Smart logistics in managing logistics channels of essential oil production

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Abstract. The article substantiates the need for the development of the main directions of increasing the efficiency of the functioning of the logistics system of essential oil production. The most progressive technologies of smart logistics are highlighted, allowing increasing the efficiency of the entire logistics system. One of the most promising technologies has been identified for radio frequency identification, which allows to control large flows of goods. The current directions for the introduction of smart logistics technologies have been identified, its problems and prospects in the management of logistics channels for essential oil production have been analyzed. The proposed methodology for assessing the cost of solutions for the implementation of smart logistics technologies that affect the change in the cost of the logistics channel management system.

1. Introduction

Today in the world there is a tendency of continuous progress in research and innovation in various fields, including logistics. The use of modern advanced technologies in logistics ensures a high speed of logistics operations, as well as a reduction in costs (financial, labor, material), which will increase the competitiveness of a business entity and increase its profit [1]. This property of logistics and its systems is extremely important, since it allows to improve the entire logistics chain of essential oil production by reducing time intervals and logistics costs in the process of supplying, manufacturing and marketing finished products [2]. This becomes especially important in conditions of high competition in the market, which requires business entities to timely adapt to a complex and dynamically developing external environment. Studies have shown that the issues of optimizing and increasing the efficiency of logistics channels management have become the object of attention of domestic and foreign scientists from the point of view of finding new innovative approaches to organizing business processes. An analysis of a number of literary sources on the problem under consideration showed that all sectors of the economy are in need of optimization of such components of logistics as transport and communications, which ensure the smooth movement of material flows along the supply chain [3].
2. Features of essential oil production, forming the need for increasing the efficiency of its logistic system
Essential oil production, which can be characterized as a complex technological process that combines the agricultural component in the form of growing essential oil raw materials and industrial component - its processing, has a significant number of logistical ties. These links are presented in the form of material and information flows from suppliers of material resources to manufacturers that grow and process essential oil raw materials, and further to enterprises that use essential oils for the production of cosmetic, chemical and other types of products. The peculiarities of essential oil production are the short shelf life of the collected essential oil raw materials of such plants as lavender and essential oil rose, as well as the need to carry out part of the technological operations, for example, harvesting under certain conditions - in the morning, in calm sunny weather. These features make the task of optimizing resource delivery chains urgent, in particular, reducing the time of logistics operations and monitoring compliance with the transportation conditions to the relevant standards. This will help maintain the rhythm of the production process, as well as reduce losses and maintain the quality of essential oil raw materials during processing [4].

An important issue is the identification and development of main directions for increasing the efficiency of the logistics system of essential oil production through the introduction of innovations and information technologies that improve the quality of services provided, as well as identifying ways to improve the efficiency of economic activities of the subjects of essential oil production.

One of the directions for optimizing the economy of essential oil production is in the plane of innovative technologies of the logistics system and the creation of a flexible management mechanism that would ensure the effective interaction of the main elements of logistics - supply, transportation, production, warehousing, sales [5], [6]. In fact, it is necessary to create chains that will ensure the integration of the public and private economy sectors work on the basis of intersectoral logistics coordination.

3. Innovative logistics technologies
Let's highlight the most progressive at the moment innovative technologies in logistics, which make it possible to increase the efficiency of the logistics system:
- Enterprise Resource Planning (ERP) - resource planning;
- Warehouse Management System (WMS) - warehouse operations management system;
- Transport Management System (TMS) - transport management;
- Customer Relationship Management (CRM) - customer and supplier relationship management system;
- Radio Frequency Identification (RFID) - radio frequency identification system [7], [8].

Considering the peculiarities of essential oil crops, which require timely collection and processing and, in most cases, cannot be stored, we consider the introduction of radio frequency identification technology, as the most effective innovation, which, unlike the usual bar coding, has a miniature memory device (chip) attached to the transport packaging of products, which stores information about its time and place of delivery. This technology allows working with a large amount of cargo, since instead of the usual scanning of the code from each package, employees can quickly get data on the entire consignment of goods. RFID systems have proven themselves in container shipping, where each container is equipped with a set of RFID-tagged sensors. The advantage of RFID is that they control the condition of the cargo, in our case, consignments of essential oil raw materials, and transmit information about it to the central station, from which the data is sent to the owner of the cargo via satellite communication. In fact, we already have a familiar analogue of monitoring system, based on GPS (global positioning system) [9], [10]. This system has a number of other advantages:
automatic input of data into the information logistics system;
monitoring the passage of raw materials and finished products along the entire logistics chain;
control of the movement of products within the logistics system;
cross-docking and control of other operations in warehouse;
inventory at any time without involving personnel;
ensuring the safety of cargo from damage and theft;
efficient organization of the work of warehouse and other places of accumulation of cargo.

