in logistics and supply, reduced demand for transport, loss of vehicles and infrastructure.

Thus, war is an objective factor that can lead to the destruction of infrastructure, interruptions in supplies, reduced consumer demand and a threat to the safety of employees. The main distinguishing feature of such a crisis at the enterprise is that its consequences can be long-lasting and difficult to recover from [8].

The difference between a traditional crisis and a crisis caused by war is as follows (**Table 2.4**) [9].

That is, the differences are primarily related to the severity and duration of the war, which forces enterprises to go beyond the framework of traditional anti-crisis management. The anti-crisis management system should take into account these challenges and help adjust the functioning of enterprises in martial law conditions [4].

The main goal of anti-crisis management of an enterprise during the war is to minimize the negative economic and social consequences of the enterprise's activities. Given that such a crisis is characterized by an acute shortage of time to respond and a limitation on the terms of overcoming the crisis, the main task of anti-crisis management is to make decisions promptly and with the least risk, which would make it possible to achieve the desired result with minimal additional efforts and minimal negative consequences [9].

At the initial stages of the war, such a desired result is to ensure the uninterrupted operation of the enterprise and its survival in new war conditions. At this time, it is important to respond quickly to changes, ensuring the safety of employees and the stability of production and supply of products. As the war progresses, the priorities of anti-crisis management may change. The task of ensuring the survival of the enterprise turns into adaptation and adjustment of functioning in war conditions.

Table 2.4 Differences between a traditional crisis and a crisis caused by war

Symptom	Traditional crisis	Crisis caused by war
Duration	Has a clear beginning and end, lasts from several weeks to several years	May last for years, without a clear end date. Its impact on business can be felt even after the end of the war
Character	Caused by various factors, both internal (management errors) and external (economic recession)	Caused by an external factor — military actions that cannot be predicted or planned
Speed of spread	Localized after identifying the causes	Global chain reaction
Consequences	Leads to financial losses, staff reductions, strategy changes	Carries not only financial losses, but also a threat to people's lives, destruction of infrastructure, loss of assets
Impact on personnel	Can lead to demotivation, fear for the future, staff turnover	Creates a risk to people's lives and health, increases emotional stress, requires additional support from the employer
Possibility of overcoming	Can be completely overcome and emerge from the crisis with minimal losses	It is impossible to completely overcome the consequences of war at the enterprise. It is only possible to adapt to new conditions, minimize the negative impact and look for opportunities for development

Source: own development based on [9]

It is clear that the impact of war on enterprises is different and anti-crisis management requires an individual approach. However, in all cases, the main principles of anti-crisis management in wartime remain efficiency, risk minimization and priority of ensuring the uninterrupted operation of the enterprise.

Thus, in times of war, especially in the first "period of shock", all decisions must be made very quickly, since the situation changes every day and in such a case, untimely response can be costly for the enterprise. In this case, increasing the speed of making anti-crisis decisions in war conditions involves reducing the levels of management, a limit on the approval of decisions, within which decisions can be made without the approval of a senior manager, or decentralization, so that decisions are made not only from the top down, but also on missions, for the rapid resolution of local problems. As one of the managers whose business survived the first stages of the war notes: "It is better to make a mistake quickly than to think long" [8].

The main goal of anti-crisis diagnostics in wartime is to identify the impact of war on the activities of the enterprise: assessing the current situation and identifying the causes of deviations.

Assessment of the current state of the enterprise includes an analysis of financial indicators, resources, personnel and other aspects of the activity. It is also important to assess the current level of risks and opportunities of the enterprise.

In addition to the analysis of standard indicators, as in a traditional crisis, for transport enterprises in wartime it is important to assess: logistics, transportation safety, material and technical base, operational indicators of activity (volume of transportation, use of vehicles, etc.).

The tools of anti-crisis diagnostics in wartime can be: financial analysis, operational analysis, scenario modeling, SWOT analysis, personnel analysis, etc.

Due to the constant change in the situation in wartime, enterprise diagnostics must be carried out as often as possible. The most effective is the implementation of a system of constant monitoring. The more often diagnostics are carried out, the greater the chance of timely identification and overcoming problems that, in the context of a crisis caused by war, can lead to serious consequences.

Anti-crisis diagnostics will allow to identify the reasons for deviations from the normal functioning of the enterprise during the war period. For example, problems in the supply of raw materials, reduced demand for products or changes in market conditions. Identifying these reasons will allow the enterprise to develop effective anti-crisis strategies for adapting to war conditions.

Forming a strategy in wartime is a difficult task at the beginning due to high uncertainty. Therefore, at the beginning of the war, in the "shock period", the enterprise should skip this stage and quickly implement anti-crisis measures. After adapting and adjusting its functioning in war conditions, the enterprise can apply various anti-crisis management strategies, in particular, protective, stabilization, survival, cost reduction, marketing, financial, etc. will be effective.

At the beginning of the war or during its exacerbation, the most effective anti-crisis strategy is the survival strategy. This strategy is aimed at helping enterprises survive during the active phase of the war, reduce costs and preserve critical resources. The main measures of this strategy may be to optimize liquidity and current asset management, restore financial stability, restore or increase production volumes. After adapting to wartime conditions, it is worth applying growth strategies that can increase the competitiveness of the enterprise.

Among the important methods that should be used in anti-crisis management in wartime, the following should be highlighted [4]:

— outsourcing — can free the enterprise from processes that do not bring direct income, but require time and human resources. Outsourcing can help ensure uninterrupted operation in the event of the loss of employees (due to layoffs, migration) who were entrusted with certain business processes;

— diversification — expanding the product range, developing new markets. This method can provide the enterprise with growth points if the main directions become irrelevant and unprofitable. In wartime, transport enterprises can expand their geographical coverage, introduce new vehicles, expand the provision of services;

— reorganization — the most effective way can be considered a merger. The merger of several enterprises can help them survive and increase the economic efficiency of their activities;

— downsizing — reducing the size of the enterprise, production facilities, and the number of personnel to increase the level of its functioning, reduce costs and the cost of products. Although reducing activity is an unpleasant step, sometimes in conditions of reduced supplies, reorientation of production, changes in logistics chains, this is the only way to maintain the previous pace of work and its resources and continue operating in the market;

— modernization — updating or improving an object or process. For transport enterprises, modernization is especially important, since most enterprises need to update equipment, modernize the sales system,

improve management systems, etc. The importance of this method during wartime is that modernization increases the competitiveness of the business, labor productivity, and ensures the transition to new systems and methods of doing business.

Anti-crisis measures must be taken to successfully adapt to wartime conditions. The measures are individual for each business. Common anti-crisis measures, such as freezing areas of work, closing projects, abandoning development plans and placing employees on unpaid leave, can indeed help at the beginning of the war. However, later these measures can have a negative impact on the further development of the enterprise. After the initial "shock period", it becomes important to create long-term strategies and plans that will allow the enterprise to adapt to new conditions and resume its activities during the war period. Let's list possible anti-crisis measures [4].

One of the important measures is communication with staff. Maintaining contact with employees and explaining the current situation to them helps to avoid panic and creates a favorable climate in the team. Regular briefings, dialogue and openness about plans and prospects allow to maintain trust and motivation of employees. informed employees about the physical condition of the company every day. Some also regularly informed clients about the situation and their current plans. These managers reported that it was important for them to return employees to work after the first days of complete instability in order to create a certain level of normal life.

Retraining employees — allows the company to retain valuable personnel potential. For example, transferring employees to other departments or positions or, if there is not enough money and it is necessary to lay off people, it is possible to reduce everyone's salary, because during the war it is important for employees to have at least some stable income.

It is necessary to pay attention to more careful work with customers — analyze the impact of the war on the client base and respond quickly to changes. For example, in case of problems with logistics, offer new delivery methods, if the problems are financial, then offer postponement, payment in installments or discounts.

Optimization of routes and resources is important especially for transport companies. Given the possible restrictions on movement and logistics during the war, it is necessary to review the optimal routes, it is possible to reduce the number of transport units in operation or introduce the use of alternative delivery routes.

One of the measures is also a reorientation to the most demanded services — expanding geographical coverage, introducing new vehicles, expanding the provision of services that are relevant.

Entering international markets is also an effective means of expanding sales markets and increasing the profitability of the enterprise. With international contracts, it is possible to provide additional sources of income and reduce dependence on the domestic market.

In war conditions, digitalization also becomes a necessity. Automation of processes or the transition to remote work will help reduce business costs and physically protect employees. Also important are technological innovations — the introduction of new technologies, such as cargo tracking systems, remote control, electronic platforms and marketplaces, etc. Thus, artificial intelligence is increasingly used in business to automate tasks, forecast, recognize patterns and obtain insights. It can be used in various industries, including finance, marketing and supply chain management, to increase efficiency, accuracy and reduce costs. Some examples of the application of artificial intelligence in business include fraud detection, stock

market forecasting, consumer behavior analysis and risk management. It can be concluded that artificial intelligence plays an important role in almost all areas of human activity [10]:

The effectiveness of anti-crisis management in wartime consists in [4]:

— achieving a change in the most important indicators of the financial and economic activity of the enterprise during the period of anti-crisis management (compared to the beginning of the war or the implementation of anti-crisis measures);

— speed of obtaining positive changes per unit of time;

— speed of making management decisions;

— stabilization of the enterprise's activities;

— speed of adaptation of the enterprise to the war;

— cost-effectiveness of obtaining positive results;

— survival of the enterprise (at the beginning of the war or in the event that the enterprise is on the front line).

One of the important sectors in the country's economy, which has significant potential, is the transport sector. However, at the present stage, the vast majority of transport enterprises have low efficiency, which indicates the presence of crisis phenomena [11]. Despite the war conditions, most of the reasons for the low efficiency of transport enterprises lie in themselves, which only intensifies the effects of external factors. Thus, reducing the impact of factors on the activity requires the transport sector enterprises to implement effective anti-crisis management.

2.4 DISCUSSION OF THE RESULTS OF THE STUDY OF ANTI–CRISIS MANAGEMENT

The proposed anti-crisis management system consists of four stages. During the diagnosis, the current state of the enterprise's activities, risks and causes of the emergence of crisis phenomena are analyzed. The formation of an anti-crisis strategy and program involves the development of an action plan and specific measures aimed at reducing the impact of crisis phenomena and maintaining the stability of the enterprise. The stage of applying anti-crisis methods and measures is key, as it involves the direct implementation of measures that can lead the enterprise out of the crisis. The last stage is an assessment of the effectiveness of the proposed methods and measures, which determines the effectiveness of the goals and objectives set, how effective the applied methods and measures are in overcoming the crisis phenomenon. If the crisis is not overcome, the enterprise must return to reviewing the strategy and adjusting it.

A crisis caused by war is a special type of crisis phenomenon. Unlike a traditional crisis, it is systemic, long-term, rapidly spreading with a chain reaction and carries not only financial losses, but also a threat to people's lives, destruction of infrastructure and loss of assets. Accordingly, anti-crisis management must take into account these challenges, in particular through the application of the considered strategies, methods and measures aimed at minimizing the impact of military actions on the activities of enterprises. Such an approach will allow to ensure more effective management in war conditions, minimize risks and maintain the stability of the functioning of transport enterprises.

2.5 MODELING OF RELOCATION LOGISTICS OF HIGH-TECH ENTERPRISES IN THE CONDITIONS OF MARTIAL LAW IN THE COUNTRY

The special legal regime of the country forced to review the logistics processes of transportation [1–6]. New directions in logistics have appeared, which need to be explored for effective planning of transportation in conditions of military threats.

The logistics of transportation of industrial cargo to the rear has its own characteristics [7, 8], which are associated with the movement of enterprises from the frontline zone to a relatively safe location, to establish the production of high-tech products, including weapons and military equipment. Transport routes are formed in advance and are associated with the choice of the location of the enterprise. The choice of location depends on the availability of supporting infrastructure, energy supply, remoteness of suppliers of components, as well as the availability of qualified personnel [9]. Therefore, it is necessary to take into account a number of factors when locating an enterprise in conditions of military threats [10, 11]. Transport logistics should contribute to the efficiency of the enterprise relocation and the formation of new routes for the supply of components for the stable functioning of high-tech production, in conditions of martial law. To assess the possible and rational routes for moving goods of a high-tech enterprise, it is necessary to form logistics indicators of transportation taking into account the risks of military threats [12]. It is advisable to use the following logistics indicators:

1. The time required to move the enterprise from the frontline zone to the rear (transportation of technological equipment, building structures, etc.) – T.

2. Costs for relocation of the enterprise to the rear – V.

3. Risks of transporting goods, with the enterprise's technological equipment, in conditions of military threats – R.

When modeling the relocation of the enterprise, from the frontline zone to the rear, it is necessary to take into account the available opportunities for choosing a relatively safe location for the enterprise, as well as possible routes for transporting technological equipment, in conditions of military threats.

To form optimization models regarding the relocation of an enterprise under martial law, let's introduce a Boolean variable x_{epl}

$$x_{epl} = \begin{cases} 1, \text{ if for the relocation of the enterprise} \\ \text{to } e\text{-th possible location the } p\text{-th way for transportation of} \\ \text{goods with technological equipment is chosen} \\ \text{with } l\text{-th possible composition of logistics components} \\ \left(\text{temporary storage city, transshipment, parking areas, etc.}\right); \\ 0, \text{ otherwise.} \end{cases}$$

Then, taking into account the variables x_{epl}, let's present the logistics indicators of the enterprise to the rear in the form

$$T = \sum_{e=1}^{M} \sum_{p=1}^{m_e} \sum_{l=1}^{n_p} t_{epl} x_{epl}, \tag{2.1}$$

where l — the number of possible location of the enterprise when it is relocated to the rear; m_e — the number of possible ways of moving the enterprise to e-th new location; n_p — the number of possible compositions of logistics components that can be used on the p-th way of moving the enterprise; t_{epl} — the time required to relocate the enterprise to the rear when choosing the e-th location, the p-th way of movement and the l-th composition of logistics components.

$$V = \sum_{e=1}^{M} \sum_{p=1}^{m_e} \sum_{l=1}^{n_p} v_{epl} x_{epl}, \tag{2.2}$$

where v_{epl} — evaluation of the costs that are necessary for the realization of the enterprise with moving it to e-th location, taking into account the choice of the p-th path of movement and the l-th possible composition of logistics components.

$$R = \sum_{e=1}^{M} \sum_{p=1}^{m_e} \sum_{l=1}^{n_p} r_{epl} x_{epl}, \tag{2.3}$$

where r_{epl} — the risk that is associated with the possible occurrence of a military threat in the relocation of the enterprise, taking into account the choice of the e-th location of its location, the p-th way of movement and the selected l-th composition of logistics components.

In the state of martial law, it is extremely important that the enterprise's relocation to the rear is carried out in the shortest time, which is related to the possible actions of military threats and the need for faster production of weapons and military equipment (WME).

Therefore, as the main logistics indicator let's use the time of movement of the enterprise (T), which must be minimized. Let's optimize with the use of integer (Boolean) programming. It is necessary to find

$$\min\ T,\ T = \sum_{e=1}^{M} \sum_{p=1}^{m_e} \sum_{l=1}^{n_p} t_{epl} x_{epl}. \tag{2.4}$$

It is necessary to take into account the possible risks of action of military threats that arise when moving the enterprise to a new location

$$R \le R^*,\ R = \sum_{e=1}^{M} \sum_{p=1}^{m_e} \sum_{l=1}^{n_p} r_{epl} x_{epl}, \tag{2.5}$$

where R^* — the permissible risk of military threats in the relocation of the enterprise.

Also, it is necessary to consider the possible cost of relocation of the enterprise

$$V \le V^*, \; V = \sum_{e=1}^{M} \sum_{p=1}^{m_e} \sum_{l=1}^{n_p} v_{epl} x_{epl}, \tag{2.6}$$

where V^* — the permissible (planned) costs of moving the enterprise to the rear.

2.6 MODELING THE SUPPLY OF HIGH-TECH COMPONENTS AT THE NEW LOCATION OF THE ENTERPRISE

When moving the enterprise to the rear, it is necessary to form the composition of suppliers of components required for the production of high -tech products, including WME. Also, it is necessary to choose rational ways of supplying accessories to a new location of the enterprise.

Therefore, let's form a logistics indicators for analyzing the process of supplying components in the form:

1. The cost of supplying components that depend on the new location of the enterprise, the composition of suppliers and the selected delivery routes — W.

2. The time required for the formation of inventories of components that will ensure a stable functioning of the enterprise at a new location — T.

3. Risks related to the supply of components in martial law — R.

Let's introduce Boolean variable x_{efy}

$$x_{efy} = \begin{cases} 1, \text{ if for } e\text{-th new location of the enterprise } f\text{-th composition of suppliers and} \\ y\text{-th composition of ways of supplying components are chosen, otherwise.} \end{cases}$$

Taking into account variables x_{efy}, logistical indicators of supply components look like

$$W = \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} w_{efy} x_{efy}, \tag{2.7}$$

where w_{efy} — the costs of formation of inventories of components, taking into account the e-th location of the enterprise, the f-th composition of suppliers and the y-th composition of supply routes; M — the number of possible location of the enterprise in the rear; s_e — the number of possible compositions of suppliers of components; q_f — the number of possible compositions of ways of supplying components.

$$T = \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} t_{efy} x_{efy}, \tag{2.8}$$

where t_{efy} — the time required to form the inventories of components to ensure the sustainable functioning of the enterprise at a new e-th location, taking into account the f-th composition of suppliers and the y-th selected composition of the ways of supplying components to the enterprise.

$$R = \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} r_{efy} x_{efy} m, \tag{2.9}$$

where r_{efy} – the risk of supplying components in the face of military threats, taking into account the choice of the e-th location of the enterprise, f-th composition of suppliers and the y-th composition supply routes.

In the state of martial law, it is extremely necessary to quickly adjust the work of a high-tech enterprise at a new location.

Therefore, as the main, most significant, logistics indicator, let's use the time (T) required to form the inventories of components, to ensure the restoration of the enterprise at a new location.

It is necessary

$$\min\ T,\ T = \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} t_{efy} x_{efy}, \tag{2.10}$$

taking into account the restrictions

$$W \le W^*,\ W = \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} w_{efy} x_{efy}, \tag{2.11}$$

where W^* – the permissible costs for the formation of inventories of components for the sustainable functioning of the enterprise at a new location.

$$R \le R^*,\ R = \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} r_{efy} x_{efy}, \tag{2.12}$$

where R^* – the permissible risks of supplying components in the face of military threats.

Multicriterial problem is possible to find the rational composition of suppliers and ways of supplying components at the new location of a high-tech enterprise.

Let's introduce a comprehensive logistics supply indicator

$$Q = \alpha_W \overset{\vee}{W} + \alpha_T \overset{\vee}{T} + \alpha_R \overset{\vee}{R}, \tag{2.13}$$

where α_W, α_T, α_R – "scales" of indicators W, T, R.

$$\alpha_W + \alpha_T + \alpha_R = 1, \tag{2.14}$$

where $\overset{\vee}{W}$, $\overset{\vee}{T}$, $\overset{\vee}{R}$ – normalized values of the indicators W, T, R.

$$\overset{\vee}{W} = \frac{W - W_{\min}}{W^* - W_{\min}}, \tag{2.15}$$

where $W_{\min}$ – the minimum cost value.

$$\overset{\vee}{T} = \frac{T - T_{\min}}{T^* - T_{\min}}, \tag{2.16}$$

where $T_{\min}$ – the minimum value of supply time.

$$\overset{\vee}{R} = \frac{R - R_{\min}}{R^* - R_{\min}}, \tag{2.17}$$

where $R_{\min}$ – the minimum value of supply risks.

In order to solve the multicriteria task of searching suppliers and ways of supply is required

$$\min Q = \alpha_W \overset{\vee}{W} + \alpha_T \overset{\vee}{T} + \alpha_R \overset{\vee}{R} = \frac{\alpha_W}{W^* - W_{\min}} \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} w_{efy} x_{efy} + \frac{\alpha_T}{T^* - T_{\min}} \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} t_{efy} x_{efy} +$$
$$+ \frac{\alpha_R}{R^* - R_{\min}} \sum_{e=1}^{M} \sum_{f=1}^{s_e} \sum_{y=1}^{q_f} r_{efy} x_{efy} - \frac{\alpha_{W_{\min}}}{W^* - W_{\min}} - \frac{\alpha_{T_{\min}}}{T^* - T_{\min}} - \frac{\alpha_{R_{\min}}}{R^* - R_{\min}}. \tag{2.18}$$

THE MODELING RESULTS OF TRANSPORTATION LOGISTICS IN THE PERIOD OF SPECIAL LEGAL REGIME

The study of logistics processes of transportation during the martial law of the country has been conducted. Separate relevant areas of study related to the relocation of high-tech enterprises in the country of martial law, as well as the supply of high-tech components at the new location of the enterprise, have been determined.

The basic logistics indicators have been formed for the necessity of evaluation of the transportation processes in the conditions of military threats (the time required to move the enterprise from the frontal zone to the rear; the cost of relocating the enterprise to the rear; the risks of transportation of goods, with technological equipment of the enterprise, in the conditions of military threats for supply; formation of stocks of components that will ensure the stable functioning of the enterprise at a new location).

Optimization models have been created to choose rational relocation and the supply of high-tech components. Local optimization of logistics indicators, taking into account restrictions, has been carried out. A multicriterial model has been created to find the rational composition of suppliers and ways of supplying accessories at the new location of a high-tech enterprise.

The proposed approach is the basis for the creation of applied information technology for planning logistics of transportation, taking into account possible military threats during the martial law of the country.

This section analyzes the current state of passenger transportation in Ukraine and evaluates the main sources of its financing. It has been found that in addition to traditional problems with insufficiency of financial resources, the activities of the enterprises have caused the consequences of war. In particular, the volume of passenger transportation decreased by 47.2% compared to the pre-war 2021. Transport infrastructure lost part of the functional capacity. The fall of passenger income has further aggravated the situation.

In view of these challenges, the relevance of the development of the strategy of financial support for the functioning of passenger transport enterprises is substantiated. The proposed strategy is based on the principles of sustainable development, which provide for a harmonious combination of economic, social and environmental aspects.

The study defines the key stages of formation of a comprehensive strategy for financing transport enterprises. Its implementation will help to create a high quality, environmentally friendly and socially responsible transport system. This will not only improve the quality of services and ensure the financial stability of enterprises, but also contribute to the overall socio-economic development of the country, maintaining the balance between economic benefits, citizens' needs and environmental protection.

Passenger transport is one of the main components of the infrastructure of each country, and its development has always been closely linked to the economic well-being and success of the state. Historically, the transport sector has acted as an important indicator of economic development, and its condition and efficiency directly affected the rates of economic growth, social progress and national security [1]. That is why the sustainable development of passenger transport enterprises is a key element of the strategy for the sustainable development of society as a whole. In the context of growing urbanization and increasing load on transport systems, it is important to ensure the efficient, environmentally safe and economically sustainable functioning of passenger transport enterprises.

Financial support for the sustainable development of passenger transport enterprises is an important component for achieving efficiency, environmental safety and economic sustainability of this industry [2]. Financing is a key factor that allows enterprises to innovate, modernize infrastructure, reduce negative environmental impacts and ensure the accessibility of transport services for the population.

For passenger transport enterprises, it is important to make optimal use of financial resources to improve the quality of service and introduce new technologies. Since these enterprises often operate in the field of public services, it is important to ensure their financial stability in order to reduce costs and increase efficiency. Investing in new vehicles, process automation and improved logistics can significantly reduce operating costs and improve the level of service.

In today's conditions, the introduction of environmentally friendly technologies is a major challenge. This requires significant financial resources, since the re-equipment of the transport fleet with environmentally friendly models, such as electric or hydrogen buses, requires large capital investments. This also applies to the modernization of infrastructure, in particular the creation of charging stations for electric vehicles or hydrogen refueling stations. Without adequate financing, such initiatives may become impossible or economically inefficient for enterprises.

Financial stability allows passenger transport enterprises not only to perform their basic functions, but also to provide flexibility in responding to changes in the economic situation, such as fluctuations in energy prices or changes in tariff policy. A key factor is the ability of the enterprise to ensure stable income through the effective use of available resources and cost optimization.

Today, most passenger transport enterprises face problems of lack of financial resources to cover their costs and ensure their development. Problems with financial resources of passenger transport enterprises are a serious challenge to their sustainable development [3, 4]. Insufficient funding, high operating costs, low profitability, difficulties in attracting investments and inefficient financial management — all this requires a comprehensive approach to solving. The introduction of modern financial instruments, attracting additional sources of financing, cost optimization and improving financial transparency can help overcome these problems and ensure sustainable development of passenger transport enterprises.

SCIENTOMETRIC ANALYSIS OF EXISTING PUBLICATIONS ON THE DEVELOPMENT OF METHODOLOGICAL APPROACHES TO THE FORMATION OF A STRATEGY FOR FINANCIAL SUPPORT OF THE CONCEPT OF SUSTAINABLE DEVELOPMENT OF PASSENGER TRANSPORT ENTERPRISES

Financial support for the sustainable development of passenger transport enterprises is one of the main factors determining the success and efficiency of this industry. Reliable and stable financing allows enterprises not only to support their current activities, but also to invest in future development, introduce innovations, modernize infrastructure and comply with environmental standards. However, most passenger transport enterprises in Ukraine lack funds to cover their costs. Due to insufficient financing, many enterprises cannot afford to purchase new vehicles or modernize existing ones. This leads to the use of outdated equipment that has high fuel consumption and frequent breakdowns. Old vehicles do not meet modern standards of comfort and safety, which negatively affects passenger satisfaction. The lack of investment in improving infrastructure and maintenance also reduces the quality of services. The lack of proper financing forces enterprises to operate at a loss. This leads to the accumulation of debts, which complicates further functioning and development. To overcome these problems, comprehensive solutions are needed, which include attracting additional sources of financing, optimizing costs, introducing modern technologies and improving the skills of personnel. Only in this way can the sustainable development of passenger transport in Ukraine be ensured and its competitiveness increased.

However, the ways of finding financial resources for passenger transport enterprises should be considered in the context of their further sustainable development.

The issue of expanding traditional sources of financing for the enterprise is addressed in the work of O. Solodovnik [5] In her work, she notes that financing the sustainable development of enterprises should be carried out with the involvement of a wide range of participants on the basis of cooperation and partnership, taking into account their interests. One of such sources is proposed to consider public-private partnership, which is defined as cooperation between public authorities and the private sector for the purpose of implementing socially significant projects in a wide range of economic activities and is carried out taking

into account the interests of all stakeholders. However, to implement the involvement of private-public partnerships to finance passenger transport development projects, it is necessary to create a clear legal basis for PPP, which defines the rights and obligations of both parties, financing mechanisms, risk sharing and dispute resolution methods.

The partnership must also comply with all regulatory requirements, including environmental standards, safety standards and other regulatory acts. It is important to ensure its compliance with local, national and international standards.

The paper also highlights the characteristic features of financing sustainable development of enterprises, namely, the implementation of sustainable development goals in the functioning of enterprises creates positive social and environmental effects; creates the opportunity to involve a wide range of participants – international financial organizations, supranational state administration bodies (within the framework of integration associations), state administration bodies, state and non-state enterprises, banks and non-bank financial institutions, individuals, etc. is carried out on the basis of cooperation and partnership, taking into account the interests of all interested groups of stakeholders; expands the range of sources of financial resources formation – allows to mobilize not only own and nationally attracted financial resources, but also international public and private financial resources; ensures the emergence and dynamic development of new methods and tools for the formation and use of financial resources, taking into account global priorities and development trends.

The work [6] is devoted to the issue of determining the economic essence and features of financial support for sustainable development of the enterprise.

A special place in the process of forming sufficient sources of financing for the enterprise's activities is occupied by the strategy of financial support. In the work [4] it is determined that the financial strategy should be aimed at implementing such areas of the company's activity as attracting financial resources, balanced placement (investment) of financial resources, ensuring the necessary level of financial security and achieving high quality management of financial activities.

RESULTS OF THE DEVELOPMENT OF SCIENTIFIC AND METHODOLOGICAL PRINCIPLES FOR THE FORMATION OF STRATEGIES FOR FINANCIAL SUPPORT OF THE CONCEPT OF SUSTAINABLE DEVELOPMENT OF PASSENGER TRANSPORT ENTERPRISES

The aim of the study is to develop and substantiate methodological approaches that will contribute to the formation of effective strategies for financial support of sustainable development of passenger transport enterprises. This includes an analysis of the current state of financial support, identification of key problems and barriers, as well as the development of recommendations for overcoming them, taking into account modern trends and innovations in the field of financing transport systems.

To achieve the aim, the following objectives were set:

– analysis of the current state of financial support of passenger transport enterprises and identification of the main sources of financing and assessment of their adequacy to ensure sustainable development;

— identification of internal and external factors affecting the financial stability of passenger transport enterprises;

— identification of key problems associated with insufficient funding, high operating costs, low profitability and other aspects;

— determination of scientific and methodological principles for the formation of effective strategies for financial support;

— development of models and tools that will contribute to the optimization of financial flows, cost reduction and increase in profitability of passenger transport enterprises.

The object of the study is passenger transport enterprises that operate in conditions of increasing load on transport systems and the need to ensure sustainable development. The object of the study covers a wide range of aspects of the activities of passenger transport enterprises that determine their financial support, efficiency, environmental safety and social responsibility. The study of these aspects will allow developing scientifically sound methodological principles for the formation of financial support strategies aimed at ensuring the sustainable development of passenger transport enterprises.

To achieve the set aim, a set of well-known scientific methods was used in the study. Generalization methods were used to generalize modern approaches to the implementation of sustainable development goals in the activities of passenger transport enterprises and to determine the sources of their financing, as well as to form conclusions and recommendations [7, 8]. The logical synthesis method was used to theoretically substantiate the importance of studying the financial support of sustainable development of passenger transport enterprises. The use of analysis and synthesis methods allowed to show the features of ensuring the functioning of passenger transport enterprises in conditions of sustainable development. For a clear presentation of the research results and their schematic interpretation, the method of constructing schemes and models was used.

The proposed general approach to the formation of a financial support strategy [9, 10] is based on the goals of sustainable development and provides for a comprehensive approach to developing a strategy taking into account economic, social and environmental aspects to ensure the sustainable development of the passenger transport industry. Such an approach will ensure not only the financial stability of enterprises, but will also contribute to improving the quality of transport services, preserving the environment and meeting the social needs of the population.

RESULTS OF THE ANALYSIS OF THE CURRENT STATE OF FINANCIAL SUPPORT FOR PASSENGER TRANSPORT ENTERPRISES

Passenger transport plays an important role in the economy of any country. Its importance goes far beyond the simple movement of people from one place to another. This industry is the foundation for many economic, social and environmental processes, influencing various aspects of society and contributing to its development. Efficient passenger transport contributes to the mobility of the workforce, providing workers with the opportunity to quickly and conveniently get to their workplaces.

This increases labor productivity, stimulates economic activity and contributes to GDP growth. However, its impact on the economy [11, 12]:

— the presence of a well-developed transport system allows workers to reduce the time spent traveling to and from work. This reduces stress, increases overall job satisfaction and improves the balance between work and personal life;

— thanks to reliable transport, people can consider work in a wider radius from their place of residence. This expands employment opportunities, reduces unemployment and promotes a more even distribution of the workforce across regions;

— efficient public transport allows employees to arrive at work on time, reducing tardiness and loss of working time. This contributes to increasing the productivity and efficiency of enterprises;

— reducing travel time and improving travel conditions helps reduce fatigue and stress among employees, which has a positive effect on their health and efficiency;

— accessibility increases the attendance of shopping centers, restaurants, cultural and entertainment institutions. This contributes to the growth of local business income and the creation of new jobs;

— the development of the transport system requires significant investments, which stimulates economic activity in the construction industry, production and transport services;

— developed transport allows for the integration of labor markets of different regions, reducing regional imbalances in the level of employment and wages. This contributes to a more even economic development of territories. Accessibility of transport makes cities and regions more attractive for highly qualified specialists, which contributes to the growth of innovative potential and the development of new industries.

