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DEVELOPMENT OF LOGISTICS IN THE DAIRY INDUSTRY: DOMESTIC AND FOREIGN EXPERIENCE

The purpose of this study is a comprehensive study of the impact of digitalization on the development of logistics in the dairy industry in Kazakhstan. The study of the logistics of the dairy industry in comparison of domestic and foreign experience is an important scientific and practical task aimed at the formation of a stable and competitive system of supply and distribution of dairy products in our country. In comparison with foreign practices, systemic problems of the dairy industry in our country have been identified: low level of farmers' cooperation (small-scale production), insufficient development of transport and refrigeration infrastructure, limited utilization of processing capacities, and weak digitalization of the industry. The analysis of foreign experience has made it possible to identify the key factors for the successful development of dairy logistics in foreign countries: a high degree of cooperation (the use of cooperative models), strict standardization of quality, widespread use of digital technologies, and export orientation. For Kazakhstan, adapting these models to account for national specifics can become a strategic direction for the industry's development and integration into international supply chains. The results suggest that the digitalization of dairy logistics in Kazakhstan is a strategic priority, allowing not only to increase the efficiency and competitiveness of the industry in the domestic market, but also to integrate into international supply chains. Based on the conducted research, proposals have been formulated for the development of logistics in the dairy industry in the Republic of Kazakhstan, including the development of cooperative forms of organization, modernization of the cold chain infrastructure, and digitalization of logistics processes in order to ensure efficiency, competitiveness, food security, and integration of Kazakhstan into international supply chains.

Keywords: dairy industry, logistics, «cold chain», farmers' cooperation, digitalization, milk processing, quality standardization, export, agro-industrial complex.

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Сүт саласының логистикасын дамыту: отандық және шетелдік тәжірибе

Бұл зерттеудің мақсаты цифрландырудың Қазақстандағы сүт саласының логистикасын дамытуға әсерін жан-жақты зерттеу болып табылады. Отандық және шетелдік тәжірибені салыстыруда сүт саласының логистикасын зерттеу біздің елімізде сүт өнімдерін жеткізу мен таратудың тұрақты және бәсекеге қабілетті жүйесін қалыптастыруға бағытталған маңызды ғылыми және практикалық міндет болып табылады. Шетелдік тәжірибелермен салыстырғанда елімізде сүт саласының жүйелі проблемалары анықталды: фермерлер кооперациясының төмен деңгейі (ұсақ тауарлылық), көлік және тоңазытқыш инфрақұрылымының жеткіліксіз дамуы, қайта өңдеу қуаттарының шектеулі жүктемесі және саланың төмен цифрландыру деңгейі. Шетелдік тәжірибені талдау ондағы сүт саласы логистикасының табысты дамуының негізгі факторларын анықтауға мүмкіндік берді: кооперацияның жоғары дәрежесі (кооперативтік модельдерді қолдану), сапаны қатаң стандарттау, цифрлық технологияларды кеңінен қолдану және экспорттық бағдарлау. Қазақстан үшін ұлттық ерекшелікті ескере отырып, осы модельдерді бейімдеу саланы дамытудың және оны халықаралық жеткізу тізбегіне интеграциялаудың стратегиялық бағыты болуы мүмкін. Алынған нәтижелер Қазақстандағы сүт логистикасын цифрландыру саланың ішкі нарықтағы тиімділігі мен бәсекеге қабілеттілігін арттырып қана қоймай, сонымен қатар халықаралық жеткізу тізбегіне кірігуге мүмкіндік беретін стратегиялық басымдық болып табылатынын болжауға мүмкіндік береді. Жүргізілген зерттеу негізінде ұйымның кооперативтік

дамытуды, «суық тізбек» инфрақұрылымын жаңғыртуды және тиімділікті, бәсекеге қабілетті-лікті, азық-түлік қауіпсіздігін қамтамасыз ету және Қазақстанның халықаралық жеткізу тізбегі-не интеграциялануын қамтамасыз ету мақсатында логистикалық процестерді цифрландыруды қамтитын Қазақстан Республикасында сүт саласының логистикасын дамыту жөнінде ұсыныстар тұжырымдалды.