An important advantage of modern logistics management information systems is the minimization of human factor influence and the timely (in real time) transmission of complete and reliable information about problems arising in the system.

However, despite the obvious advantages of introducing information systems for logistics management, it should be borne in mind that the effectiveness of the process of their implementation is determined by the degree of penetration of logistics at various levels of management of the logistics system. And here it is extremely important that the existing management system be able to be coordinated and regulated by rationalizing and optimizing the management of all logistic flows of a business entity.

Let us highlight the current directions for the implementation of smart logistics technologies in the management of logistics channels for essential oil production. First of all, it is marketing research of the market for essential oil products. The next important area is the design and development of technical and economic requirements, the development of new technologies and types of products. It is also necessary to pay attention to the issues of material and technical support and production processes, control and testing and research of the possibilities of improving the characteristics and properties of essential oil products. Packaging and preservation of the properties of essential oil products, as well as their distribution and marketing are the most vulnerable components of the entire process.

Important areas are technical assistance and maintenance of production equipment, as well as its disposal after the end of its service life. In more detail, the problems and prospects for the introduction of innovations and information and communication technologies in the management of logistics channels for essential oil production are presented in Table 1.

| Problems                              | Perspectives                                                                 |
|---------------------------------------|------------------------------------------------------------------------------|
| Imperfection of the regulatory and    | Ensuring an innovative way of developing the domestic economic                |
| legal framework                       |                                                                               |
| Limited financial resources of        | Possibilities of involving business entities of essential oil production     |
| business entities                     | in the global logistics market                                               |
| Presence of stereotypes and resistance| Ability to compete in the global logistics market                             |
| to change                             |                                                                               |
| Risks, associated with the            | State support for priority areas of innovation and logistics                 |
| implementation of innovations         | activities of business entities                                              |
| Insufficient qualifications of         | Increasing the degree of protection of the rights and interests of           |
| personnel in the industry             | subjects of innovation and logistics activities                              |

The last two years of the pandemic have made major changes in the development of information and communication technologies. Not only the number of Internet users is increasing, the number and frequency of traffic in the system, the amount of time spent on the Internet is also growing. More and more operations and business processes are being implemented online, including the management of...
logistics channels. However, this is no longer enough, it is necessary to introduce smart logistics (logistics 4.0), which requires a complete digitalization of supply chains, which requires significant investments in the automation of business processes of the subjects of essential oil production. Among the main advantages of smart logistics, we note the following:

- faster data processing;
- saving time;
- convenience of information analysis;
- safety;
- minimization of the influence of the human factor;
- optimization of production according to the principle "just in time";
- increased planning safety;
- more efficient use of the vehicle fleet;
- reducing the waiting time in the loading and unloading areas;
- overcoming barriers between the links of the supply chain;
- increasing the productivity of production processes.

At the same time, we note that all these advantages are provided by a unified information and logistics system, thanks to which business processes become transparent, and costs are optimized.

All processes in logistics 4.0 involve full automation, thanks to which the system will collect the necessary data and transfer it to storage, where the data will be used to optimize the stocks of essential oil production and their processed products, the processes of their distribution and marketing. The system will automatically offer and sell services in accordance with the requirements of consumers. The study made it possible to identify the main directions of the development of logistics 4.0 (table 2). As you can see, all the main directions of development of smart logistics are actively involved in the management of logistics channels.

### Table 2. Main directions of smart logistics development.

| Data processing          | Cooperation                        | Automation          |
|--------------------------|------------------------------------|---------------------|
| - big data               | - formation of supply chains       | - robotization      |
| - internet of things     | - blockchain technologies          | - 3D printing       |
| - open data              | - smart contracts                  | - machine learning  |

So, big data is used to organize, store and analyze unstructured information that takes place in complex logistics systems, which is also the logistics system of essential oil production. It should be noted that despite the fact that business entities are aware of the importance and necessity of using digital technologies in supply chains, the level of digitalization of essential oil production logistics cannot even be called low, it is practically absent. Business entities use their usual communication channels to work with carriers and interact with each other. Obviously, on the basis of data sets, it is possible to provide a clear and transparent process for the operation of the entire logistics system of essential oil production. Therefore, it is necessary to actively introduce and use digital technologies both for managing all business processes of production, transportation, distribution, storage of products, and for making informed management decisions. At the same time, in order to obtain the desired return from the use of big data technology, it is necessary not only to collect and store data, it must be grouped and processed, used in organizing the process of managing logistics channels by automating business processes.