The economic activity and development of the country are largely reflected in the volume of passengers transported by passenger transport. The dynamics of gross domestic product (GDP) is one of the key indicators that affects the transport sector (**Fig. 2.8**). The crises that occurred in the country's economy also significantly affected the passenger transport industry. But the industry suffered the greatest shocks in connection with the war. The volume of passengers transported by urban passenger transport in 2022 decreased by 47.6% compared to the pre-war year 2021. Passenger transport enterprises themselves also suffered significant losses as a result of the war. According to analytical calculations, direct losses caused to municipal enterprises and private carriers, in particular to destroyed transport, amount to 0.83 billion USD — these are destroyed trolleybuses, trams, buses [11, 13].

Table 2.5 presents the losses of rolling stock of passenger transport enterprises of Ukraine. As of January 2024, 11% of trolleybuses, 7.9% of trams and more than 5% of buses from their total number were lost. And these losses are not final, since every day the cities of Ukraine suffer from enemy missile attacks.

The largest enterprise in the city of Kyiv, which carries out passenger transportation by both buses and electric transport, is the Municipal Enterprise "Kyivpastrans". The financial resources of the enterprise are presented in **Fig. 2.9**. The enterprise is dependent on borrowed credit resources. Over the past three years, the amount of bank loans of the enterprise has increased threefold. There has also been a sharp increase in the enterprise's accounts payable for goods, works and services to its counterparties.

Table 2.5 Losses of rolling stock of passenger transport enterprises of Ukraine

Types of damaged rolling stock	Units	Initial number of objects	Number of damaged objects
Trolleybuses	Units	2 980	344
Trams	Units	1 922	152
Buses	Units	241 426	13 182

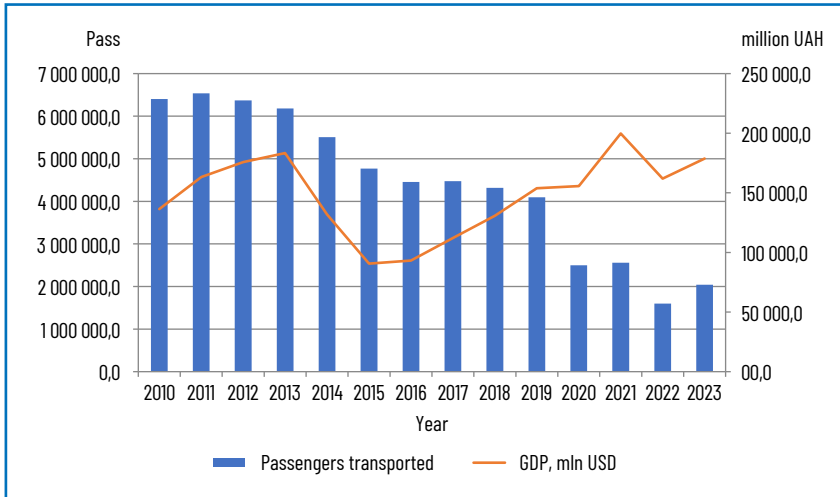

Fig. 2.8 Dynamics of GDP and number of transported passengers in Ukraine during 2010–2023

Therefore, the enterprise operates mainly at the expense of borrowed funds, which indicates a lack of its own financial resources. This creates significant pressure on the financial stability of the enterprise, since high dependence on external financing can lead to increased financial risks. Attracting loans or other external resources may be necessary to ensure current activities, but it also increases debt servicing costs and reduces the flexibility of the enterprise in managing financial flows. Therefore, to achieve financial stability and reduce dependence on external sources, the enterprise needs to develop a strategy for increasing its own financial resources, optimizing costs and increasing profitability.

Analysis of the current state of financial support of passenger transport enterprises shows that they face a number of financial problems, in particular, a lack of own resources and high dependence on external financing. To ensure financial sustainability and support long-term development, it is necessary to implement comprehensive strategies aimed at optimizing costs, diversifying sources of financing and strengthening the role of state support.

Only in this way will enterprises be able to improve their financial situation, improve the quality of services and contribute to the sustainable development of the transport sector.

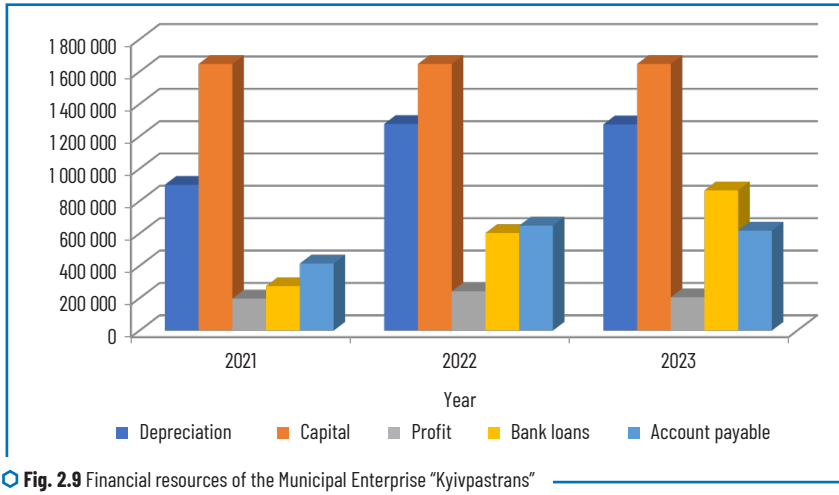

Fig. 2.9 Financial resources of the Municipal Enterprise "Kyivpastrans"

Source: [14]

RESULTS OF DETERMINING SCIENTIFIC AND METHODOLOGICAL PRINCIPLES FOR THE FORMATION OF EFFECTIVE STRATEGIES FOR FINANCIAL SUPPORT OF THE CONCEPT OF SUSTAINABLE DEVELOPMENT OF PASSENGER TRANSPORT ENTERPRISES

The concept of "strategy" is key in various fields of activity, including business, public administration, social sciences and others. A strategy is a long-term action plan aimed at achieving certain goals or objectives in conditions of uncertainty and limited resources. It includes an analysis of the current state, defining goals, developing ways to achieve them and monitoring implementation. A strategy is a fundamental tool for achieving long-term success. That is why there is a need to form an effective strategy for financial support of the concept of sustainable development. Forming a strategy for financial support of the concept of sustainable development of passenger transport enterprises is a critical element for achieving long-term success and stability of this industry. In modern conditions of urbanization and increasing load on transport systems, it is important to ensure the efficient, environmentally safe and economically sustainable functioning of passenger transport enterprises. The purpose of forming a strategy for financial support of the concept of sustainable development of passenger transport enterprises is to create an effective and reliable financial base to support the long-term and balanced development of

transport enterprises, as well as to ensure environmentally responsible and economically efficient functioning of this industry. It should also be noted that when developing this strategy, it is necessary to take into account the goals of sustainable development in order to ensure a comprehensive and balanced approach to the development of the passenger transport industry (**Fig. 2.10**). A fundamental aspect of sustainable development is economic sustainability, as it provides the basis for the long-term and balanced growth of enterprises and society as a whole. It determines the ability of economic systems to withstand internal and external shocks, adapt to changes and ensure sustainable development in the long term.

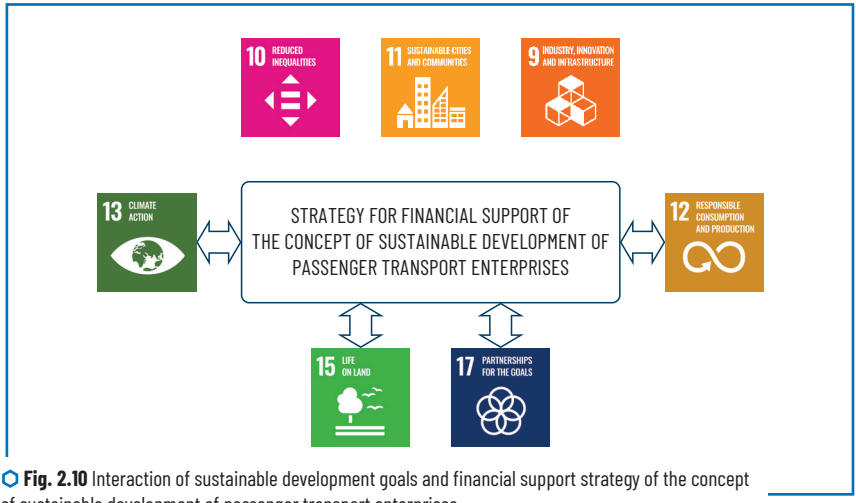

Fig. 2.10 Interaction of sustainable development goals and financial support strategy of the concept of sustainable development of passenger transport enterprises

The basis of economic stability is financial stability, which provides for:

– effective financial management through optimization of financial flows, control over costs and ensuring a sufficient level of liquidity;

– diversification of financing sources;

– financial risk management through the implementation of mechanisms for identifying, assessing and minimizing financial risks.

Economic stability is an integral part of the competitiveness of enterprises. It allows enterprises not only to survive in a competitive environment, but also to thrive, ensuring stable and effective functioning in the long term.

Effective use of resources is a key factor in ensuring economic stability and competitiveness of enterprises. Cost optimization and increasing the efficiency of operational activities allow enterprises not only to reduce costs, but also to increase the productivity and quality of their services. Cost optimization consists in analyzing and reducing costs at all stages of the enterprise's operational activities. Increasing the

efficiency of operational activities allows enterprises to use their resources more productively and provide high quality services. This is achieved through process automation, optimization of logistics processes, and the implementation of advanced management practices.

Environmental responsibility is an integral part of the concept of sustainable development. It consists in ensuring the use of natural resources and waste management in a way that minimizes the negative impact on the environment, preserves it for future generations, and promotes the harmonious coexistence of man and nature. Reducing emissions of harmful substances into the atmosphere, water, and soil is an important component of environmental responsibility, which is especially relevant for passenger transport enterprises. Environmental responsibility of passenger transport enterprises is a critical aspect of their activities aimed at reducing the negative impact on the environment and promoting sustainable development. Ensuring environmental responsibility includes several main areas, such as optimizing resource use, implementing environmentally friendly technologies, reducing emissions, waste management, and raising environmental awareness among employees and passengers. Implementation of this principle involves optimizing and rational use of fuels and lubricants, implementing energy-efficient technologies, implementing environmentally friendly technologies, reducing harmful emissions and raising the environmental awareness of enterprise employees.

The social responsibility of passenger transport enterprises involves taking into account the needs and interests of different groups of the population that use their services. This includes creating comfortable and accessible conditions for all passengers, ensuring safety, supporting social programs and initiatives, and promoting community development. Social responsibility is an important aspect of the activities of enterprises, which allows increasing the trust and satisfaction of customers, as well as strengthening their reputation in society. The social responsibility of passenger transport enterprises includes the following components:

— accessibility and inclusiveness. Passenger transport should be accessible to all segments of the population, therefore vehicles and infrastructure should be equipped with ramps, elevators and special places for passengers with disabilities. This also includes accessibility for the elderly and families with children;

— passenger safety. Transport companies must adhere to high safety standards through regular maintenance of vehicles, the implementation of modern security systems [15], such as surveillance cameras, GPS trackers, emergency communication systems. Also, the implementation of this requirement involves regular training and courses for drivers and other personnel on passenger safety, first aid and emergency response;

— social programs and initiatives. This component involves providing discounts on travel for pensioners, students, large families and other socially vulnerable categories of the population;

— environmental initiatives involve the implementation of measures aimed at reducing harmful emissions, saving energy and resources, as well as conducting information campaigns among passengers on the environmental aspects of using transport and supporting environmentally conscious behavior.

The social responsibility of passenger transport enterprises covers a wide range of measures aimed at ensuring accessibility and safety, improving the quality of service, supporting social programs and

environmental initiatives. Taking into account the needs and interests of different groups of the population is a key element of social responsibility, which contributes to increasing the level of trust in the enterprise, improving its reputation and ensuring sustainable development. The implementation of socially responsible practices allows passenger transport enterprises to effectively use their resources, adapt to changes and achieve long-term success. Innovation is a key factor contributing to the sustainable development of passenger transport enterprises. They allow introducing the latest technologies, improving the quality of services, reducing costs and environmental impact, as well as increasing competitiveness. In the context of rapid technological development and growing requirements for environmental and social responsibility, innovations are becoming an integral part of the sustainable development strategy. The financial strategy of passenger transport enterprises should be focused on creating favorable conditions for the implementation of innovations. This includes investments in research and development, attracting external investments, optimizing costs, creating internal innovation funds, supporting environmental and social innovations. An effective financial strategy will allow enterprises not only to implement advanced technologies, but also to increase competitiveness, ensure environmental and social responsibility, and promote sustainable development of the industry as a whole.

Institutional capacity and effective management play a key role in ensuring the sustainable development of passenger transport enterprises. Development of the regulatory framework, organizational structure, professional resources, strategic and financial planning, operational management, monitoring and evaluation — all this contributes to achieving sustainable development goals. Effective management ensures optimal use of resources, improving the quality of services, reducing risks and increasing the competitiveness of enterprises, which, in turn, contributes to the sustainable development of society as a whole [16]. These components contribute to the proper functioning of enterprises, ensuring the quality of services, efficient use of resources and adherence to the principles of sustainable development.

It should also be noted that the formation of a strategy for the financial support of passenger transport enterprises should be closely correlated with the goals and objectives of the general strategy for the development of the industry, the region and the economy of the country as a whole. This ensures consistency of actions at all levels, contributes to the effective use of resources and allows for comprehensive development. Therefore, when forming a strategy, the goals and objectives of the general strategy for the development of the transport industry should be taken into account, namely, harmonization with industry priorities, coordination with infrastructure projects.

The formation of a strategy for the financial support of sustainable development of passenger transport enterprises is a multi-stage process that requires careful planning, analysis and coordination [17]. The main stages of the formation of a strategy for the financial support of the concept of sustainable development of passenger transport enterprises are presented in **Fig. 2.11**. The first initial stage of the formation of the strategy is the formulation of its mission.

The mission of the strategy for the financial support of the concept of sustainable development of passenger transport enterprises is to create conditions for sustainable, environmentally responsible and socially oriented development of the industry. This includes ensuring financial stability, supporting innovation, reducing environmental impact and improving the quality of life of the population through the

accessibility and quality of transport services. It also means creating conditions that allow transport enterprises not only to survive in the face of economic challenges, but also to develop, responding to the modern needs of society and the environment.

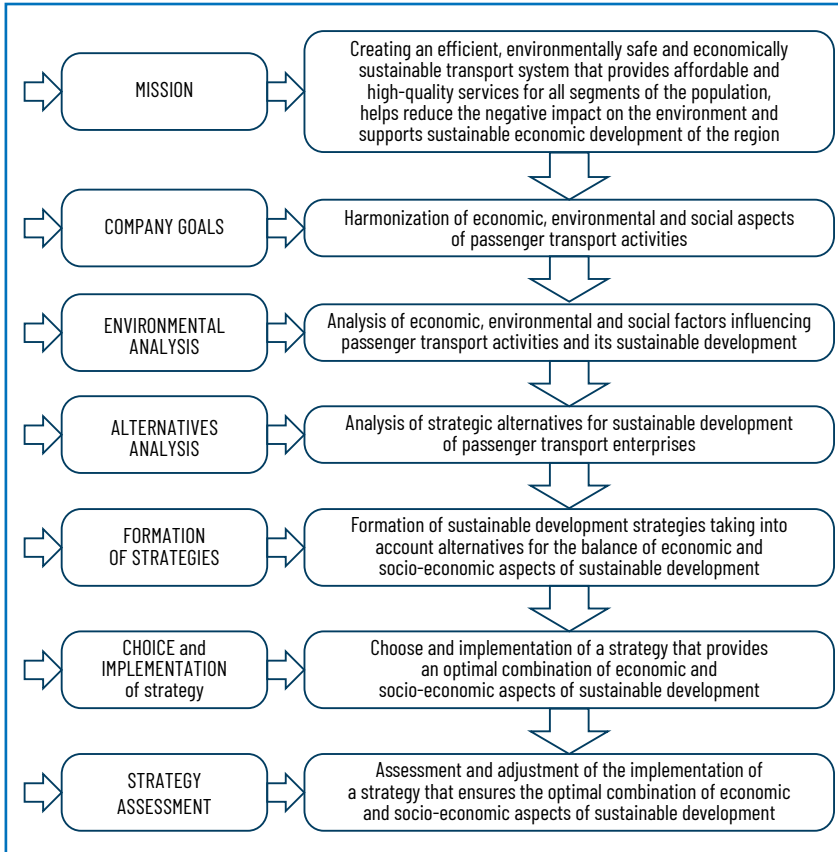

Fig. 2.11 Stages of formation of a strategy for financial support of the concept of sustainable development of passenger transport enterprises

Accordingly, the mission objectives should be:

– ensuring long-term financing involves creating conditions for stable financing of sustainable development projects through diversification of income sources, attracting investments ;

– increasing competitiveness through efficient use of resources, optimizing costs and implementing innovations;

— preserving and improving the environment by reducing environmental impact through the implementation of environmental initiatives and technologies;

— supporting social equality — involves ensuring accessibility and quality of transport services for all segments of the population, with an emphasis on social justice and inclusiveness.

The phased implementation of the stages of formation of a strategy for financial support of the concept of sustainable development of passenger transport enterprises will contribute to the development of a high-quality, environmentally friendly, cost-effective and SOCIALLY responsible transport system. This will not only improve the quality of services, but also contribute to the overall economic and social development of the country, while maintaining a balance between the needs of citizens, economic benefits and environmental protection.

A generalized scheme of the strategy for financial support of the concept of sustainable development of passenger transport enterprises is presented in **Fig. 2.12**.

The generalized scheme of the financial support strategy of the concept of sustainable development of passenger transport enterprises is an important tool for systematizing and optimizing financial flows in this area. The proposed strategy should take into account not only economic aspects, but also social and environmental factors, since sustainable development requires a balance between work efficiency, environmental care and social needs of citizens.

The economic aspects of the financial support strategy are aimed at ensuring stable and effective use of enterprise resources. Their components are:

1. Financial sustainability of enterprises. Passenger transport faces high costs for infrastructure maintenance (roads, stops, depots), technical maintenance of vehicles (buses, trolleybuses, trams, trains), personnel remuneration, fuel and energy. On the other hand, the main sources of income are fares from passengers, budget financing and other payment sources. Cost optimization and revenue growth are important for achieving financial sustainability of enterprises. In many countries, including Ukraine, passenger transport often requires state subsidies due to low transportation tariffs. This is due to the fact that passenger transport is a socially important service, and tariffs often do not cover all costs.

2. Pricing policy and tariffs. Setting tariffs that correspond to the level of costs and revenues of the enterprise is one of the most important economic aspects. Determining fair and affordable tariffs, as well as ensuring their flexibility depending on demand, is of great importance for achieving economic efficiency.

3. Investments in infrastructure development. Investments in new, more efficient vehicles (electric buses, low-floor trams, new routes) can reduce fuel and maintenance costs, increase the level of safety and comfort for passengers.

4. Productivity and efficiency. Proper route planning, including determining the frequency of runs and load levels, can significantly increase transport efficiency. Route optimization can reduce service costs and reduce waiting times for passengers.

5. Attracting private investment. In conditions of limited budget financing, private investment can become an important source of capital for the development of passenger transport. For large infrastructure projects, bond loans or other forms of financing can be used, which allows attracting private investors and minimizing dependence on the state budget.

6. Economic impact on the region and the country's economy. Passenger transport directly affects the economy of a city or region, ensuring labor mobility, supporting the labor market, and promoting the development of trade and tourism. Increasing the availability of transport contributes to increased economic activity, improving access to jobs, and maintaining economic stability in regions.

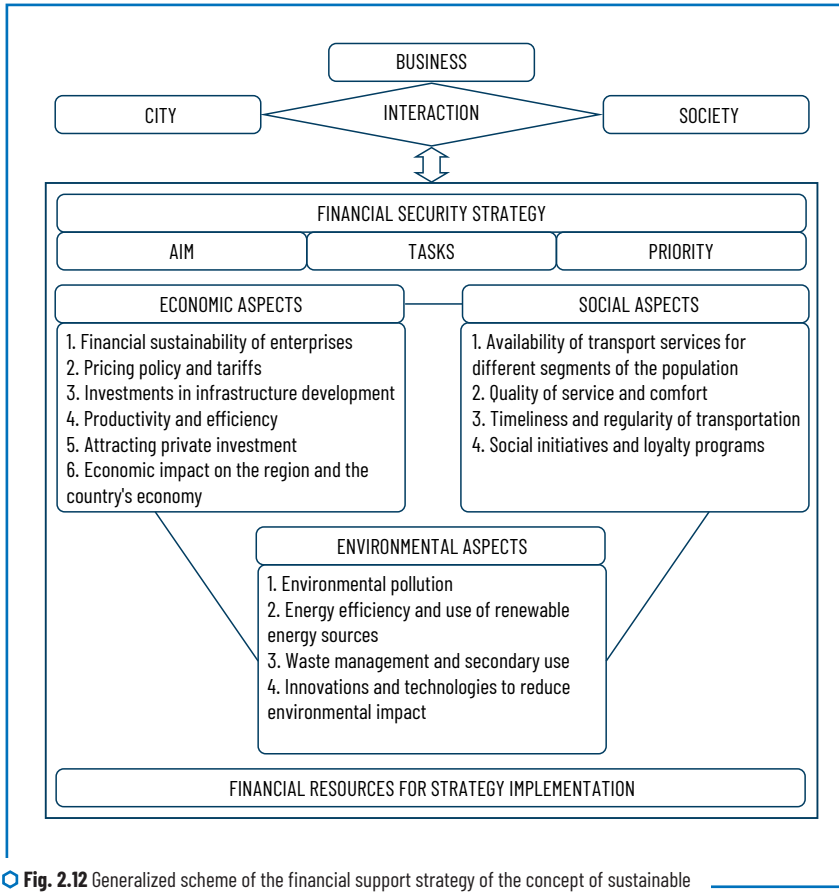

Fig. 2.12 Generalized scheme of the financial support strategy of the concept of sustainable development of passenger transport enterprises

Social aspects of passenger transport activities focus on ensuring accessibility and quality of services for all segments of the population.

This includes:

1. Accessibility of transport services for different segments of the population. Passenger transport should be accessible to all segments of the population, including people with disabilities, pensioners, chil-

dren, students, as well as socially vulnerable groups. Adaptation of infrastructure (ramps, elevators, special places for wheelchairs) and ticket benefits are important.

2. Quality of service and comfort. High quality of service and comfort during trips are of great importance for citizens using passenger transport. This includes cleanliness, availability of air conditioning, comfortable seats, provision of Wi-Fi and access to other amenities.

3. Timeliness and regularity of transportation. For passengers, it is important that transport runs regularly and the schedule is convenient and predictable. Irregular or delayed runs can lead to increased travel time, which creates significant social inconvenience.

4. Social initiatives and loyalty programs. The development of loyalty programs, in particular for frequent travelers or for students and pensioners, encourages citizens to use public transport. This may include cards with bonuses, discounts or free trips after a certain number of uses.

The environmental aspects of the financial security strategy are aimed at preserving the environment and reducing the negative impact of transport on the environment. They include:

1. Environmental pollution. Passenger transport is a significant source of carbon dioxide (CO_2) emissions, which contribute to climate change. CO_2 emissions depend largely on the type of transport (buses, trams, trolleybuses, trains). Transport running on fossil fuels (diesel, gasoline) is the main source of these emissions. In addition to CO_2, traditional vehicles also emit nitrogen oxides (NO_x), sulfur dioxide (CO_2), particulate matter and other harmful substances that cause air pollution, impair human health and can lead to the formation of acid rain.

2. Energy efficiency and the use of renewable energy sources. The use of energy from renewable sources, such as solar, wind and hydropower, to charge electric vehicles is an important component of reducing the negative impact on the environment. For example, electric buses or trams powered by energy produced from renewable sources significantly reduce emissions of pollutants into the atmosphere.

3. Waste management and recycling. One aspect of environmental responsibility is the proper management of waste generated during the operation of vehicles. This includes the disposal of old vehicles, batteries and other components that can pollute the environment.

4. Innovation and technologies to reduce environmental impact. The introduction of new technologies, such as automation, unmanned vehicles and intelligent transport systems, can significantly increase the efficiency of transport and reduce its environmental footprint.

The overall strategy for financial support for the concept of sustainable development of passenger transport enterprises is complex and multifactorial. It should synthesize economic, social and environmental aspects to ensure the sustainable development of the industry.

Such an approach will ensure not only the financial sustainability of enterprises, but will also contribute to improving the quality of transport services, preserving the environment and meeting the social needs of the population.

The proposed general approach to the formation of a financial support strategy is based on the goals of sustainable development and provides for a comprehensive approach to developing a strategy taking into account economic, social and environmental aspects to ensure the sustainable development of the passenger transport industry. Such an approach will ensure not only the financial stability of enterprises.

CONCLUSIONS

The state of the passenger transport industry was analyzed and the main sources of financing were assessed. In addition to the problem of lack of financial resources, the war made significant adjustments to the activities of passenger transport enterprises. The decline in passenger transport volumes was 47.2% compared to the pre-war year of 2021. The infrastructure of passenger transport enterprises also suffered significant losses. The decrease in passenger income also negatively affected the volume of transportation. In view of this, the development of a strategy for financial support for the activities of enterprises is particularly relevant. However, the development processes of passenger transport enterprises should take place taking into account the concept of sustainable development and based on the principles of sustainable development.

As a result of the study, the main stages of forming a strategy for financial support for the concept of sustainable development of passenger transport enterprises were formed. The implementation of the stages of forming a strategy for financial support for the concept of sustainable development of passenger transport enterprises will contribute to the development of a high-quality, environmentally friendly, cost-effective and socially responsible transport system. This will not only improve the quality of services, but also contribute to the overall economic and social development of the country, while maintaining a balance between the needs of citizens, economic benefits and environmental protection.

A generalized strategy for financial support of the concept of sustainable development of passenger transport enterprises has been developed. The general strategy for financial support of the concept of sustainable development of passenger transport enterprises is comprehensive and multifactorial. It is based on the principles of sustainable development and synthesizes economic, social and environmental aspects to ensure sustainable development of the industry. Such an approach will ensure not only the financial sustainability of enterprises, but will also contribute to improving the quality of transport services, preserving the environment and meeting the social needs of the population.

USE OF ARTIFICIAL INTELLIGENCE

The authors used OpenAI ChatGPT (using the GPT-4 model, version 2023) and Anthropic Claude (Claude 2, 2023) as AI language assistant models during writing. They served to improve the writing process, but did not replace the authors' scientific analysis.

The AI-based writing tools were used to assist in text generation (suggesting starting expressions for some paragraphs), stylistic improvement, language editing (to correct grammatical errors and improve the quality of academic writing), and to recommend titles or headings/subheadings.

The authors carefully edited the AI-generated drafts, checking the accuracy of informational claims against data and sources, ensuring scientific accuracy and objectivity in the manuscript. This human review ensures that the article includes the authors' analysis and original conclusions.

The authors claim full responsibility for this publication.

The use of ChatGPT and Anthropic Claude did not influence the results or conclusions of the study. The authors used AI tools for writing, but not for data analysis or conclusions. The results and conclusions of the study were based on the authors' independent assessment of the data and their work in the related literature, and we declare that the interpretations provided are the authors' own.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest with respect to this study, including financial, personal, authorship or other, that could influence the study and its results presented in this article.

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3 INCLUSIVE PROJECT MANAGEMENT OPPORTUNITIES IN NATIONAL ECONOMY DEVELOPMENT

ABSTRACT

The section presents the results of a comprehensive study of inclusive project management as a tool for transforming the national economy in the face of global challenges. The authors examined the methodological foundations of inclusivity in project management, analyzed international experience, and conducted an empirical assessment of the relationship between inclusive practices and innovative capacity using the example of ten countries. The results obtained confirm the hypothesis of the positive impact of inclusive management on human capital development, economic sustainability, and innovative growth. The constructed regression model demonstrated a high level of correlation between the inclusion index, human development, and innovation index, as well as the multiplicative effect of social diversity.

For the first time, four approaches to inclusive project management (socially oriented, institutional, innovative, gender-inclusive) were systematized and practical recommendations were developed taking into account international standards. A critical analysis of Ukrainian realities was conducted, barriers were identified, and directions for further research were outlined — from dynamic econometric modeling to the impact of inclusive practices on local community development.

KEYWORDS

Inclusive governance, project management, human capital, innovative capacity, economic sustainability, social participation, gender equality, sustainable development, econometric modeling, post-war recovery.

In the current conditions of globalization and the growth of socio-economic interdependence of countries, the problem of inclusive development is becoming particularly urgent. In the context of sustainable economic growth, ensuring equal access to opportunities for all social groups, including vulnerable, low-mobility segments of the population, representatives of national minorities, persons with disabilities, women, youth and the elderly, is becoming a priority. One of the tools for implementing this approach is inclusive project management, which acts not only as a mechanism for achieving social justice, but also as a factor in increasing efficiency and innovation in management systems.

The relevance of the study is due to the fact that inclusive approaches to project management have the potential to have a positive impact on the qualitative transformation of economic structures, stimulating entrepreneurship, attracting new groups to economic activity and creating added value at the

national level. An analysis of the practical activities of many countries has shown that inclusive project management contributes to increasing labor productivity, forming flexible and sustainable teams, as well as increasing the level of trust in institutions.

Despite the existence of separate studies devoted to inclusivity in the context of management or social development, the integration of an inclusive approach into project management at the level of state economic policy remains understudied, especially in countries with transforming economies, such as Ukraine. Moreover, the lack of adapted tools and mechanisms complicates the implementation of inclusive practices in the real project environment.

Thus, the study of inclusive project management opportunities in the context of national economic development is extremely timely and socially significant.

The aim of the article is to substantiate the theoretical foundations, analyze international experience and develop practical recommendations for the integration of inclusive project management into the strategic paradigm of national economic development.

The scientific novelty of the study lies in the attempt to:

— determine the role of an inclusive approach as a tool of socio-economic transformation;

— develop a systemic model of the impact of inclusive project management on macroeconomic indicators;

— propose adaptive mechanisms for implementing inclusive practices in project management in the context of Ukrainian realities.

3.1 THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF THE STUDY

The concept of inclusivity comes from the broader discourse of sustainable development, where it is interpreted as a social model that guarantees equality of opportunities, participation and access to resources and processes for all categories of the population. The theoretical basis is formed by A. Sen's ideas about capabilities — the ability of an individual to realize their own potential under favorable conditions of the environment [1]. His approach focuses not on GDP growth, but on expanding the spectrum of life opportunities of individuals, which correlates with the goal of inclusive project management — to involve all social groups in the processes of project development, implementation and evaluation.

M. Porter and M. Kramer [2] in the concept of Creating Shared Value (CSV) emphasize that business should create not only economic, but also social value. Their model is intertwined with project management, because projects can be a platform for integrating the goals of inclusivity and business efficiency — for example, through the employment of people with disabilities in IT projects or taking into account gender balance in teams.

