






Sustainable Development of the Agro-Industrial Complex through Modeling Aspects of Logistics Management



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ABSTRACT

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The main purpose of this study is to model a logistics management system that ensures the sustainable development of the agro-industrial complex in one of its three major areas. The focus of the study is the sustainable development of the agro-industrial complex within a specific industry. The research methodology involves the use of modern methods for creating control system models, based on graphical representation of sustainable development. The model resulting from this study serves as the foundation for the article and includes the necessary elements for planning the sustainable development of the agro-industrial complex. As a result, a strategic logistics management model was developed to ensure the sustainable development of the agro-industrial complex within a single industry. In addition, tactical and operational logistics management models were proposed to ensure the sustainable development of the agro-industrial complex in a particular industry. The study is limited by its focus on only one of the three major areas of the agro-industrial complex. Future research should explore the sustainable development of all other areas within the agro-industrial complex.

1. INTRODUCTION

Examining the current state of logistics in the agro-industrial complex within the framework of sustainable development is crucial for the economic growth of any country. In management, economics, and agricultural sciences, there are several reasons why modern public and private enterprises, organizations, and institutions need to employ logistics. These reasons include continuous sustainable development, enhancing the competitive advantages of logistically organized systems of goods distribution by reducing production costs and improving supply quality, addressing the energy crisis, promoting scientific and technological progress, and, most importantly, computerizing the management process.

The concept of sustainable development of the agro-industrial complex is a comprehensive idea that emphasizes striking a balance between meeting today's needs and safeguarding the interests of future generations, which include the necessity for a safe and healthy environment.

Logistics within the agro-industrial complex represents a new application of logistics (agro-logistics) related to its principles and methods in agricultural production.

The agro-industrial complex serves as a strategically significant link for the sustainable development of any country. Food security, international competitiveness, the level and quality of food provision for the population, and

social standing are all partially dependent on the sustainable development of logistics within the agro-industrial complex. Stabilizing and further developing the logistics sector within the agro-industrial complex is impossible without an effective management system as the primary decision-making center.

Nowadays, logistics is not only a high-priority area for the sustainable development of state policies in many countries, but it should also be a key aspect for enhancing the mechanisms regulating the logistics sector of the agro-industrial complex. To perform an in-depth analysis of the logistics sphere of the agro-industrial complex, it is essential to devise specific decisions and develop practical recommendations for improvement based on strategic, tactical, and operational elements that ensure sustainable development.

Planning a logistics management strategy is comparable to the overall planning of an enterprise's sustainable development strategy. As with general strategy planning, the first step is to identify the primary goals and then develop more detailed measures to accomplish them through tactical and operational actions. A creative approach to this process presents excellent opportunities for devising new models to ensure the sustainable development of the agro-industrial complex. As such, our study will concentrate on modeling strategic logistics management with elements of tactical and operational measures to guarantee the sustainable development of the agro-industrial complex.

The primary goal is to model a logistics management system that secures the sustainable development of the agro-industrial complex in one of its three major areas. The focus of the study is the sustainable development of the agro-industrial complex within a specific industry.

The structure of our article can be divided into several parts: a literature analysis section, a methodology and methods description section, a presentation of the study results section, a discussion of the study results section, and a conclusion and suggestions for further research section.

2. LITERATURE REVIEW

As leading scientists and practitioners note [1, 2], in agricultural production the question arises of solving a complex of problems of a social and environmental nature, since the dominance of only economic interests causes irreparable harm to the environment, affects the quality of life of citizens, indirectly reduces the level of food security of the country and in ultimately destroys the national security of the state. The combination of the interaction of the three main components (economic, environmental, and social) is an effective way to ensure the sustainable development of the agricultural sector of the national economy.

According to scientists [3, 4], sustainable development is achievable under the conditions of harmonization of certain elements, in particular: economic activity in the agricultural sector with environmental consequences for the environment; stimulation of the social component, and the formation of consumer demand for environmental goods; the inclusiveness and effectiveness of the institutional environment; innovativeness and environmental friendliness of production processes with the adjustment of the interaction of the external and internal environment in the direction of the effective use of the potential of the agricultural sector of the national economy.

