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EFFICIENCY OF LOGISTICS CHAIN MANAGEMENT IN THE GRAIN PRODUCT SUBCOMPLEX OF THE AGRO-INDUSTRIAL COMPLEX OF UKRAINE

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Abstract

The results of improving of conceptual-categorical apparatus of the study of logistics systems and effective functioning of enterprises of grain products subcomplex of Agro-Industrial Complex (AIC) by clarifying and specifying the definitions of "logistics chain" and "efficiency of management of logistic chains" are presented in this article. It is proved that in order to adapt Ukrainian logistics systems to the level of world requirements, a qualitative assessment of the effectiveness of logistics chain management should be carried out using the a high-quality assessment of logistics chain management needs to be made using the World Bank's Logistics Performance Index (LPI). The results of the analysis of the impact of the relevant factors and the development of ways to activate the appropriate reserves on the management of logistics chains in the grain subcomplex are the basis for improving methodological approaches to identify opportunities to increase the efficiency of this process. The classification of factors of influence on the efficiency of functioning of logistic chains in the grain subcomplex of AIC is offered, and the division of microlevel factors into structural-organizational and functional-economic ones is substantiated. It is determined that the most characteristic factors of macro and meso level are the effectiveness of governmental regulation, the degree of involvement of the grain products subcomplex of agroindustrial complex in international logistics systems and the degree of development of the grain market infrastructure.

Key words**:** *logistics chain, management, grain products subcomplex of AIC, Logistics Performance Index, functional capacity*

INTRODUCTION

The development of the grain products subcomplex of AIC should have a strong theoretical foundation, which actualizes applied scientific research. Grain products subcomplex of agroindustrial complex is a set of functionally dependent agricultural and industrial enterprises that provide the formation of grain supply, its primary processing, storage, processing for flour, cereals, compound feeds, as well as sale, including for export, through mediocre involvement of relevant infrastructure elements and serves as a source of raw materials for food industry enterprises [10].

Effective technology of increasing the efficiency of grain production and production of its processing is logistic activity, which today can unite all elements of the grain products subcomplex of agroindustrial complex into a single chain and create conditions not only for the internal efficient production and consumption of its strategically important products, but also the formation of powerful efficient export grain flows. Logistics itself is able to consolidate all the constituent elements of the economic mechanism and to ensure the optimal structural and functional balance of the grain subcomplex of agroindustrial complex and its

effective internal and external institutional environment.

The retrospective analysis shows that there is a long period of formation of the historical image of Ukraine as a state, which is already integrated in the international logistics systems. During the time of Cossacks (XVI–XVIII centuries) the island of Khortytsya became the place of establishment of the Zaporozhian Sich, which, in addition to the defense-military, performed important trade and customs functions on the Dnieper waterway (known ancient route "from the Varangians to the Greeks"), actually representing a logistics center. Due to the fact that the Dnieper and its tributaries connected the countries of Northern and Western Europe with Crimea and Turkey, the Cossacks controlled the goods flows not only of Ukraine but also of Poland, Lithuania and the South of Russia. Thus, under the treaty of 1649, the Cossacks were granted permission by the Turkish Sultan to sail the Black Sea freely with all its ports, and were granted the privilege of free cooperation with the Turkish merchants, the creation in their ports of warehouses with goods, and also exempted for a hundred years from payment of duties and taxes to the Ottoman Empire [15]. The well-known Cossack boats(called "chaika",a seagull in English) served as vehicles, and the remains of the Cossack shipyard, where large boats were built, were found in Khortytsia. These facts testify to the objectively formed traditional geopolitical place of Ukraine in the network of logistics chains of global cargo flows.

Theoretical and methodological principles of logistic activity are the subject of study of foreign scientists D.J. Bowersox and D.J. Closs [4], M.R. Linders [13], as well as Ukrainian scientists – E.V. Krykavsky [12], A.P. Velychko [20] and others, who summarized relevant world experience and adapted it to the peculiarities of domestic realities, created the theoretical foundation for enriching and developing the logistical concept of managerial decision making. Comprehensive research on possible ways of solving problems of development of agrarian economy and grain production of Ukraine in the context of development of logistical bases of their functioning was carried out by V.I. Boyko [3], O.M. Shpychak [17], V.V. Yurchyshyn [21] and other scientists. Solving the problem of improving the efficiency of logistics chains requires identifying and maximizing the reserves of formation of potential opportunities for improving the end results. Since the classification of factors is the basis for the classification of reserves of this type, the purpose of this article is to determine the most significant factors influencing the efficiency of logistics chains in the grain products subcomplex of agroindustrial complex and the development of reserve-intensive directions of their involvement.

