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## Industry 4.0 technologies in agriculture productivity effects, value chain integration, and sustainability outcomes

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**Abstract.** The increasing volatility of energy markets and climate-related risks poses significant challenges to agricultural productivity and financial sustainability. In this context, the effective use of digital data and Industry 4.0 technologies has emerged as a strategic mechanism for enhancing operational efficiency and resilience in agricultural systems. The purpose of this study is to examine how digital maturity, supported by digital data integration, influences productivity, value chain integration, sustainability performance, and financial resilience under projected 2030 energy shock scenarios. The study employs a quantitative empirical approach combining Data Envelopment Analysis (DEA), Partial Least Squares Structural Equation Modeling (PLS-SEM), and scenario-based Monte Carlo simulation. Using simulated secondary data representing different levels of digital maturity, the research evaluates structural relationships and financial sensitivity to energy price shocks. The results demonstrate that digital data utilization significantly improves technical efficiency ( $\beta = 0.45, p < 0.001$ ) and value chain integration ( $\beta = 0.63, p < 0.001$ ), which together explain 52% of sustainability performance variance ( $R^2 = 0.52$ ). Scenario modeling confirms that digitally advanced enterprises exhibit lower NPV volatility and greater financial resilience under a +40% projected energy shock. ANOVA results ( $\eta^2 = 0.41$ ) indicate substantial differences across digital maturity levels. The findings provide both theoretical and practical contributions by

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- Journal:** *Innovation and Green Development*
- Article type:** Full Length Article
- Title:** METHODOLOGICAL ISSUES OF IMPLEMENTING STRUCTURAL CHANGES IN INDUSTRIAL SECTORS
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# METHODOLOGICAL ISSUES OF IMPLEMENTING STRUCTURAL CHANGES IN INDUSTRIAL SECTORS

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**Abstract.** This article discusses theoretical and methodological approaches to assessing the market position, financial and economic performance, and management efficiency of enterprises in the effective implementation of structural changes in industrial sectors, as well as ways to eliminate them.

**Keywords:** business cycle, structural changes, innovation, investment, debtors, creditors, empirical research, diversification, market capacity, capital, competition.

## ENTRANCE

The success of socio-economic reforms in economic sectors essentially depends on the effectiveness of structural changes taking place in the national economy. In scientific literature, various terms are used to describe the process of structural changes. For example, the concept of "structural changes" reflects the essence of the gradual (evolutionary) changes taking place.

The term structural change has entered the economic literature as a synonym for the English term "restructuring" and is used in the sense of structural reorganization or structural change. Since the process of structural change is a complex, multifaceted, and contradictory process, various approaches have been developed to clarify its essence, and today, there is no single and generally accepted definition that would clarify its essence.

According to the perspective aimed at elucidating the essence of structural changes, it is appropriate to view this process as a qualitatively fundamental change not only in the structure of the economy, but also in state intervention in the economy, the financial system, changes in the structure of demand, etc. In other words, according to this perspective, the processes that occurred in the developed countries of the world in the 1970s are considered [1].

## **REVIEW OF RELATED LITERATURE**

Structural changes in the economy are also described as a phase of a long economic cycle wave. Supporters of this view include the founder of the theory of long waves, N.D. Kondratev, as well as Yu.V.Yakovtsev and S.I.Glazev [2]. A complete renewal of the structure of the economy occurs due to long-term cycles, which include cycles of short duration. According to the theory of cyclical renewal of the structure of the economy, structural changes are explained by the transition to new technologies. Technological progress is introduced into the economy at the beginning of the cycle with innovations that lead to the emergence of new industries. In the middle of the cycle, these industries expand, and technological changes spread to traditional industries. At the end of the cycle, the previous technologies are completely replaced by new ones, and the process of structural changes comes to an end.

It should be noted that technological and sectoral structural transformation processes are possible only in the context of institutional change. The experience of the 20th century shows that even under the most favorable conditions, significant institutional change takes at least 30-40 years to occur.

The institutional conditions for implementing progressive structural changes in industrial production are: strengthening property rights, forming a legal framework for the development of intellectual property relations and innovative activities, forming an infrastructure that ensures an active innovation process, creating a favorable investment climate, and forming regular cooperation between the state and business.