Түйін сөздер: сүт саласы, логистика, «суық тізбек», фермерлер кооперациясы, цифрландыру, сүтті қайта өңдеу, сапаны стандарттау, экспорт, агроөнеркәсіптік кешен.

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Развитие логистики молочной отрасли:
отечественный и зарубежный опыт

Целью данного исследования является всестороннее изучение влияния цифровизации на развитие логистики молочной отрасли Казахстана. Исследование логистики молочной отрасли в сопоставлении отечественного и зарубежного опыта является важной научной и практической задачей, направленной на формирование устойчивой и конкурентоспособной системы снабже-ния и распределения молочной продукции в нашей стране. В сравнении с зарубежными прак-тиками выявлены системные проблемы молочной отрасли нашей страны: низкий уровень коо-перации фермеров (мелкотоварность), недостаточная развитость транспортной и холодильной инфраструктуры, ограниченная загрузка перерабатывающих мощностей и слабая цифровизация отрасли. Анализ зарубежного опыта позволил определить ключевые факторы успешного раз-вития логистики молочной отрасли в зарубежных странах: высокая степень кооперации (при-менение кооперативных моделей), жёсткая стандартизация качества, широкое использование цифровых технологий и экспортная ориентация. Для Казахстана адаптация данных моделей с учётом национальной специфики может стать стратегическим направлением развития отрасли и её интеграции в международные цепочки поставок. Полученные результаты позволяют пред-положить, что цифровизация молочной логистики в Казахстане – стратегический приоритет, позволяющий не только повысить эффективность и конкурентоспособность отрасли на внутрен-нем рынке, но и интегрироваться в международные цепочки поставок. На основе проведённого исследования сформулированы предложения по развитию логистики молочной отрасли в Ре-спублике Казахстан, включающие развитие кооперативных форм организации, модернизацию инфраструктуры «холодовой цепи» и цифровизацию логистических процессов в целях обеспе-чения эффективности, конкурентоспособности, продовольственной безопасности и интеграции Казахстана в международные цепочки поставок.

Ключевые слова: молочная отрасль, логистика, «холодовая цепь», кооперация фермеров, цифровизация, переработка молока, стандартизация качества, экспорт, агропромышленный комплекс.

Introduction

The dairy industry is one of the key subsystems of the agro-industrial complex, which plays an important role in ensuring food security and improving the quality of life of the population. Kazakhstan annually produces over 6 million tons of milk, but more than 70% of this volume is accounted for by small farms and personal subsidiary farms of the population. Such a production structure makes it difficult to form stable supply channels, leads to high logistical costs and limits opportunities to enter foreign markets.

The modern development of the industry requires not only an increase in production volumes, but also an increase in the efficiency of logistics processes, including the collection, transportation, processing and distribution of dairy products. In this context, the issue of cold chain integration, digitalization of flow control, and the development of cooperation between manufacturers is becoming particularly relevant.

International experience (the Netherlands, New Zealand, China, the Russian Federation and the EU) demonstrates successful examples of cooperative models, strict standardization of quality, and widespread adoption of digital technologies. These approaches have allowed countries to significantly increase the competitiveness of their dairy products on the global market. For Kazakhstan, the adapta-

tion of these models, taking into account national specifics, can become a strategic direction for the development of the industry and its integration into international supply chains.

Thus, the study of the logistics of the dairy industry in comparison of domestic and foreign experience is an important scientific and practical task aimed at the formation of a sustainable and competitive system of supply and distribution of dairy products.

Literary review

The issues of the development of the dairy industry and logistics processes in the agro-industrial complex of Kazakhstan and foreign countries are actively studied in the scientific literature.

Over the past ten years, information and communication technologies have been actively introduced in all segments of the food industry. The use of ICT and digital platforms significantly expands the possibilities of integrating digital solutions aimed at improving the efficiency of communication, service and trade processes between people, enterprises and facilities (Evangelista et all., 2014). Currently, there are practically no industries that would not be affected by digitalization (Nagy et all., 2018). Logistics and supply chain management are also being affected by these transformations.