The literature notes that the concept of sustainable development is of exceptional importance for the effective functioning of the agricultural sector of the national economy, which is facilitated by several important factors: 1) agricultural producers are one of the main consumers of natural resources; 2) agriculture plays an important role in the interaction between the development of society and the environment; 3) the agricultural sector is multifunctional: it produces food products (the priority needs of society are satisfied), as well as non-food products (substituting non-renewable natural resources); 4) the industry makes a significant contribution to the viability of rural areas [5].

Strategy and tactics play an important role in ensuring the sustainable development of the agro-industrial complex. A significant number of scientists agree with this [6, 7]. According to the generally accepted principles of sustainable development, tactical priority in the agricultural sector should be based on the principles of flexibility and adaptability to changing environmental conditions with the introduction of environmental responsibility of business entities and society as a whole; rational use of natural resources, which will ensure competitiveness; application of modern agricultural practices; the formation of a worldview position in order to guarantee a gradual movement towards the observance of the concept of sustainable development as a strategic goal.

Summarizing the analysis of scientific literature [8-11], it can be noted that sustainable development is possible with the

formation of a long-term unity and relationship regarding the reproduction of production potential, human resources, and the natural environment. A decisive role in ensuring the sustainability of the development of the agricultural sector and its industries is played by adjusting the influence of external and internal factors, as well as taking into account the need to combine the involved components. Therefore, sustainable development should not be perceived as overcoming anthropogenic problems, but also as a basis for the most efficient use of the sector's potential.

The formation of a sustainable development strategy for the agricultural sector should be based on taking into account a combination of factors and cover a sequence of stages to achieve strategic directions, economic performance, social significance, and environmental safety of the agricultural sector of the national economy, based on the introduction of public-private partnership, the construction of which is built in three main stages: 1) development; 2) implementation; 3) adaptation and evaluation of results, the implementation of which is based on the principles and principles of a systematic approach [12].

At the same time, despite the active scientific interest in the scientific literature on the problems of ensuring the sustainable development of the agro-industrial complex, there are a number of aspects that remain undisclosed. Our study has scientific significance and relevance since it differs from others in that it will focus on the strategic, tactical, and operational aspects of the logistical management of the agro-industrial sector in the context of ensuring its sustainable development.

3. METHODOLOGY

For modeling, we need a proven method that is ideal for forming a model of a process such as logistics management. We proposed to use the methodology of structural analysis and graphical technologies, which includes many techniques for modeling management processes (and in our case, logistics management).

The SADT (Structured Analysis and Design Technique) method is considered a classic method of the process approach to management. The main principle of the process approach is to structure the activities of the organization in accordance with its processes for ensuring sustainable development. It is the process of ensuring sustainable development, which forms a result that is significant for the consumer, that is the value, and it is their improvement that should be addressed in the future.

The SADT method is a set of rules and procedures designed to build a functional model of an object of any subject area (in our case, a logistics management system to ensure the sustainable development of the agro-industrial complex). The SADT functional model reflects the functional structure of an object, i.e., the actions it takes and the links between these actions to ensure sustainable development [13, 14].

Our choice fell on IDEF0 methods as part of SADT. Its detailed characteristics will be described already in the presented results of the study, however, a number of general aspects should be described here.

The IDEF0 methodology is based on the following concept:

1. Block modeling and its graphical representation of sustainable development. The graphics of blocks and arcs of the SADT-diagram displays the function as a block, and the

input/output interfaces are represented by the arcs entering the block and leaving it, respectively. The interaction of blocks with each other is described using interface arcs that express constraints, which in turn determine when and how functions are performed and managed to ensure sustainable development.

2. Conciseness and accuracy. The implementation of the SADT rules requires the conciseness and accuracy of the developed documentation and the naming of structural elements (blocks and arrows), while not imposing excessive restrictions on the actions of the one who will make logistical management decisions.