The concept of inclusive growth has also been developed in the works of authors such as R. Ranieri and R. Ramos [3], who proposed to consider inclusivity through the prism of a broad distribution of the benefits of economic development, with an orientation towards sustainability and human capital.

According to D. Khang and T. Moe [4], project management in developing countries should be adaptive to the socio-cultural context, which is a direct challenge for inclusive approaches. At the same time,

J. Thomas and T. Mengel [5] believe that inclusivity contributes to strengthening interpersonal relationships in teams and increasing the long-term viability of projects.

To achieve the objectives of the study, a combination of qualitative and quantitative methods of analysis was used, which corresponds to the interdisciplinary nature of the topic:

— content analysis of more than 80 publications from the Scopus, WoS, EBSCO databases, covering the years 2015–2024;

— SWOT analysis was used to identify the strengths and weaknesses of implementing an inclusive approach in Ukrainian conditions;

— case analysis of the programs "Inclusive City" (UNDP), "Community for All" (GIZ), "Women in Business" (EU4Business) — as examples of effective project inclusion;

— comparative analysis — assessment of the difference in approaches to inclusion between countries with different levels of development and their consequences for macroeconomic indicators.

Based on a literature review and analysis of practices, three leading paradigms of inclusive project management were identified:

1. Socio-oriented approach. The main goal is to include marginalized and vulnerable groups (people with disabilities, migrants, LGBTQ+ representatives, women in rural areas, etc.) in all stages of the project life cycle. An example is the UN Women program in Ukraine, which involves women in entrepreneurship through microgrants. This approach is mainly used in public, educational or social projects. It is based on the principles of gender equality, accessibility and participation, set out in Sustainable Development Goals 5, 10, 11.

2. Institutional-adaptive approach. Its essence is to adapt organizational policies, management culture and processes to the requirements of a diverse environment. For example, giant companies such as Google or Accenture implement diversity & inclusion policies in their own internal projects. Such organizations modify recruitment procedures, training, change management, communication channels in accordance with the needs of employees with different backgrounds.

3. Innovation-economic approach. It is based on the fact that diversity in the team stimulates creativity, new business models and innovation. According to a McKinsey study [6], companies with a high level of ethnic and gender diversity have a 33–35% higher probability of financial success. Inclusive project management in this paradigm is seen as a tool for increasing competitiveness. For example, startups that include people with disabilities in their development create products with greater market accessibility (universal design).

OECD studies [7] prove that inclusive policies in the project environment directly affect the following macroeconomic factors:

— reduction of unemployment among vulnerable groups of the population;

— increase of labor productivity by attracting new human capital;

— increase of entrepreneurial activity among women and youth;

— reduction of social spending of the state due to strengthening of economic participation of citizens.

In the Scandinavian countries (Sweden, Norway), introduction of inclusive standards in state projects has become one of the key factors of macroeconomic stability.

The toolkit of inclusive management covers a number of standards and frameworks that help to integrate principles of D&I (diversity and inclusion) into project processes:

— ISO 26000: Guidance on Social Responsibility — a framework document that defines the principles of ethical, responsible management, including inclusion as a component of corporate policy [8];

— PMI (Project Management Institute) Diversity Framework — a model for assessing the level of inclusion in project teams [9];

— GPM Global P5 Standard for Sustainability in Projects — includes indicators of gender equality, equal access to resources, social responsibility in project management [10];

— UNDP Project Appraisal Framework [11] — integration of the principles of social impact and community involvement in project development;

— Balanced Scorecard with D&I KPIs — a modernized strategic management system that takes into account quantitative indicators of inclusion (number of women in the team, coverage of low-mobility groups, level of involvement of participants, etc.).

3.2 INCLUSIVE PRACTICES IN PROJECT MANAGEMENT: INTERNATIONAL EXPERIENCE

In global practice, there is a clear trend towards integrating inclusivity into the strategic project management system. Countries with a high level of institutional maturity are actively implementing the principles of inclusivity at both the state and corporate levels.

According to the OECD report [12], inclusivity is considered not only as a social imperative, but also as an economically feasible strategy that contributes to attracting new human resources, innovations and increasing management efficiency.

Conditionally inclusive approaches can be classified into the following main types:

— Institutional approach — state regulation and policy that provides regulatory consolidation of inclusivity in project management;

— Gender-oriented approach — emphasis on involving women, LGBTQ+ communities, and supporting gender equality in project teams;

— Innovative approach — using inclusivity as a means of enhancing creativity, entrepreneurship and digital transformation;

— Social approach — focusing on the integration of vulnerable groups (migrants, people with disabilities, unemployed) into work and project activities.

Table 3.1 below provides a comparative analysis of inclusive approaches in five countries (Sweden, Canada, South Korea, Germany, Ukraine). The nature of the approach, implementation tools and achieved results are assessed.

Sweden — Gender Mainstreaming in Public Projects. Sweden has legislated a requirement for public institutions to integrate gender performance indicators (KPIs) into all public projects. For example, the Stockholm transport modernization project took into account the needs of women with children and people with limited mobility. This allowed increasing the public satisfaction index by 27% in two years [12].

Canada — Indigenous Entrepreneurship Projects. The Indigenous Growth Fund program provides support to small businesses started by representatives of indigenous peoples. More than 65 projects have been

implemented in the areas of digital services, agriculture, and the processing industry. The program works in partnership with Impact Hub and Startup Canada [16].

Germany — Integration durch Qualifizierung (IQ). The IQ (integration through qualification) program is aimed at refugees and migrants, who are given the opportunity for professional adaptation and certification. Particular attention is paid to sectors with a shortage of specialists: construction, healthcare, and elderly care. According to IQ Netzwerk, more than 45,000 people underwent retraining in 2020–2023 [18].

Table 3.1 Comparative analysis of inclusive project management practices in different countries

Country	Approach to inclusion	Implementation tools	Results
Sweden	Institutional-oriented (state policy)	Inclusion Act, government funding	92% of government projects include gender KPIs
Canada	Innovative-social (grant programs for startups)	Startup Canada, Impact Hub, grant initiatives	50+ inclusive startups per year employment growth
South Korea	Gender-inclusive (female entrepreneurship)	Women Start Program, educational incubators	35% of new entrepreneurs are women from rural regions
Germany	Social capital and professional integration of migrants	Jobcenter programs, adaptation centers	Social integration of 20,000 refugees annually
Ukraine	Fragmented, support from donors (UNDP, GIZ)	Grants, local initiatives, NGO support	Local successes, lack of national strategy

Source: compiled by the authors based on [2, 8, 12–18]

An analysis of international practice shows that successful inclusive project management requires systemic support at all levels: legislative, institutional, educational, and financial. In Ukraine, although there are positive initiatives (for example, "Community for All" with the support of GIZ), they remain local and not integrated into national policy.

To increase efficiency, it is necessary to:

— consolidate the principles of inclusivity in the legislation on project activities and public administration;

— develop standard indicators for assessing the inclusivity of projects (gender balance indices, indicators of participation of low-mobility groups);

— implement national training programs for personnel in inclusive project management;

— create an open register of successful inclusive projects supported by donors (UNDP [19], GIZ [20], USAID [21], EU, etc.), with methodological conclusions.

3.3 THE POTENTIAL OF AN INCLUSIVE APPROACH FOR UKRAINE

Ukraine is at the stage of active reform of the management system and adaptation to EU standards. Despite a number of progressive changes in social policy and public administration, inclusive project

management does not yet have a clear systemic implementation. The lack of a single legislative or strategic framework complicates the implementation of inclusive approaches at the national level [22, 23]

Fig. 3.1 summarizes the assessment of the current state according to six key parameters [19, 24].

Fig. 3.1 Assessment of key aspects of inclusive project management in Ukraine (2024)

Analysis of the practical implementation of inclusive project management in Ukraine allows to highlight the main challenges for the development of this area:

1. Fragmentation of practices. Most inclusive projects are implemented at the level of individual territorial communities or on the initiative of public organizations. For example, the NGO "Bezbariernist", "Center for Social Leadership" and "Social Consulting" work with local authorities to implement universal design and involve citizens in budgeting, but these practices remain isolated [20].

2. Unequal access to project participation. The participation of women, people with disabilities, and youth in project activities is often limited by the inaccessibility of information, physical or digital barriers. This is supported by research on digital inequality in Ukraine [22].

3. Lack of expert environment. There are still no accredited training programs in inclusive project management in domestic universities. There are individual courses [25], separate modules in social entrepreneurship programs [26], but they do not create a sustainable human resource.

But it is worth noting positive examples of the implementation of inclusive project management in Ukraine:

1. The "Community for All" program [20]. Projects of barrier-free space, inclusive sites and adapted routes have been implemented in 12 communities. Local strategies with accessibility KPIs have been developed. Over 1,000 citizens have been involved.

2. The DOBRE program [21]. Promoted women's participation in community planning. Over 40 ATCs have adopted gender equality policies in budgeting. An inclusive public budget model has been implemented.

3. Educational initiatives [25, 26]. The "Social Project Management" course contains modules on inclusivity. UCU programs teach inclusive thinking through social entrepreneurship cases.

To develop an inclusive project management system in Ukraine, it is necessary to:

— develop and approve a national strategy for inclusive project management [27];

— introduce a system of indicators for assessing inclusivity within the project cycle [23];

— institutionalize interdepartmental cooperation between the Ministry of Education, Science and Technology, the Ministry of Economy, the Ministry of Social Policy, and the Ministry of Finance [19];

— implement educational programs in state higher education institutions based on best European practices [26];

— expand state support for inclusive startups through financing mechanisms [28].

3.4 THE IMPACT OF INCLUSIVE PROJECT MANAGEMENT ON THE DEVELOPMENT OF THE NATIONAL ECONOMY

Inclusivity in project management is not only a social and ethical principle, but also an important tool for enhancing economic efficiency, sustainability and innovation. According to research by the International Monetary Fund [29], countries that integrate inclusive approaches into public policy demonstrate less social inequality, higher labor productivity and innovation.

Inclusive project management:

— expands the labor market by involving vulnerable groups in productive activities [30];

— increases business adaptability due to diversity in the team [31];

— reduces social costs for the state, as it activates the potential of those groups that are usually excluded [32];

— stimulates innovation — the more points of view, the higher the likelihood of non-standard solutions [33].

According to the World Economic Forum [34], countries with a high inclusive development index also demonstrate high indicators of the Human Development Index (HDI) and Innovation Potential (GII).

For example:

1. Sweden (inclusivity 6.42) has one of the highest levels of involvement of vulnerable groups in the labor market (82%) and at the same time is in the top 10 in the Global Innovation Index.

2. Canada demonstrates similar trends: active support for inclusive entrepreneurship ensures stable positions in the HDI (0.936) and GII (59.5) (UNDP, 2023).

To confirm the connection between the level of inclusive development and the innovative capacity of national economies, a comparative analysis of data for 2023 was conducted for four countries — Sweden, Canada, South Korea and Germany (**Table 3.2**). The following indicators are included in the assessment:

— Inclusive Development Index [34] — assesses the accessibility of economic growth for broad segments of the population (scale 1–7);

— Human Development Index [35] — an indicator of quality of life, life expectancy, education and living standards;

— Employment rate among vulnerable groups of the population — in particular women, people with disabilities, migrants;

— Innovation Index [33] — an integrated assessment of the country's ability to innovate (scale 0–100).

Table 3.2 Impact of inclusive governance on macroeconomic indicators

Country	Inclusion index	Vulnerable employment, %	HDI	GII
Sweden	6.42	82	0.945	60.7
Canada	6.25	78	0.936	59.5
South Korea	6.10	75	0.916	55.2
Germany	6.32	80	0.942	58.6

Source: compiled by the authors based on [33–35]

To determine the strength and direction of the relationship between the inclusion index and the innovation index, the Pearson correlation coefficient (*r*) was calculated

$r = 0.919$,

p-value = 0.081.

This indicates a very strong positive correlation between inclusive development and the innovation capacity of national economies ($r > 0.9$), i.e. countries with a higher level of inclusion tend to develop the innovation sector more effectively.

Although the p-value is not statistically significant at the 0.05 level (due to the small sample size of $n = 4$), the strength of the correlation is convincing, and it is theoretically and empirically supported by numerous studies [31, 33, 34].

The results of the empirical analysis indicate that there is a strong positive correlation between the Inclusive Development Index (IDR) and the Innovation Index (GII) ($r = 0.919$). This allows to make an assumption about the presence of a functional influence of one phenomenon on another.

Based on the results of the analysis, an economic model of the multiple influence of inclusive project management on macroeconomic indicators (3.1) was formulated.

The model formula

$$Y = \beta_0 + \beta_1 \cdot IDR + \beta_2 \cdot E_{VG} + \beta_3 \cdot HDI + \varepsilon, \quad (3.1)$$

where Y — innovation capacity rate [36];

IDR — inclusive development index [34];

E_{VG} — employment rate of vulnerable groups (%);

HDI – human development index [35];

β_0 – constant;

$\beta_1, \beta_2, \beta_3$ – coefficients of influence of the corresponding factors;

ε – residual error of the model (the influence of other factors not taken into account).

The coefficient β_1 is expectedly positive: with an increase in the level of inclusivity in project management, the country's innovative potential also increases, since the involvement of various groups contributes to the emergence of new ideas and solutions.

The β_2 coefficient is also positive, since higher participation of the population in the labor market indicates a more complete use of human capital.

The β_3 coefficient (*HDI*) reflects the general socio-economic background and the level of development of human resources, which is the basis for sustainable innovation.

The above results allow to draw a reasonable conclusion: inclusive project policy contributes not only to social stability, but also to the growth of knowledge-intensive industries, which is a key factor in long-term economic growth. In the example of Sweden and Canada, countries with a high inclusion index also hold high positions in the HDI and GII, demonstrating the synergy between social equality, human capital and innovation (**Fig. 3.2**).

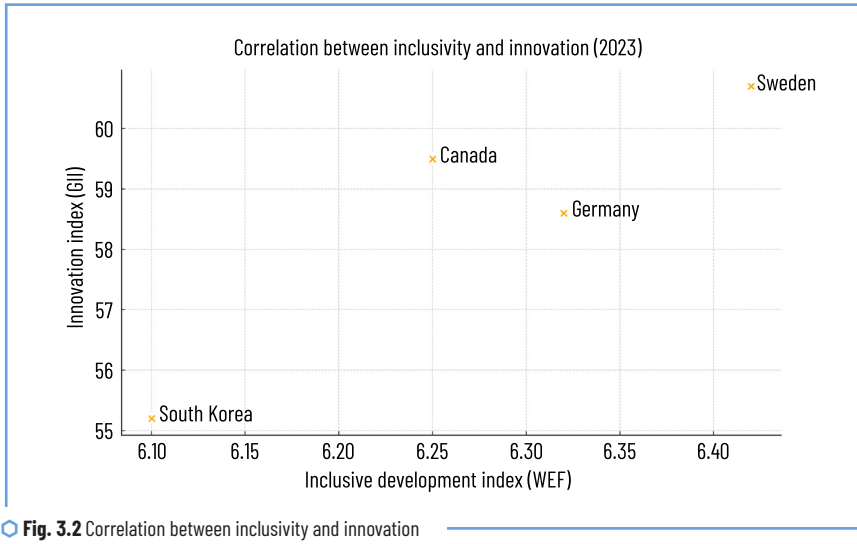

Fig. 3.2 Correlation between inclusivity and innovation

This graph demonstrates a clear positive correlation between the level of inclusive development and the innovative activity of countries. This indicates that the inclusion of diverse social groups in the design, planning and implementation processes contributes to the creation of more competitive economic systems.

Building a regression model based on an international sample. To deepen the empirical research, a sample of 10 countries was collected that have high values of inclusive development, human development index and innovative capacity. The model includes the following independent variables: *IDR*, E_{VG}, *HDI*, dependent variable: *GII* (3.2).

Results of the regression analysis (**Fig. 3.3**)

$$GII = -101.78 + 9.26 \cdot IDR - 0.18 \cdot E_{VG} + 124.95 \cdot HDI + \varepsilon. \quad (3.2)$$

R^2 = 0.,931 — the model explains 93.1% of the variation in the innovation index.

Adjusted R^2 = 0.897 — high explanatory power even taking into account the number of predictors.

F-statistic = 27.04, *p*-value <0.001 — the model is statistically significant overall.

Of the three variables, the most significant is the human development index (*HDI*): β = 124.9, *p* = 0.068, which is close to statistical significance at the 0.1 level.

The Inclusion Index (*IDR*) has a positive, although not statistically significant coefficient β = 9.26, indicating a trend of influence.

The employment rate of vulnerable groups (E_{VG}) has the smallest impact and is not statistically significant in this model, which may indicate the influence of structural factors (institutional barriers, employment policies, etc.).

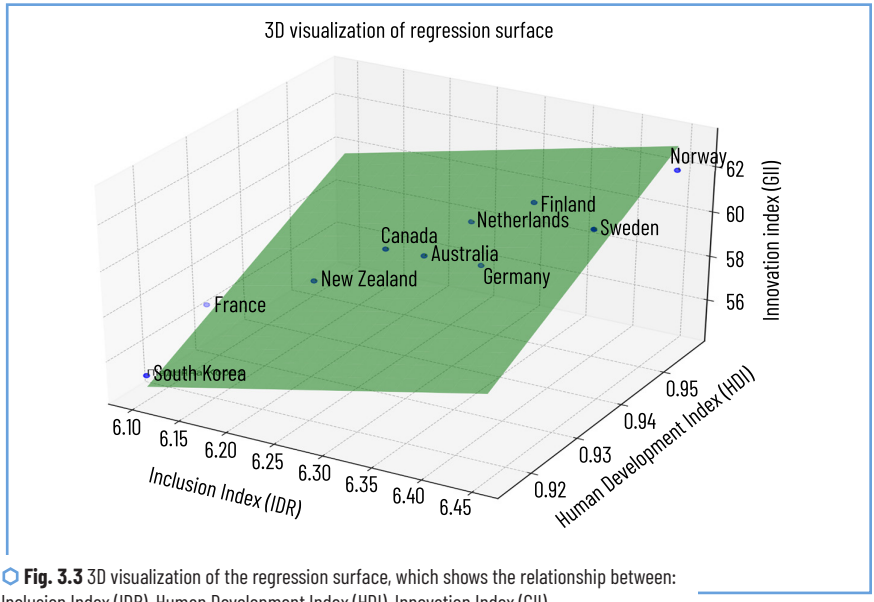

Fig. 3.3 3D visualization of the regression surface, which shows the relationship between: Inclusion Index (IDR), Human Development Index (HDI), Innovation Index (GII)

Each point on the graph is a separate country with its position in the space of variables. The regression surface (green) models the theoretical position of the country under the condition of the average value of employment of vulnerable groups (E_{VG}).

The Human Development Index (*HDI*) is the most powerful factor correlating with innovation activity. This is logical, because the *HDI* includes the level of education, life expectancy and income — the foundation for innovation.

Inclusion (*IDR*) also has a positive effect on *GII*, although in this model statistical significance was not found due to the small sample size. However, the direction of the effect confirms the previous hypotheses.

The employment rate of vulnerable groups (E_{VG}) is not a strong predictor of innovation on its own, but when combined with other variables (especially through the multiplier effect with *HDI*) it can amplify the effect.

The model confirms that inclusive project management indirectly contributes to the growth of innovation capacity by strengthening human potential. This confirms the need to include inclusive strategies in national innovation development policies, especially for countries with transformational economies such as Ukraine.

For Ukraine, the implementation of a systemic approach to inclusive project management can become a multiplier of the macroeconomic effect, in particular:

— involving youth, women, people with disabilities in entrepreneurship and management processes can reduce the shadow economy and increase tax revenues [35];

— inclusive projects in education (e.g. soft skills modules, entrepreneurship, digital literacy) form a new type of human capital adapted to the challenges of the future;

— expanding digital accessibility — through the universal design of websites, platforms, and electronic services — promotes participation in the economy even for low-mobility groups, reducing digital inequality [36];

Inclusion operates at all levels — from microeconomics (employment) to macroeconomics (exports, innovation, sustainable development).

3.5 RECOMMENDATIONS FOR THE INTEGRATION OF INCLUSIVE PROJECT MANAGEMENT INTO ECONOMIC POLICY

Based on the theoretical analysis, empirical research and statistical modeling, a set of practical recommendations has been formulated for different levels of the management system: state, regional, corporate and educational. They are aimed at creating a system architecture of inclusive project management capable of influencing structural transformations in the national economy:

1. State level:

1) development and adoption of the National Strategy for Inclusive Project Management until 2030. What this means: the strategy should become a framework document that will establish the goal, objectives, principles, directions and indicators of the integration of an inclusive approach to project management in the state.

What does the implementation entail:

— initiation of an interdepartmental working group under the Cabinet of Ministers of Ukraine;

— analysis of existing barriers to the participation of vulnerable groups in the project cycle;

— creation of an inclusivity map by region (together with the Ministry of Social Policy, the Ministry of Economy);

— identification of target groups: women, youth, people with disabilities, IDPs, veterans, etc.

Analogous — "Barrier-Free Strategy" 2021-2030 [37];

2) institutionalization of interdepartmental coordination. Inclusivity of projects should become an interdisciplinary policy, not a "social topic". Therefore, it is worth ensuring the mandatory participation of representatives of relevant ministries in the approval of state projects and grant programs.

How to implement this:

— create units for D&I expertise in the project offices of the Cabinet of Ministers;

— introduce mandatory inclusion indicators in tender documentation;

— create a common database on the status of participation of vulnerable groups in projects (for example, in Prozorro [38]);

3) introduction of mandatory gender and social expertise of public and public-private projects. If the project involves infrastructure, services or IT solutions, it affects broad groups of the population. Without gender and social assessment, there is a high risk of reproducing discrimination or barriers.

How to do this:

— adopt a regulatory act of the Ministry of Economy on the need for such an assessment for projects >5 million UAH;

— develop templates for expert assessment forms;

— involve independent NGOs and international organizations (UN Women, UNDP [39, 40]) in the expertise.

Analogous — gender assessment of USAID programs, gender budgets in EU countries [41].

4) digital platform "Inclusive Projects of Ukraine". Open source of information on all projects with an inclusive component: beneficiaries, budgets, results, opportunities for participation.

Platform functions:

— mapping of projects by regions and categories;

— search for grants and programs;

— tools for submitting ideas for competitions (e-dem, e-budget);

— the possibility of participating in public monitoring.

Example — "Prozorro" or the USAID EDGE platform.

2. Regional and municipal level:

1) regional roadmaps for inclusive development. Each region or ATC has its own specifics: ethnic composition, level of urbanization, presence of low-mobility groups. The roadmap will allow adapting the national policy to the local context.

Stages:

— conducting a local survey and consultations;

— determining target indicators (e.g., % of women in the public budget);

— annual report on the participation of vulnerable groups in project planning and implementation.

2) inclusive quotas in the "Public Budget". Introduce a norm that at least 20% of the budget is allocated to projects initiated or aimed at:

— women;

— youth;

— people with disabilities;

— IDPs or veterans.

Thus, Kyiv, Lviv, Mariupol (until 2022) already had targeted programs to support projects for women.

3. Business and corporate sector:

1) recommendations for implementing Diversity & Inclusion (D&I) policies.

Create a D&I standard for Ukrainian companies — an analogue of ESG reporting, which would include:

— the share of women in management;

— the presence of gender-neutral HR procedures;

— product/service inclusivity (universal design);

— employee training.

For example, IKEA, Google, McKinsey publish D&I reports annually.

2) grant programs for inclusive startups. Within the framework of the Ukrainian Startup Fund, launch targeted programs:

— "Women in Tech";

— "Inclusive Hackathons";

— "StartUp for Veterans";

— "IT for the Blind".

What is needed: additional points for inclusivity when evaluating applications; co-financing from international partners; mentoring programs with the participation of inclusive entrepreneurs.

4. Education and science:

1) creation of academic programs in inclusive project management. The need for managers who are able to combine social analysis, project thinking and public administration.

Formats:

— bachelor's programs (e.g., at KNEU, LNU, NAPU);

— master's programs with PMI/IPMA certification;

— online courses on Prometheus, Coursera (in collaboration with international experts).

2) financing applied scientific research. Deepening the analytics and practical basis of inclusive development.

Forms of support:

— targeted scientific competitions of the Ministry of Education and Science and the National Research University of Ukraine;

— grants for young researchers;

— introduction of the topics of "social innovation", "D&I in the public sector" in state R&D;

— UNDP, GIZ, EU have already funded similar research in Ukraine (2020–2023).

The expected results from the implementation of these recommendations in the development strategy of Ukraine are given in **Table 3.3**.

Table 3.3 Expected results

Direction	Indicator	Expected improvement by 2030
Social	Increase in participation of vulnerable groups, %	+20%
Economic	Level of inclusive startups	+50%
Institutional	Share of projects with D&I policies	Up to 70%
Innovative	Growth in GII (Global Innovation Index)	+10 points

SOCIO–ECONOMIC DIRECTION OF DEVELOPING INCLUSIVE PROJECT MANAGEMENT CAPABILITIES

Project management is based on a systematic approach to managing software development, including planning, organization, implementation and control to achieve set goals within a given time and budget. It involves the use of specific methods and tools, the formation of organizational and executive skills and abilities to ensure the effective and timely implementation of project tasks. The most important component of project management is social management — the implementation of targeted organizing and regulating influence on the joint (collective) activities of people in order to effectively achieve common results in accordance with real social needs. In a broader context, social management is fueled by the principles of inclusive organization of joint activities within socio-economic systems of varying complexity.

In the most general sense, inclusion means a principle of social organization according to which all individuals, regardless of origin, appearance, gender, health status, etc., are given the opportunity for fair access to available resources and active participation in various spheres (life, work, education, healthcare, culture, art, etc.) of common life. Inclusion is the process of involving, including or entering a subject/object into a certain state, formation/environment as part of a whole.

The primary basis for the scientific understanding of the phenomenon of social inclusion was the education system. The starting norm for the organization of inclusive education is the openness of general education institutions to provide educational services to everyone who wishes, regardless of physical, intellectual, social, emotional and other characteristics. According to the definition of UNESCO, inclusion in the education system is implemented through attentive response to the diversity of students' needs regarding forms and methods of participation in the learning process, in the activities of cultural communities, as well as through contributing to the reduction of refusals to enter schools and cases of exclusion from them. Its main goal is to eliminate barriers to education and professional training of people with special needs [1]. In this context, the organization of the educational process according to the principle of inclusion expands learning opportunities for people with disabilities, cognitive and mental characteristics, representatives of ethnic minorities and marginalized groups, labor migrants, foreign students, persons in penitentiary institutions, etc.

The first attempts to integrate people with disabilities into normal conditions of social life were made in the 1970s in the Scandinavian countries, the USA, and Japan. At the turn of the century, large-scale public events took place; the international movement "Education for All" took shape; the legislative framework in the field of inclusive education acquired proper quality. However, it later became obvious that the phenomenon of inclusive organization concerns the development not just of the educational sphere, but of the social system as a whole. The concept of inclusive development went beyond the boundaries of narrow social groups and educational programs, spread to the general system of social organization, and was adopted by business entities [2].

It is believed that the economic determination of the concept of inclusive development is associated with the formulation of the principle of corporate management: "unrepresented groups of employees in the team mean under-receipt of the company's profit". According to it, monotonous ("homogeneous") personnel, limited by the customs of their own life experience, are not capable of generating breakthrough ideas and solving complex problems in the modern multicultural environment. While ethnicity, gender, age, and work style of individuals based on shared "heterogeneous" experience become a valuable market asset and a factor of successful activity for the company.

"Careful observation" of each employee of the company can reveal the peculiarities of its behavior, thinking, lifestyle, professional inclinations and skills; skillful combination of such qualities by management can turn an ordinary worker into a creative person. At the same time, companies that effectively use the potential of heterogeneous personnel no longer experience a shortage of valuable personnel. By creating decent conditions for the professional and personal development of employees, companies increase the overall creativity of the staff, and, consequently, their own competitiveness [3].

An inclusive economic system is personified, because it is built taking into account the creative abilities and productive qualities of each of its subjects. This creates conditions for positive socio-economic synergy. On the one hand, as creative abilities and skills are revealed and implemented in the social and labor sphere, an inclusive organization becomes a leading factor in economic growth/value addition [4]. On the other hand, through the efforts of public/team support, economic growth/newly created value is directed towards expanding the opportunities of each individual to acquire decent living standards [5].

An essential feature of the inclusive organization of economic systems in the conditions of the new reality is the creation of incentives for the revival of entrepreneurship in various forms on new social principles. After all, the information economy forms a capital demand for the unique creative abilities of an individual, capable of changing the formats and foundations of social existence faster and more effectively than most social institutions. At the same time, the attribute of such abilities is the principle of individual responsibility, which is based on the standards of high ethical norms and is able to raise the individual to the level of a global economic entity [2].

Therefore, the principles of polyphonic inclusive arrangement of socio-economic systems at the national, regional and global levels should organically follow from the principles of microeconomic social organization and the socio-economic nature of the firm as a well-directed existence of economic space-time (relations of marginal utility and value), localized at the level of a business organization and translated by it through the value (institutional) harmonization of relations of economic efficiency and social

responsibility (capitalization and socialization) to the macro-level of management in the existence of institutional architectonics [6].

In the conditions of the new information and network reality, the nature of the firm undergoes modification under the influence of the institutions of social responsibility of the organization and public-private partnership, which are based on the system of jointly-divided rights and property relations and, through the effective management of bundles of legal powers, ensure an inclusive value reorientation of state-owned enterprises to indicators of economic efficiency, and corporations to the performance of social functions. An important component of such modification is the institution of management, which is designed to ensure the balanced functioning and sustainable development of the firm through the harmonization of the interests of capital owners and employees within the framework of an inclusive approach to the organization of personnel work.

In the extensive institutional system of scientific management as a sphere of implementation of the principles of socio-economic inclusion, project management acquires significant importance — at the same time a science, art and a specific technology of software development management, an organizational tool for effectively solving project tasks of varying complexity in business, state and municipal administration, and in public activities. The object of project management is a set of mutually agreed program tasks and works that are performed within a given time, using limited resources to achieve the planned goal — obtaining a unique innovative software development of the highest possible quality and reliability.

The key properties that distinguish project management from functional or process management are considered to be the "big triad of project management" — fulfilling the unconditional requirements for:

— defining clear goals and objectives;

— preliminary planning of the stages of project work, taking into account the assessment of the possibilities of adjacent adaptive distribution and effective use of limited resources;

— searching and implementing the best alternative solution to the problem of combining the time of work, the quality of the final product and its cost for the customer and performers [7].

The leading role in the realization and implementation of the mission of developing a high-quality project model in the conditions of a given time, limited material, financial, information and other resources is played by a well-coordinated team of specialists with a clear division of functions and powers, headed by a project manager. It is clear that the inclusive organization of the activities of such a team will contribute to the most effective achievement of the specified program goals. The inclusive organization of project activities is ensured by the choice of an appropriate management methodology.

To enhance the inclusive capabilities of project management when choosing a methodology, attention should be paid to the quantitative composition, capabilities and style of work of the team. It is also important to take into account the scope of activity, project priorities, project complexity, role specialization, and company size. Having the right management methodology at your disposal, it is possible to form unique adaptive technologies and significantly increase the efficiency of project implementation. Let's present the inclusive capabilities of a number of current methodological approaches.