It is appropriate to compare this idea with the current widespread theory of economic growth of R.Solow [3]. According to this theory, the long-term rate of economic growth depends not only on the productivity of labor and the amount of capital, but also on their joint productivity. In this case, if the amount of labor and capital used contributes to the increase in the output of the economy, then the productivity of these factors is a structural feature of the economy. Changes in this indicator determine the ability of the economy to develop; therefore, it can be considered the cause of structural changes in the economy. The magnitude of the productivity of labor and capital lies not in individual changes, but in long-term changes in the joint productivity of these factors [4]. As another classification of structural changes in the economy, it can be said that S. Kuznets was awarded the Nobel Prize "for his empirical substantiation of economic growth". In his opinion, the main goal of his empirical research is directly related to "the growth of the national product in the country - deep structural changes in the economy". He concludes that "the main source of modern economic development is scientific and technical progress and innovative technologies".

## **RESEARCH METHODOLOGY**

The methodological approach of the study assumes that structural changes change the elements of the enterprise, under the influence of external and internal environmental factors, to form sales. In this case, we can divide internal and external environmental factors into the following groups.

*Internal factors:*

1. The structural structure of the enterprise's property.
2. Size of resources (financial).
3. Human resources and management.
4. It consists of organizing technological development and research.

*External factors:*

1. Markets (capacity, demand, main segments).
2. Consumers (reasons for purchasing).
3. Competition (competitive strength, trends).
4. Service sectors (main areas, development prospects).
5. Suppliers of key raw materials.
6. Transport, warehouse, banking infrastructure.

Based on these circumstances, why do industrial enterprises make structural changes, namely, a decrease in efficiency and labor activity, a lack of working capital, unsatisfactory financial indicators, and high accounts payable and receivables? Such situations, of course, require structural changes based on changes in the scale of trade or market conditions. The main goal is to increase the competitiveness of the enterprise by increasing its value.

Structural changes in the economy are broad-based measures aimed at increasing economic efficiency and market competitiveness. Since the real sector is a subject of the market adaptation process, structural changes are carried out in two types.

First, structural changes consist of directly addressing the micro-level problems of the economy, providing each enterprise with the necessary capital with the help of individual, purposefully selected strategic investors, and applying modern management practices.

Secondly, to implement rapid and massive structural changes in the general sectors of the economy. This involves the use of all property relations and the creation of tangible financial resources and jobs. In the experience of many developed countries, the above two types of structural changes have been used in the context of market reforms and the modernization and diversification of the economy.

Today, the main need for structural changes in individual enterprises of industrial sectors is caused by the following negative circumstances:

- mismatch between market demand and manufactured products;
- lack of an effective system for product production and management based on market demand, and low sales activity;
- lack of competition between foreign manufacturers and national production;
- monopoly of certain enterprises;
- low consumer quality of products during production;
- and moral obsolescence of fixed assets of enterprises;
- the need for the enterprise's assets even after privatization;
- high financial costs for production sectors;
- the presence of expensive objects in the assets of enterprises.

Ensuring financial stability and increasing the level of efficiency in industrial sectors, as well as increasing production capacity and expanding export volumes, on the one hand, depends on the targeted use of the internal capabilities of the enterprise, and on the other hand, on studying the economic, legal and organizational environment in which structural changes are implemented, identifying external influences, and taking into account and evaluating various factors affecting the economic and financial activities of the enterprise.

In this context, the final stage of diagnosing industrial enterprises assesses the internal factors and opportunities for implementing structural changes in the industry, external factors affecting it, existing problems, and opportunities for solving them.

To ensure the successful operation of industry enterprises in the domestic market environment, it is important to analyze the macroeconomic factors of market development, state regulation of production and service activities, and the state of the mechanical engineering products market, and draw appropriate conclusions from them.

The external market environment requires studying the price situation and general trends in world markets, including the development of the raw materials market, the fuel market, and the market for the products of machinery manufacturing enterprises of foreign countries.