3. Information support. SADT-model is one of the first stages of project development, then the model is transferred for further work to ensure sustainable development. Thus, the model should be designed so that in the future they can work with it and understand what is included in it.

4. Formalism. The development of models requires adherence to strict formal rules that provide the advantages of a methodology of unambiguity and integrity of complex multi-level models for ensuring sustainable development.

5. Iterative modeling of sustainable development. Model development is a step-by-step, iterative procedure for a logistics management system.

This methodology was chosen for several reasons.

1. Ease of use
2. Accessibility of the graphic language
3. Ability to better display sustainability information.

But it is impossible to model the sustainable development of the entire agro-industrial complex. Not just like that, it is

called a complex. It includes various industries. You should choose where all the authors of the article have practical experience, namely in the food industry, refrigeration, storage, specialized transport, trade, and other enterprises and organizations involved in bringing the final product to the consumer, including wholesale markets, retail trade, and catering.

Also, it is impossible to analyze the agro-industrial complex of the whole world; one should choose a specific country and take into account the specifics of its agro-industrial complex in a given industry area. We have chosen the country of residence of the authors and work - Poland, which is in great need of establishing a sustainable development of the agro-industry.

4. RESULTS OF RESEARCH

The first step will be to present how we see the achievement of the set goals through the proposed modeling technique. The main goal will be to ensure the sustainable development of the above-mentioned agro-industrial complex for Poland. This will be the starting point, the achievement of which will be accompanied by certain stages (Figure 1).

The next step is to identify the structural elements to achieve the goal. In this, according to the modeling technique, we should be helped by: resources (I), mechanisms (M) and control elements (C). All this can be depicted graphically (Figure 2).

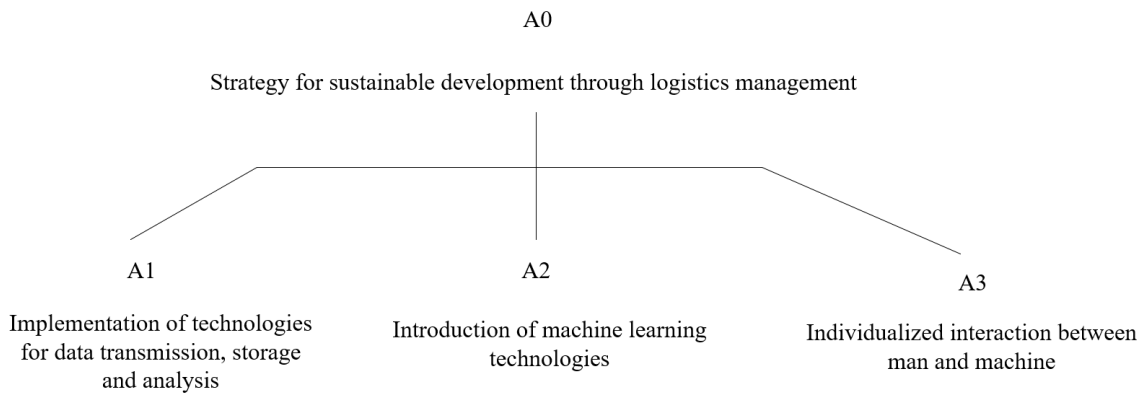


Figure 1. Stages of ensuring the sustainable development of Poland's agro-industrial complex