Automation allows you to collect a large amount of information that can be grouped in different ways. For example, this can be data, obtained during the processing of applications from manufacturers, consumers, suppliers, carriers. You can also establish additional statuses that a particular participant in the logistics system wants to fix.
4. Mechanism of collective cooperation in logistics management of essential oil production

So, let's summarize the main advantages of automating the process of managing logistics channels:

- optimization of the logistics system work;
- formation of effective communications;
- reduction of costs and time for organizing business processes;
- planning and decision-making based on reliable and complete analysis of information;
- data processing;
- increasing the efficiency of production, distribution, transportation and other processes;
- combining the work of all links into a single self-governing intelligent system, which, receiving information about material assets throughout the entire supply chain, independently processes and analyzes the data received, makes sure that orders are accumulated in the right place, at the right time, stored correctly and as quickly as possible ended up with end users.

As for technology such as open data, they can give a great impetus to the development of logistics of essential oil production due to the fact that maintaining and recording open registers of service providers at all links of the supply chain is an effective tool to reduce risks and, accordingly, unreasonable losses and costs. Of course, to achieve the required activities, government support is needed in terms of creating a set of open data with information visualization, which will significantly increase the efficiency of outsourcing in logistics. It is also necessary to use more advanced GIS systems to obtain reliable open data.

To finance the digitalization of logistics channel management, you can use the mechanism of collective cooperation, which is called crowdfunding. By voluntarily pooling resources, including financial ones, via the Internet (you can use blockchain technologies), you can support open data resources that are of interest to all participants in the supply chain.

The proposed mechanism may work as follows. The logistics company organizes an online platform (platform) where the process participants can "meet" - for example, cargo owners and transport service providers to organize the transportation of certain transport consignments of cargo (raw materials, processed products, finished products, and so on) as in mono-loads (full truckload) and under-load conditions (less-than-truckload). The digitalization of this process practically levels the playing field for all participants, regardless of their size - both for small and medium-sized and for large ones. In addition, there can be many online platforms where you can find out rates, book shipment and control the cargo during transportation along the entire route. Like any technology, crowdfunding has both advantages and disadvantages. One of the main ones is that, firstly, online platforms may not include all transport corridors and, secondly, there is no opportunity to discuss the price for the services provided.

In conditions of constantly growing costs, as well as numerous risks, caused by the human factor, the robotization of transport and warehouse deserves special attention, which allows automating all processes amenable to mathematical algorithms.

Using these technologies, employees are freed from low-skilled and dangerous work, which robots can do not only faster, but also more accurately and more economically. In addition, manufacturers have the opportunity to expand production and solve personnel problems, caused by the lack of specialists. Robotics change the mentality and life of people as it forces them to increase their intelligence, develop intellectual labor and protect intellectual property.

It should be noted that many manufacturers are already quite actively and successfully operating robotics for electronic orders, including chat bots, when anyone can place their personal order, which the manufacturer will receive directly and, as a result, we get real savings from interaction without unnecessary connections.
5. Economic and mathematical apparatus for evaluating the efficiency of implemented information and communication technologies

An important issue is the assessment of the cost of decisions regarding the implementation of certain information and communication technologies, for which an appropriate valuation toolkit is needed, which can be presented on the basis of an economic and mathematical apparatus, for example, using the theory of fuzzy sets. To justify this approach, we present several arguments:

- the models, created on the basis of the theory of fuzzy sets, have a high adaptive ability to expert assessments and are quite adequate in the process of their practical use. So, in economics, the models of Mamdani, Sugeno, Larsen, Tzukamoto and others have already been actively used and have proven their success [11].
- the criterion of the effectiveness of assessing the cost of the information and communication technologies being introduced into the management of logistics channels of essential oil production within the framework of the theory of fuzzy sets can be expressed by maximizing the degree of correspondence of the obtained assessments to a specific market situation, arising at one time or another.
- the cost assessment of the applied information and communication technologies (ICT) within the framework of the theory of fuzzy sets relies on both qualitative and quantitative forms of its implementation, which makes it possible to assess the features, as well as internal and external signs, properties and other characteristics of the logistics system.

Based on the general methodology of assessment processes, based on the theory of fuzzy sets, we note that it is based on a number of theoretical premises:

1) the object of research (in our case, the logistic system of essential oil production) must be in a state that corresponds to a finite set of states $S$, in which it finds itself under the influence of external and internal processes. It should be taken into account that the lack of the possibility of measuring them leads to some limitations of the set $S$, on which two indisputable subsets $S_1 \cup S_2$ are distinguished, where $S_1$ is a subset of states that, in terms of the level of development of characteristics, are consistent with the characteristics of the desired state of the object of research; $S_2$ is a subset of states that, in terms of the level of development of the object's characteristics, do not agree with the characteristics of the desired state. Then we see that the subset $S_1 = \{s_i\}, i = 1, n$ contains the types of states of the research object, which enable it to function and develop. As for the subset $S_2 = \{s_j\}, i = 1, m$, it contains the types of states that correspond to such changes in the parameters of the object or structural links that affect the occurrence of deviations from the desired result;

2) the solution to the problem of describing and assessing the real state of the research object is based on the analysis of the set $S$ or subsets $S_1$ and $S_2$;

3) the assessment is based on the positions of analysts and the methods of its implementation.