The work of logistics systems is based on the organization of flows of material resources and related information, as well as on the application of strategies that ensure the rational use of resources. The introduction of ICT makes it possible to track the movement of material and information flows, collect and analyze data to optimize supply chain management (Chae et all., 2013).

This article emphasizes that consistency of information and material flows is a key condition for reducing food losses and increasing the sustainability of supply chains for perishable products, in particular milk and dairy products (Kaipia et all., 2013). Logistics plays a central role in ensuring this synchronization and effective process management. Well-designed and implemented logistics solutions can significantly reduce food waste.

This study contributes to the development of scientific literature, confirming the positive impact of modern technological trends on inventory management processes, which is demonstrated by a concrete practical example. The work combines the analysis of scientific sources on logistics, supply chain management, and information and commu-

nication technologies as key drivers of innovation with consideration of the real problems of marketing dairy products in domestic practice.

Logistics plays a key role in ensuring the availability of products on the market, connecting the processes of production and final consumption. The field of logistics management includes such areas as the organization of input and output transportation, fleet control, warehousing, processing and movement of materials, order fulfillment, logistics network design, inventory management, forecasting supply and demand, as well as interaction with external logistics service providers.

Logistics management is an integral part of the Supply Chain Management System (SCM) and is aimed at planning, implementing and controlling efficient processes for the transportation, storage and return movement of goods, services and related information between the source of origin and the end user. The main purpose of these processes is to fully satisfy the needs of customers.

SCM refers to the organization and coordination of a set of functions performed both within an enterprise and in interaction between companies that jointly form a supply chain. The main task of SCM is to create added value through the delivery of goods and services to the market (Martins et all., 2019).

In recent decades, logistics and supply chain management have increasingly focused on issues of sustainable development (Ansari et all., 2017). The concept of sustainability has gone beyond purely economic indicators, also encompassing the impact on the environment and the quality of life of the population (Wang et all., 2007). However, the sustainability of supply chains is possible only if real economic results are achieved (Liu et all., 2012), while the economic component remains the main criterion for the implementation of most sustainable development projects.

The study by (Makenova, 2024) highlights the importance of the agricultural sector in the sustainable development of rural areas. In the context of the dairy industry, the formation of modern logistics chains is crucial to ensure the sustainability of production and competitiveness of dairy products. Using both domestic and international experience can help achieve these goals.

The scientific article by (Smagulov A., 2025) analyzes the domestic and international experience of digitalization of food logistics. The directions of digital transformation identified by the authors, as well as the existing barriers, are directly related to the problems of logistics development in the dairy

industry. Here, the introduction of innovative technologies is crucial to increase efficiency and competitiveness.

The article by A. Balkibayeva and other authors (Balkibayeva et all., 2018) emphasizes that the sustainable development of the dairy subcomplex is closely related to logistics, since efficiency gains are achieved not only through expanding the scale of farms and investing in infrastructure, but also through improving logistics chains and rational use of resources.

Job E. Utegenova, A. Maidyrova, and A. Iskakov (E.K. Utegenov et all., 2022) identified regional production imbalances and the dairy industry's dependence on imports, emphasizing the need to modernize logistics in this sector.

Also, the issues of cost management in the dairy industry are of great interest to many researchers. In the work of (Isaeva, 2024) emphasizes that the complexity and diversity of business processes in this industry necessitate the use of individual cost differentiation and the choice of optimal management tools. Special attention is paid to the production and transportation of milk, as these processes make up the bulk of the total costs of the enterprise. The author notes that the choice of accounting method (traditional or activity-based) directly affects the financial performance of the organization. In addition, the literature emphasizes that improving logistics efficiency remains one of the most urgent and challenging tasks. While financing issues are widely discussed in various sectors, logistics requires deeper analysis and practical solutions.

Foreign studies complement our understanding of this issue. Especially issues related to optimizing dairy logistics and cold chain management are becoming increasingly important due to the growing demands on product quality and the need to reduce overall costs. Scientific research in this area is aimed at developing more flexible and comprehensive modeling approaches that take into account environmental uncertainty, technological constraints, and environmental factors.