Agile is one of the most common basic approaches to project management, based on the principles of teamwork, combining its speed and efficiency, iterativeness with data orientation, and the priority of the intellectual capabilities of the individual over technological processes.

It is believed that due to its versatility, the Agile system can be used by a project team of any level; The key problem here is the correct choice of a complementary methodology. Thus, the effect of the system can be enhanced using the methods of Scrum, Kanban, Crystal, Scrumban, and extreme programming. Using the Agile methodology together with one of the listed methods allows to form a holistic philosophical concept of project management and provide a synergistic effect to achieve the desired results.

Waterfall is a cascade project management model. Unlike the Agile system, the waterfall methodology is applied according to clear rules formed by the software development cycle (SDC). Project management is presented as a linear process in which work cycles are organized in a sequential order and cascade down like a waterfall.

According to this approach, all work tasks are interconnected; so that the implementation of the previous solution opens up opportunities for work on the next. Thanks to this, the work proceeds in a measured and consistent manner — according to a strict plan and adherence to the principle of information exchange throughout the entire project implementation period. The cascade methodology involves the development of a well-thought-out detailed project work plan and in this sense is well suited for the implementation of large projects that require the coordination of multiple interests of stakeholders.

Scrum is a methodology based on the use of a set of short (two to four weeks) "sprints" that form the project cycle. The Scrum methodology is designed for small (up to 10 people) teams. During the project, the master (project manager) holds daily sprint meetings, demonstrations, retrospectives for intensive brainstorming of key participants and timely completion of intermediate project tasks. This is the difference between the Scrum methodology and the cascade approach, where individual tasks are sequentially interconnected.

The methodology is self-sufficient, but is often associated with the Agile system. After all, the two approaches are united by common principles, including the priority of teamwork and the fact that the intellectual capabilities of the individual are valued here above organizational and technological processes. Sprints are acceptable for the work of small teams, but are also suitable for large teams.

Kanban methodology (from Japanese: billboard, signboard) is an organization of production and supply on the principle of "just in time". The progress of the project is demonstrated using visual elements-boards; among other things, this technique is used to reduce possible delays in the performance of work. For visualization, software is usually used, with the help of which the boards can be easily moved within projects.

The Kanban philosophy is a simplified transparent project structure: the main attention of the participants is focused not on the detailing of the project cycle, but on the definition of key program tasks for execution.

Kanban boards are suitable for use by any project teams; they are especially suitable for organizing remote work. After all, the visual capabilities of "kanban boards" allow employees to stay abreast of events in any spatial location.

Scrumban methodology combines the principles of organizing project work according to the Scrum and Kanban methodologies. The project cycle is developed taking into account a series of sprints, as in Scrum; and its implementation plan can contain key milestones, as in Kanban. This combination allows to

perform key parts of the work without complicating the project plan. The Scrumban methodology (just like Scrum) uses organizational meetings to improve teamwork and adjust target priorities.

The method combines simplicity and clarity: it allows to break projects into smaller tasks that maintain visual simplicity.

PRINCE2 (Projects in Controlled Environments) is a methodology developed by the UK government for the implementation of IT projects, which is still successfully used in the field of traditional product marketing.

It is based on a cascade model for determining the key links of project implementation at the stages from initiation, management and control of processes to project closure. The development cycle is formed as a comprehensive process of organizing corporate projects based on a clear distribution of the roles of participants.

The methodology has proven itself well for effectively solving a set of individual functional project management tasks. Suitable for large-scale corporate projects with a large number of stakeholders. When used in small projects, it can complicate and slow down their implementation.

Lean is a methodology for optimal project management. It involves creating a simple and understandable project structure and identifying reserves for saving resource costs. In the process of application, the effectiveness of teamwork is achieved with fewer resources.

Originally used to optimize material costs in leading automotive companies; today, as a universal approach, it is used to solve the problems of waste and uneven distribution of resources. Similar to the method of a rational unified process, but unlike it, it is aimed at optimizing resource losses during the implementation of projects, not development.

Useful for use by project teams of any size; but best suited for large organizations.

Six Sigma is a philosophy of project quality management, which is appropriate to use in conjunction with the Lean (Lean Six Sigma) or Agile (Agile Six Sigma) methodological models. Improvement of project processes is achieved using the technology of continuous expert assessments.

For greater efficiency in project development and implementation, the Six Sigma approach is transformed into a phased Six Sigma DMAIC approach with the allocation of stages:

— Define — definition. Preliminary definition of the scope and economic justification of the project is the subject of discussion at the first founding meeting of the participants;

— Measure — measurement. Collection of data for possible improvements of the project process;

— Analyze — analysis. Clarification of the causes of possible and actual problems;

— Improve — improvement. Elimination of the identified causes of "bottlenecks";

— Control — control. Generalization of the results of management decisions for use in subsequent projects.

The Six Sigma methodology is most suitable for use in large organizations with large staff.

Critical Path Methodology: involves breaking down the project process into milestones and focusing management efforts on achieving the maximum possible results.

Aims at identifying critical tasks in the project and planning work to solve them. Best suited for small and medium-sized projects and teams; ineffective for large, complex projects with multiple deliverables and stakeholders.

Project Management Body of Knowledge (PMBOK®) Guide is a set of practical recommendations for implementing projects (from initiation to completion and closure), developed by the Project Management Institute (PMI), and is considered a separate methodology. The application of the methodology involves highlighting five stages in the project process (initiating, planning, implementing, performing, and closing) and providing a number of consolidated management rules for performing the tasks of each of them. This approach helps to confidently manage the implementation of the project from start to finish. The PMBOK® Guide does not contain sufficiently clear instructions, so it can be taken as a basis for developing a personal unique approach to project management.

The methodology can be used when organizing independent project activities, when implementing standard projects by small teams. For large teams and projects, it is recommended to use it in conjunction with a more detailed methodology (for example, the critical path method).

Extreme Programming Methodology (eXtreme Programming, XP). It is used for dynamic projects with tight deadlines. Work is carried out in tight, short cycles with many intermediate releases; as a result, the project can be effectively implemented in a short time.

Based on the principles of simple communication, effective feedback, respect, courage. The set of rules includes all stages from planning to testing.

Designed for use by small/medium-sized stalker teams. Implementation of projects in a short time involves intense work of personnel in extreme conditions and is not recommended for use on a permanent basis.

The inclusive potential of current methodological approaches to project management is summarized in the **Table 3.4**.

Table 3.4 Inclusive potential of methodological approaches to project management

Current methodologies	Content	Social object of inclusive impact	Expected synergistic effect
1	2	3	4
Agile	Contents	Project team of any level	Formation of a philosophical mission of project management
Waterfall	Universal system for organizing the project process	Large project development team	Consensus of multiple interests of stakeholders
Scrum	Organization of project work as a linear, sequentially ordered process, "cascading" from the execution of the previous to the next task	Small teams; large teams with the separation of specialized mobile groups	Coherent resulting interaction of a series of consecutive brainstorming sessions of key participants
Kanban	Formation of the logic of the spatial-temporal project cycle as a set of intellectual sprint rounds	Project teams of any level; remotely coordinated participants	Implementation of the project in accordance with the principle of "just in time"

Continuation of Table 3.4

1	2	3	4
Scrumban	Organization of the project cycle using the principle of structural simplicity with a focus on solving key program tasks	Project teams of any level with the possible separation of functional mobile groups in their composition	Detailing of the project plan during brainstorming sprints without complicating its visual simplicity
Lean	Formation of a "transparent" structure of the project work cycle based on an appropriate combination of organizational principles of the Scrum and Kanban methodologies	Project teams of any composition; best for the staff of large companies/ corporations	Achieving greater efficiency of project work with fewer resources
Six Sigma	Methodology of rational project management through structural simplification and optimization of resource costs	Staff of large companies/ corporations	Cumulative effect of project quality management based on continuous expert assessment
PRINCE2	at the project implementation stage	Large corporate project development team with a large number of stakeholders	Cumulative effect of consensus of interests from the sequential execution of a set of detailed nodal management tasks
Critical path methodology	Philosophy of project quality management through combination with Lean (Lean Six Sigma) or Agile (Agile Six Sigma) technologies and possible detailing of project stages	Small and medium mobile project teams	Maximum possible coincidence of the received real project results with the expected ones
Project Management Body of Knowledge (PMBOK®) Guide	Formation of a comprehensive process of cascading organization of the corporate project cycle based on a clear distribution of the roles of participants	Self-organization of individuals, small teams; large teams — with the use of more detailed technologies	Effect of confident project management from initiation to completion
Extreme programming methodology	Formation of a project process roadmap with the identification of key milestones and their tasks. A standardized set of practical recommendations for organizing project activities from initiation to completion. A set of rules for developing a dynamic project cycle covering all stages (from planning to testing) for the effective implementation of extraordinary design developments	Small/medium groups of creative stalkers to complete extreme project tasks in a short time	Cumulative effect of dynamic execution of a set of tasks and presentation of releases in the mode of continuous brainstorming

Source: compiled by the author based on information resources on the Internet

The stated inclusive potential of the corporate management system must be institutionally mastered and directed towards the public good.

INSTITUTIONAL DIRECTION FOR DEVELOPING INCLUSIVE PROJECT MANAGEMENT CAPABILITIES

Institutional approaches to defining project management involve the use of the theory of economic organizations. In neoclassical theory, the concept of a firm practically merged with the concept of a production function. As a result, it did not even raise questions about the reasons for the existence of firms, the features of their internal structure, etc. It can be said that it equated a firm with an individual economic agent.

The transactional theory of the firm is an attempt to overcome such a simplified approach. Its development was influenced by several fundamental ideas associated with the names of a number of prominent economists. In 1937, R. Coase was first able to pose and partially resolve a question that was not even raised by traditional theory: why does a firm exist if there is a market? We can pose a question regarding the definition of project management: is an individual project an institution within the framework of the existence of a market?

Although R. Coase is rightfully considered the founder of the transactional theory of the firm, chronologically it was preceded by the concept of F. Knight, set out in the book "Risk and Uncertainty". Knight considered the employment relationship to be a distinctive feature of the firm and attributed its existence to the fact that it contributes to a better distribution of risk between employees (who try to prevent risk) and entrepreneurs (neutral to risk). In exchange for stable pay, insured against random fluctuations, employees agree to submit to the control of the entrepreneur. So in project management, the first question that is determined is which team should implement a specific project? Usually projects are temporary teams that are formed within one firm, exist here and implement the idea into real life and ensure the transition from project to operational activity. If it happens that the project is created "from scratch" and is managed by the owner of the future business, then this project should be considered as corresponding to the firm (according to the institutional concept). If institutions are the "rules of the game," then management teams can be compared to sports teams.

It is precisely the effort to prevent the costs of concluding agreements in the market that, according to Coase, can explain the existence of a firm in which resource allocation occurs administratively (through orders, rather than on the basis of price signals). Thus, a project team is also a firm that concludes a contract to undertake obligations to implement a project and allocate resources within it. Within the project group, search costs are reduced, the need for frequent renegotiation of contracts disappears, and business ties become more stable.

But then the opposite question arises: why is the market needed if the entire economy and project management can be organized like a single firm?

To this, Coase replied that the administrative mechanism is also not free from costs that increase as the size of the project team increases (loss of controllability, bureaucratization, etc.). Therefore, the

boundaries of the project team will pass where the marginal costs associated with the use of the market are compared with the marginal costs associated with the use of a hierarchical project team.

The next step in the development of the transactional approach was taken in the work of A. Alchian and G. Demsets "Production, Information Costs and Economic Organization". They derived the essence of the project team from the advantages of cooperation, when, by jointly using a certain resource as part of a whole team, better results can be achieved than by acting alone.

However, production by a single team makes it difficult to assess the contribution of each participant to the common result, giving rise to incentives to "leave". Hence the need for control, which would introduce such behavior into strict limits. The agent of the project team, who assumes the functions of a controller in accordance with agreements with other participants, becomes the owner or leader of the project group.

The project team should have an inherent organizational culture. Thus, the theory of D. Kreps is built around the concept of "organizational culture". A set of certain principles forms, according to Kreps, the "organizational culture" of a firm: what distinguishes it from other firms and project teams. If a project group is formed within a specific company, it has the cultural approaches that are inherent in this company, but if a project team is created "from scratch", it must build its own organizational culture. This refers to short-term, medium-term and long-term approaches to the formation of a project culture. The institute of a project team should be based on those universal human values that are inherent in group managers. The project team leader should transfer and saturate subordinates with those qualities that allow them to temporarily be principled in the implementation of the full project cycle. In addition, such small groups, which are usually created to implement the project, should have an appropriate link to such teams and groups within the country and beyond, this is how project networks are formed. When it comes to construction projects, especially those involving the construction of social infrastructure facilities, the organizational culture should be tied to the understanding of the social responsibility of the builder to society regarding the quality of the structures and their contribution to the socio-economic environment. If a project is created in the event sector, then, firstly, it is short-term, which means it should have a "concentrate" of cultural influences on the recipients of the service, and secondly, its implementation should affect the understanding of the cultural aspect of the event, its social content. Following the chosen principle, even when it is unprofitable, gives the project team a reputation for being "reliable" and "fair", which gives tangible long-term benefits. Organizational culture is closely related to issues of social responsibility, because it can be fundamentally argued that business should work not only to make a profit, but also to achieve a social effect. Project teams that are temporarily created should show this social responsibility when brainstorming and implementing a specific project. So, if the team is aimed at forming industrial production, then there should be a specialist in sustainable development and a specialist in public relations to convey the idea of forming social demand for the products of the future manufacturing enterprise. Also, the cultural factor of one team affects the "aura" of all others that arise in this area, and the quality of project networks.

Organizational culture and the reputation associated with it are a valuable resource: they can be sold by selling the company. It is more difficult to sell a project team, but it can be transferred or re-subordinated to another group of owners, which occurs extremely rarely. However, the reputation of the temporary project group is crucial for future orders and the use of the group's specialists in subsequent projects.

However, maintaining reputation sometimes comes with certain caveats. Any organizational culture of a project team is adapted to a clearly defined category of random events. By spreading the same principle to distant areas, adaptation to change becomes less and less effective, which becomes an obstacle to vertical integration. The boundaries of a project group will be determined by its organizational culture and will take place where better adaptation in some types of activity will begin to be balanced by worse adaptation in others. Adaptation is very important for project teams and their inclusive development. Thus, subordination to the conditions of military operations led to the creation of projects that are socially responsible, these are various types of volunteering and enterprises of the defense-industrial complex. These enterprises were the result of the actions of project teams that a priori adapted to modern realities. This is a culture of mutual assistance, support for significant projects, and in particular, for the restoration of Ukraine's economy.

Transactional theory identifies several cross-cutting characteristics that define the essence of a project team. These are the existence of a complex network of project contracts, the short-term nature of relationships, production by a single team, an administrative mechanism of coordination through orders, investment in specific assets. In all of them, the project team acts as a tool for saving transaction costs. The rules of the game, which are institutions that set a system of incentives (positive and negative), direct people's activities in a certain direction. In this way, they reduce uncertainty and make the social environment more predictable. Certainty affects the activities of project teams on their impact and the development of an inclusive economy. After all, young people, the elderly and people with disabilities should also have access to participation in project teams and contribute to the implementation of projects. When people believe in the reliability and fairness of laws, contracts in project management and property rights, they refrain from attempts to steal or lie. Thus, institutions perform their main function — saving transaction costs. However, the creation and maintenance of general "rules of the game", in turn, requires considerable costs. The rules of the game must be implemented in the activities of project teams as specific institutions, since these teams must be correct in terms of their impact on the environment, on the inclusive participation of various actors of project teams in the social division of labor, and on the formation of general social behavior. The rules of the game correspond to what is called "codes of conduct" in law. This is one of the sources of law, which provides for the isolation of such behavior that would be optimal for specific aspects of doing business and the economic activity of the state in general. Such codes concern, in particular, the behavior of transnational corporations and their project teams in host countries of the world. How not to create a monopoly on resources, how to be socially responsible and bring benefits to both the recipient country and the regions of the country and the world in general.

Note that the composition of the D. North identifies three main components:

1) informal constraints (traditions, customs, various social conventions);

2) formal rules (constitutions, laws, judicial precedents, administrative acts);

3) mechanisms of engagement (courts, police).

Informal institutions form the "tip of the iceberg". They are formed spontaneously, without conscious intention, as a side effect of the interaction of many people who follow their own interests. Much in this process has been clarified by game theory, which has become the most popular tool of neo-institutional

research today. If traditions are created, customs are formed and conventions appear in the activities of project teams, this indicates the birth of a stable organizational culture and the formation of a "school" of projects as their synergy and even a simple set.

Formal institutions and mechanisms for their protection are established and supported consciously, mainly by the power of the state. They are built in a certain hierarchy: higher-order rules are more difficult to change than lower-order rules (a constitution is more difficult than a law, a law is more difficult than an administrative act). Formal rules allow for a sharp, one-time break (during periods of revolutions), while informal ones change only gradually. Formal features of project teams act as their main constraints. The legal field of project management activities is formed from the perspective of commercial law and is determined by it. Formal conditions for the existence of projects determine the specific boundaries of these projects and form a team hierarchy from executive managers to the project head. Formal conditions also characterize specific stages in the life cycle of project activities.

Technical progress, the opening of new markets, population growth, etc. — all this leads either to a change in the prices of the final product as a result of project activities, or to a change in the prices of some factors in relation to the prices of others. When prices change, one or both members of the project team begin to understand that they would be better off revising the conditions of its existence. However, the organizational forms of the management team are inscribed in the rules of a higher order. If the transition to a new type of project team requires a revision of a certain fundamental rule, the project participants may incur expenses in order to try to replace it.

New institutionalists distinguish the categories of "institution" and "organization" (and the project team as well). The latter represents a certain subjectification of institutions, their source and, if necessary, the force that supports them, as a result of which a certain "institutional synthesis" is formed as a single object of research.

Also, the second aspect is the influence of institutions on the economic development of society. Yes, it is necessary to understand the impact of project teams (as institutions) and the development of inclusion in a particular society. When teams involve and influence different segments of the population with disabilities, there is an interaction between these phenomena.

All of the above aspects of project management were inherent in the inhabitants of Ukraine in different eras and at different times. Creating a business from scratch is the prerogative of courageous leaders. So, let's give an example of the creation of a brewery by the Czech colonist S. Chep:

Dynasty in Ukrainian

Few even the most ardent beer connoisseurs know for sure how it was born. Many people think: they poured wort into containers, added malt and yeast, and maybe a little alcohol, boiled it all, cooled it and — into bottles or barrels.

Until a certain time, the main character — Andriy — believed so, until he got acquainted with the real process of the birth of the age-old amber drink at PJSC "Berdychiv Brewery".

This event occurred one spring morning, when Andriy visited his grandfather-brewer at work. It was he who told his grandson this whole story.

In Ukraine, as in the whole world, beer has been brewed since ancient times. Back in 1798, Berdychiv, which had only 4,820 inhabitants, had its own brewery. According to one of the ancient legends that spread far beyond the borders of Ukraine, there once lived a wealthy peasant family in the Czech Republic...

In 1861, the Czech colonist Stanislav Chep bought a plot of land in Berdychiv and built a brewery on Bilopolska Street. Before that, three small breweries already existed in the city, which was developing intensively. Chep not only built the factory's workshops, but also drilled an artesian well, the water tests of which gave impressive results, promising high-quality beer. It is not by chance that they say: "The same beer, but on different water."

Many auxiliary premises were built, housing for employees, and a hop cellar was laid. Huge cellars were equipped on the territory of the factory to store barrels of beer. In the summer, there was always ice in them to keep the products at a constant temperature. Chep himself and his family lived right here, at the factory, his apartment was in the same building as the brewery.

At the beginning of the 20th century, the factory was listed as number 15, it produced high-quality beer, sent it to other cities. At that time, 10 to 15 people worked there.

The city park "Eldorado" was opened near the factory. Such a neighborhood contributed to the sale of Chep beer.

"Grandpa!" asked Andriy, interrupting the story, "why did this Czech take money to Ukraine, and not to America, Canada or Germany? Perhaps, if he lived in our time, he would not even think of doing this, he would have done it differently.

Grandpa thought for a moment, smiled and said: "You are still young. Some import, others export. The law is this: it is better where we are not." Why did Sun Interbrew buy a controlling stake in PJSC "Rohan Brewery" in December 2000, which became the largest beer producer in Ukraine? It now also owns JSC "Chernihiv Brewery "Desna", PJSC "Mykolaiv Brewery "Yantar". And Baltic Beverages Holding AB owns shares in "Beer and Non-Alcoholic Combine "Slavutych" and PJSC "Lviv Brewery".

— Istria is repeating itself, — Andriy exclaimed, — foreigners again want to buy up factories and plants. Is Ukraine attractive for investment?

The above example shows that Ukraine is an attractive country for projects and attracts foreigners to its projects who, knowing about project activities, offer to create teams and implement ideas and concepts in various kinds of businesses.

INNOVATIVE DIRECTION OF DEVELOPMENT OF INCLUSIVE PROJECT MANAGEMENT CAPABILITIES

Project management in the 21st century is undergoing significant transformations under the influence of digitalization, globalization and the growth of a socially responsible approach to business. Among modern trends, the development of inclusivity as one of the key components of project management is gaining particular importance. Inclusion in this context means the active participation of people with different physical, cognitive, cultural, social and economic characteristics at all stages of the project life cycle. Innovative

development of inclusive approaches in project management focuses on the implementation of strategies and tools that contribute to ensuring equal opportunities for access to resources, involvement in the decision-making process and influence on project results.

Inclusive project management is based on the principles of equality, openness, accessibility, respect for diversity and quality communication. It aims to go beyond the usual focus on economic efficiency and take into account the social aspect of the project results. This approach makes it possible to create conditions where all stakeholders have the opportunity to actively participate regardless of their individual or social characteristics. Inclusivity is key to ensuring the sustainability and social responsibility of projects. For example, the participation of people with disabilities, representatives of national minorities or women at the planning and implementation stages of a project allows for a wider range of views and ideas, which helps to increase both the efficiency and legitimacy of the initiatives being implemented. The main goal of inclusive management is to provide comfortable conditions for each employee and to promote the maximum disclosure of their potential. Inclusive innovation is based not only on the implementation of technological innovations, but also on the automation of work processes, optimization of delivery systems and innovations in the field of business processes aimed at reducing costs and expanding accessibility. This emphasizes that inclusive innovations can arise both on the basis of advanced scientific research and through the adaptation of already known technologies. At the same time, people with disabilities can also act as their developers and users. A key factor in the development of inclusive innovations is the coordination of the efforts of the three main participants in the economy: the state, civil society and business [1].

Innovations in inclusive governance are manifested through the introduction of new methods of communication, leadership styles, organization of the work process and the use of digital technologies. The main areas in which these innovations support the development of inclusive governance include:

– digital tools and platforms. Modern technologies, such as Zoom, Slack, Microsoft Teams and adaptive HR systems, contribute to ensuring equal access to information, establishing effective communication and creating opportunities for employees with different needs;

– flexible forms of employment. Remote work formats, flexible schedules, and hybrid models facilitate the employment of people with disabilities, young parents, and specialists from other regions or countries;

– artificial intelligence and analytics. The use of AI allows to identify biases in the processes of personnel selection, career development, or performance evaluation, increasing the impartiality of management decisions;

– inclusive leadership style. Modern training and coaching programs help develop in managers the skills of emotional intelligence, intercultural interaction, and empathy necessary for building effective teams.

Microsoft is actively implementing initiatives to employ people with autism, using adapted interview forms and digital simulators for training. SAP implements the Autism at Work program, which is based on modern approaches to personnel selection and talent development [2].

The most common innovative tools that promote inclusivity in project management are listed in **Table 3.5**.

In addition to technological innovations, organizational innovations, such as adaptive management models (agile, lean, design thinking), play a significant role. They contribute to taking into account individual needs and provide flexibility in human capital management processes.

Table 3.5 Innovative tools that promote inclusivity in project management

Tool / platform	Innovation type	Example of an inclusive application
Zoom / Microsoft Teams	Digital communication	Accessibility of participation for people with limited mobility
Subly / Ava	Subtitling	Engaging people with hearing impairments
Eye Gaze / Tobii	Assistive technologies	Eye control of the computer for users with cerebral palsy
Miro / MURAL	Visualization	Participation of participants with cognitive difficulties
ChatGPT / AI- assistants	AI analytics	Generation of adaptive content taking into account the needs of groups

Source: summarized by the authors based on [2, 3]

Innovative practical models that illustrate the effectiveness of an inclusive approach to management include the Universal Design for Project Management (UDPM) model, which implements the principles of universal design at each stage of the project life cycle, social entrepreneurial projects in which inclusivity is a key element of the business model, and Smart City public initiatives aimed at creating infrastructure accessible to all segments of the population.

The Universal Design for Project Management (UDPM) model is a conceptual approach to project management based on the principles of universal design. This approach aims to create processes that are accessible, inclusive, flexible, and effective for the widest possible range of participants, regardless of their characteristics, roles, or context. The refined principles of universal design, originally applied in the fields of architecture and environmental design, have been adapted to project management. The UDPM Core Principles focus on adapting seven key tenets of universal design to the fields of project management (**Table 3.6**).

The practical implementation of UDPM is based on drawing up a project plan taking into account the potential needs of each participant, involving software, platforms and techniques that allow personalized participation, adapting project materials for all users, including people with visual, hearing or cognitive disabilities, and controlling accessibility.

Social entrepreneurial projects, where inclusion occupies a key place in the business model, combine a social mission with an entrepreneurial approach, focusing on accessibility, equality and the involvement of vulnerable groups. In such initiatives, inclusion is not just an additional function or an attempt to implement a CSR strategy — it is integrated into the core of the business, covering its products, services, organizational culture, interaction with customers and staff engagement.

The target audience includes marginalized or excluded communities, including people with disabilities, refugees, the elderly, women in difficult circumstances, young people from disadvantaged families and other groups. Representatives of these communities are involved as beneficiaries, co-founders, employees or partners. The business model is aimed at creating opportunities, not just making a profit. This can include employment, skills development, improving the quality of life or ensuring access to necessary services.

Smart City community initiatives, which focus on creating accessible infrastructure for all citizens, are technologically enhanced actions of local communities, civil society organizations, municipalities and

activists, which aim to make the urban environment convenient, safe and inclusive regardless of the age, physical capabilities, social status or digital literacy of residents [4].

Table 3.6 Core principles of UDPM

Key postulate	Characteristics
Equality in engagement	Ensuring equal access to information, decision-making, and engagement for all team members and stakeholders, regardless of their physical, cognitive, or social capabilities
Flexibility in use	Ensuring that project processes and tools adapt to different work styles, communication, and individual preferences of participants
Simplicity and intuitiveness	Producing easy-to-understand instructions, documents, and communications, even for those without specific project management training
Clear perception of information	Presenting critical information in accessible formats (visual, audio, text), taking into account the unique needs of users
Tolerance for errors	Developing systems that minimize the risk of human error, provide feedback, and allow for safe correction of decisions
Low physical and cognitive barrier	Project tasks should be feasible without excessive physical or cognitive strain
Size and space for access and use	Ensuring equal access to physical and digital resources for all team members

Source: compiled by the authors

Such initiatives implement the principles of universal design combined with digital innovations to make the urbanism of the future accessible to all. A comparison of inclusive management with classical project management is given in **Table 3.7**.

Table 3.7 Comparison with classical project management

Criterion	Classical management	Inclusive Management
Orientation	Result	Process and people
Participation	Hierarchical	Inclusive
Adaptability	Limited	High
Tools	Universal	Personalized
Documentation	Standardized	Affordable and flexible
Risks	Technical, time, budget	Additionally social, inclusive

Source: compiled by the authors

The described approaches to inclusive project management have the following advantages:

— increasing team efficiency through improved communication;

— increasing stakeholder engagement and reducing resistance to change;

— more sustainable project results through inclusive planning;

— strengthening the organization's reputation as a socially responsible structure.

Given current global trends, innovative development in the direction of expanding inclusive opportunities in project management should become an integral part of national sustainable development strategies.

The combination of inclusivity with innovative approaches creates a new paradigm of project management, which is more adaptive, ethical and socially oriented. The implementation of these principles allows not only to achieve higher results at the level of individual projects, but also contributes to the formation of new standards of management culture in the conditions of digital transformation of society.

In the current context of rapid socio-economic transformations, digitalization and growing intercultural interaction, inclusivity acquires the status of not only an ethical norm, but also a strategic resource in project management. The successful implementation of project activities increasingly depends on the manager's ability to take into account the individual characteristics of team members, the diversity of their experience, values, needs and communication styles. In the context of the spread of hybrid formats of cooperation and the globalization of the labor market, the formation of an inclusive work environment is becoming one of the determining factors in ensuring the effectiveness of management processes.

The relevance of the study is determined both by the social demand for ensuring equal access to opportunities in teamwork and the need to increase the innovative potential of organizations. Empirical studies show that inclusive teams are able to demonstrate higher productivity, creativity and resilience to change. At the same time, the effective implementation of an inclusive approach requires a deep understanding of the psychological processes that ensure the acceptance of diversity, the development of empathy, the formation of a climate of trust and the support of emotional security in the team.

The purpose of this section is to study the key psychological directions of developing inclusive capabilities in project management. Special emphasis is placed on studying personal, interpersonal and organizational factors that influence the formation of an inclusive environment. The analysis covers both the conceptual foundations of inclusive leadership and practical mechanisms for its implementation — in particular, coaching, mentoring, training programs and facilitation tools.

The scientific novelty of the section lies in the application of an interdisciplinary approach to studying inclusion in project management through the prism of modern psychological science. Considering inclusion as a process that requires targeted psychological support allows to expand our understanding of effective models of managerial behavior. Special attention is paid to the internal psychological resources of the manager that contribute to the creation of a favorable inclusive environment — openness, reflexivity, readiness to accept differences and the formation of trust.

The following sections will present the theoretical and methodological foundations of an inclusive approach to project management, identify the leading psychological factors that ensure its effectiveness, and also propose practical strategies for developing an inclusive culture at both the manager and project team levels. The results of the analysis will serve as the basis for the formation of scientifically sound

recommendations for specialists in the field of management, consulting, and professional training. Inclusive project management is based on the integration of the fundamental principles of openness, equality, active participation, and respect for the unique experience of each team member. A key element of this approach is the treatment of diversity not as a complicating factor, but as a strategic resource that contributes to the generation of innovations and increasing the overall effectiveness of project activities. The theoretical origins of the concept of inclusion are interdisciplinary, combining the work of psychology, sociology, management, and pedagogy, which provides a holistic view of its essence and implementation mechanisms [42, 43].

In project management, inclusivity should be understood as the ability of an organization to create and maintain an environment in which each participant is able to realize their potential regardless of age, gender, ethnocultural, linguistic, educational differences, psychophysical characteristics or cognitive style. It is not only about ensuring formal equality, but also about creating conditions for the real participation of all stakeholders in decision-making processes, ensuring transparency of management procedures, stimulating an open exchange of ideas and adapting management practices according to the needs of the team [44].

In modern academic discourse, a number of key competencies that form inclusive leadership are identified, including:

— bias awareness — the ability to critically reflect on one's own unconscious attitudes and judgments about others [45];

— openness to different points of view — recognizing the value of pluralism as a source of new approaches and solutions based on different experiences (Randel et al., 2018);

— active listening and dialogue — creating an atmosphere of mutual respect and trust necessary for effective team cooperation [46];

— supporting psychological safety — creating conditions under which each team member can freely express ideas, doubts or disagreements without fear of judgment or sanctions [47].