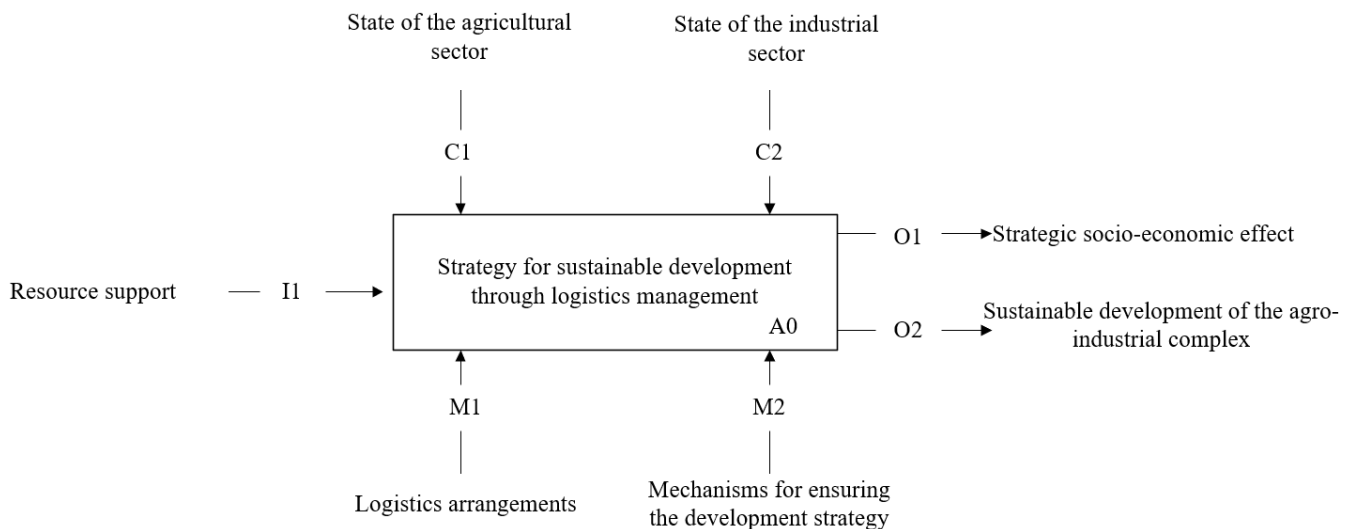


Figure 2. Structural elements of achieving the A0 goal

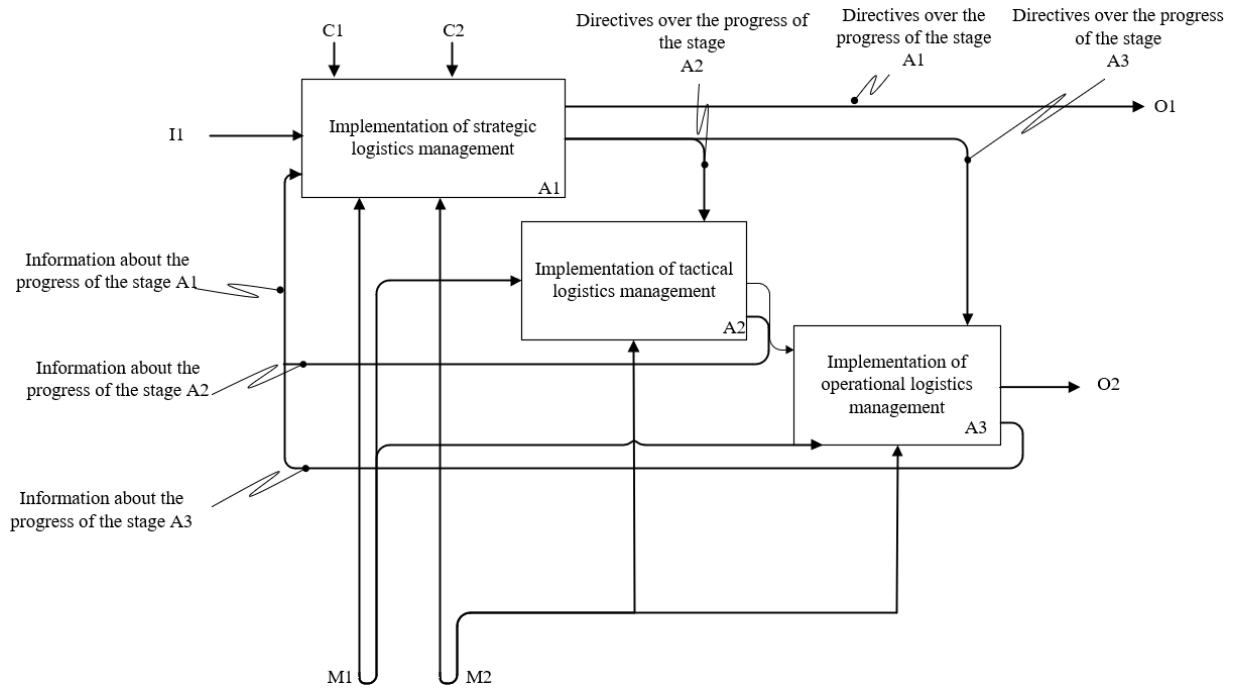


Figure 3. Model for ensuring strategic logistics management for the sustainable development of the agro-industrial complex