The next stage of developing a strategy for implementing structural changes requires the development and implementation of short-term options and a plan for structural and economic changes to be implemented in the industrial sector. The selected goal is supplemented by the country's macroeconomic indicators at the micro level, that is, taking into account the implementation of existing or planned investment projects.

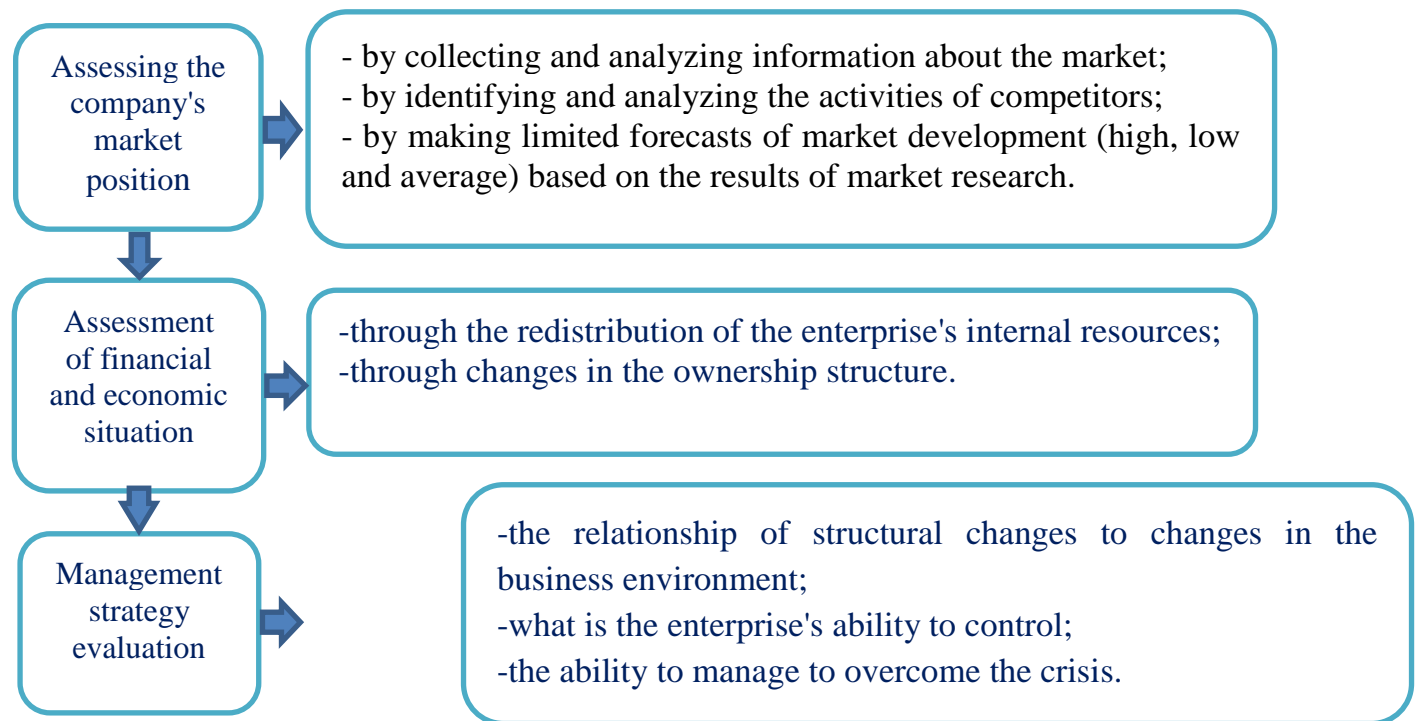
In developing a long-term plan for structural changes, the main focus will be on the production of competitive products, technical and technological equipment of industrial enterprises, and the introduction of advanced management methods in production. The long-term plan also provides for adjustments to the implementation of strategic planning based on the current situation.

The next stage is the implementation of the plan. First of all, it is important to develop a concept for implementing structural changes. The concept clearly indicates the goals, tasks, and responsibilities of those implementing structural changes, and the timeframe for implementing the structural change strategy. The final stage is carried out in close connection with the previous stages and involves the implementation of qualitatively new changes and the adaptation of the product to world standards.