MATERIALS AND METHODS

To achieve this goal we solved the following tasks: based on the application of the dialectical method of cognition of objective reality and using the index method of analysis and method of comparison, the estimation of efficiency of logistics chains in Ukraine in terms of qualitative evaluation of the logistic component, the method adopted by the world Bank in the global rankings. Using heuristic decision-making methods, we have selected and appropriately classified factors that aggregate key influences on the logistics chains of the system under study. The study also used a monographic method for an in-depth study of the features of the influence of individual factors on the efficiency of logistics systems and to find ways to use appropriate reserves in the studied subcomplex of agroindustrial complex on the example of its individual enterprises. In order to carry out theoretical generalizations of the results of the research and to formulate conclusions and proposals, an abstract-logical method of scientific search was used.

RESULTS AND DISCUSSIONS

Dynamic state of the logistics system provides interaction of its elements , and achieving the desired end results requires the coherence and

purposefulness of the actions of these components. The existence of material, information, financial and service flows is possible in systems in which the elements, interacting with each other, create corresponding circuits. The logistics chain is a linearly ordered set of logistics process participants who carry out logistical operations to bring an external material flow from one logistics system to another under industrial use or to the end consumer under non-productive consumption. Logistics chain management efficiency is the ability to realize the objective function of a logistics system, which means delivering to the consumer the required quantity of products of appropriate quality at a certain place and in a set time with predetermined (mainly minimal) logistics costs [9]. Logistic system in the grain products subcomplex of agroindustrial complex is an aggregate of elements (subsystems) that provide the movement of material (grain) flow through the logistics chain from the primary source of raw materials (field) to end consumers of finished products (sectoral enterprises of food industry, animal husbandry complexes) and alter the grain flow in the process of applying to it operations in the functional areas of the elevator and processing industries. Grain from the producer under the influence of spatial and temporal parameters goes through certain stages (Fig. 1) on the way to end users, while attracting a significant number of infrastructure elements. A linearly ordered set of these elements is formed, that is, participants in the logistics chain, consolidates their efforts to achieve the final synergistic effect – obtaining financial resources for the final product sold. This condition of extended production reproduction for each element of the logistics chain is a common goal and responsibility, since any failures in the discreteness of material flows and their mismatch with the specified time and space parameters will lead to the total loss of each element, regardless of the quality and completeness of its performance of certain functions.

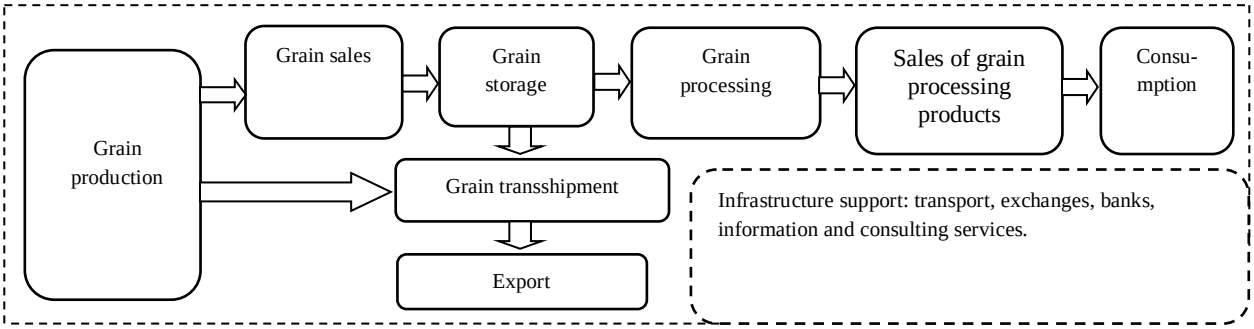

Fig.1. Schematic interpretation of logistics chains in the grain production complex of the agro-industrial complex.
Source: created by authors.