In general, the model can be represented as a decomposition diagram for achieving the set goal A0, which is to ensure the sustainable development of the agro-industrial complex in Poland (Figure 3).

To fulfill A1 "Implementation of strategic logistics management" in the context of ensuring the sustainable development of the agro-industrial complex, we will characterize the key stages:

A11. Implementation of a cost reduction strategy. The cost reduction strategy aims to reduce the variable costs associated with moving and storing goods/services. The level of customer service in this process remains unchanged, and the priority is to increase profits by reducing costs. We consider the provision of direct deliveries, the involvement of logistics

providers, the reduction of transport costs due to transport routing, the consolidation of loads, and the construction of an optimal range of sales, as alternative ways to reduce costs.

A12. Implementation of a capital reduction strategy. The capital investment reduction strategy is aimed at minimizing investments in the logistics system, aimed at maximizing the return on logistics investments. For example, instead of using their own warehouse space for storage, warehouses are rented; using the principle of "just in time" instead of creating reserve stocks; services are purchased from specialized logistics service providers. However, it is necessary to take into account the fact that setting goals for reducing capital investments often leads to an increase in variable costs.

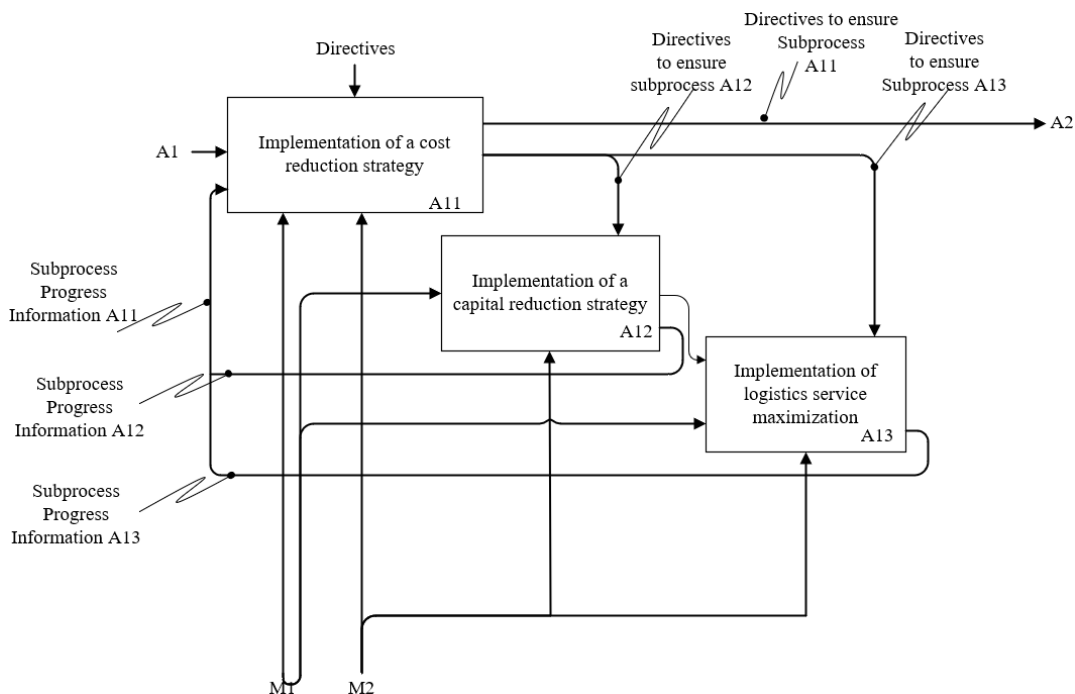


Figure 4. Model for ensuring strategic logistics management for the sustainable development of the agro-industrial complex