For example, during a study of the activities of Indonesian dairy cooperatives (Huang, 2018), a stochastic programming model was developed. The model was aimed at optimizing the processes of milk collection and delivery, taking into account the limitations on the length of the route, uncertainty in travel time and the possibility of using external refrigeration facilities. To solve this problem, the authors suggested using the set coverage method. This method has made it possible to effectively take into

account various operational requirements. The approach has shown its ability to provide high-quality solutions at reasonable computational cost. This is especially important for cooperatives operating in conditions of limited resources and complex logistics.

Another line of research in the work of X.Zhong and others (Zhong et all., 2022) focus on the problem of high cost logistics of cold dairy products. This is due to the contradiction between the strict requirements for temperature control during storage and transportation of dairy products and the insufficient development of the cold chain infrastructure. In the course of the research, a system of indicators was developed that reflects the factors affecting costs in this area. Three key aspects were identified: the characteristics of dairy products, the specifics of the transportation process, and the state of the refrigeration logistics market. The hierarchical analysis method was used to assess the significance of these factors and determine their relative importance. The obtained results allowed us to develop optimal cost reduction strategies. This approach demonstrates the potential of multifactorial cost estimation and management methods in the dairy industry.

Modern research in the field of supply chain management highlights the need for new tools and strategies in the face of increasing uncertainty and complexity of logistics processes. In the broader context of supply chain management, the work (Oger, 2020) is of interest. The authors note that supply chains in modern conditions face increased uncertainty and a high degree of interconnectedness of participants, which requires a rethink of decision support systems. In their article, they develop a conceptual framework for designing a DSS (decision support system) in the field of strategic supply chain capacity planning and confirm its effectiveness through two industrial experiments.

According to Russian researchers (M. I. Gorbachev, 2019), logistics management in the dairy industry requires the use of specialized software solutions that optimize the transportation process. The use of such tools helps to reduce the cost of delivering one liter of milk and increase the efficiency of building routes. As an example, the authors recommend using software packages to calculate milk collection routes, in particular the MapXPlus Milk system, which can streamline logistics operations.

In the article by (Lu, 2025) analyzed the current trends in the development of dairy logistics in China. The authors note the active introduction of digital platforms and the expansion of the «cold

chain», which helps to minimize losses and improve product quality. (Hansen, 2015) analyzes the role of innovation and sustainability in the European dairy industry, emphasizing the importance of integrating environmental and digital solutions into logistics processes. A study by Kazakhstani scientists (Moldashev A.B., 2023) examines the impact of government support on the development of the dairy industry in Kazakhstan, including measures to modernize transport and processing infrastructure.

Thus, a review of the literature shows that the effective development of logistics in the dairy industry requires a combination of infrastructure modernization, the introduction of digital technologies, increasing the level of farmers' cooperation and the use of international experience.

Methodology

The research materials used are official statistical data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, analytical reports from the Ministry of Agriculture, as well as publications by domestic and foreign researchers on the development of the dairy industry and logistics. Additionally, the regulatory legal acts regulating the functioning of the dairy industry and the agro-industrial complex were analyzed.

The methodological basis of the study was based on systematic and comparative approaches, which allowed us to consider the logistics of the dairy industry as an integrated system, including production, collection, processing, transportation and distribution. Statistical analysis was applied to assess the state of dairy logistics in Kazakhstan, which revealed key trends and problem areas. A comparative analysis of foreign practices (the Netherlands, New Zealand, China, the Russian Federation, and the EU countries) revealed the factors of their successful development and the possibility of adapting these models to domestic conditions.

The validity of the results is ensured by the use of relevant empirical data and the multidimensional nature of the applied methods, which made it possible to comprehensively assess the state of logistics in the dairy industry and identify areas for its improvement.

Results and discussion

Kazakhstan's dairy industry has significant production potential, but its structure and efficiency of use differ significantly from international standards. According to the Bureau of National Statistics, in 2023, the country produced about 6.1 million tons of milk, which is 2.3% higher than in 2022. At the same time, the average annual production growth over the past five years has been only 1.8%, which indicates a slow pace of development.