Revealing deviations from the characteristics of the desired state means that the research object is in the process of transition from one state $S_k$ to another state $S_l$. In this case, the conditions for the functioning of the object can change if $S_k$ and $S_l$ belong to the subset of states $S_1$. The mathematical expression of the algorithm for the functioning of fuzzy sets was reflected in the works of a number of researchers - L.A. Zade, A.O. Geyman, I.G. Fadeeva, A.P. Rotshtein and others [12-13].

Thus, by assessing the cost of information and communication technologies based on fuzzy sets, we mean a process by which, on the basis of available data, it is possible to establish essential parameters that are not directly measured, but they determine the nature of technology assessment and allow us to analyze changes in the state of the research object.

Let us consider the dependence of the indicator of the cost of introducing information and communication technologies into the management of logistic channels of essential oil production on the factors of influence on them, based on the theory of fuzzy sets, for which we will use the Mamdani model, a distinctive feature of which is that its rules contain fuzzy values (membership functions).
The study showed that the main blocks of ICT assessment features, implemented into the research object, which affect the change in the cost of the logistics channel management system, can be grouped into several blocks:

- block A includes features that indicate the market perception of a particular technology;
- block B includes signs indicating the key characteristics of the technology under consideration;
- block C reflects other characteristics that indicate the specifics of the assessment of a particular technology.

These blocks contain those signs (characteristics) that reflect the level of consumer value of a particular ICT and are the basis for establishing its value, which, subsequently, will affect the management decision regarding the choice of a specific technology for its implementation in the logistics channel management system. At the same time, we note that a change in the level of a specific feature within a particular block means a change in the level of consumer value of the selected technologies, which is reflected in the cost level. The detailing of blocks by features is presented in Table 3.

Table 3. Signs and factors of influence of the assessment of information and communication technologies on the change in the cost of the management system for logistics channels

| Block A (x1) | L1 | The level of potential efficiency from the use of technologies |
|--------------|----|-------------------------------------------------------------|
| L2 | Level of potential convergence of technologies |
| L3 | Technology diffusion level |
| Block B (x2) | L4 | The level of science intensity of technologies |
| L5 | The level of competitiveness of technologies |
| Block C (x3) | L6 | Risk level of technologies |
| L7 | Level of legal protection of technologies |

The hierarchical scheme of signs and factors of influence of the assessment of information and communication technologies on the change in the cost of the logistics channel management system is presented in Figure 1.

Figure 1. The hierarchy of signs and factors of influence of the assessment of information and communication technologies on the change in the cost of the management system for logistics channels.
As a result of the interpretation of the elements of the hierarchy, we obtain the following dependencies: S, being the top of the hierarchy, is a relative indicator of the change in the value of the cost of information and communication technology; x1, x2, x3, as noted above, are generalizing factors of influence; U1, U2, U3, U4, U5, U6, U7 - respectively, signs of factors influencing the cost.

A fuzzy subset of the set S is defined as the set of ordered pairs \( A = \{(x, \mu_A(x)) : x \in S\} \), where \( \mu_A(x) \) is the characteristic membership function, which receives a value in some ordered set \( M = [0, 1] \) - the membership set \( \mu(x) > 0 \), \( x \in S \), \( \mu(x) > 0 \), \( \sup \mu_S = 1 \). In this case, the function \( \mu_S \) indicates the degree of belonging of the element \( x \) to the subset \( A \) and is, in fact, a tool for transforming variables for further application of the fuzzy logic method.

6. Conclusion

Thus, one of the significant reserves for increasing the efficiency of the management system is the introduction of the concept and methodology of logistics, which is an organizational innovation for essential oil production that can be used to transform and adapt economic systems of any level. It is logistics that can become for essential oil production a reliable and effective mechanism for transforming the policy of reforming the industry, taking into account the specific conditions of its functioning.

It is fundamentally important that it is the logistics toolkit that makes it possible to take into account the needs, state and dynamics of demand, as well as the market situation, the nature of economic ties development, and create conditions for maximum adaptation of essential oil production to the needs of the market, when making management decisions.

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