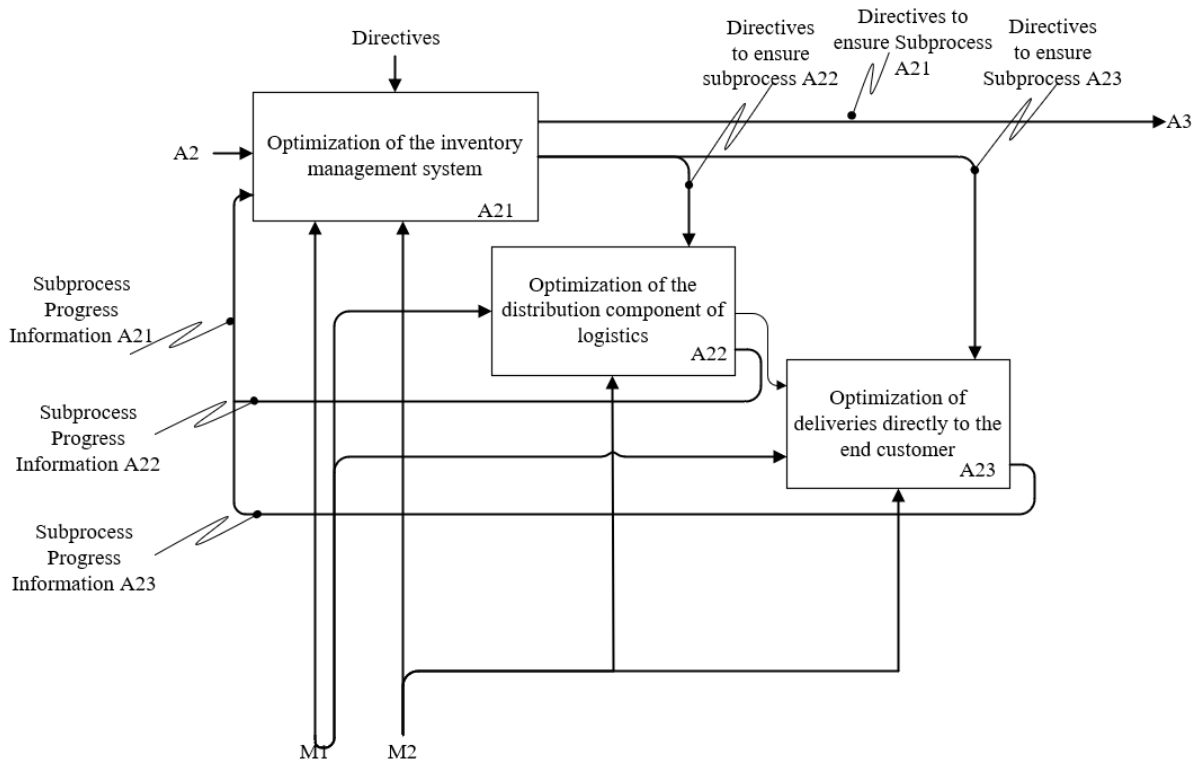


Figure 5. Model for ensuring tactical logistics management for the sustainable development of the agro-industrial complex