An analysis of the production structure shows that the majority of milk (about 70%) is produced in small–scale farms of the population, while only 30% is produced in agricultural enterprises and large dairy farms. This disparity creates a number of problems:

- instability in the supply of raw materials, as small farms cannot provide uniform volumes;
- low level of standardization of milk quality;
- difficulties in forming stable logistics channels.

In the regional context, Kazakhstan's dairy production is characterized by a high concentration in a number of regions. The largest volume falls on the Almaty region – 902 thousand tons, East Kazakhstan region – 812 thousand tons, Zhambyl region – 565 thousand tons and North Kazakhstan region – 520 thousand tons. These regions form the basis of the country's raw material base, providing over half of the total milk production. These regions account for more than 45% of the total milk production in the country, which indicates a pronounced regional concentration (statistics, 2024). However, processing capacities are unevenly distributed, as a result of which a significant part of the raw materials is used for personal consumption or sold in raw form without deep processing.

A comparison of Kazakhstan's indicators with foreign countries indicates a significant gap in productivity. While in Kazakhstan the average milk yield per cow remains at 2.5–3 thousand liters per year, in the Netherlands and New Zealand this figure reaches 8-9 thousand liters. This difference is due to the higher level of cooperation, strict standardization of quality and the use of innovative technologies in these countries. For clarity, comparative data are shown in Figure 1.

Thus, the production potential of the dairy industry in Kazakhstan remains significant, but its disclosure requires:

1) increasing the role of large dairy complexes;
2) development of farmers' cooperation;
3) introduction of modern technologies for feeding and keeping livestock;
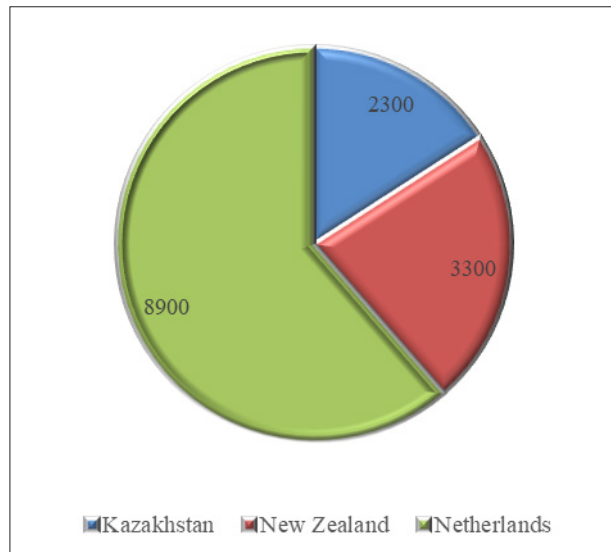4) creating conditions for the integration of small producers into the organized supply chain.

Figure 1 – Comparative milk yield of dairy cattle
(liters per year)
Note – the statistical data were collected and processed
by the authors based on open data in the sections
«industry statistics» of the National Bureau of Statistics
of the Republic of Kazakhstan and «Main topics»
of the Food and Agriculture Organization (FAO), 2024.

In the Republic of Kazakhstan, there are more than 200 milk receiving points equipped with modern cooling systems, which creates the basis for maintaining the quality of raw materials at the early stages of the logistics chain. However, their territorial distribution is significantly uneven. The highest concentration is observed in the North Kazakhstan region (58 points), the Almaty region (46 points) and the East Kazakhstan region (42 points), which is due to the high proportion of dairy cattle breeding in these regions.

Despite the presence of a milk receiving infrastructure, the capacities of processing enterprises are loaded on average by only 60-65%. This indicates the instability of the supply of raw materials, which is largely explained by the predominance of small-scale production, the lack of stable supply channels and problems in the transportation system. For comparison, in the countries of the European Union, the utilization rate of processing capacities exceeds 85-90%, which is achieved through a well-developed system of farmers' cooperation, standardization and centralized logistics organization. For a visual comparison, we present the data in Table 1.