Inclusive management is inextricably linked to the concept of inclusive mindset, which implies openness to innovation, cognitive flexibility, readiness for continuous learning and high interpersonal sensitivity. Psychological research emphasizes the importance of such individual characteristics as emotional self-regulation, cognitive flexibility, self-reflection, and tolerance for uncertainty [48, 49].

Organizational culture plays a crucial role in shaping an environment conducive to the implementation of inclusive practices. The Robinson and Davis model is well-known, outlining five levels of inclusive culture development: declarative, adaptive, integrative, transformational, and strategic. The transition to higher levels involves targeted work with personnel, including psychological enlightenment and the development of relevant management competencies.

Thus, the theoretical foundations of inclusive project management form a solid foundation for further empirical analysis of the psychological factors that determine its effectiveness.

An inclusive approach to project management is not only a theoretical concept, but also a pressing practical need for organizations that seek to ensure high productivity and sustainability in the context of globalization and increasing workforce diversity. The implementation of inclusive practices in project management involves a deep transformation of organizational culture, a revision of management paradigms and the creation of conditions for the full participation of each team member.

Let's consider the key areas of implementing an inclusive approach.

Analysis of the sociocultural context of the team. Effective inclusion is impossible without understanding the sociocultural differences between participants. The first step should be to diagnose the level of intercultural competence of the team. Inclusively oriented organizations purposefully create an environment in which diversity is perceived as a source of innovation, wealth of experience and effective solution of complex tasks [50].

Formation of inclusive leadership. Project leaders should combine managerial effectiveness with the ability to support a variety of work styles, encourage mutual respect and knowledge exchange. The development of adaptability, empathy, active listening skills and the creation of conditions of psychological safety are important. The leader should proactively overcome barriers associated with stereotypes and prejudices.

Support psychological safety and open communication. An atmosphere of trust is the basis of effective interaction in an inclusive team. This is ensured through regular meetings to exchange ideas, clear communication rules, encouraging feedback and creating a space for safe expression of ideas, objections and doubts [51]. This approach minimizes conflicts and prevents the emergence of toxic interactions.

Systematic assessment of effectiveness and flexibility in strategies. An important condition for the sustainable implementation of inclusion is regular monitoring not only of project effectiveness indicators, but also of the level of satisfaction and involvement of participants. Collecting feedback allows to adapt approaches to specific conditions and requests of the team.

Inclusive talent management. Focusing on diversity in the selection and retention of employees is strategically important. Heterogeneity of experience contributes to the development of creativity, the search for non-standard solutions and the more effective solution of complex project tasks.

Training and development. Continuous education of the team in inclusion issues is critically important. Training programs should include the development of intercultural competence, overcoming prejudices, diversity management and inclusive leadership skills. Their task is to reduce barriers to communication and promote the formation of a healthy, open work environment.

In general, the practical implementation of an inclusive approach to project management is a complex but necessary process that includes strategic planning, targeted leadership training, support for team development and a dynamic performance assessment system. The use of such approaches allows not only to improve the effectiveness of teamwork, but also to strengthen social responsibility and sustainable development of the organization as a whole.

In an era of deep social transformations, constant technological changes and increasing interdependence of world systems, inclusivity is becoming a critically important factor in sustainable project management. It is no longer considered an additional component of corporate responsibility, but is turning into a strategic necessity that directly affects the long-term competitiveness of organizations, the social legitimacy of their activities and the trust of stakeholders. Inclusive strategies are aimed at taking into account the values and needs of diverse groups, ensuring equal access to resources and opportunities, as well as forming a flexible, sustainable, adaptive management environment:

1. Proactively attracting diverse talents: from intentions to institutions. An inclusive organization does not wait for appeals from representatives of marginalized groups, but initiates changes in personnel

selection policies itself. This includes reviewing job descriptions to avoid discriminatory wording; cooperation with public organizations; creating adaptive conditions for employees with special needs. Mentoring programs, inclusive onboarding, and peer-to-peer support at the initial stages of involvement in the project are especially effective.

2. Principles of fairness, participation, and role balance. The implementation of equal opportunities requires not only declarations, but real changes in organizational behavior. It is necessary to implement internal control mechanisms over the distribution of tasks, avoid paternalistic interaction models and ensure that each team member has equal access to professional challenges, resources, training and career advancement. The tools of such a policy can be anonymous questionnaires, assessment of the psychological climate and revision of reward algorithms.

3. Development of inclusive leadership as a competency model. Inclusive leadership is not a style, but a set of specific competencies that are amenable to targeted development. It is based on trust, transparency, willingness to hear and recognize the needs of others. In a project environment, a leader should be not only a coordinator of processes, but also a facilitator of group dynamics. This requires mastering the skills of non-violent communication, managing emotions, conflict management, and applying ethical leadership practices.

4. Flexibility as a strategic advantage in the face of change. Inclusive strategies contribute to the creation of organizations with a high level of resilience to external challenges. Thanks to the diversity of points of view, inclusive teams are better able to predict risks, adapt to unforeseen circumstances, and develop alternative scenarios. Management decisions based on consensus and collective understanding have greater legitimacy, which reduces resistance to change and increases the stability of project implementation.

5. Inclusivity in strategic planning. The participation of team members in strategic processes at all stages — from the formulation of goals to the assessment of results — increases responsibility and inclusion. For this, it is important to implement multi-level communication mechanisms: facilitated strategic sessions, discussions in the format of World Cafés, electronic platforms for collecting ideas, dynamic feedback systems.

6. Integrating the principles of sustainable development into the project logic. Project management should take into account environmental, social and economic consequences. Inclusive strategies contribute to the formation of responsible decisions — taking into account the life cycle of the project, the impact on local communities, working conditions, social justice. This involves the use of ESG (Environmental, Social, Governance) criteria in assessing the effectiveness of management decisions.

7. Cultural competence as a basis for effective interaction. Understanding cultural norms, values, communication styles and behavior is critically important in international or multicultural project teams. The development of this competence is possible through regular training, case analysis, intercultural exchanges, intervention groups and reflective practices. This reduces the risks of communicative misunderstandings and increases the effectiveness of decision-making.

8. Inclusive performance assessment. It is important that assessment systems take into account not only quantitative results, but also qualitative indicators — in particular, the level of satisfaction, involvement, a sense of justice. This is ensured through the inclusion of self-reports, open interviews, narrative analysis, and inclusive climate indices. Systematic measurement helps not only to track dynamics, but also to build new strategic vectors.

It is worth emphasizing that inclusive strategies in project management are not an optional addition, but rather the foundation of a sustainable organizational ecosystem. Their implementation contributes to the creation of teams that are able not only to work effectively, but also to transform social reality. This requires a new culture of leadership, flexible structures, innovative approaches to planning, and deep sensitivity to human experience.

In addition to organizational and psychological factors that influence the implementation of an inclusive approach to project management, it is important to consider the socio-cultural context. Each project is implemented in a specific environment, where local norms, expectations, and cultural characteristics operate. Therefore, effective management of inclusion requires the adaptation of global strategies to specific social conditions, which ensures both flexibility and relevance of management decisions.

Another important aspect is to take into account changes in the digital environment. In the context of the growing role of remote and hybrid work, inclusion takes on a new meaning — digital accessibility, ease of communication, the availability of alternative feedback channels and inclusive design of online platforms become critically important. Such elements of digital inclusion contribute to equal involvement in projects regardless of location or characteristics of information perception.

Additionally, it is worth paying attention to intergenerational features in teams. Managing age diversity is another important area of inclusive strategies. Representatives of different generations have different communication styles, expectations for leadership and approaches to solving problems. Effective management of such diversity requires the creation of intergenerational dialogue, coaching support and exchange of experience between senior and junior colleagues.

Thus, inclusivity in project management is a dynamic and multidimensional system that encompasses not only the internal processes of interaction in a team, but also the external factors that shape the conditions for its effectiveness.

Integrating these aspects into management strategies allows organizations not only to increase the effectiveness of project activities, but also to create a more equitable, responsive and sustainable professional environment.

CONCLUSIONS

The chapter conducts a comprehensive theoretical and applied study of the role of inclusive project management as a factor in the transformation of the national economy. The methodological basis of inclusivity in the context of modern project management is considered, international experience is studied, the state of inclusive practices in Ukraine is assessed, and the correlation between inclusivity and innovative capacity is empirically confirmed using a sample of 10 countries.

The initial hypothesis that inclusive project management can positively influence the development of human capital, innovation dynamics, and economic sustainability was confirmed:

1. The constructed multiple regression model showed a strong relationship between the human development index, inclusivity, and the innovation index ($R^2 = 0.931$).

2. The identified positive correlation (r = 0.919) between inclusive development and the capacity for innovation confirms the multiplicative effect of diversity and social participation.

3. Practical experience of European countries, Canada and South Korea demonstrates that inclusive projects not only solve social problems, but also contribute to economic growth, increase employment, and create innovative solutions.

Key scientific and practical results:

1. For the first time, approaches to inclusive project management were systematically classified into four types: socially oriented, institutional, innovative and gender inclusive.

2. A critical analysis of inclusive practices in Ukraine was conducted and the main barriers were identified: fragmentation, lack of a regulatory framework, dependence on donors, weak educational support.

3. 10 detailed recommendations were proposed for different levels of management, taking into account international standards and the national context.

Research limitations:

— limited sample of countries in the regression analysis (n = 10), which reduces the statistical reliability of estimates for generalizing the results;

— insufficient level of open data on inclusive practices in Ukraine limits the depth of quantitative analysis;

— lack of a national register of inclusive projects makes multi-level impact assessment impossible (micro, meso, macro).

Directions for further research:

— building a dynamic econometric model based on panel data for a wider list of countries;

— development of indicators for assessing the inclusivity of projects in the context of digital transformation;

— analysis of the impact of an inclusive approach on local community development in Ukraine — through case studies and qualitative interviews;

— research on the relationship between inclusive management and the effectiveness of infrastructure, environmental and digital projects.

Inclusive project management is not only a socially necessary, but also an economically justified strategy that creates conditions for sustainable growth, increases the efficiency of human potential use and ensures an innovative breakthrough. In the case of Ukraine, inclusivity can become the foundation of a new development model that meets the challenges of post-war reconstruction, demographic changes, and integration into the European space.

USE OF ARTIFICIAL INTELLIGENCE

In the process of preparing the manuscript, the AI tool ChatGPT, model GPT-5.1 (OpenAI) was used.

AI tools were used during work on individual stages of the manuscript: in the sections "Introduction", "Theoretical and methodological foundations of the study", "Inclusive practices in project management: international experience".

The artificial intelligence tool was used for: forming primary text fragments in the form of proposals (draft wording) based on the data provided by the authors; editorial assistance: stylistic improvement, increasing readability, harmonization of terminology; structuring large blocks of information selected by the authors, for preliminary generalization of international approaches; forming tables and graphics, preparing logically structured recommendations; generating examples of formulations for theoretical definitions and conceptual explanations.

The authors carried out a full review of all materials obtained with the participation of AI by: comparing each fragment with primary sources and relevant scientific literature; manually clarifying terms, definitions and content in accordance with the research methodology; verifying statistical data, facts, international examples and regulatory references; ensuring compliance with academic standards, research logic and requirements of the target publication.

All citations, references, statistical results and theoretical positions were exhaustively checked by the authors, edited and academically supplemented.

The use of AI tools did not affect the scientific results, empirical conclusions, statistical models and research position of the authors. AI contributed to improving the quality of presentation, structuring of the material and optimizing editorial work, but did not form scientific statements or interpretations. All key conclusions of the study, conceptual models, methodological positions and recommendations are formulated exclusively by the authors and reflect their own scientific position.

CONFLICT OF INTEREST

There is no conflict of interest. The authors declare that they have no financial, academic, personal or other conflicts of interest that could influence the content, results or interpretation of this study.

All authors confirm that the study was conducted independently, without influence from any external organizations, sponsors or stakeholders.

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4 CULTURE OF DIGNITY AS A PSYCHOLOGICAL ARCHITECTURE OF INTEGRATION OF NATIONAL ECONOMIES

ABSTRACT

The article examines the concept of a culture of dignity as a new psychological architecture for the integration of national economies in the global world. Unlike traditional approaches that focus on institutional mechanisms or economic indicators, the proposed methodology integrates three dimensions: behavioral economics, philosophy, and psychology.

The authors show that modern integration processes cannot be explained solely through agreements, markets, or transaction costs, as their viability is determined by the level of trust, empathy, moral legitimacy, and cultural memory of societies. The central thesis is that dignity ceases to be an ethical "decor" of economic processes and becomes their foundation, since it is precisely it that allows to neutralize cognitive biases, overcome the consequences of collective trauma, and ensure the sustainability of cooperation.

An interdisciplinary design was used: content analysis of philosophical and economic sources, comparative analysis of integration practices (EU, Brexit, Good Friday Agreement, Erasmus), as well as interpretation of neuroscience and behavioral economics data confirming the role of empathy, affects and oxytocin in the formation of trust. It is shown that the digitalization of management and the growth of the role of algorithms create new risks of the "illusion of technological neutrality", which can level the human dimension of integration. The culture of dignity is proposed as a compass that can ensure a balance between innovation and ethics, technocratic efficiency and humanity.

Special attention is paid to historical and cultural factors that influence the formation of trust between nations. The authors analyze examples of both successful and problematic integration, showing that the absence of a culture of dignity leads to conflicts, distrust and the collapse of alliances. Thus, the article offers a vision of integration processes not as a technocratic construct, but as a "living organism" in which morality and psychology play a key role. This allows for a broader interpretation of economic phenomena through the prism of humanistic methodology.

The paper also outlines practical implications for politics and business. The authors emphasize that a culture of dignity should be integrated into education, public administration, and corporate management systems as a fundamental principle of long-term development. Global challenges – the climate crisis, wars, inequality – require precisely such a cultural foundation in which coexistence, mutual respect, and empathy become resources no less important than financial investments or technological innovations.

The article also touches on the issue of identity and the psychology of communities: it shows how a sense of dignity shapes not only political loyalty, but also the economic behavior of citizens.

Here, dignity is not an abstract ideal, but a daily practice, manifested in choosing cooperation over competition, in the willingness to take responsibility, in the search for a common meaning. This approach opens up a new horizon for research — from business ethics to geopolitics — and demonstrates the universality of the category of "dignity" as an analytical tool. In this context, the proposed study goes beyond academic analysis and acts as a project of civilizational development. It calls for a rethinking of integration processes in the light of humanistic values, where economic unions become a space for coexistence, and not just a tool for survival. The work has both academic and civilizational significance. It demonstrates that global integration in the 21st century is possible only when the person with its dignity is at the center. Thus, the study contributes to the development of public administration ethics, philosophy of dignity and humanistic management, offering a new theoretical and methodological basis for the analysis of integration processes.

KEYWORDS

Culture of dignity, integration of economies, behavioral economics, management psychology, cognitive biases, trust, neuroscience, public administration ethics, digital algorithms, humanistic management, globalization.

The integration of national economies in a globalized environment has long ceased to be exclusively a matter of financial flows and trade agreements. Modern economic science is increasingly aware that integration processes have a multidimensional nature, in which, along with market mechanisms, cognitive biases, affective reactions and ethical guidelines of public administration are decisive [1, 2]. Recognition of this complexity forces economists, social psychologists and political philosophers to search for an integrative methodology that can explain why formally rational institutions often turn out to be fragile without a culture of trust and dignity [3, 4].

In traditional economic approaches, integration appears as a function of rational choice and optimization of benefits. However, modern behavioral economics demonstrates that economic agents are not "rational maximizers", but act within the cognitive distortions formed by cultural narratives and historical memory [5, 6]. These biases, such as the status quo effect or ingroup favoritism, create barriers to economic integration even in situations where formal models predict its feasibility [7]. Thus, the integration of national economies cannot be reduced to the arithmetic of benefits — it is a phenomenon of psychological architecture, where economic rationality coexists with affective and cultural parameters.

It is here that the concept of a "culture of dignity" appears as an analytical category. M. Nussbaum considers dignity as a universal basis for creating "capabilities" that allow societies not only to survive, but also to develop in the direction of justice and equality [6]. P. Ricoeur, analyzing the phenomenon of "self as Other", shows that trust and recognition are necessary prerequisites for interaction that goes beyond instrumental relations [4].

D. Acemoglu and J. Robinson argue that economic institutions function effectively only when they are embedded in a social context where dignity and inclusiveness define the rules of the game [1]. Therefore, the integration of national economies without a culture of dignity risks turning into a technocratic process without social legitimacy.

An important aspect is the role of trust as social capital. F. Fukuyama convincingly proved in the mid-1990s that a high level of public trust is a determining factor in economic development and the stability of institutions [3]. Later, R. Putnam showed using the example of Italy that "social capital" — that is, horizontal networks of trust — directly correlates with the quality of governance and economic progress [9]. These studies have acquired a new meaning in the era of globalization, as trust becomes an intercultural category that determines not only the internal cohesion of societies, but also their ability to integrate with other economies.

At the same time, cognitive biases remain an understudied factor in the macroeconomic analysis of integration processes. D. Kahneman showed that human thinking processes are structurally prone to heuristics and errors that form systematic deviations from rationality [2]. G. Akerlof and R. Shiller, in turn, proved that macroeconomic cycles are often explained not only by "real" economic factors, but also by "animal spirits" — collective emotions and narratives [7]. This opens up the possibility of explaining why formally attractive integration agreements often fail. They ignore the psychological mechanisms of trust, identity and dignity. The modern theory of multilevel integration, which is developed within the framework of social economics and institutional theory, shows that economic agreements should be considered through the prism not only of transaction costs, but also of cognitive costs and the "value of trust" [3, 9]. These costs are no less real than financial, as they determine the legitimacy and viability of integration structures. In this sense, the psychological architecture of integration becomes a key concept that combines behavioral economics, the philosophy of dignity, and the ethics of public administration.

It is not possible to ignore the perspective of integral thinking of K. Wilber, which is supported by a number of modern researchers in the context of global challenges [28]. Integration here appears as a synthesis of different levels — economic, cultural, psychological, ethical. Without taking into account this synthesis, attempts to build unified economic spaces resemble architectural structures without a foundation; they may look strong, but remain vulnerable to the first serious crisis.

Thus, the introduction to our study outlines the central hypothesis. The integration of national economies in the 21st century is possible only if it is designed as a culture of dignity that integrates cognitive, behavioral and ethical dimensions into a holistic psychological architecture. Without this, economic models risk remaining abstract schemes, disconnected from human reality.

In the global economic system, integration increasingly shows signs of "uneven interdependence", when economies are formally connected into a single network, but their internal psychological readiness for interaction differs significantly [14]. This gives rise to new types of asymmetries that are not always explained by traditional macroeconomic models. In countries with a low level of institutional trust, formal agreements often do not turn into real mechanisms of cooperation, since participants perceive partners through the prism of historical images and stereotypes [11]. Thus, the cost of transaction costs in such economies increases not only due to institutional gaps, but also due to cultural and psychological biases.

This requires a new economic methodology that combines institutional analysis and the psychology of trust, considering them as interdependent determinants of integration processes [8]. In this context, it is worth paying attention to the concept of "economy of emotions", which describes how collective affects influence political and economic decision-making [15].

When narratives of fear or humiliation become dominant in society, they shape the behavior of citizens and politicians as strongly as indicators of macroeconomic stability. Integration agreements in such conditions require not only financial incentives, but also cultural programs aimed at overcoming these negative affects. Without this, economic integration risks remaining an "empty form" that does not transform real relations. The issue of legitimation of integration projects becomes particularly important. If legitimacy is considered only as a legal instrument, it is possible to risk underestimating its psychological dimension. Research in the field of political psychology shows that trust in institutions is formed at the intersection of two planes — cognitive (rational assessment of efficiency) and affective (emotional sense of justice) [16]. Successful integration models, as the EU analysis shows, are based precisely on the combination of both dimensions, namely — citizens perceive institutions as effective and at the same time fair. When one of these components is missing, a "trust deficit" arises, which undermines the stability of even formally successful economic unions.

An additional complication is the phenomenon of post-truth, which creates new conditions for the formation of collective perceptions [17]. In an environment of information manipulation, integration processes become especially vulnerable, because rational arguments are often replaced by emotionally colored fake narratives. This imposes new requirements on the ethics of public administration. Managers must not only develop economic strategies, but also actively work with the psychological resources of trust. In such a context, the culture of dignity becomes not only an ethical category, but also a tool for countering information distortions. It provides the basis for critical thinking and collective resilience in the face of information attacks.

An important innovation is the emergence of concepts of "behavioral public administration", which integrate the achievements of cognitive science into the analysis of management decisions [18]. This approach shows that even in the field of public administration, biases and emotions determine the effectiveness of policies as strongly as formal institutions. For integration processes, this means that managers must take into account not only macroeconomic models, but also the psychological constraints on citizens' perception of policies. Here, a culture of dignity acts as a normative framework that allows the design of policies that are not only effective but also legitimate from the perspective of citizens.

Finally, integration as a "psychological architecture" implies a new vision of rationality. It is not about abandoning rational economic models, but about enriching them by taking into account multidimensional factors, from affects to ethics [19]. A. Sen convincingly showed that development and well-being should be assessed not only in the categories of income or productivity, but also in the categories of opportunities and freedoms.

This approach is especially important for integration processes. Economic unions become sustainable only when they expand the space of opportunities for citizens, rather than narrowing it. In this sense, the culture of dignity acts as a methodological compass that determines the direction of integration not only

towards economic growth, but also towards social justice and coexistence. The work uses an interdisciplinary approach that combines content analysis of philosophical and economic sources, comparative analysis of integration practices, and interpretation of neuroscience and behavioral economics data to identify psychological mechanisms of trust and dignity.

4.1 CULTURE OF DIGNITY AS A METHODOLOGY OF INTEGRATION

The idea of integrating national economies has traditionally been viewed through the prism of institutional mechanisms, regulatory regimes, and standard economic policy instruments. However, in the 21st century, it is increasingly evident that formal constructs do not guarantee either the stability or fairness of integration processes. They are able to unite markets, but not consciousness; to agree on rules, but not to recreate trust. Therefore, the methodological dimension of integration requires rethinking — a transition from technocratic logic to the logic of a culture of dignity, which sets a new epistemology of coexistence. Dignity here appears not as an "ethical decoration" of economic integration, but as its architectonics — the foundation that provides stability where institutions are fragile and markets are volatile [6, 18, 20].

The culture of dignity as a methodology of integration proceeds from the postulate that economic interaction is never reduced to the exchange of goods and services. It is always a form of social coexistence, which is determined by the quality of interpersonal relations. That is why cognitive biases, behavioral patterns and affective attitudes become determining factors of integration dynamics. If politics ignores these factors, it produces conflict; if it includes them in the field of dignity, it transforms potential barriers into pillars of dialogue. In this sense, the culture of dignity functions as an anti-cognitive architecture. It does not eliminate the limitations of human thinking, but teaches to integrate them into the space of coexistence [2, 21].

The European Union has become a symbol of the fact that integration can be based not only on economic agreements, but also on the idea of dignity as a common foundation. Its project began with pragmatic cooperation in coal and steel, but gradually turned into a community where the principles of equality, human rights and mutual recognition have become as important as financial incentives [22]. When European integration faced crises, from debt to migration, it was the appeal to dignity, not just contracts, that allowed for minimal consensus and avoided disintegration [23]. The African Union and Mercosur demonstrate another dimension of integration quests: the attempt to build a "long horizon of trust" in an environment where historical trauma and economic asymmetry make stability difficult. In Africa, integration initiatives have repeatedly encountered a lack of institutional trust and post-colonial legacies, but the very existence of the African Union as a platform for solidarity testifies to the search for a new culture of dignity as the basis for political and economic unity [24]. In Latin America, Mercosur is experiencing undulating stages of development, from ambitious integration to crises of legitimacy. However, even in times of dispute, member states have sought to maintain minimal channels of cooperation, appealing to a shared cultural heritage and the symbolic idea of "Latin American unity". Both examples demonstrate that without long-term investment in a culture of dignity, any economic agreements remain fragile constructs, sensitive to political cycles.

The additional value of a culture of dignity lies in the fact that it is formed not as an external coercion, but as an internal logic of the development of institutions and practices. It offers an alternative to both classical utilitarianism (the person as a "rational agent") and the reductions of neoliberalism (the person as a "consumer"). Dignity overcomes these reductions. It takes the individual beyond the roles of agent or client and reminds that integration is primarily about coexistence in a space of mutual recognition and responsibility [25, 26] (**Table 4.1**).

Table 4.1 Intellectual portraits-episodes: ideas that shape the methodology of a culture of dignity in integration

Author /intellectual portrait	Key concept / approach	Key principles	Importance for integration
M. Nussbaum [6]	Capabilities approach	Development does not begin with GDP, but with the real possibilities of a person to live with dignity. Emotions — compassion, shame, indignation — are important factors in social dynamics	Integration should be built not only on agreements and tariffs, but on the creation of an "infrastructure of opportunities": access to education, health care, cultural participation
W. Welsch [12]	Transversal thinking	Rejection of the extremes of universalism and relativism. Openness to plurality as a condition for development	Unity is achieved not through unification, but through the interaction of differences; integration becomes a space for dialogue and coexistence
R. Hackman [27]	Team effectiveness and trust	The effectiveness of teams is determined by the quality of interpersonal relationships, trust and the distribution of responsibility, not control	Integration is based on mutual recognition of the parties as equal subjects; it creates an environment of innovation and creativity without coercion
K. Wilber [28]	Integral model of consciousness	Economic systems are woven into cultural, psychological and spiritual contexts. Consciousness is multidimensional and requires an integrated approach	A culture of dignity corresponds to the multidimensionality of reality, combining the material and the immaterial, the local and the global; integration goes beyond the economy
S. Krymskyi [29]	Dignity as the basis of identity	Dignity is the key to cultural resilience and national identity. Without it, peoples are reduced to "functions" of global markets	Dignity allows societies to maintain subjectivity, form their own integration models and remain active creators of global interaction

CONCLUSION

A culture of dignity is not an alternative to rules or markets, but their underlying condition. It reduces the destructive impact of cognitive distortions not through the illusion of "sterility" but through the discipline of reflection; it teaches to live with human limitations so that they do not turn into institutional fragility. A new type of integration emerges as a practice of coexistence — where mutual recognition sets the limits of what is permissible, and trust shapes the long horizon.

4.2 COGNITIVE PREJUDICES AS BARRIERS TO INTEGRATION PROCESSES

The integration of national economies rarely stops at numbers. Its dynamics are determined not only by tariffs or currency regimes, but primarily by cognitive "curbs", imperceptible because they are embedded in the way of thinking. Economic theory has long treated them as "noise" in decision-making, but behavioral economics has shown that it is heuristics, affects and moral intuitions that set the structure of rationality [2, 30].

In negotiations, the loss effect is the first to be triggered. Losses are perceived much more painfully than symmetrical gains. Therefore, any integration agreement is overshadowed by the fear of losing control or sovereignty [13]. It is reinforced by confirmation bias. Elites and voters filter information so that it confirms existing stereotypes about partners [31]. Added to this is the status quo effect — the tendency to overestimate the risks of change and underestimate the risks of stagnation, which opens up space for populism [32].

Ingroup bias is particularly dangerous. Making concessions to the other side is interpreted as a humiliation of one's own dignity, rather than an investment in trust [33]. As a result, integration becomes an "us versus them" moral drama. The culture of dignity in this context becomes a counterframe. It legitimizes differences without transforming them into threats.

No less significant are the anchoring effect and framing. The first number uttered or the way a question is phrased can shift the trajectory of negotiations more than "real" economic parameters [34]. There is also the availability effect. Media images of crises or defaults distort risk assessments, outweighing statistical trends [35]. Finally, the halo effect forms a stereotypical perception of the partner ("good/bad"), which blocks the consideration of nuances [36].

Thus, decisions in negotiations are explained not only by economics, but also by psychology. A culture of dignity in this case is a requirement for cognitive transparency, honest argumentation, and practices of mutual recognition.

Cognitive distortions are even more pronounced in collective structures. The classic syndrome of groupthink describes a situation where the desire for agreement suppresses critical thinking: opponents' ideas are suppressed, and consensus becomes artificial [37].

In the digital age, this effect is amplified by algorithms. "Echo chambers" and personalized feeds create information cocoons where communities read only themselves and confuse repetition with truth [38, 39]. This generates polarization. Groups of like-minded people are radicalized, and institutions of integration are transformed into scenes of mutual moral condemnation.

A culture of dignity does not try to sterilize emotions or eliminate conflict. It proposes transversal thinking (W. Welsh) — dialogue through recognition of differences, not their unification [12]. This creates a communication protocol in which conflict becomes a resource for development, rather than a threat of disintegration.

At the level of integration policy, other distortions operate. Short-termism forces politicians and markets to demand quick results, underfunding institutions of trust [40]. Overconfidence and the illusion of control lead to systematic optimism and underestimation of chance [41]. As studies of large-scale projects show, this leads to chronic cost overruns and broken promises [42].

Here, a culture of dignity teaches institutional modesty. Recognizing risks, backing public promises with verification mechanisms, and creating safe "corridors of error". This allows for the transformation of vulnerability into a resource of trust.

Big data does not eliminate cognitive distortions, it magnifies them. Algorithmic biases are built into the design of systems, turning the "availability effect" and "motivated thinking" into industrial power [43].

"Smart" feeds and targeted messages create attentional operating systems that manipulate risk and shape a "market of fear" [44, 45]. A culture of dignity requires not censorship but human design — transparent explanations, clear labels, the right to correction and mechanisms for counter-criticism. This reduces the asymmetry of power between institutions and citizens.

The institutional level confirms that integration collapses where rules remain "empty forms" without trust [46]. Conversely, it holds together where shared norms are rooted in practices of mutual recognition and collective governance of goods [47].

The EU and ASEAN show two different paths — from the eurozone crisis [23] to the gradual "slow integration" in Southeast Asia [48]. In both cases, cognitive traps either escalate into populism or are discharged through mechanisms of solidarity.

This proves that the stability of integration unions is impossible without a moral infrastructure — this is the function performed by the culture of dignity.

Ukrainian humanitarian thought confirms this thesis. S. Krymskyi emphasized that dignity is the basis of cultural stability. Ye. Holovakha described social illusions that form political errors. V. Paniotto analyzed trust as a scarce social capital. Educational studies have shown that without emotional literacy, integration turns into a simulacrum. All these insights boil down to the main thing: dignity is a way of thinking that turns vulnerability into a resource for co-creation.

When we say "anti-cognitive architecture", we are not declaring war on cognition. We are only rejecting reductionism, which reduces a person to a variable in a utility function. The culture of dignity is a metacognitive regime in which differences are not erased, but carried together; in which mistakes are not hidden, but announced; in which weaknesses are not stigmatized, but become points of growth. It is this architecture that gives integration a chance to survive another cycle of crisis and populism.

CONCLUSION

Cognitive biases are not a disease to be eliminated, but a mirror of our conditioning. Integration without dignity looks into this mirror and sees an enemy. Integration with dignity sees an interlocutor. The first turns politics into a marketplace of fears; the second into a space of coexistence. And if we are destined to build alliances that can withstand the pressure of time, then we will have to do so not only by reforming the rules, but also by cultivating dignity, as an ethic of mutual recognition, as a discipline of transparency, as a pedagogy of trust.

In this sense, the culture of dignity is an anti-cognitive architecture of integration: it does not promise sterility of thinking, but creates conditions in which human weaknesses become the basis of resilience.