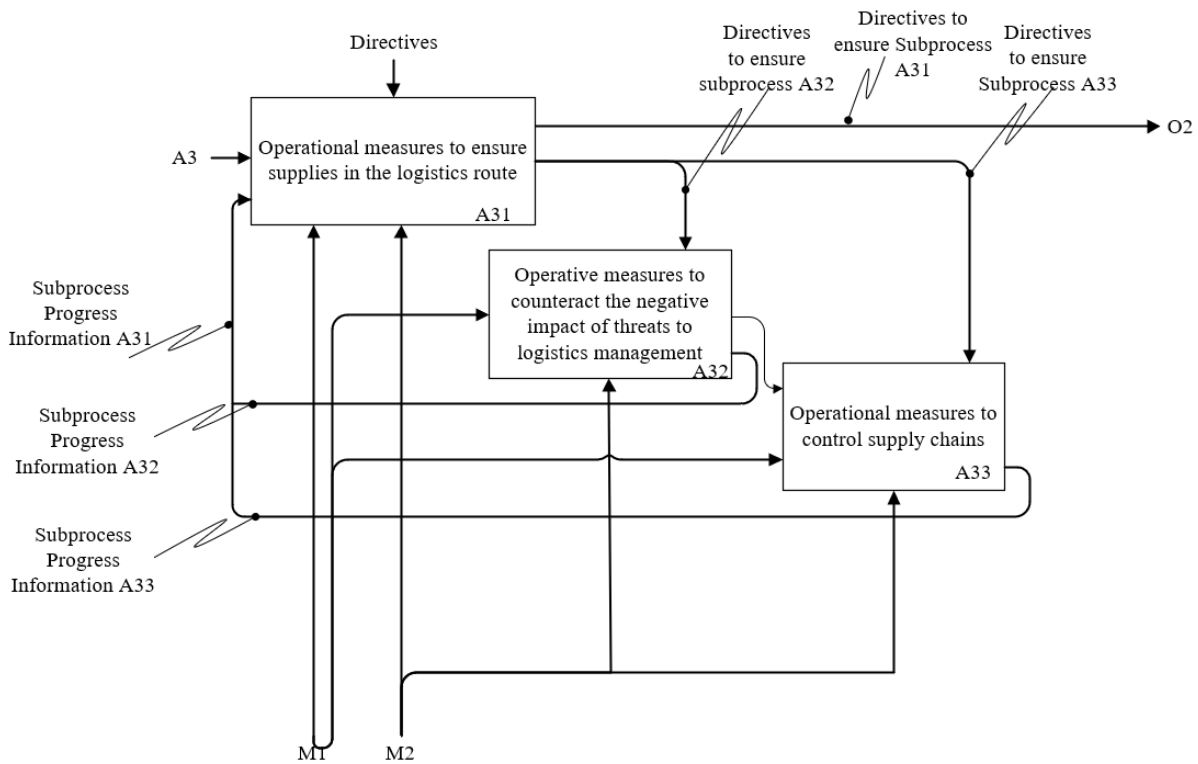


Figure 6. Model for ensuring operational logistics management for the sustainable development of the agro-industrial complex

A13. Implementation of logistics service maximization. The strategy for maximizing and improving the logistics service is focused on maximizing revenues in the face of stable logistics costs. That is, the strategy is chosen with the consent of the client to pay a higher cost of goods for additional logistics services (Figure 4).

To fulfill A2 "Implementation of tactical logistics management" in the context of ensuring the sustainable development of the agro-industrial complex, we will

characterize the key stages:

A21. Optimization of the inventory management system. The content of this optimization process involves the calculation and analytical justification of a possible stock of goods (raw materials, materials) of the agro-industrial socio-economic system, as well as the process of ensuring the quality of service for consumers of products and services, which will stimulate a reduction in the volume of costs for the formation and storage of finished agricultural products. The key

optimization criterion is the level of the average amount of reserves in monetary and quantitative terms.

A22. Optimization of the distribution component of logistics. The essence and significance lie in ensuring the growth of potential and permanent consumers of transport and logistics services through the systematization of processes, as well as the formation of the quality and timeliness of the provision of services. The key ways to optimize these processes should be the development of a distribution channel distribution strategy, the formation of retail and wholesale regional warehouses of products, as well as the construction of retail stores to stimulate an increase in sales of agricultural products.

A23. Optimization of deliveries directly to the end customer. The content of the presented process is to provide consumers with the opportunity to supply products in person and within a certain period of time, which will provide a stable and constant income for the implementation of transport and logistics services for business processes (Figure 5).