Table 1 – Key Performance Indicators: comparison of goals using the example of foreign examples and Kazakhstan

KPI	Foreign target	Kazakhstan-current situation	Kazakhstan-recommended target
Logistics losses	−50 % via IoT/AI	Up to 55 % chain	losses 50%
Reduction in Dairy Collection Efficiency	≥ 90 %	Unclear, small farms, low coordination level	≥ 90 %
Delivery time	≤ 24 h	Delivery time is often significantly higher	≤ 24 h
Transport capacity	utilization+34 % Loading efficiency through modularity	Can be	increased by at least 30 %
Share Low-emission transport share	≥ 60 % (approx. EU)	Not detected	≥ 60 %
Capacity utilization	rate Full load	60 % KZ load	≥ 80-90 %
Self-sufficiency in raw	materials 90 %	25-30 %	≥ 80 % until 2027
Export	Growth + market diversification	-30 % volume, focused on cheap imports	Stabilization and growth of export channels
Note – the data were compiled by the authors on the basis of the technical regulations of the Customs Union «On Food Safety» by the Decision of the Commission of the Customs Union dated December 9, 2011 No. 880.			

Thus, the existing differences in the efficiency of processing capacity use between Kazakhstan and the EU countries confirm the need to improve the infrastructure for milk collection and transportation, as well as strengthen cooperation mechanisms in agriculture.

One of the key constraints to the development of dairy logistics in Kazakhstan remains the underde-

veloped transport infrastructure. Currently, the fleet of specialized tanker trucks and refrigerated trucks covers no more than 50% of the industry's needs, which leads to temperature disruptions at certain stages of delivery.

The consequence of such restrictions is the loss of milk quality, reaching 5-7% of the total volume. This is manifested in a decrease in bacterial purity, a decrease in shelf life and the need for additional processing of raw materials at processing plants. In turn, this increases the cost of the final product and reduces its competitiveness.

Milk and its processed products belong to the group of perishable products, which require strict compliance with transportation rules at all stages of movement – from farms and processing enterprises to the end user. The conditions of carriage are regulated by the Technical Regulations of the Customs Union TR CU 033/2013 (as amended by the Decision of the Eurasian Economic Commission Council dated 06/23/2023 No. 70). According to the provisions of the document, the movement of raw milk,

skimmed milk and cream is possible only if there is a veterinary accompanying document certifying the passage of veterinary and sanitary control and guaranteeing the safety of products. Section IV of the regulations defines the key safety requirements at the stages of production, storage, transportation and sale of dairy raw materials. In particular, the maximum shelf life and transportation of raw milk before industrial processing should not exceed 36 hours at a temperature of 4 ± 2 ° C. For products intended for baby food, this period has been reduced to 24 hours (dairy, 2023). The regulations also emphasize the need for strict temperature control: chilled milk must have a temperature of no more than 10 °C during transportation. Transportation is allowed only in hermetically sealed containers made of materials that are safe for contact with food. Vehicles are required to provide conditions that comply with the established standards of TR CU 033/2013 (as amended on 06/23/2023 No. 70). Detailed indicators of temperature conditions for various categories of dairy products are presented in Table 2.

Table 2 – Temperature and shelf life of milk and dairy products

Product Name	Storage temperature, ° C	Shelf life
Pasteurized milk	+2…+6	72 hours
Cream	+2…+5	36 hours
Butter	-10…-12	7-10 months
Hard cheese	0…+4	4-8 months
Soft cheese	0…+3	15 days
Ice cream	-20…-24	1-1. 5 months
Sour cream	0…+6	5-85 days
Kefir	+2…+5	3 days
Cottage cheese	+1…+3	55 days
Yogurt	+3…+5	25 days
Condensed milk	0…+10	12 months
Powdered milk	+1…+8	8 months
Note – the data were compiled by the authors on the basis of the technical regulations of the Customs Union «On Food Safety» by the Decision of the Commission of the Customs Union dated December 9, 2011 No. 880.		