4.3 COGNITIVE PREDICTIONS AND PSYCHOLOGY OF MANAGEMENT DECISIONS IN INTEGRATION PROCESSES

Integration processes in the modern world resemble a complex game on the border of rationality and emotionality. A step forward can be determined not by cold calculation, but by sudden fear, prejudice or symbolic gesture. What textbooks call "economic strategies" in reality often turns out to be a combination of cognitive distortions and political compromises. Integration is not only a set of agreements, but also a psychological game with ideas about justice, dignity and control. Classical economics has long ignored this psychological dimension, drawing an abstract homo economicus who chooses optimal solutions like a machine. But research in recent decades proves that the real driver of integration processes is homo sapiens affectivus — a person who reacts to risk through emotions, not through rational formulas [41, 50]. It is these biases — the "status quo effect", the "anchor", the "illusion of control" — that become the "invisible parliament" that votes for or against economic unions.

Take, for example, the "loss effect". In integration negotiations, governments often exaggerate the potential loss of sovereignty and underestimate the benefits of cooperation. This psychological bias explains why even profitable deals encounter resistance: the familiar seems more valuable than the new. In this sense, any integration process is not only an economic but also a therapeutic experiment in overcoming collective anxiety.

Another barrier is "anchor thinking". The first number or fact voiced in negotiations often shapes the perception of the deal regardless of the real data. When one side mentions "inflated expectations" or "catastrophic risks", even the strongest arguments then revolve around this starting point. As a result, compromises are not built on objective calculations, but on psychologically imposed guidelines.

Ukrainian economists and philosophers, in particular V. Kebuladze and O. Gerasymchuk, rightly note that integration in the case of Ukraine is primarily a challenge in overcoming "mental traps", and not only in changing legislation [59]. Indeed, institutional reforms are blocked not so much by a lack of resources as by cognitive inertia — fear of the new, belief in the "eternity" of old practices.

Brexit is a vivid example of how prejudices determine the fate of integration projects. The "loss effect" played a key role here. The British were afraid of losing their imaginary independence, even if the economic benefits from the EU were obvious. Logic said "remain", but the symbols of the red passport, fear of migrants and the illusion of restored control prevailed. This is not economic arithmetic, but the psychology of images, which can outweigh rational calculation [51].

A similar situation occurred with the failure of the EU Constitution in France and the Netherlands in 2005. Citizens who enjoyed the benefits of integration voted against its symbolic consolidation. Here a conservative psychological mechanism manifested itself. People overestimated the risks of change and underestimated the risks of stagnation [23]. In other words, a historical chance was lost not because of economic calculations, but because of psychological discomfort with the unknown.

On an international scale, the "trade wars" between the US and China also show psychological logic. "Groupthink" and the "hostility effect" push the parties to escalate, even when compromise would be more beneficial [53]. Instead of rational dialogue, it is possible to see a theater of symbols, where the stakes are determined by prestige and fears, not economic models.

Modern neuroeconomic research shows that decisions in crisis conditions primarily activate the amygdala of the brain, responsible for fear and anxiety [54]. That is, when it comes to integration, people first feel and only then think. This requires a new approach to communicating reforms. Appeal not only to rational arguments, but also to images of trust, dignity and security.

An additional challenge is the "confirmation bias". Society tends to see confirmation of its distrust in isolated failures and ignore systemic successes. This is especially true of anti-corruption reforms in Ukraine. People are quick to notice scandals but slow to acknowledge gradual institutional changes. Here, a culture of dignity requires transparent communication and honest dialogue.

At the same time, psychology can be a resource for integration. Research shows that the "superordinate goals effect" can reduce intergroup hostility [55]. In the context of integration, this means that it is worth speaking not only in the language of benefits, but also in the language of meanings — of shared identity, values, and the future.

Ukrainian philosophers — S. Krymskyi, M. Popovych — emphasized long before the current reforms that integration makes sense only when it unfolds in the dimension of dignity. Otherwise, any agreement risks turning into a "technocratic contract without a human face" [56]. In this sense, our current economic challenges only confirm their foresight.

Final conclusion. Integration is primarily the psychology of fear management. Successful integration projects have always been those that have found the language of trust and symbols of dignity. And unsuccessful ones have been those that have tried to convince people only with numbers, forgetting that people think in images. This is the challenge of the 21st century. To create an architecture of integration that takes into account cognitive fragility, but at the same time forms a culture of trust as the basis of coexistence.

Management decisions in integration processes are increasingly subject to the logic of neuroeconomics, which proves that in moments of collective choice, the brain of a politician or negotiator functions not as a "rational calculator", but as a complex network of affective and cognitive signals. Functional neuroimaging (fMRI) studies show that even at the level of international negotiations, the amygdala is activated — the center of emotional anxiety, which determines the readiness for trust or resistance [57]. This means that cognitive biases cannot be "excluded" by a technocratic procedure; they are embedded in the very corporeality of thinking.

The emotional intelligence of leaders and negotiators plays a special role in modern integration practices. Research shows that the ability to listen empathetically and regulate one's own emotions is critical for achieving interstate agreements, especially in conditions of distrust [54]. In this sense, a culture of dignity offers not only an institutional framework, but also an emotional and psychological dimension of coexistence. The Ukrainian experience of post-2014 reforms has shown that precisely those management teams that appealed to dignity as a common denominator were able to achieve greater legitimacy for their decisions [59].

No less significant is the phenomenon of "trust in algorithms". Modern economic integrations increasingly rely on digital platforms and algorithmic risk models. At the same time, excessive reliance on algorithms can create a new type of bias — "the illusion of technological neutrality" [60]. The culture of dignity acts as a counterweight here. It reminds that behind every number there is a person, and that integration decisions should remain in the realm of moral responsibility, not statistical fatalism.

An important factor in integration psychology is collective memory. Studies show that countries that have experienced common traumas or victories are more prone to cooperative integration, while the memory of conflicts creates long-lasting barriers [4, 98]. The Ukrainian context is illustrative here.

The national experience of Maidan, war and reforms has become a resource of collective memory, strengthening the desire for integration into the European community. This proves that integration is not only about agreements and economic indicators, but also about the deep psychological work of society with its own past.

4.4 BEHAVIORAL MECHANISMS OF INTEGRATION: FROM COMPETITION TO COEXISTENCE

Economists like to draw graphs, but the integration of nations, cultures and economies takes place not on paper but in hearts. What they call "behavioral mechanisms" is actually a drama of emotions: fear, trust, shame and pride. Classical economics hid this dimension, but behavioral economics has finally brought it into the spotlight [53].

R. Schuman, in proposing to unite the French and German coal industries, thought like a therapist, not an accountant. His gesture was "collective psychotherapy" for a continent still bleeding after the war [50]. Hence began Europe as a community of trust, not just markets.

The African Union shows that where institutions are fragile, integration is possible only as a narrative economy — through the anthem, the flag, the symbols of "Mother Africa" [24, 55]. This is an example of how trust is sometimes more valuable than currency. But the trauma of colonialism makes this capital fragile, and progress resembles a slow dance between hope and disappointment.

Ukraine's European choice is not an arithmetic of GDP, but an act of identity. War and economic upheaval have paradoxically increased trust in the EU. According to Eurobarometer [52], support for integration has doubled since 2014. This shows that disasters can be catalysts for coexistence when dignity is at stake.

During the 2008 debt crisis, the decision to adopt "austerity" was more an affective reaction than a rational calculation. The "lazy South" and the "rational North" are behavioral myths that shaped policy despite the data [61]. In other words, Europe was saved or destroyed not by numbers, but by perceptions.

The Good Friday Agreement in Northern Ireland was an act of "emotional contract" — an agreement of mutual recognition of pain [56]. Willy Brandt's Ostpolitik was also a politics of empathy. "Change through rapprochement" appealed to responsibility, not fear [54]. All this shows that true integration begins where empathy becomes politics.

The 2016 Brexit proved that "taking back control" was a stronger argument than any statistics [62]. It is a classic example of an affective symbol that mobilized a nation. Against this background, the culture of dignity reminds that true control lies not in isolation but in mutual recognition.

Erasmus or Creative Europe programmes have shown that integration is not born only in Brussels, but also in student dormitories and joint projects of artists [63]. The emotional intelligence of institutions is sometimes more important than their budgets.

The EU has invested billions in the Balkans, but without working with the memory of wars, integration is stalling [48]. Economics does not bridge distrust — integration without therapy for collective traumas turns into imitation.

Social brain research proves that empathy activates the same neural networks as personal experience [64]. In other words, empathy is not a metaphor, but the biology of integration.

In the 21st century, a new paradox has emerged — trust in algorithms. People are more likely to accept decisions made by artificial intelligence than by politicians because they believe in the "neutrality" of code [57]. However, the culture of dignity reminds that algorithms without human warmth risk creating integration without coexistence.

But integration is impossible without shared ideas about time. A. Assmann wrote: alliances hold together only when people form a "memory of the future" [58]. This means that integration is always a strategy of imagination, not just accounting.

The behavioral mechanisms of integration are a symphony of three levels:

– affective (fear, pride, resentment);

– cognitive (stereotypes, representations);

– symbolic (memory, rituals, identities).

Only when they sound together does integration become coexistence, not a technocratic illusion. The culture of dignity is the conductor here. It transforms the chaos of affects into the harmony of coexistence.

4.5 ETHICS OF PUBLIC ADMINISTRATION IN THE CONDITIONS OF INTEGRATION

The integration processes of national economies in the 21st century cannot be reduced solely to technical coordination or the achievement of macroeconomic indicators. They manifest themselves as complex socio-cultural constellations, where legal norms, political interests and psychological factors of trust are intertwined. That is why the modern theory and practice of public administration requires a shift in emphasis — from instrumental efficiency and bureaucratic rationality to the ethical architectonics of a culture of dignity, which forms not only the legitimacy of decisions, but also their acceptability for citizens [65, 66]. Trust and trustworthiness are increasingly considered not as psychological variables, but as institutional resources that determine the ability of integration regimes to stability [67, 68]. Procedural fairness and transparency of political processes are more important for public support than the final results of policies [69]. An example is the practice of the European Union on the protection of personal data. The General Data Protection Regulation (GDPR) has become not only a legal act, but also a symbol of a new culture of trust [22].

The digitalization of governance has raised the question of "algorithmic reputation" — trust in decisions made by automated systems. In response to the challenges, the concept of "dignified algorithmics" has emerged, where the criteria are explainability, the absence of discriminatory effects and the preservation of user autonomy [70, 71]. The European Guidelines on the Ethics of Artificial Intelligence (AI HLEG, 2019)

outline the framework for the responsible use of algorithms in the social sphere [10]. Regulatory "sandboxes" in the Kingdom of Denmark and the Kingdom of the Netherlands have become examples of how innovation and the protection of civil rights can be combined.

Behavioral approaches have proven that people make decisions in ways that are not predicted by classical rational choice models [72]. Choice architectures that use the "nudge" effect are actively used by state institutions. However, in integration processes, the key criterion is not only efficiency, but also dignity — whether the citizen retains freedom of choice, or whether its decision is actually determined by a hidden design [73]. Thus, the concept of dignity impact assessment arises, which involves a mandatory analysis of whether the autonomy of the subject is preserved in the conditions of institutional interventions [74].

Integration processes require adaptability, and here the importance of "experimentalist governance" [75] increases. It assumes that institutions have the right to make mistakes, provided that the mistake becomes a learning resource. Regular policy review cycles, real-time monitoring and public feedback mechanisms form an ethic of transparency and shared responsibility. "Green" standards in global supply chains are a vivid example of how the principles of adaptive governance strengthen integration practices.

Citizens' assemblies, mini-publics, participatory budgets are institutions that give integration processes the character of co-construction [76, 77]. Dignity ethics here manifests itself in recognizing the voice of each participant as legitimate, regardless of its social status. An example is the Irish citizens' assemblies, which have proven that political decisions become sustainable if they go through horizontal practices of co-creation [78].

The uniqueness of the Ukrainian experience lies in the combination of digital solutions and principles of dignity. ProZorro has become a symbol of transparency in public procurement, where algorithms work not for manipulation, but for openness of processes [79, 80]. The platform "Diia" in wartime turned out to be not just a tool for providing services, but a service of subjectivity: it supports the citizen as an active participant in public life, even in crisis conditions [81, 82].

The COVID-19 pandemic has shown that crises are the litmus test for public governance [83, 84]. Inequality in access to resources, the complexity of coordination, and different cultural models of trust have determined how successful the policies of individual states have been. Issues of burden sharing and ethical legitimacy of restrictions have gained central importance, turning the pandemic into a laboratory for testing the viability of a culture of dignity.

Governance ethics is impossible without special competencies. A modern manager must master not only analytical but also affective skills: metareflection, the ability to regulate emotions and practice ethical application of behavioral insights [65, 66]. The policy-lab concept in combination with ethics-lab offers a new model of training civil servants, where technical and ethical skills are integrated.

Neuroscience confirms: trust has a biological dimension. Studies of the role of oxytocin in the formation of prosocial strategies prove that emotional patterns directly affect economic cooperativeness [85, 86]. This sets the task for management to create conditions that stimulate empathy and social cooperation, avoiding the reduction of citizens to "biobehavioral objects" [87]. Dignity ethics requires explicability even in the field of neuropolitics.

Integration processes can remain the mechanics of contracts or become practices of coexistence. It is the culture of dignity that determines whether it is possible to overcome the limitations of cognitive biases and transform political and economic structures into spaces of trust. This is not only a survival strategy, but also a chance to build global communities based on mutual respect and the subjectivity of each [88].

4.6 CONCLUSIONS. CULTURE OF DIGNITY AS A STRATEGY FOR THE FUTURE

In the 21st century, integration ceases to be an exclusively economic or political task. It increasingly takes on the character of a deep fusion of consciousnesses, collective perceptions and cultural practices. The culture of dignity, which opposes itself to technocratic and utilitarian models of governance, opens up the possibility of shaping integration processes not as a balance of interests, but as coexistence — a joint deployment of potentials in a space of trust and mutual recognition [53, 89]. In this sense, public administration appears as a laboratory of the future. It either reproduces old algorithms of control and competition, or becomes a field for institutional innovation, where the ethics of dignity sets new architectonics of interaction [90, 91]. Unlike the instrumental approach, which reduces a person to a "rational agent", the culture of dignity brings multidimensional subjectivity back to the center of attention - with its emotions, historical memory, cultural identity.

It is important to emphasize that cognitive biases and affective reactions do not disappear in large integration processes, but it is the culture of dignity that allows to neutralize their destructive effect. It creates an environment where biases are not displaced, but "melted" into common practices of mutual understanding [92, 93]. Such melting is possible only through educational and institutional mechanisms that form managers with developed empathy and the ability to think not in terms of benefit, but in categories of coexistence.

Modern neuroscience confirms this thesis. Studies demonstrate that trust is not only culturally symbolic, but also biologically fixed in nature. In the processes of social interaction, neural networks associated with empathy and social prediction are activated [94]. Neurochemical mechanisms, in particular the role of oxytocin, form a kind of "emotional glue" of coexistence [95]. Moreover, experiments in neuroeconomics show that even in high-level negotiations, brain mechanisms of trust determine readiness for long-term unions [96]. Thus, the culture of dignity receives additional legitimation. It is based not only on philosophical intuition, but also on the biological and psychological foundations of coexistence. For Ukraine, which is at the epicenter of integration processes with Europe, the culture of dignity also has a civilizational dimension. In the works of M. Popovych, it appears as a strategy of modernity, where the memory of identity is combined with openness to global values [56]. And in the works of O. Zabuzhko, another, existential truth is articulated. Culture is the field of memory's struggle with amnesia, and therefore the place where trust in oneself becomes a condition for trust in the world [49]. In this combination — of philosophical reflection and cultural experience — lies a clue on how to move from the logic of survival to the logic of coexistence.

Thus, the conclusion is obvious. The strategy of the future consists in shifting the emphasis from instrumental management to a culture of dignity. It proposes architectonics where ethics becomes not an external regulator, but an internal "muscle" of integration processes. Only then will integration go beyond economic agreements and become a true union of consciousnesses.

The originality of this study lies in the fact that the culture of dignity is understood not only as a normative ideal or ethical imperative, but as a multidimensional strategy of integration, which has philosophical, psychological and neuroscientific foundations.

While previous studies have mostly focused on the economic or political aspects of integration processes [90, 99], the proposed approach combines the analysis of collective memory [98], affective regulation [97] and neural mechanisms of trust [94, 95]. Such an interdisciplinary lens allows to move from the discourse of survival to the discourse of coexistence and to show that integration is primarily a project of cultural and psychological transformation of humanity. In this sense, the work offers not only an academic, but also a civilizational contribution to the understanding of the ethics of public administration and the future of global interaction.

USE OF ARTIFICIAL INTELLIGENCE

The authors confirm that during the preparation of the manuscript, artificial intelligence tools were used exclusively within the limits of permitted operations that did not affect the scientific novelty or results of the research.

In the process of preparing the manuscript, AI tools were used — ChatGPT, GPT-5-mini, OpenAI.

AI tools were used to support reader convenience, style, text structuring and source search, which were checked and confirmed by the authors.

The authors carried out a full check of all materials obtained with the AI participation by: comparing each fragment with primary sources and current scientific literature; manually clarifying terms, definitions and content in accordance with the research methodology; verifying statistical data, facts, international examples and regulatory references; ensuring compliance with academic standards, research logic and requirements of the target publication.

All citations, references, statistical results and theoretical positions have been checked by the authors, edited and academically supplemented.

The AI use did not affect the scientific argumentation, results and conclusions.

The authors confirm that all scientific data and research results are exclusively original, created by the authors, and AI tools were used as an auxiliary editorial and technical tool.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest regarding this study, including financial, personal, authorship or other nature, which could affect the study and its results presented in this article.

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5 PRODUCTION CLUSTER IN THE AGRO-INDUSTRIAL COMPLEX AS A FACTOR IN ENSURING FOOD SECURITY

ABSTRACT

The research focuses on the functioning of grain product cluster enterprises. The study addressed the growth rate and operational characteristics of grain product cluster enterprises.

Sustainable development of Kazakhstan's economic sectors and sectors requires the exploration and implementation of new, more efficient forms of production and business activities. Given the current complex socio-economic conditions in agricultural production, the grain product cluster is becoming one of the most in-demand sectors in the agro-industrial sector. Therefore, a priority area of national policy is to increase production volumes both to fully meet domestic demand and to increase exports. This approach requires the unification of efforts by all agricultural sector entities, coordination of activities, and a focus on achieving high end results.

One of the triggers for solving this problem is the integration of commodity producers, which allows for the unification of all links in the production cycle in the technological chain "raw material production – finished product production" within a single complex. A study of domestic and international experience shows that integrated entities such as grain product clusters achieve high levels of efficiency and competitiveness. The development of grain product cluster models and mechanisms, the modernization of agricultural and processing industries, and the selection of methods and tools that enhance agribusiness's responsiveness to innovative development require appropriate theoretical and methodological support, taking into account the specifics of production in each industry. Practical experience shows that, despite the intensification of integration processes in grain product clusters, inefficiencies and the disintegration of a number of such formations are occurring. This is largely due to the fact that, under the new economic conditions, the traditional mechanism of the grain product cluster in Kazakhstan's agro-industrial complex does not allow for the systematic implementation of large-scale innovation processes, limiting itself to minor (local) changes.

Successful implementation of projects to form and develop grain product clusters requires in-depth study, generalization, and systematization of the experience of using such a mechanism by both national and foreign companies that have achieved high results in this area. Currently, the grain product cluster remains in its early stages of development, largely due to the specific high-risk characteristics of its industries.

KEYWORDS

Assessment methodology, growth rate, integral indicator, optimization model, trends, development, food security, strategy, socio-economic status, influence, efficiency, grain, trend, trigger, function, location, result.

The special role of grain in the agricultural sector's commercial output is determined by its strategic importance as a staple food and a crucial — and for some livestock sectors, a crucial — feed component. Furthermore, the Republic of Kazakhstan, due to its inherent natural and other characteristics, has become a major grain producer. In the context of economic transformation, maintaining grain production and ensuring the rational use of its development potential is largely determined by the functioning of the grain product cluster.

Grain production in the republic has always been one of the most important characteristics of the country's economic independence and prosperity. This highly valuable commodity is strategic in nature, which determines significant state interest in grain production; on the other hand, it is the foundation for the development of the grain product cluster in the agricultural sector.

The key feature of the grain product cluster's functioning is the specific nature and purpose of the goods it processes, namely grain and grain products, and their high share in the national food consumption structure. Bread and grain products, as a vital and irreplaceable commodity, enjoy guaranteed demand from the population. They satisfy approximately a third of the population's daily food needs, up to 50% of the daily protein requirement, 30 to 50% of the required energy, up to 50–60% of B vitamins, and up to 80% of vitamin E. Moreover, grain protein, with its high nutritional value, is significantly cheaper than animal protein, which, to a certain extent, helps to combine the issues of quantity and quality into a single whole. Grain production is a special element of the grain product sub-complex. Grain crops occupy approximately half of the area under agricultural crops and decisively determine the level and pace of development not only of farming but of agricultural production as a whole. As the largest branch of agriculture, grain production forms the basis of the country's food supply and serves as the raw material base for the development of flour and cereal milling, feed milling, starch production, alcohol production, brewing, and other industries. Grain production is largely responsible for the employment of a significant portion of the population, as well as the sectoral, regional, and national economic efficiency of the agricultural sector [1].

Along with the social significance of grain as a valuable, essential, and everyday food product for the population, as well as the basis for livestock production, the financial aspect is also of considerable importance. Grain is one of the most reliable sources of income for commodity producers, giving them relative independence in the reproduction process. The strategic importance of grain in the country's food supply is also determined by significant export reserves, which can become a significant source of foreign exchange revenue for the national budget (**Table 5.1**).

The discrepancy between per capita grain production and consumption across the country, as well as the local nature of production of certain types of grain, necessitate the transportation of grain from one region to another. A key feature of grain, distinguishing it from other agricultural products, is its high transportability and suitability for long-term storage, allowing for the rapid implementation of long-distance interregional grain shipments.

In determining the principles of formation and operation of a grain product cluster, a methodological approach is adopted that views the cluster as a complex system of market relations through which the production structure spontaneously adapts to the volume and structure of social needs, distributing production factors among various industries [2]. Alternatively, a cluster can be conceptualized as a collection

of markets of various types, interconnected by a common goal — ensuring the normal functioning of the reproduction process in the region. Thus, a grain product cluster is a geographically distinct, complex economic system comprising a set of commodity relations and connections between its entities, which include rural producers, enterprises and organizations involved in the storage, processing, and drying of grain, and its processing, as well as infrastructure facilities that facilitate the accelerated flow of materials, financial resources, and information.

Table 5.1 Grain requirements for the production of processed products

Name	Potential capacity of enterprises, tons	Domestic demand, tons	Required amount of grain for potential processing, tons	Required amount of grain for domestic consumption, tons	Required area for potential production, thousand hectares
Flour	5,139,550	1,800,000	7,342,214	2,580,000	6,440
Compound feed	2,418,750	2,665,700	2,845,588	3,136,117	2,496
Cereals	503,337	337,400	1,198,421	1,997,368	1,051
Alcohol, thousand dal	30,189	3,719	928,892	114,418	814
Total	–	–	12,315,115	7,827,903	10,801

The study examined the works of the following authors on assessing the effectiveness of grain product clusters: M. R. Hagerty [3], L. Kaufman, P. J. Rousseeuw [4], T. Hastie [5].

An analysis of the methods showed that the most probabilistic assessment model is possible using a non-stationary time series with a mathematical model that allows for the assessment of grain cluster development trends and its key characteristics. For this purpose, an algorithm was developed that applies the theoretical principles of modeling two-parameter monotonic functions. The created program automates the process of finding empirical approximating functions for the trend. The described algorithm uses the least-squares method and a theorem based on the general property of linear dependence of parameters in a class of functions. This program is capable of approximating trends not only for linear functions but also for nonlinear ones (e.g., quadratic, logarithmic, hyperbolic, exponential, and others).

This method for determining an empirical approximating function in the class of monotone two-parameter functions is more efficient than other methods, requiring less execution time.

A time series is a set of observations measured over specified temporal or spatial intervals and arranged chronologically. Examples of such series include annual demand for a commodity, weekly prices for a commodity, food production, etc. Different economists and statisticians define time series using different terms. Some of the definitions are given below:

– W. N. van Wieringen [6] describes a time series as a set of quantitative data arranged in the order of their occurrence;

— H. Morris [7] defines a time series as a set of statistical observations arranged chronologically;

— K. D. Patterson [8] considers a time series to be statistical data collected, recorded, or observed in successive increments;

— C. Y. Chen et al. [9] characterize a time series as a set of quantities relating to different periods of time or to variables such as steel production, per capita income, gross national product, tobacco prices, or the industrial production index;

— C. H. Meyers [10] defines a time series as a sequence of repeated measurements of a variable, made periodically over time;

— W. Z. Hirsch [11] describes a time series as a sequence of values of the same variable corresponding to successive points in time;

— S. Spiegel [12] defines a time series as a set of observations made at a specific time, usually at equal time intervals.

In time series analysis, special attention is paid to identifying patterns in their dynamics over a long period. The goal of statistics is to provide a characterization of changes in statistical indicators over time. How does a country's gross national product and national income change from year to year? What are the trends in increasing or decreasing unemployment and wages? Are there significant fluctuations in grain yields, and can a trend toward their increase be identified? These questions can only be answered using specialized statistical methods designed to analyze development and change over time, or, as is customary in statistics, to study dynamics. Studying patterns of change over time is a complex and labor-intensive research process, as any phenomenon under study is influenced by numerous factors acting in various directions.

In statistical analysis of dynamics, it is necessary to clearly distinguish between two main elements — trend and variability — in order to provide a quantitative characterization of each using specific indicators.

To construct a classical mathematical model of a time series, its components must be analyzed. These components include the trend or tendency, periodic fluctuations, and random fluctuations. In other words, this can be symbolically described as follows

$$y_t = f(T, P, E),$$

where y_t represents the level of the time series, i.e., the value of a specific indicator at time t; T denotes the trend or tendency that determines the underlying dynamics of the series over a significant time interval; P represents periodic fluctuations that exhibit a similar pattern of development over specific periods of time, associated with seasons. In other words, these are deviations from the mean that occur periodically and are characterized by seasonality; E denotes random fluctuations, which represent deviations from the mean of the series at specific points in time and are caused by external factors.

Obviously, not all time series have the same set of components. For example, the stationary series mentioned earlier in the introduction is described as follows

$$y_t = \underline{y} + E.$$

In other words, the time series depends on the mean value of the level, i.e., the mathematical expectation $\underline{y}$, which remains unchanged and is constant over the entire time interval. Furthermore, the series depends on random fluctuations or a random component, which can be expressed as $E = y_t - \underline{y}$.

However, most time series are characterized by non-stationarity and can be described as follows

$$y_t = f(t) + E,$$

where the function $f(t) = T$ represents a time dependence describing the patterns of changes in the levels of the time series over the entire time interval under consideration; in other words, it is a trend. In contrast, E represents random fluctuations [13].

Functions describing a trend can be divided into two groups:

1. The first group includes monotonic functions and functions that do not exhibit limiting growth. In other words, these functions continue to grow over time.

2. The second group, in contrast, exhibits limiting growth, or in other words, reaches a saturation level.

To more accurately identify the type of function describing a trend, the following preparatory steps are carried out:

1. Identifying the type of time series to determine its components. An assessment is made of whether the time series is stationary, consisting only of random fluctuations and a mean, or non-stationary with a trend or periodicity, or both.

2. Given that periodic and random fluctuations are not considered, excess noise is removed using smoothing methods.

To determine the trend of stationarity or non-stationarity in a time series, methods for identifying the type of time series are used.

The following methods are used to achieve this goal.

Before selecting a model for a time series trend, it is important to establish the presence of a trend in the series. If a time series follows a trend, the levels of the series are correlated with each other, meaning that each subsequent level depends on the previous one. This relationship between the values of the series is known as the autocorrelation of the series levels. The following formula is used to measure the degree of autocorrelation

$$r_{y_t - y_{t-\tau}} = \frac{\underline{y_t y_{t-\tau}} - \underline{y_t}\,\underline{y_{t-\tau}}}{\sigma_{y_t}\sigma_{y_{t-\tau}}},$$

where

$$\underline{y_t y_{t-\tau}} = \frac{\sum_{t=\tau+1}^{n} y_t y_{t-\tau}}{n-\tau},$$

$$\underline{y_t} = \frac{\sum_{t=\tau+1}^{n} y_t}{n-\tau},$$

$$\underline{y_{t-\tau}} = \frac{\sum_{t=\tau+1}^{n} y_{t-\tau}}{n-\tau}.$$

τ is the magnitude of the time shift and takes values as natural numbers. For $\tau = 1$, the first-order autocorrelation coefficient is calculated, $\tau = 2$ the second, and so on. This coefficient is between -1 and +1, and the closer it is to them, the more pronounced the correlation is. Thus, if the time series has a trend, the absolute value of the first-order coefficient will be close to one. Whereas for a stationary time series with small fluctuations in levels, this coefficient will be close to zero. For further shifts $\tau = 2, 3,...$, the periodicity of the time series is studied, namely, the period of oscillations, which is equal to the shift at which the coefficient is closest to ±1. For example, a monotonically increasing or decreasing time series will have a positive correlation coefficient close to one; however, the greater the magnitude of the shift, the further it will move away from one [14]. Thus, if the time series has a trend, the absolute value of the first-order autocorrelation coefficient will be close to one.

5.1 DEVELOPMENT TRENDS AND ANALYSIS OF THE GRAIN PRODUCT CLUSTER

The regional grain product cluster is based on its territorial isolation and close ties between enterprises from various industries within the cluster, including those involved in the production of the final product. Participants in the regional grain product cluster include: agricultural enterprises; agricultural machinery enterprises; food processing enterprises; integrated agro-industrial complexes (corporations); consulting organizations; research institutes; educational institutions; government agencies; and financial institutions. The cluster core may include enterprises specializing in grain production, storage, and processing, around which infrastructure organizations are concentrated. The regional cluster was formed in three stages: the preliminary stage, during which the clustering potential is determined and a program for implementing cluster projects is developed; the main stage involves activating clustering processes in the region and determining the composition of participants in cluster schemes; and the final stage involves assessing the cluster's performance based on indicators characterizing economic development [15]. Cluster development as a tool for enhancing regional competitiveness and innovative economic development is a new approach to the country's regional development. The objectives of the Kazakhstan cluster initiative are to create conditions for maximizing Kazakhstan's competitive advantages in developing the non-resource sector of the economy by engaging private businesses in the industry.

The main grain producer in the Republic of Kazakhstan is the northern region: Akmola, Kostanay, and North Kazakhstan regions, which account for approximately 66% of the country's gross harvest.

The total area under grain crops is shown in **Table 5.2**.