To fulfill A3 "Implementation of operational logistics management" in the context of ensuring the sustainable development of the agro-industrial complex, we will characterize the key stages:

A31. Operational measures to ensure supplies are in the logistics route. The supply of agro-industrial products occurs daily and therefore, logistics management through operational activities must establish continuous supply in the interests of sustainable development.

A32. Operative measures to counteract the negative impact of threats to logistics management. Every day, the agro-industrial complex is faced with a diverse number of threats, which should be responded to accordingly.

A33. Operational measures to control supply chains. Constant operational, minute-by-minute monitoring processes of control over the logistics supplies of agro-industrial products (Figure 6).

According to the chosen topic, we have chosen Ukraine and its system of fiscal policy in the context of sustainable development.

In general, the opinion of the authors comes down to the fact that when it comes to the issue of sustainable development, it should be planned by appropriate processes and stages. This can be achieved in a graphical modeling language to better depict all the elements of sustainable development.

5. DISCUSSIONS

Speaking of the constancy of agricultural development, single out agronomic sustainability (sustainability of the crop industry), which means the preservation of the productivity of agricultural land for a sufficiently long period [15]. Similarly, we can talk about the sustainability of the livestock industry, that is, regarding the long-term and cost-effective development of this area of production, subject to the effective use of the latest achievements in the field of genetic engineering and progressive zooveterinary technologies.

Scientists come to the conclusion [16, 17] that the sustainable development of agriculture refers to complex socio-economic models and at any time is influenced by a large number of different limiting factors, the classification of which is necessary to determine promising areas for increasing the sustainability of agricultural production.

Similar results of research by other scientists [18-20] show that in modern conditions of economic development, there is a need for an enterprise to achieve stability in the market and consolidate its position among competitors. The solution to this problem is associated with the formation of their own market strategy, ongoing marketing research, monitoring the micro- and macro-environment of the company, and the development of a certain behavior model, which will allow developing and mastering new market segments. For an enterprise, rational entrepreneurship is very important, which means commercial activity is successfully organized in time and space, which is provided by an appropriate mechanism and technology for its development. The enterprise itself can be considered a logistics system, since, in a broad sense, logistics covers all processes, providing planning, regulation, management, and control.

However, by presenting examples of such scientific achievements in the discussion of research, we would like to emphasize the distinctive features of our own results. So, the difference lies in specifying a separate area of the agro-industrial sector and presenting the agricultural sector of a single country as an example. In addition, as is well known, ensuring sustainable development covers a significant proportion of the entire socio-economic system, which is why we chose a logistics management system and it was through it that we presented models of the possibility of achieving constancy.

6. CONCLUSIONS

Summing up, we concluded that the problems of poor sustainable development of logistics links lie in the field of customs procedures, and compliance with contractual obligations related to agrologistics. Vulnerable links in the chain "from the field to the table" are storage and transportation. Thus, the state of sustainable development of the agricultural logistics system does not meet modern requirements and leads to economic losses for both agricultural producers and other economic entities involved in the process of promoting agro-industrial products to the markets. Effective sustainable development of the agro-industrial logistics system is an integral part of a developed national economy, food security of the state, and sustainability in the country. After all, improving the year-round provision of the population with food at affordable prices, spreading the positions of agricultural producers in international markets, and reducing the share of imported products in domestic consumption will bring, for example, Poland closer to the highly developed countries of the world.

It should also be noted that when modeling, the specifics of a particular region or country play a certain role in the construction of certain stages and the process of achieving the goal. The formed purpose of modeling in our case was based on the needs of Poland.

The elements of scientific novelty were presented in the form of a three-level model of logistics management for ensuring the sustainable development of the agro-industrial complex in one of the industries for a particular country.

As a result of the study, a model of strategic logistics management was formed to ensure the sustainable development of the agro-industrial complex in a single industry. In the context of practical use, we propose to ensure the sustainable development of the agro-industrial complex a

logistics management system.

The study is limited by choosing only one of the three major areas of the agro-industrial complex. Subsequent studies should be aimed at considering the sustainable development of all other areas of activity within the agro-industrial complex.

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