In addition to complying with the requirements of TR CU 033/2013, the processes of storing and transporting milk and dairy products must comply with the provisions of TR CU 021/2011 (as amended in 2021), which sets out microbiological indicators of food safety. The implementation of these standards ensures that the consumer receives products that meet the criteria of quality and safety (On the adoption of the technical regulations of the Customs Union "On Food Safety, 2022).

The milk supply chain includes a sequence of stages: the delivery of raw materials from farms to

reception points, the subsequent transfer to processing plants, and then the transportation of finished products to the final consumer.

Compliance with sanitary and hygienic standards during milk transportation involves limiting microbial contamination, controlling acidity, and using airtight, regularly treated containers. In practice, deviations from the established requirements are often recorded, which increases the risks of reducing product quality. At the same time, the experience of the EU (the Netherlands, Germany) demonstrates the effectiveness of the «cold chain», minimizing losses during transportation by up to 1-2%, and the American technology of railway transportation using insulated wagons and ice cooling ensures the preservation of raw materials at temperatures close to 0° C, while reducing ice consumption by up to 40%. These practices are of particular interest for adaptation in Kazakhstan, where there is an urgent need to improve the efficiency of logistics in the dairy industry.

In addition, digital temperature monitoring systems and automated logistics management platforms are actively used in European practice, which allows real-time monitoring of compliance with sanitary standards. Such projects are just beginning to be implemented in Kazakhstan, but their scale is still limited to pilot regions.

Thus, the development of modern transport and refrigeration infrastructure is one of the key areas for improving the efficiency of the dairy industry in Kazakhstan. Strengthening the «cold chain» will not only reduce product quality losses but also increase the utilization of processing facilities, as well as expand export potential.

Current trends in the development of agri-food markets demonstrate that digitalization is one of the key factors in the efficiency of logistics in the dairy industry. In Kazakhstan, the introduction of digital solutions is still at an early stage: the overall level of digitalization is estimated at about 40%, reflecting the availability of separate pilot projects related to electronic traceability of supplies, automation of warehouse processes and the use of GPS monitoring of transport.

However, a significant part of the industry still operates according to the traditional model, where accounting and quality control of products are carried out manually. This leads to delays in document flow, increased transaction costs, and limits the ability to respond quickly to changes in market demand. In addition, insufficient implementation of digital platforms reduces the transparency of the supply chain and complicates the monitoring of compliance with sanitary standards at all stages of logistics.

In contrast, in the Netherlands and New Zealand, the level of digitalization reaches 85-90%, which ensures:
- full traceability of milk from the farm to the processing plant;
- automated temperature control at all stages of transportation and storage;
- online monitoring of the quality of raw materials and their compliance with international standards;
- integration of logistics processes into national and global trading platforms.

For example, in the Netherlands, the Milk Monitoring System (MMS) is actively used, which allows real-time monitoring of milk composition, sanitary conditions of transportation and transport coordinates. New Zealand is implementing the FarmIQ platform, which unites farmers, processors and exporters into a single digital ecosystem, ensuring transparency of the entire value chain.

In the Russian Federation, the MapXPlus Milk software package, developed by TransSis, is a specialized solution for milk processing enterprises that independently organize the collection of raw materials from the population. This complex functions as a single dispatch center that provides real-time visualization: the video wall displays the movement of vehicles, the availability of milk at reception points, as well as data on collected and unassembled volumes from the population.

The key objective of the MapXPlus Milk system is to create optimal milk collection routes both at reception points and directly from rural households. At the same time, the main criterion for the effectiveness of its use is the reduction of unit transportation costs, that is, the cost of delivering one liter of milk to the processing plant. Additionally, the system provides for the possibility of separate collection of raw materials depending on their quality characteristics, which helps to increase the level of control and processing efficiency (TransSys, 2025).

For Kazakhstan, the introduction of such solutions, given the predominance of small-scale dairy production, could reduce logistical losses by 3-4%, reduce transaction costs and expand export opportunities by increasing the confidence of foreign partners in the quality and transparency of products. At the same time, it is important to take into account the need for government support for the digitalization of the industry, including subsidizing the introduction of smart storage and transportation systems, as well

as training personnel to work with digital platforms.