Table 5.2 Dynamics of grain crop area in the Republic of Kazakhstan, 2020–2024, thousand hectares

Crop Name	2020	2021	2022	2023	2024	Specific gravity, 2024, %
Wheat	11,354.4	11,296.6	12,057.1	12,719.4	12,810.6	81.4
Barley	2,517.0	2,976.8	2,728.8	2,157.5	2,175.6	13.8
Buckwheat	95.8	67.5	55.1	87.1	119.9	0.8
Grain corn	150.1	156.3	162.8	188.7	188.4	1.2
Rye	21.5	21.2	23.9	43.9	34.3	0.2
Oats	235.2	243.5	228.9	202	197.9	1.3
Millet	43.4	50.9	50.5	38.2	37.4	0.2
Sorghum (dzhugara)	3	8.3	7.8	9	17.4	0.1
Corn mixture	86.4	91.8	85.9	69.6	61.3	0.4
Triticale	1.5	0.8	1.6	5.6	6.3	0.04
Rice	101.5	102.0	102.3	99.6	87.9	0.6
Total grains	14,609.8	15,015.7	15,504.7	15,620.6	15,737	100

Source: Office for National Statistics [16, 17]

Analyzing **Table 5.2**, the dynamics of sown areas of grain crops in the republic of Kazakhstan, wheat in 2018 amounted to 11,354.4 thousand hectares, and in 2022 it increased to 12,810.6 thousand hectares, which is an increase of 81.4% of the share, also showed an increase in grain crops buckwheat from 95.8 thousand hectares to 119.9 thousand hectares, grain corn 150.1 thousand hectares to 188.4 thousand hectares, rye 21.5 thousand hectares to 34.3 thousand hectares, sorghum (dzhugara) 3 thousand hectares to 17.4 thousand hectares, triticale 1.5 thousand hectares to 6.3 thousand hectares.

The area sown to barley decreased from 2,517,000 hectares in 2018 to 2,175,600 hectares in 2018, accounting for 13.8% of the total. Oats, millet, mixed cereals, and rice also saw their area sown to decrease by 0.6% to 1.3%.

In 2024, wheat will account for the largest share of grain sown area across all farm categories in the the Republic of Kazakhstan (81.4%), followed by barley (13.8%), followed by other crops, which range from 0.1% to 1.3%.

Fig. 5.1 shows the share of grain crop area across all farm categories. In 2022, wheat (81.4%) accounted for the largest share of grain sown area across all farm categories in the republic, followed by barley (13.8%), followed by other crops, which ranged from 0.1% to 1.3%. **Table 5.3** shows the dynamics of grain crops by farm category.

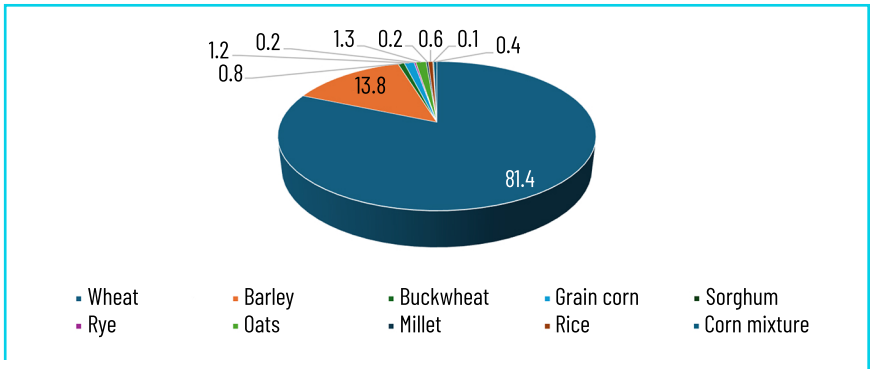

Fig. 5.1 Proportion of grain crop acreage in all farm categories in the republic of Kazakhstan in 2024, %

Table 5.3 Dynamics of grain crop acreage by farm category in the Republic of Kazakhstan, 2020–2024, thousand hectares

Category of farms	2020	2021	2022	2023	2024	2024/2020, %	2024/2023, %
1	2	3	4	5	6	7	8
Wheat							
All categories of farms	11,354.4	11,296.6	12,057.1	12,719.4	12,810.6	112.8	100.7
Agricultural enterprises	7,685.1	7,516.6	7,998.9	8,443.8	8,525.7	110.9	101.0
Individual entrepreneurs and peasant (farm) households	3,669.3	3,780.1	4,058.1	4,275.6	4,284.8	116.8	100.2
Barley							
All categories of farms	2,517.0	2,976.8	2,728.8	2,157.5	2,175.6	86.4	100.8
Agricultural enterprises	1,330.7	1,632.4	1,463.7	1,100.3	1,141.9	85.8	103.8
Individual entrepreneurs and peasant (farm) households	1,186.3	1,344.4	1,265.1	1,057.2	1,033.7	87.1	97.8
Buckwheat							
All categories of farms	95.8	67.5	55.1	87.1	119.9	125.2	137.7
Agricultural enterprises	38.7	24.9	26.9	47.2	61.5	158.9	130.3
Individual entrepreneurs and peasant (farm) households	57.1	42.6	28.2	39.9	58.4	102.3	146.4
Grain corn							
All categories of farms	150.1	156.3	162.8	188.7	188.4	125.5	99.8

Continuation of Table 5.3

1	2	3	4	5	6	7	8
Agricultural enterprises	30.4	36.3	35.7	54.6	60.5	199.0	110.8
Individual entrepreneurs and peasant (farm) households	113.8	114.7	122	128.9	122.9	108.0	95.3
Households of the population	5.9	5.3	5.2	5.2	5	84.7	96.2
Rye							
All categories of farms	21.5	21.2	23.9	43.9	34.3	159.5	78.1
Agricultural enterprises	7.6	7.1	10.1	25.3	22.9	301.3	90.5
Individual entrepreneurs and peasant (farm) households	13.9	14.1	13.8	18.5	11.3	81.3	61.1
Oats							
All categories of farms	235.2	243.5	228.9	202	197.9	84.1	98.0
Agricultural enterprises	152.5	161.7	151.3	134.6	128.8	84.5	95.7
Individual entrepreneurs and peasant (farm) households	82.7	81.7	77.4	67.4	69.1	83.6	102.5
Households of the population	–	0.1	0.2	–	–	–	–
Millet							
All categories of farms	43.4	50.9	50.5	38.2	37.4	86.2	97.9
Agricultural enterprises	20.0	22.4	26.5	18.0	18.3	91.5	101.7
Individual entrepreneurs and peasant (farm) households	22.8	28.1	23.5	19.8	18.5	81.1	93.4
Households of the population	0.6	0.4	0.5	0.4	0.6	100.0	150.0
Sorghum (dzhugara)							
All categories of farms	3	8.3	7.8	9	17.4	580.0	193.3
Agricultural enterprises	1.9	3.1	3.5	4.5	10.8	568.4	240.0
Individual entrepreneurs and peasant (farm) households	1.1	5.1	4.3	4.5	6.6	600.0	146.7
Corn mixture							
All categories of farms	86.4	91.8	85.9	69.6	61.3	70.9	88.1
Agricultural enterprises	53.3	61.5	57	43.1	46.9	88.0	108.8

Continuation of Table 5.3

1	2	3	4	5	6	7	8
Individual entrepreneurs and peasant (farm) households	33.1	30.3	28.9	26.5	14.4	43.5	54.3
Triticale (wheat-rye hybrid)							
All categories of farms	1.5	0.8	1.6	5.6	6.3	420.0	112.5
Agricultural enterprises	1.5	0.6	1.3	4.2	6.3	420.0	150.0
Individual entrepreneurs and peasant (farm) households	–	0.2	0.3	1.4	–	–	0.0
Rice							
All categories of farms	101.5	102.0	102.3	99.6	87.9	86.6	88.3
Agricultural enterprises	55.5	49.6	48.4	46	42.7	76.9	92.8
Individual entrepreneurs and peasant (farm) households	46	52.3	53.9	50.6	45.2	98.3	89.3
Total grains	14,609.8	15,015.7	15,504.7	15,620.6	15,737	–	–

Source: Bureau of National Statistics [16, 17]

As **Table 5.3** shows, the country's sown area is increasing, driven by rising investment and domestic market demand. A total of 128 million tenge in loans have been issued to 15 farms for spring sowing through JSC Agrarian Credit Corporation. An increase in the area under oilseed, forage, vegetable, and melon crops, as well as social crops such as buckwheat and sugar beet, is planned. At the same time, the area under monocultures and moisture-intensive crops such as wheat, rice, and cotton will be reduced. Furthermore, 97 investment projects in agricultural crops are planned. **Table 5.4** shows the sown area by region.

Table 5.4 Grain crop sown area by region in the Republic of Kazakhstan, 2024, thousand hectares

Region	Wheat	Barley	Buckwheat	Grain corn	Rye	Oats	Millet
1	2	3	4	5	6	7	8
Republic of Kazakhstan	12,810.6	2,175.7	119.9	188.4	34.3	197.9	37.4
Abay	257.4	50.3	3.0	4.2	4.4	4.5	–
Akmola	4,024.8	483.0	1.3	0.9	0.6	49.1	2.2
Aktobe	276.6	73.9	–	1.1	2.4	0.9	3.8

Continuation of Table 5.4

1	2	3	4	5	6	7	8
Almaty	38.9	83.2	–	50.2	0.3	1.3	–
Atyrau	–	0.0	–	–	–	0.2	–
West Kazakhstan	133.2	49.1	0.1	–	8.4	1.4	3.7
Zhambyl	153.9	211.7	–	18.5	–	–	0.4
Zhetysu	100.3	160.7	1.8	44.6	–	1.3	1.1
Karaganda	744.3	142.1	–	0.2	0.3	16.9	0.2
Kostanay	3,518.4	281.6	15.6	11.6	8.8	50.8	7.6
Kyzylorda	11.1	0.3	–	0.7	–	0.0	0.6
Pavlodar	693.4	118.7	75.7	3.8	2.8	25.4	14.4
North Kazakhstan	2,421.1	401.9	8.7	5.0	3.1	37.7	0.1
Turkestan	215.2	48.3	–	45.1	0	–	0.9
Ulytau	20.9	10.3	–	–	–	0.1	–
East Kazakhstan	189.1	59.7	13.7	2.6	3.1	8.2	2.4
Astana city	1.6	–	–	–	–	–	–
Almaty city	–	–	–	–	–	–	–
Shymkent city	10.4	0.9	–	0.1	–	–	–

Source: National Statistics Bureau [16, 17]

Next, let's examine grain production in the republic (**Table 5.5**).

Table 5.5 Grain production dynamics in the Republic of Kazakhstan, 2020–2024, thousand tons

Crop Name	2020	2021	2022	2023	2024	2024 /2020, %	2024 /2023, %
1	2	3	4	5	6	7	8
Wheat	13,944.1	11,451.7	14,258.0	11,814.1	16,404.5	138.9	75.5
Barley	3,971.2	3,830.1	3,659.3	2,366.8	3,287.2	138.9	15.1
Buckwheat	82.7	45.0	40.1	78.0	89.8	115.1	0.4
Grain corn	862.1	896	958.1	1,129.5	1,098	97.2	5.1
Rye	22.5	23.2	29.8	39.8	59.8	150.3	0.3
Oats	336.1	267.0	240.2	182.3	229.1	125.7	1.1

Continuation of Table 5.5

1	2	3	4	5	6	7	8
Millet	40.2	42.6	39.9	35.8	37.2	103.9	0.2
Sorghum (dzhugara)	2.3	6.6	4.2	4.5	18.6	413.3	0.1
Corn mixture	117.1	107.6	96.0	57.6	58.5	101.6	0.3
Triticale	2.0	1.6	2.7	3.9	8.2	210.3	0.0
Rice	482.9	560.7	556.8	503.8	431.4	85.6	2.0
Total grains	15,892.0	13,402.0	16,225.8	12,719.8	21,722.3	134.0	100

Table 5.5 shows the dynamics of grain production in the Republic of Kazakhstan by gross harvest. In 2024, the gross grain harvest increased by 34% compared to 2023, reaching 21,722.3 thousand tons, including wheat and barley — by 38.9% (16,404 thousand tons and 3,287.2 thousand tons), buckwheat — by 15.1% (89.8 thousand tons), rye — by 1.5 times (59.8 thousand tons), oats — by 25.7% (229.1 thousand tons), millet — by 3.9% (37.2 thousand tons), sorghum (dzhugara) by 4.1 times (18.6 thousand tons), corn mixture — by 1.6% (58.5 thousand tons), triticale — by 2.1 times (8.2 thousand tons), grain corn decreased — by 2.8% (1,098 thousand tons), rice — by 14.4% (431.4 thousand tons).

Wheat also occupies the largest share in the production of grain crops, 75.5% of the total volume of grain crops, then barley — 15.1%, grain corn — 5.1%, other grain crops vary from 0.1 to 2% (**Fig. 5.2**).

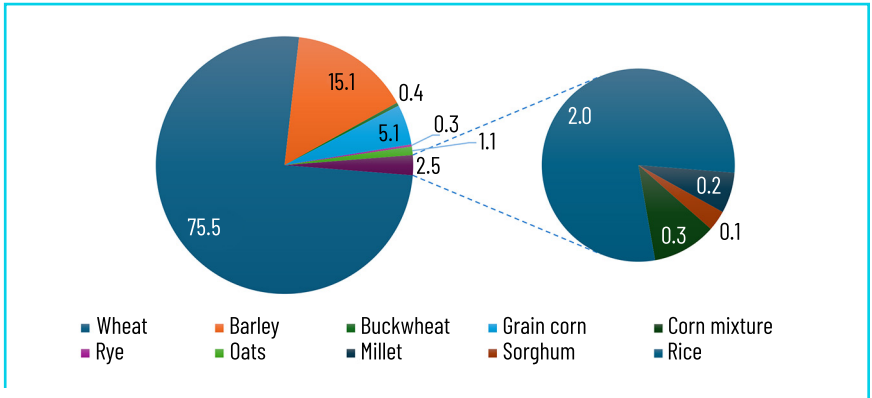

Fig. 5.2 Share of grain production in the republic of Kazakhstan in 2024, %

The gross wheat harvest in the country in 2024 increased by 17.6% compared to 2020 and 2021, and by 38.9% compared to 2023 (**Table 5.6**).

Table 5.6 Gross wheat harvest dynamics in all farm categories by region of the Republic of Kazakhstan for 2020–2024, thousand tons

Region	2020	2021	2022	2023	2024	2024 /2020, %	2024 /2023, %	Specific gravity, 2024, %
Akmola	3,994.8	3,293.6	4,127.6	3,355.0	4,616.3	115.6	137.6	28.1
Kostanay	3,923.6	2,330.6	3,455.0	2,587.3	4,809.2	122.6	185.9	29.3
North Kazakhstan	2,988.3	2,874.3	3,299.8	2,802.6	3,546.6	118.7	126.5	21.6

Note: compiled by the author based on data [16, 17]

Gross grain harvests generally meet the country's domestic needs and provide export potential. At the current stage of development of the country's grain product cluster, it is important to consider various organizational and economic factors to ensure consistent technological processes are not disrupted during grain production, processing, and sales, to avoid significant product losses, and ultimately to meet consumer demand.

At the same time, economic relations between enterprises should be based solely on mutually beneficial terms, excluding any elements of dictatorship by either the state or monopolistic enterprises consuming agricultural products and producing material and technical resources. As in any reproductive process, the full grain production cycle concludes with post-harvest processing, procurement, storage, and processing. Improving grain quality and, consequently, revenue from its sale, requires producers to complete a full range of technological operations within a short timeframe: cleaning, drying, correctly forming commercial batches of grain according to quality characteristics and varietal composition, and storing it for subsequent sale.

5.2 OPTIMIZATION MODEL OF GRAIN PRODUCTION

In today's agricultural economic environment, improving the economic efficiency and competitiveness of grain production is a crucial component of the successful functioning of the grain industry. The development of grain production creates an objective economic environment for improving the allocation of crop acreage, creating sustainable preconditions for increasing grain production volumes.

An analysis of the grain cluster's performance in the agro-industrial complex revealed that, in recent years, the development of grain production has not met the requirements of a rational organization of agricultural production. It is worth noting that, despite some positive trends that emerged in 2020–2024, the achieved level of grain production efficiency does not allow the grain product cluster to conduct expanded reproduction. In the grain production of most of the enterprises under consideration, the structure of grain crop acreage does not meet the requirements for the development of a rational farming system.

It goes without saying that improving the economic efficiency of grain production is impossible without the creation of a real mechanism to ensure the sustainable and balanced development of the grain product cluster [18]. Changes in the size of the grain industry inevitably lead to variations not only in individual crop and livestock sectors, but also in the entire sectoral structure of clusters as a whole. The vast majority of farms in the region do not produce only one type of agricultural product and can rationally combine the production of various crop and livestock products. And, of course, within the framework of the ongoing research in the grain product cluster, while adhering to scientifically sound agricultural practices, it is not possible to limit ourselves to the cultivation of grain and leguminous crops alone.

The most important factor determining the positive development of the grain product cluster is the formation of an optimal sectoral structure [19]. A rational sectoral structure represents a balanced relationship between the crop and livestock sectors that allows for the most complete and efficient use of available resources and the achievement of maximum economic benefits.

Global and domestic experience demonstrates that determining the optimal structure of the crop and livestock sectors is most effectively achieved using modeling methods. Modeling the industry structure helps grain-producing farms with limited production resources achieve increased grain production efficiency with minimal labor and cost expenditure.

Optimizing the parameters of agro-industrial complex sectors contributes to the effectiveness of management decisions aimed at increasing the gross output of grain farming, and also optimizes profit margins and profitability, which, in turn, positively impacts the social conditions of rural development [20].

Optimization of the industry structure of the grain product cluster is driven by the fact that the actual combination of individual parameters of crop production sectors and, accordingly, the production structure of grain, legumes, and forage crops, as well as the nutritional value of feed, directly determines the development of livestock sectors [21].

The following objectives were set during the model calculations:

1. Statistical processing of actual data on the components of the grain product cluster of the agro-industrial complex.

2. Approximation of a functional relationship smoothing the actual data.

The tasks are solved using probabilistic statistical research methods. This includes:

— describing changes in actual data through constructing a time series;

— obtaining an analytical form of two-parameter nonlinear regressions reflecting the main characteristics of the change dynamics;

— constructing statistical estimates of the validity of the dynamic relationship;

— testing hypotheses for the adequacy of the regression model of dynamics.

This approach allows for a more accurate assessment of the trends and development potential of the grain product cluster, which, in turn, can be used to develop effective development strategies for this sector [22]. **Table 5.7** contains a selection of the most significant indicators for assessing the production of material and technical resources.

As can be seen from **Table 5.7**, the maximum changes during the analyzed period occurred with the production of mowers, including mowers mounted on a tractor, not included in other groups. Their number

increased 311 times in 2024 compared to 2015. But it is not possible to use this indicator, as well as the number of crawler tractors, in further calculations, since in some periods there is no data on them, and this will not allow building high-quality forecast models. Growth is also observed in all other indicators. For example, the number of agricultural and forestry tractors increased by 467 units, or 1.37 times, and grain harvesters — by 402 units, or 2.56 times.

Table 5.7 Production of material and technical resources for the grain product cluster in the Republic of Kazakhstan in 2015–2024

Indicator	Years, *i*									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Tractors for agriculture and forestry, pieces, $x_1(i)$	1,256	1,448	1,362	1,209	1,227	941	292	350	1,047	2,398
Seeders, planters and seedling machines, units, $x_2(i)$	152	170	206	206	6	19	185	236	223	197
Mowers, including mowers mounted on a tractor, not included in other groups, pieces, $x_3(i)$	–	15	–	1	24	93	69	155	238	383
Row harvesters, pieces, $x_4(i)$	278	342	221	286	356	297	401	457	512	1,078
Combine harvesters, pieces, $x_5(i)$	258	565	524	491	489	544	210	303	395	924
Crawler tractors, units, $x_6(i)$	3	4	6	–	1	–	–	–	–	–

Source: Bureau of National Statistics [16, 17]

Let's present the characteristics of changes in the indicators of the production of material and technical resources for the grain product sub-complex, expressed by the formula

$$\hat{x}_k(i) = \frac{100 x_k(i+1)}{x_k(i) + x_k(i+1)}, \quad (5.1)$$

where $x_k(i)$ and $x_k(i+1)$ — indicators of i and $i+1$ consecutive years when:
$x_1(i)$ — production quantity of agricultural and forestry tractors;
$x_2(i)$ — production quantity of seeders, planters and seedling machines;

$x_3(i)$ — production quantity of mowers, including mowers mounted on a tractor, not included in other groups;
$x_4(i)$ — production quantity of row headers;
$x_5(i)$ — quantity of production of grain harvesters.

According to (5.1), the dynamics of changes in the indicators of the production of material and technical resources for the grain product sub-complex can be presented in the form of **Tables 5.8** and **5.9**.

Table 5.8 Dynamics of changes in the production of material and technical resources for the grain product sub-complex in the Republic of Kazakhstan in 2016–2024

Years, *i*	2016	2017	2018	2019	2020	2021	2022	2023	2024
$x_1(i)$	53.55	48.47	47.02	50.37	43.40	23.68	54.52	74.95	69.61
$x_2(i)$	52.80	54.79	50.00	2.83	76.00	90.69	56.06	48.58	46.90
$x_3(i)$	No data	No data	No data	96.00	79.49	42.59	69.20	60.56	61.67
$x_4(i)$	55.16	39.25	56.41	55.45	45.48	57.45	53.26	52.84	67.80
$x_5(i)$	68.65	48.12	48.37	49.90	52.66	27.85	59.06	56.59	70.05

Source: Bureau of National Statistics [16, 17]

Table 5.9 Grain production and grain processing products in the Republic of Kazakhstan in 2014–2024, thousands of tons

Years, *i*	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Grain production, $y(i)$	12,864.8	18,231.1	17,162.2	18,673.7	20,634.4	20,585.1	20,273.7	17,428.6	20,065.3	16,375.9
Production of ego processing products	4,163.1	4,073.9	4,093.7	3,955.9	4,205.5	4,129.2	4,032.1	3,533.9	3,642.0	3,588.0

Source: Bureau of National Statistics [16, 17]

The materials of **Table 5.9** show that grain production in the Republic of Kazakhstan fluctuated greatly. Thus, in 2018, growth was noted — by 5366.3 thousand tons, or 1.42 times. In 2017 — a decrease, in 2018 — growth, which lasted for the next two years, then again a decrease, etc. If to compare grain production in 2024, then its volume was 16,375.9 thousand tons, which is 10,584.6 less than in 2015, or 1.65 times. The 2024 indicator ranks second from the bottom after 2015 in terms of the lowest volumes of grain production in the Republic of Kazakhstan for 2015–2024. The indicator of grain processing production also fluctuates in the analyzed period, but not so significantly. Its minimum volumes were recorded in 2022 — 3,533.9 thousand tons, and the maximum in 2019 — 4,205.5, which is 671.6 thousand tons less, or 1.19 times.

Let's present the characteristics of changes in grain production indicators, expressed by the formula

$$\hat{y}(i) = \frac{100y(i+1)}{y(i)+y(i+1)}, \tag{5.2}$$

where $y(i)$ and $y(i+1)$ – indicators of i and $i+1$ consecutive years.

According to (5.2), the dynamics of changes in grain production indicators can be presented in the form of **Table 5.10**.

Table 5.10 Dynamics of changes in the production of material and technical resources for the grain product subcomplex in the Republic of Kazakhstan in 2016–2024

Years, *i*	2016	2017	2018	2019	2020	2021	2022	2023	2024
$\hat{y}(i)$	58.63	48.49	52.11	52.49	49.94	49.62	46.23	53.52	44.94

Thus, **Table 5.10** received processed statistical data describing the dynamics of changes in the production of material and technical resources for the grain product cluster in the Republic of Kazakhstan in 2016–2024.

The purpose of this stage is the analysis of paired regression dependencies of changes in grain production indicators $\hat{y}(i+1)$ of the $(i+1)$-th year, that is, changes in the indicators $\hat{x}_k(i)$ of material and technical resources for the grain product cluster of the i-th year, constructed according to the algorithm.

5.3 REGRESSION ANALYSIS OF THE DEPENDENCE OF GRAIN PRODUCTION INDICATORS ON TRACTOR PRODUCTION INDICATORS

Thus, the regression dependence of the change $f_1(i+1)$ in grain production on the change $\hat{x}_1(i)$ in the production of tractors for agriculture and forestry has the following form

$$f_1(i+1) = \frac{\hat{x}_1^2(i)}{0.02\hat{x}_1^2(i)+0.06}. \tag{5.3}$$

Differentiating the empirical function $f_1(i+1)$ on $\hat{x}_1(i)$, it is possible to obtain the elasticity coefficient

$$K_e = \frac{\partial f_1(i+1)}{f_1(i+1)\partial\hat{x}_1(i)}\hat{x}_1(i) = \frac{0.12}{0.02\hat{x}_1^2(i)+0.06}.$$

Based on the statistical data $\hat{x}_1(i)$ of **Table 5.2**, the elasticity coefficient K_e takes values less than 1. Therefore, if $\hat{x}_1(i)$ changes by 1%, $f_1(i+1)$ will change by less than 1%.

It is possible to present the data of **Table 5.2** in the form of a variation series. The graphical representation of the regression dependence can be presented in the form of **Fig. 5.3**.

From **Fig. 5.3** it follows that a 15-percent increase in the production of agricultural and forestry tractors contributes to the growth of grain production.

The coefficient of correlation and analytical values of paired regression is –0.0018, which indicates the fact of non-correlation. Non-correlation is explained by the absence of linear dependence. At the same time, the error relative to the method of averages is 0.238, that is, there are insignificant differences between the actual data and the values determined by formula (5.3).

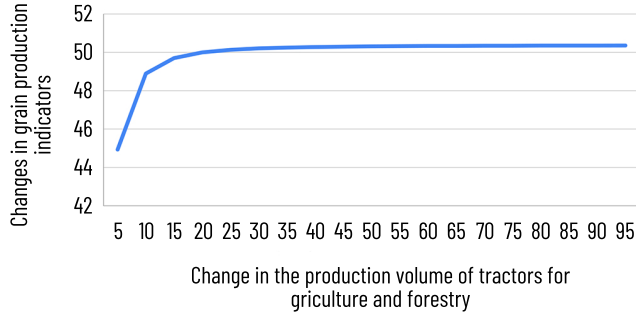

Fig. 5.3 Regression dependence of change in $f_1(i+1)$ of grain production on change $\hat{x}_1(i)$ in agricultural tractor production

Let's consider the differences $d_1(i)$ between the empirical values of $f_1(i+1)$, calculated according to formula (5.3), and actual grain production data $\hat{y}(i)$

$$d_1(i) = f_1(i) - \hat{y}(i),$$

presented in **Table 5.11**.

Table 5.11 Comparison of empirical values of $f_1(i)$ and actual grain production data

Years, *i*	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
$f_1(i)$	50.32	50.31	50.31	50.32	50.29	50.11	50.32	50.35	50.34
$\hat{y}(i)$	58.63	48.49	52.11	52.49	49.94	49.62	46.23	53.52	44.94
$d_1(i)$	–8.31	1.82	–1.80	–2.18	0.35	0.49	4.10	–3.17	5.41

To test the hypothesis for the adequacy of the proposed model, it is possible to assume that the difference $d_1(i)$ is a random variable obeying a Gaussian distribution with a mean of $\mu = -0.37$ and a standard deviation of $\sigma = 4.12$.

In other words, the probability that, for any indicator $\hat{x}_1(i)$, the probability of deviation of the empirical values of $f_1(i)$, calculated according to formula (5.3), from the actual grain production data $\hat{y}(i)$, is determined by the formula

$$P(d_1) = 1 - erf\left(\frac{-0.37 + d_1}{4.12}\right) + erf\left(\frac{-0.37 - d_1}{4.12}\right).$$

In a study based on Pearson's χ^2, due to the fact that the critical region for this statistic is right-sided: $[K_{kp}; +\infty)$, where the boundary value

$$K_{kp} = \chi^2(k - r - 1; \alpha).$$

According to the χ^2 distribution tables and the values of σ, $k = 5$, $r = 2$ (parameters μ and σ are estimated from the sample), this corresponds to $K_{kp}(0.05; 2) = 5.95$ for a significance level of $\alpha = 0.05$. Due to the fact that

$$K_{obs} = 0.123 < K_{kp}(0.05; 2),$$

this confirms the adequacy of the hypothesis for applying the proposed model.

5.4 REGRESSION ANALYSIS OF THE RELATIONSHIP BETWEEN GRAIN PRODUCTION INDICATORS AND THE PRODUCTION OF TRANSPLANTING EQUIPMENT

The regression relationship between the change in $f_2(i+1)$ of grain production and the change $\hat{x}_2(i)$ in the production of seeders, planters, and transplanting machines is as follows

$$f_2(i+1) = \sqrt{\frac{\hat{x}_2(i)}{0.003\hat{x}_2(i) - 0.0008}}. \quad (5.4)$$

Differentiating with respect to the empirical function $f_2(i+1)$, it is possible to obtain the elasticity coefficient

$$K_e = \frac{\partial f_2(i+1)}{f_2(i+1)\partial \hat{x}_2(i)}\hat{x}_2(i) = \frac{44.44(0.003\hat{x}_2(i) - 0.0008)}{\left(\hat{x}_1(i) - 0.27\right)^2}.$$

Based on statistical data $\hat{x}_2(i)$, the elasticity coefficient K_e takes values less than 1. Therefore, for a 1% change in $\hat{x}_2(i)$, $f_2(i+1)$ will change by less than 1%.

By representing the data $\hat{x}_2(i)$ as a variation series, a graphical representation of the regression relationship can be shown in **Fig. 5.4**.

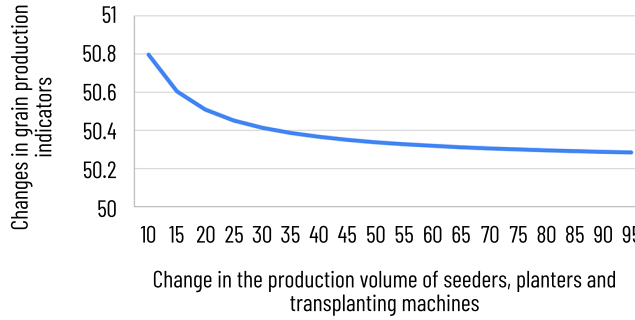

Fig. 5.4 Regression dependence of change in $f_2(i+1)$ in grain production on change $\hat{x}_2(i)$ in production of seeders, planters, and transplanters

From **Fig. 5.4**, it follows that changes in the production of seeders, planters, and transplanters do not contribute to growth in grain production.

The correlation coefficient and analytical values of the paired regression are -0.503, indicating a lack of correlation. This lack of correlation is explained by the lack of a linear relationship. Moreover, the error relative to the mean method is 0.373, indicating minor discrepancies between the actual data and the values determined by formula (5.4).

Let's consider the differences $d_2(i)$ between the empirical values of $f_2(i)$, calculated according to formula (5.3), and the actual grain production data $\hat{y}(i)$

$$d_2(i) = f_2(i) - \hat{y}(i),$$

presented in **Table 5.12**.

Table 5.12 Comparison of empirical values of $f_2(i)$ and actual grain production data

Years, *i*	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
$f_2(i)$	50.33	50.33	50.34	52.34	50.30	50.29	50.33	50.34	50.35
$\hat{y}(i)$	58.63	48.49	52.11	52.49	49.94	49.62	46.23	53.52	44.94
$d_2(i)$	-8.30	1.84	-1.77	-0.16	0.36	0.67	4.10	-3.18	5.41

To test the hypothesis for the adequacy of the proposed model, it is possible to assume that the difference $d_2(i)$ is a random variable obeying a Gaussian distribution with a mean of $\mu = -0.11$ and a standard deviation of $\sigma = 4.06$.