## **RESULTS AND DISCUSSION**

Thus, structural changes in industrial enterprises, the development of scientifically based directions of the strategy connects the resources and human resources of the industry with specific investment and innovation projects, mitigating and reducing their negative impacts based on the study of threats that may arise in the short, medium, and long term. It creates favorable conditions for interconnected activities and opportunities for strengthening cooperation between enterprises producing complementary products.

For this, the industrial sectors It is important to effectively implement structural changes based on an assessment of the financial and economic situation, market performance, and management strategy (Figure 1).



**Figure 1. Industry the effectiveness of structural changes in enterprises improvement directions<sup>1</sup>**

Based on the above three approaches, one of the main and most important principles for increasing the effectiveness of structural changes in industry is to take into account the specific characteristics of each sector. The role and significance of industrial sectors in the national and foreign economy, their level of development, the characteristics of their provision with economic resources, and other factors require the development and application of their own methods and tools, solutions and conclusions, mechanisms and levers for structural changes.

From the table above, it can be seen that the need for structural changes and the main problems in it are expressed in the inadequacy of the means of production in the industry, improper organization of product production and sales, and the dependence of joint-stock enterprises on the stock market, while the main disadvantages can be assessed in terms of negative consequences, such as the fact that structural changes have not been widely implemented in the development of this industry, and the fact that the owners of enterprises are not long-term investors.

<sup>1</sup>Author's development based on research

To this end, it is necessary to promptly assess the market position, financial and economic performance, and management efficiency of industrial enterprises.

*The market situation of industrial enterprises:*

a) determining and increasing the company's position in the markets by summarizing and analyzing information based on the following directions:

the economic development indicators of regions and sectors, the directions that determine state policy in the creation of raw materials for consumer products, and the sale of products manufactured by the enterprise;

the current level of production in the country, the volume of exports and imports of raw materials consumed and manufactured products, as well as import-substituting products in terms of production volume;

about market and consumer segmentation;

of the market for the main and each segment ( elasticity of emerging prices, potential and real capacity of the market, its saturation with products and goods);

the geographical distribution of goods, export markets.

b) identifying competitors and analyzing their activities:

general information about competitors ( sales volume by market segment, total market share, objectives, market behavior, self-assessment, etc.);

strengths and weaknesses of competitors (product quality, movement of goods, sales policy, provision of after-sales service, pricing policy, prepayment, forms of settlement by live means, extension of payment terms, etc.);

identifying products that can be produced while increasing the level of competition in the commodity sector ( the ability of suppliers and buyers to reach an agreement through the use of substitute products in the process of pressure transfer).

c) pessimistic, optimistic, and moderate forecasts based on the results of marketing research on effective methods of market development, and it is recommended to do the following within each:

determining the duration of the life cycle and phases of each type of product produced;

assessing the potential risks of the enterprise during its activities.

When assessing corporate governance, the following indicators are taken into account:

1. Response to changes in the business environment.

a) Is the problem the result of a change in external conditions or a decline in the overall business picture?

b) Did management quickly determine the change, or did they wait for a shortage to occur?

c) Does management have a clear, workable, and credible strategy for solving problems?

d) Is there clarity in the unified approach to problems within the management structure?

e) Does the company have the political power to address the external factors of the problem?

2. Ability to control the enterprise.

- a) Does the enterprise have a clearly defined business plan?
  - b) Does the enterprise have adequate financial controls?
  - c) Does the enterprise have adequate management functions?
  - d) The enterprise's workforce meets the movement requirements. Is there any work being done to confirm?
  - e) Is effective cash flow during the management period of the enterprise considered?
3. Management skills to overcome stress.
- a) Can management clearly identify problems and address them? Will he take responsibility for?
  - b) Is the management capable of developing a realistic and effective recovery plan?
  - c) Is management able to repay the loan and support creditors?
  - d) A clear path to recovery and a clear sense of entrepreneurial spirit?
  - e) Does management have the necessary technical skills, or are there significant gaps?

When we logically evaluate this process, the financial situation of the networks The evil itself requires a positive approach to it. To do this:

1) Management of internal resources of enterprises through redistribution:  
 managing cash flows;  
 cost reduction based on identifying and preventing losses and high costs;  
 of products in the above regions, improving the selection of additional products while expanding the specified types and assortment.