Thus, the digitalization of dairy logistics in Kazakhstan is a strategic priority that allows not only to increase the efficiency and competitiveness of the industry in the domestic market, but also to integrate into international supply chains.

The analysis of international practices makes it possible to identify factors contributing to the improvement of logistics efficiency:

- high degree of farmers' cooperation (Netherlands – over 70% of farmers are united in cooperatives);

- strict standardization of the quality of raw materials and products (EU – unified EN ISO standards);

- active implementation of digital technologies (smart sensors, Big Data, blockchain);

- export orientation and flexible logistics network (New Zealand – more than 90% of dairy products are exported).

Kazakhstan has a number of systemic problems – fragmented suppliers, limited processing capacity, weak transport infrastructure and a low level of digitalization. At the same time, foreign experience demonstrates successful models that can be adapted to increase the competitiveness of the domestic dairy industry.

Domestic and foreign experience shows that the development of logistics in the dairy industry requires an integrated approach that includes not only infrastructure modernization, but also institutional transformations. Today, there is a significant gap between the production potential and the efficiency of the logistics system in Kazakhstan. Despite the presence of more than 200 milk receiving points and the functioning of processing plants, their utilization is only 60-65%, which indicates the uneven supply of raw materials and the limited capabilities of the cold chain. This reduces the competitiveness of domestic products in both domestic and foreign markets.

At the same time, foreign experience (the Netherlands, Germany, New Zealand, China, and the Russian Federation) demonstrates that the key drivers of successful logistics are a high degree of manufacturer cooperation, the introduction of digital technologies, and an export orientation. For example, in the Netherlands, more than 70% of farmers are united in cooperatives, which ensures a stable supply of raw materials and an even distribution of income. The EU has uniform quality standards (EN ISO), which eliminate the risk of significant fluctuations in the parameters of raw materials and products. New Zealand, which focuses on more than 90% of dairy

exports, has built a flexible logistics network that minimizes costs and optimizes supplies. In China, key attention is being paid to the development of the cold chain and digital supply management platforms, which reduce logistical losses and ensure a high level of product traceability.

For Kazakhstan, an important area of modernization is the development of digitalization: at the moment, the level of digital technology adoption is estimated at only 40%, which is significantly lower than in the Netherlands and New Zealand (85-90%). This hinders the transparency of the supply chain and the prompt monitoring of product quality.

Thus, the discussion shows that in order to increase the efficiency of dairy logistics, Kazakhstan needs to:

- strengthen producer cooperation and stimulate the creation of agro-industrial clusters;

- accelerate the digitalization of processes and develop a «cold chain» to reduce transportation losses;

- increase the export potential of the industry.

All this will significantly reduce costs, increase competitiveness and ensure the sustainable development of the dairy industry in the face of global competition.

Conclusion

The conducted research has shown that Kazakhstan's dairy industry has significant production potential, but the efficiency of its logistics system remains at a relatively low level compared to international practices. The main problems are related to the predominance of small-scale production, the uneven distribution of milk receiving points and processing facilities, the underdeveloped transport and refrigeration infrastructure, as well as the low level of digitalization.

A comparative analysis of foreign experience (the Netherlands, New Zealand, the EU, China, and the Russian Federation) allowed us to identify the key factors for the successful functioning of dairy logistics: high degree of farmers' cooperation, strict standardization of quality, introduction of digital technologies and export orientation. These elements ensure the sustainability of the supply of raw materials, minimization of logistical losses and competitiveness of products on the global market.

For Kazakhstan, the adaptation of these practices requires:

- cooperative forms of production and sales organization;

- creation of a unified system of quality standards harmonized with international standards;

- accelerated digitalization of the processes of collection, transportation and processing of dairy products;

- expansion and modernization of the cold chain infrastructure;

- increasing the export orientation of the industry.

The implementation of these measures will reduce costs, increase the utilization of processing capacities, reduce product quality losses and ensure Kazakhstan's integration into international supply chains. Ultimately, this will contribute to strengthening the country's food security, increasing the incomes of rural producers and increasing the competitiveness of domestic dairy products in the macro-regional market (SCO, EAEU).

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