In other words, the probability that, for any indicator $\hat{x}_2(i)$, the probability of deviation of the empirical values of $f_2(i)$, calculated according to formula (5.4), from the actual grain production data $\hat{y}(i)$ is determined by the formula

$$P(d_2) = 1 - erf\left(\frac{-0.11 + d_2}{4.06}\right) + erf\left(\frac{-0.11 - d_2}{4.06}\right).$$

In a study based on Pearson's χ^2, due to the fact that the critical region for this statistic is right-sided: $[K_{kp}; +\infty)$, where the boundary value

$$K_{kp} = \chi^2(k - r - 1; \alpha).$$

According to the χ^2 distribution tables and the values of σ, $k = 5$, $r = 2$ (parameters μ and σ are estimated from the sample), this corresponds to $K_{kp}(0.05;2) = 5.95$ for a significance level of $\alpha = 0.05$. Due to the fact that

$$K_{obs} = 0.117 < K_{kp}(0.05;2),$$

this confirms the adequacy of the hypothesis for applying the proposed model.

5.5 REGRESSION ANALYSIS OF THE DEPENDENCE OF GRAIN PRODUCTION INDICATORS ON CHANGES IN MOWER PRODUCTION

The regression dependence of the change in $f_3(i+1)$ in grain production on the change in mower production, including tractor-mounted mowers not included in other groupings, is as follows

$$f_3(i+1) = \sqrt{\frac{1}{0.002\hat{x}_3(i) + 0.004}}. \quad (5.5)$$

Differentiating the empirical function $f_3(i+1)$ with respect to $\hat{x}_3(i)$, it is possible to obtain the elasticity coefficient

$$K_e = \frac{\partial f_3(i+1)}{f_3(i+1)\partial \hat{x}_2(i)} \hat{x}_3(i).$$

Based on statistical data $\hat{x}_3(i)$, the elasticity coefficient K_e takes values less than 1. Therefore, with a 1% change in $\hat{x}_3(i)$, $f_3(i+1)$ will change by less than 1%.

By representing the data $\hat{x}_3(i)$ as a variation series, a graphical representation of the regression dependence can be shown in **Fig. 5.5**.

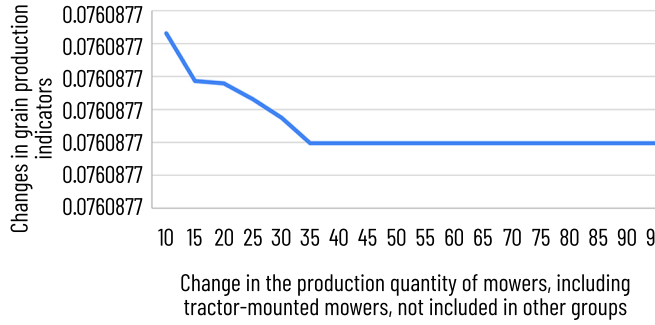

Fig. 5.5 Regression dependence of change in $f_3(i+1)$ of grain production on change $\hat{x}_3(i)$ in mower production, including tractor-mounted mowers not included in other groupings

Fig. 5.5 shows that the change in mower production, including tractor-mounted mowers not included in other groupings, is 0.603.

The correlation coefficient and analytical values of the paired regression are 0.603, indicating a lack of correlation. This lack of correlation is explained by the lack of a linear relationship. Moreover, the margin of error relative to the mean method is 1.88, indicating significant discrepancies between the actual data and the values determined by formula (5.5), which are explained by the small sample size of the observed indicator.

Let's consider the differences $d_3(i)$ between the empirical values of $f_3(i)$, calculated according to formula (5.3), and the actual grain production data $\hat{y}(i)$

$$d_3(i) = f_3(i) - \hat{y}(i),$$

presented in **Table 5.13**.

Table 5.13 Comparison of empirical values of $f_3(i)$ and actual grain production data

Years, *i*	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
$f_3(i)$	47.65	47.65	47.65	47.65	47.65	47.65
$\hat{y}(i)$	52.49	49.94	49.62	46.23	53.52	44.94
$d_3(i)$	-4.85	-2.29	-1.97	1.42	-5.87	2.71

To test the hypothesis for the adequacy of the proposed model, it is possible to assume that the difference $d_3(i)$ is a random variable obeying a Gaussian distribution with a mean of $\mu = -1.81$ and a standard deviation of $\sigma = 3.37$.

In other words, the probability that, for any indicator $\hat{x}_3(i)$, the probability of deviation of the empirical values of $f_3(i)$, calculated according to formula (5.5), from the actual grain production data $\hat{y}(i)$ is determined by the formula

$$P(d_3) = 1 - erf\left(\frac{-0.81 + d_3}{3.37}\right) + erf\left(\frac{-0.81 - d_3}{3.37}\right).$$

In a study based on Pearson's χ^2, due to the fact that the critical region for this statistic is right-sided: $[K_{kp}; +\infty)$, where the boundary value

$$K_{kp} = \chi^2(k - r - 1; \alpha).$$

According to the χ^2 distribution tables and the values of σ, $k = 5$, $r = 2$ (parameters μ and σ are estimated from the sample), this corresponds to $K_{kp}(0.05; 2) = 5.95$ for a significance level of $\alpha = 0.05$. Due to the fact that

$$K_{obs} = 0.551 < K_{kp}(0.05; 2),$$

this confirms the adequacy of the hypothesis for applying the proposed model.

5.6 REGRESSION ANALYSIS OF THE DEPENDENCE OF CHANGES IN GRAIN PRODUCTION INDICATORS ON CHANGES IN ROW HEADER PRODUCTION INDICATORS

The regression dependence of changes in $f_4(i+1)$ in grain production on changes in $\hat{x}_4(i)$ of row header production is as follows

$$f_4(i+1) = \sqrt{\frac{1}{0.002\hat{x}_4(i) + 0.004}}. \quad (5.6)$$

Differentiating the empirical function $f_4(i+1)$ with respect to $\hat{x}_4(i)$, it is possible to obtain the elasticity coefficient

$$K_e = \frac{\partial f_4(i+1)}{f_4(i+1)\partial \hat{x}_4(i)} \hat{x}_4(i).$$

Based on statistical data $\hat{x}_4(i)$, the elasticity coefficient K_e takes values less than 1. Therefore, with a change in $\hat{x}_4(i)$ by 1%, $f_4(i+1)$ will change by less than 1%.

By representing the data $\hat{x}_4(i)$ as a variation series, a graphical representation of the regression dependence can be shown in **Fig. 5.6**.

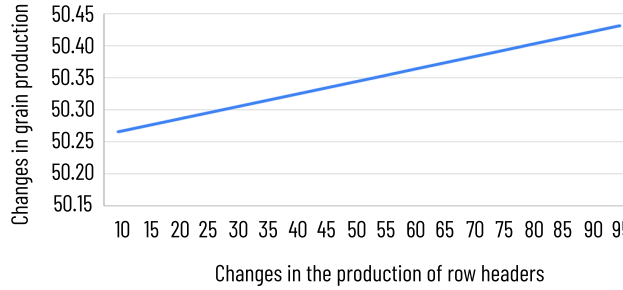

Fig. 5.6 Regression dependence of change in $f_4(i+1)$ of grain production on change $\hat{x}_4(i)$ in row header production

The correlation coefficient and analytical values of the paired regression are 0.11, indicating a lack of correlation. This lack of correlation is explained by the lack of a linear relationship. Moreover, the error relative to the average method is 1.29, indicating minor discrepancies between the actual data and the values determined by formula (5.6).

Let's consider the differences $d_4(i)$ between the empirical values of $f_4(i)$, calculated according to formula (5.6), and the actual grain production data $\hat{y}(i)$

$$d_4(i) = f_4(i) - \hat{y}(i),$$

presented in **Table 5.14**.

Table 5.14 Comparison of empirical values of $f_4(i)$ and actual grain production data

Years, *i*	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
$f_4(i)$	50.14	50.17	50.14	50.14	50.16	50.14	50.14	50.14	50.12
$\hat{y}(i)$	58.63	48.49	52.11	52.49	49.94	49.62	46.23	53.52	44.94
$d_4(i)$	-8.49	1.68	-1.97	-2.35	0.22	0.52	3.92	-3.37	5.18

To test the hypothesis for the adequacy of the proposed model, it is possible to assume that the difference $d_4(i)$ is a random variable obeying a Gaussian distribution with a mean of $\mu = -0.52$ and a standard deviation of $\sigma = 4.12$.

In other words, the probability that, for any indicator $\hat{x}_4(i)$, the probability of deviation of the empirical values of $f_4(i)$, calculated according to formula (5.6), from the actual grain production data $\hat{y}(i)$ is determined by the formula

$$P\left(\left|d\right| > d_0\right) = 1 - erf\left(\frac{-0.52 + d_0}{4.12}\right) + erf\left(\frac{-0.52 - d_0}{4.12}\right).$$

When studying using the Pearson criterion, due to the fact that the critical region for this statistic is right-sided: $[K_{kp}; +\infty)$, where the boundary value

$$K_{kp} = \chi^2(k - r - 1; \alpha).$$

According to the χ^2 distribution tables and the values of σ, $k = 5$, $r = 2$ (parameters μ and σ are estimated from the sample), this corresponds to $K_{kp}(0.05;2) = 5.95$ for a significance level of $\alpha = 0.05$. Due to the fact that

$$K_{obs} = 0.134 < K_{kp}(0.05;2),$$

this confirms the adequacy of the hypothesis for applying the proposed model.

5.7 REGRESSION ANALYSIS OF THE DEPENDENCE OF CHANGES IN GRAIN PRODUCTION INDICATORS ON CHANGES IN COMBINE HARVESTER PRODUCTION INDICATORS

The regression dependence of changes in $f_5(i+1)$ in grain production on changes in $\hat{x}_5(i)$ of combine harvester production is as follows

$$\hat{y}(i+1) = \sqrt{\frac{1}{0.002\hat{x}_4(i) + 0.004}}. \tag{5.7}$$

Differentiating with respect to the empirical function $f_5(i+1)$, it is possible to obtain the elasticity coefficient

$$K_e = \frac{\partial f_5(i+1)}{f_5(i+1)\partial \hat{x}_5(i)}\hat{x}_5(i).$$

Based on statistical data $\hat{x}_5(i)$, the elasticity coefficient K_e takes values less than 1. Therefore, with a 1% change in $\hat{x}_5(i)$, $f_5(i+1)$ will change by less than 1%.

By representing the data $\hat{x}_5(i)$ as a variation series, a graphical representation of the regression dependence can be shown in **Fig. 5.7**.

The correlation coefficient and analytical values of the paired regression are 0.11, indicating a lack of correlation. This lack of correlation is explained by the lack of a linear relationship. Moreover, the error relative to the average method is 0.308, indicating minor discrepancies between the actual data and the values determined by formula (5.6).

Let's consider the differences $d_5(i)$ between the empirical values of $f_5(i)$, calculated according to formula (5.7), and the actual grain production data $\hat{y}(i)$

$$d_5(i) = f_5(i) - \hat{y}(i),$$

presented in **Table 5.15**.

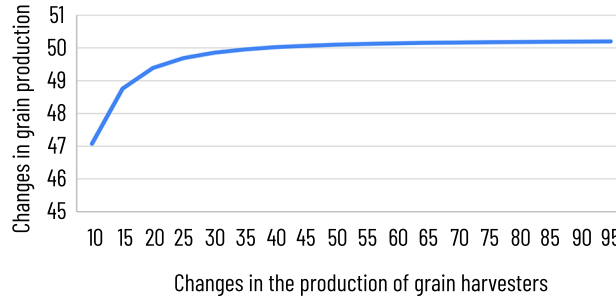

Fig. 5.7 Regression dependence of change in $f_5(i+1)$ of grain production on change in $\hat{x}_5(i)$ of combine harvester production

Table 5.15 Comparison of empirical values of $f_5(i)$ and actual grain production data

Years, *i*	2016	2017	2018	2019	2020	2021	2022	2023	2024
$f_5(i)$	50.17	50.09	50.09	50.10	50.11	49.80	50.14	50.13	50.17
$\hat{y}(i)$	58.63	48.49	52.11	52.49	49.94	49.62	46.23	53.52	44.94
$d_5(i)$	-8.46	1.60	-2.02	-2.39	0.17	0.18	3.91	-3.39	5.23

To test the hypothesis for the adequacy of the proposed model, it is possible to assume that the difference $d_5(i)$ is a random variable obeying a Gaussian distribution with a mean of $\mu = -0.57$ and a standard deviation of $\sigma = 4.11$.

In other words, the probability that, for any indicator $\hat{x}_5(i)$, the probability of deviation of the empirical values of $f_5(i)$, calculated according to formula (5.7), from the actual grain production data $\hat{y}(i)$ is determined by the formula

$$P(d_5) = 1 - erf\left(\frac{-0.57 + d_5}{4.11}\right) + erf\left(\frac{-0.57 - d_5}{4.11}\right).$$

In a study based on the Pearson criterion, due to the fact that the critical region for this statistic is right-sided: $[K_{kp}; +\infty)$, where the boundary value

$$K_{kp} = \chi^2(k - r - 1; \alpha).$$

According to the χ^2 distribution tables and the values of σ, $k = 5$, $r = 2$ (parameters μ and σ are estimated from the sample), this corresponds to $K_{kp}(0.05; 2) = 5.95$ for a significance level of $\alpha = 0.05$. Due to the fact that

$$K_{obs} = 0.138 < K_{kp}(0.05; 2),$$

this confirms the adequacy of the hypothesis for applying the proposed model.

The obtained research results are based on analytical functions (5.3)–(5.7), representing paired nonlinear regressions of the dependencies of changes in grain production indicators on changes in indicators of material and technical resources for the grain products subcomplex in the Republic of Kazakhstan. Consequently, functions (5.3)–(5.7) determine trends and thereby determine a set of forecasts for changes in grain production. The presented methodological approach, which allows for the selection of the best approximating function from a class of monotonic two-parameter functions. The value of each of these functions at a point corresponding to the generalized average over argument x, according to economic and mathematical modeling for processing observation results, are united by a common property characterizing the logic of their combination to solve the problem.

Due to the combined influence of five indicators of material and technical resources:

— production of tractors for agriculture and forestry;

— production of seeders, planters, and transplanters;

— the production volume of mowers, including tractor-mounted mowers, not included in other groupings;

— the production volume of row reapers;

— the production volume of combine harvesters.

As a result, it is possible to obtain the $d_1(i)$, $d_2(i)$, $d_3(i)$, $d_4(i)$, $d_5(i)$ between the empirical values of $f_1(i)$, $f_2(i)$, $f_3(i)$, $f_4(i)$, $f_5(i)$, calculated according to formulas (5.3)–(5.7), and the actual grain production data $\hat{y}(i)$, presented in **Table 5.16**.

Table 5.16 Differences between the empirical values calculated according to formulas (5.3)–(5.7) and the actual grain production data

Years, *i*	2016	2017	2018	2019	2020	2021	2022	2023	2024
$d_1(i)$	–8.31	1.82	–1.80	–2.18	0.35	0.49	4.10	–3.17	5.41
$d_2(i)$	–8.30	1.84	–1.77	–0.16	0.36	0.67	4.10	–3.18	5.41
$d_3(i)$	–	–	–	–4.85	–2.29	–1.97	1.42	–5.87	2.71
$d_4(i)$	–8.49	1.68	–1.97	–2.35	0.22	0.52	3.92	–3.37	5.18
$d_5(i)$	–8.46	1.60	–2.02	–2.39	0.17	0.18	3.91	–3.39	5.23

In the next step, to further refine the problem under study, it is proposed using forecasting tools. For this purpose, sixty-three graphs were created using Excel (for twenty-one indicators in three forecast scenarios: optimistic, probabilistic, and pessimistic). **Table 5.17** derives the equations for five indicators characterizing the performance of the grain product subcomplex, demonstrating the highest quality of forecast values (i.e., having the highest R^2 approximation coefficient).

Table 5.17 Forecast of changes in selected indicators of the performance of the grain product subcomplex in the Republic of Kazakhstan until 2026

Forecast variant	Equation	Year				2026 to 2023, %
		2023	2024	2025	2026	
1	2	3	4	5	6	7
Row reapers, pieces						
Optimistic	$y = 4.2663x^2 + 2.3132x + 236.12$	795	890.3	952.1	1,013.5	127.5
Probability	$y = 3.3108x^2 + 12.056x + 218.76$		826.9	888.7	950.4	119.5
Pessimistic	$y = 2.3562x^2 + 21.963x + 200.78$		770.8	832.6	882.3	111.0
Production of grain processing products, thousand tons						
Optimistic	$y = -1.6957x^2 - 29.492x + 4231.3$	3,588	3,665.2	3,610.2	3,555.7	99.1
Probability	$y = -2.7316x^2 - 18.788x + 4212$		3,604.1	3,544.3	3,484.6	97.1
Pessimistic	$y = -3.4089x^2 - 12.034x + 4200.2$		3,550.7	3,496.8	3,442.5	95.9
Other industrial uses of grain, thousand tons						
Optimistic	$y = 4.711x^2 + 85.951x + 621.64$	2,053.8	2,380.2	2,526.3	2,672.1	130.1
Probability	$y = 2.4842x^2 + 108.66x + 581.15$		2,232.9	2,378.8	2,524.8	122.9
Pessimistic	$y = 0.2462x^2 + 131.51x + 540.4$		2,085.8	2,230.7	2,376.5	115.7

Continuation of Table 5.17

1	2	3	4	5	6	7
Granaries, units						
Optimistic	$y = 1.1241x^2 + 32.823x + 3726.1$	4,219	4,300.2	4,346.3	4,392.4	104.1
Probability	$y = 0.3716x^2 + 40.499x + 3712.4$		4,250.4	4,296.5	4,342.6	102.9
Pessimistic	$y = -0.2592x^2 + 46.82x + 3701.4$		4,202.5	4,252.7	4,302.9	102.0
Transportation by road, thousands of tons						
Optimistic	$y = 5.789x^2 - 158.54x + 1804.9$	1,081.6	747.2	671.6	596.0	55.1
Probability	$y = 4.5809x^2 - 146.17x + 1782.7$		670.0	592.6	515.1	47.6
Pessimistic	$y = 1813.1e\text{-}0.09x$		594.5	513.2	431.9	39.9
Potential personal consumption of grain by the population, thousands of tons						
Optimistic	$y = 0.0511x^2 + 3.9524x + 308.72$	353.2	366.2	370.3	374.4	106.0
Probability	$y = -0.0362x^2 + 4.8375x + 307.15$		360.1	364.4	368.7	104.4
Pessimistic	$y = -0.0877x^2 + 5.3532x + 306.25$		355.7	361.7	365.1	103.4

Based on the three forecast scenarios, the maximum growth is expected for other industrial grain use, at 130.1%. Even under the pessimistic forecast, this growth will be 115.7% in 2026 compared to 2023.

Overall, four indicators in **Table 5.16** show growth. The second-largest change is in the number of row headers, at 127.5% under the optimistic forecast. The largest decrease in the forecast value is for grain transportation by road, at 39.9% under the pessimistic forecast.

Fig. 5.8 and **5.9** show forecast graphs for the number of grain storage facilities and other industrial grain use. These indicators have the highest R^2 approximation coefficient. Thus, for the number of grain storage facilities in the Republic of Kazakhstan through 2026, R^2 has a maximum value under the optimistic forecast — 0.9838. Therefore, there is a high probability, approximately 98%, that this forecast will be realized. For other industrial uses of grain, R^2 also has a maximum value with an optimistic forecast — 0.9344, that is, with a 93% probability it will be realized.

For the remaining indicators in **Table 5.16**, the following forecasts will be fulfilled. For row harvesters and potential personal grain consumption, the optimistic forecast is expected, with an 84% and 85% probability of occurrence, respectively. For grain processing and road transportation, the pessimistic forecast is expected, with an 82% probability for both indicators. It is not possible to derive all sixty-three graphs used in this research paper due to space limitations.

However, it should be noted that for eleven of them, the approximation coefficient R^2 ranged from 0.9003 (the pessimistic forecast for other industrial grain use) to 0.9838 (the optimistic forecast for the number of grain storage facilities). R^2 is an indicator of forecast quality: the closer its value is to one, the higher the probability of fulfillment. For ten graphs, the approximation coefficient ranges from

0.8025 to 0.8702, and for nine, from 0.705 to 0.7932. This means that the reliability of the calculations for twenty-nine forecast scenarios ranges from 70 to 98%.

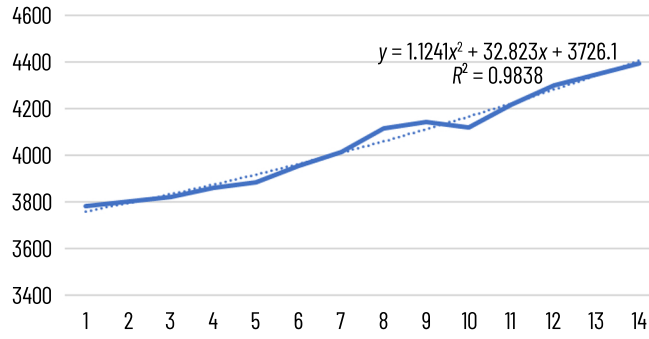

Fig. 5.8 Optimistic forecast for the number of grain storage facilities in the republic of Kazakhstan until 2026, units

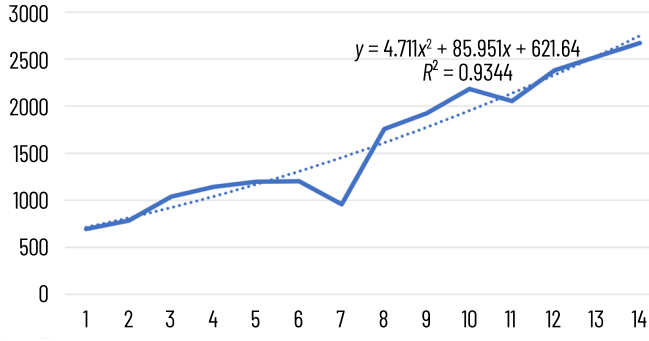

Fig. 5.9 Optimistic forecast for other industrial grain use in the republic of Kazakhstan until 2026, thousands of tons

The developed grain production optimization model, based on modern mathematical modeling technologies, represents an important and effective analytical method. Its advantage lies in its ability to provide a detailed and in-depth assessment of the grain product sector's performance, taking into account numerous key aspects.

This tool considers multiple components of the grain product cluster, such as:

1. Production of material and technical resources: assessing the availability of the necessary resources for the efficient operation of the entire system.

2. Grain cultivation and processing: analyzing the efficiency of grain production and processing processes, taking into account various needs, including food and technical ones.

3. Grain processing for various purposes: considering the diverse needs of grain processing, including its use in the food industry, technical processes, and feed production.

4. Storage systems: assessing the effectiveness of grain storage methods and systems that affect grain quality and availability.

5. Transportation: analyzing transport logistics and the efficiency of grain transportation from production sites to processing and sales points.

6. Sales processes: assessing strategies and methods for marketing grain and its processed products, including wholesale and retail sales.

The model not only provides a means of accurately assessing the current state of the grain product cluster but also has a powerful forecasting tool. This methodology not only provides a powerful means of accurately analyzing the current state of the grain product cluster but also has broad potential for forecasting future trends over various periods. Its versatility allows for its successful application across various industries and fields of activity, opening up new opportunities for additional research and analysis.

The efficient functioning of a grain product cluster is determined by the system of economic relations between its partners, through which the economic interests of enterprises are expressed.

The primary form of economic relations between producers, purchasers, and processors of agricultural products, as well as market participants involved in their sale and storage, is a business contract, which defines the mutual obligations of the parties during the performance of certain actions. Through this contract, agricultural enterprises regulate the volume of services provided and the mutual supply of materials, tariffs and prices for products and services, and determine penalties for violations of terms regarding volume, assortment, quality, and delivery times. Such relationships make it possible not only to avoid significant raw material losses and significantly reduce production and distribution costs, but also to improve the quality of the final product.

The complex problems of grain production in the Republic of Kazakhstan encompass the entire value chain. Addressing these interconnected issues requires the implementation of a range of measures and significant investment, which must be sustained over a long period. The effects of individual measures interact and should reinforce each other, ensuring increased efficiency in grain production. It is advisable to "switch on" self-organization mechanisms and actively utilize them. Therefore, to effectively implement a set of measures for grain production development, it is necessary to develop a Strategy in which the effects of previous measures are enhanced by the implementation of subsequent ones. In other words, a synergistic approach must be applied when developing such a Strategy.

The need to develop a Strategy is also driven by the following factors:

— the grain product cluster strives to produce only high-margin products, particularly wheat. Due to the spontaneous search for high-margin crops and imperfect industry regulation, overproduction of certain products occurs;

— the grain product cluster lacks the necessary methods and information to accurately determine the range and volume of agricultural crop production;

— state agricultural management bodies use ineffective forecasting and strategic marketing methods.

An important objective of state agricultural policy is to improve the quality and competitiveness of agricultural products and improve the well-being of rural residents.

The effective functioning of the grain product cluster is impossible without active government intervention. In the conditions of the functioning of a socially-oriented market economy, the possibility of state regulation is objectively determined by the nature of a mixed economy, which is characterized by a combination of competition, freedom of choice of buyer and seller with the need for the state to ensure equal "rules of the game" for all economic entities in the grain product cluster and social protection for the low-income part of the population.

Under these conditions, the development of economic relations in the grain product cluster is associated with the emergence of a number of contradictions:

— the desire of economic entities in the grain sector to achieve leadership positions, which leads to the replacement of perfect competition with monopoly, which is unacceptable in a market economy;

— the differentiation of economic actors, the ruin of some of them resulting from fierce competition, and the need for social protection for low-income groups;

— the limited regulatory impact of the market mechanism on the reproduction process, which fails to ensure environmental safety, the development of fundamental science, education, healthcare, etc.;

— the consolidation of capital for the development of scientific and technological progress, the implementation of its most significant achievements in the form of various innovations. The elimination of these contradictions cannot be achieved through market self-regulation. They require appropriate action from society, represented by the state.

Creating favorable conditions for the production and promotion of agricultural products on the market and providing after-sales service to customers contribute to increasing their competitiveness. It's clear that, given the same prices, the highest-quality product will be in greatest demand. Therefore, agro-industrial enterprises should pay significant attention to analyzing and assessing their competitiveness.

State support for the development of economic entities within the grain product cluster at the regional level serves two main functions: compensatory (reimbursement of a portion of acquisition and construction costs) and incentive (reimbursement of a portion of production costs).

Clusters are recognized as an important tool for promoting innovation, industrial development, competitiveness, and economic efficiency. The main goal of cluster support is to increase the competitiveness of cluster participants and the regional economies as a whole. The development of cluster initiatives in Kazakhstan can be divided into three stages. In the first stage, from 2006 to 2012, clusters were formed in priority economic sectors. In the second stage, from 2014 to 2020, territorial clusters were formed in the regions. As a cluster development operator, QazIndustry facilitated the consolidation of regional enterprise groups into territorial clusters to enhance the competitiveness of enterprises and their products.

Together with cluster participants, project pools were developed for further financing with the participation of both the state and the clusters. The third stage began in 2020 and is currently ongoing. This stage is characterized by the formation of a methodological and legal platform for the operation of territorial

clusters and the provision of state incentives. In June of this year, the Rules for the Competitive Selection of Territorial Clusters, as well as the Rules for the Formation and Maintenance of a Register of Territorial Clusters, were approved within the framework of the Law "On Industrial Policy". The rules provide for co-financing of the costs of joint projects by territorial cluster participants, with up to 50% of costs (up to 30,000 MCI) reimbursed by the state. Cluster policy participants are entitled to co-financing of up to 50% of costs (up to 3,000 MCI) to support the functioning of the cluster organization. Funding is also planned for the implementation of a project to modernize shared laboratories for testing and evaluating products from regional cluster participants (up to 40,000 MCI). QazIndustry regularly provides analytical, informational, consulting, and technical support to the pilot regional clusters.

CONCLUSIONS

A study of the grain product cluster in the Republic of Kazakhstan using mathematical modeling aims to provide a high-quality forecast to substantiate effective development scenarios. To determine a methodology for assessing the state of the grain product cluster, statistical processing of actual data on the components of the grain product cluster in the agro-industrial complex and approximation of a functional relationship smoothing the actual data were conducted. The tasks are solved using probabilistic statistical research methods. Of all existing methods, two-parameter regression modeling in economic research was selected. In general, two-parameter regression is a simple and effective tool for analyzing and evaluating economic data, which can be particularly useful in situations of limited resources.

The obtained research results are based on analytical functions representing paired nonlinear regressions of the relationships between changes in grain production indicators and changes in material and technical resource indicators for the grain product cluster in the Republic of Kazakhstan.

Consequently, the functions determine trends and, thereby, provide a set of forecasts for changes in grain production. The value of each of these at the point corresponding to the generalized average for argument x is determined using economic and mathematical modeling for processing observation results.

The developed grain production optimization model, based on modern mathematical modeling technologies, represents an important and effective analytical method. Its advantage lies in its ability to provide a detailed and in-depth assessment of the grain product sector's performance, taking into account numerous key aspects. The model not only accurately assesses the current state of the grain product cluster but also provides a powerful forecasting tool. Its versatility allows for the successful application of the method across various industries and fields of activity, opening up new opportunities for additional research and analysis.

In conclusion, it should be noted that in Address to the Nation "A Fair Kazakhstan: Law and Order, Economic Growth, and Social Optimism", the President of the Republic of Kazakhstan emphasized the need for systemic efforts to unlock the country's industrial potential. K.-J. Tokayev highlighted a list of 17 major projects compiled by the government, with a particular emphasis on the development of high-value added value. An important point is the maximum use of domestic raw materials and components, as well as the development of related industries around large enterprises.

The construction of a deep wheat processing plant in Kostanay is a large-scale undertaking, designed to process 415,000 tons of wheat per year. The project operator is Kostanay Grain Industry LLP. Completion is scheduled for 2027, and the total investment is 70 billion tenge. The plant will produce several types of products: lysine (40,000 tons per year), gluten (35,300 tons per year), bioethanol (60,000 tons per year), carbon dioxide (56,000 tons per year), feed vinasse (99,000 tons per year), and bran (28,000 tons per year). Upon completion of construction and reaching design capacity, 650 permanent jobs are planned to be created. Gluten, a high concentration of which is found in Kazakh grain, has a wide range of global applications in its pure form. The products are sold in Europe and the Americas. In addition to gluten, deep grain processing will yield glucose-fructose syrup, wheat starch, modified starch, and bran. This is a virtually waste-free process. The project concept has already been developed, technology and equipment suppliers have been identified, and negotiations are underway. The design and integration of the basic designs will be carried out with the participation of the Austrian company Vogelbusch. Process engineering is also actively underway with local and international equipment suppliers. A memorandum of cooperation has been signed between the KazFoodProducts group of companies, the Chinese company Myande Group, and the Akimat of the Kostanay region. This partnership strengthens the project's international ties and opens up opportunities for the application of advanced technologies at all stages of the plant's construction and operation.

USE OF ARTIFICIAL INTELLIGENCE

The author confirms that AI ChatGPT (GPT-3.5, GPT-4, GPT-5.x) was used exclusively for searching open sources or sources of the last 5 years for literature review.

The author conducted a full check of all materials obtained with the AI participation, by checking each fragment with primary sources and current scientific literature. All citations and references were checked by the author, edited and academically supplemented.

The use of AI tools did not affect the scientific results, empirical conclusions, statistical models and the author's research position.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest in this study, including financial, personal or any other that may affect the results described in this work.

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