2) Through the property form of structural changes:  
 focus on selling inefficient fixed assets and liquidating unused assets;  
 in order to reduce temporary standards, it is necessary to modify production operations and organize shifts in the production of product parts. In this case, it is advisable to change the activities of economically insolvent enterprises and efficiently operating enterprises in the following order.

These analytical assessments indicate that, in our opinion, it is advisable to implement the following priority tasks and directions for structural changes in industrial enterprises (Table 1).

**Table 1**

**Directions for the targeted development of industrial sectors in the context of structural changes<sup>2</sup>**

S/n	Content of priority tasks	Implementation goals
1.	Organization of efficient production activities, property reform, and privatization in the process of structural	- industry establishing a truly inclusive ownership structure in enterprises; -development of competition; - enterprises produce finished products and components, specializing in production;

<sup>2</sup> Author's development based on research

	changes	-consists of forming effective production activities based on successful structural changes in the economy.
2.	Industrial production new transition to the next stage, and market demands are coming out develop.	- from raw materials and organize the effective use of production capacities; - to establish intensive development of production based on market demands; - supply and demand balance to provide; -to increase the independence of the enterprise in setting prices and organizing product production in a free form.
3.	Introduction of new structures related to structural changes and changes in the production schedule	- structural -organizational change: (material and technical base of the network); - rational and social division of labor support; - structural changes , skilled worker and increase the number of experienced employees; -strengthening control over financial resources and involving them in targeted plans.
4.	Increasing the performance of industrial enterprises in determining strategically important tasks	-the country's relations with its domestic and foreign partners; - ensuring the interaction of the main production sector and its subsidiary enterprises; -alternative production units operating in the industry, as well as decisions on joint ventures.

The effective implementation of these tasks, firstly, through urgent measures, is necessary to improve the general condition of the industry and improve the attitude of workers and other employees towards production. This will ensure the reliability of the industry to attract external investments. Secondly, it will be possible to implement a production project based on capital investments that will ensure the future of the industry.

When implementing efficient production projects, it is necessary to pay attention to the affiliation of activities to one sector, their homogenization, and changes in the ownership structure. This, in turn, requires an assessment of the following priority tasks in the industrial structure:

- grouping of product types of industrial enterprises that do not meet the requirements of the world and national markets;
- improving the introduction of selected and new types of products;
- redistribution of equipment and experienced managers, consultants, and qualified employees necessary for production;
- it is necessary to improve the market-based management.

Structural changes in the activities of industrial sectors largely depend on the composition and territorial location of production. In this regard, the sector eliminates regional imbalances in production at enterprises. It is important to establish a mutually beneficial structure for enterprises. structure, availability of raw materials, and demand are priorities in many places. The economic development of the region in the development of

production areas Based on its potential and social characteristics, the following It is necessary to solve the following tasks:

reevaluation of enterprises processing raw materials;  
establishment of additional production enterprises;  
the structural structure of labor resources in the regions, the integration of labor resources, and the employment of the population to ensure employment.

#### **CONCLUSION AND SUGGESTIONS**

In conclusion, it can be said that in economically distressed enterprises, great attention is paid to financial changes. Although these industrial enterprises have been granted privileges, their inability to produce products has led to. However, creditors are reluctant to act without a credible production plan, that is, for enterprises undergoing structural changes. It is difficult for them to provide funds. For this, structural change is needed to reduce the deficit. It is advisable to implement the strategy option in this situation. In these estimated cash flows, the interest rate (investment rate ) (i.e., using a single rate to determine the present value of the investment) should be strengthened. As a result, the interest rate charged should be based on the investment and should represent the real value of the investment made.

When a business is comfortable in efficiently operating industrial enterprises, it is necessary to assess the value of the company. In this regard, special attention should be paid to joint-stock companies. For this, the sale and advertising of products it is necessary to strengthen the activities of private capital. That is, the ratio of the value of the assets to the borrowed funds is calculated. During the period of structural changes, it is necessary not to reduce the current production of products. It is necessary to involve the sectors in their target plans by collecting receivables from industrial enterprises.

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