Functional areas of logistics in the grain production complex of the agro-industrial complex (Fig. 1) is the production of grain, its implementation by grain producers and, accordingly, the purchase of processors, storage of grain, with possible transshipment in ports for export, processing of grain mass for flour, cereals, feed, sale of processed products to the relevant areas of the food industry, for which it is a raw material. Each of the defined functional areas is formed by a set of elements (enterprises and organizations), which is the result of transformational processes in the economy, in order to create logistics chains for efficient movement of material flows from the primary source of raw materials to consumers of final products.

In international practice, the logistics Performance Index (LPI) is used to compare the efficiency of logistics systems between different countries as a result of the functioning of logistics chains [5].

The value in the range from 1 to 5 developed by the World Bank LPI are determined by the evaluation of the following characteristics: the

effectiveness of customs and border clearance procedures; quality of trade and transportation infrastructure (Infrastructure); the level of organizational simplification of international shipments based on competitive prices (International shipments); competence of logistics services (Logistics competence); opportunities for routing and tracking the passage of goods (Tracking & tracing); compliance with delivery dates (Timelessness). The higher the country's LPI, the more developed its integrated logistics system is and the more efficient its logistics chains are.

This index was first used in 2007 and in 2018, according to the results of the monitoring of trends and the degree of development of logistics, Ukraine took the 66th position among 160 countries in the world (Table 1).

The development of logistics in Ukraine is characterized by progressive dynamics, as evidenced by the national index of its efficiency. In 2014, the LPI reached 2.98 points, which secured a place in the world ranking between Argentina (2.99) and Egypt (2.97). Of course, the military actions in the East of Ukraine affected the decrease in the LPI (– 0.24 in 2016), but the assessment of the index in 2018 showed an improvement in the situation with the efficiency of logistics systems in the state. The most developed components of the domestic logistics system, according to experts of the World Bank, are the ability to lay routes and track the passage of goods (3.11 or 52th places), and, accordingly, the timeliness of their deliveries (3.42 or 56th place), and the least developed- the quality of trade and transport infrastructure (2.22) - 119th place among 160 countries in the world covered by the LPI rating research.

Table 1. Rating of Ukraine on the logistics efficiency Index (LPI) among 160 countries in the world (2018)

Rating indicators		2007	2010	2012	2014	2016	2018
Logistic Performance Index (LPI)	**place**	**73**	**102**	**66**	**61**	**80**	**66**
	index	***2.55***	***2.57***	***2.85***	***2.98***	***2.74***	***2.83***
Customs	place	97	135	88	69	116	89
	index	*2.22*	*2.02*	*2.41*	*2.69*	*2.3*	*2.49*
Infrastructure	place	74	79	70	71	84	119
	index	*2.35*	*2.44*	*2.69*	*2.65*	*2.49*	*2.22*
International shipments	place	83	84	83	67	95	68
	index	*2.53*	*2.79*	*2.72*	*2.95*	*2.59*	*2.83*
Logistics competence	place	90	77	61	72	95	61
	index	*2.41*	*2.59*	*2.85*	*2.84*	*2.55*	*2.84*
Tracking & tracing	place	80	112	50	45	61	52
	index	*2.53*	*2.49*	*3.15*	*3.2*	*2.96*	*3.11*
Timeliness	place	55	114	68	52	54	56
	index	*3.31*	*3.06*	*3.31*	*3.51*	*3.51*	*3.42*

Source: Prepared by the authors based on (LPI. Global Rankings, 2018).

To eliminate situational positions and random deviations of individual countries in the annual LPI ratings, consider the weighted average for the last four observations (LPI 2012, 2014, 2016, and 2018). In the world Bank's reporting, this indicator is called the Aggregated LPI (2018) and contains comparisons of 167 countries. Points for each year in each component, according to the World Bank methodology, were calculated with weight values: 6.7% in 2012, 13.3% in 2014, 26.7% in 2016, and 53.3% in 2018. Thus, the latest data have the greatest weight, which more fully reflects the objective state of modern logistics development in countries.

In table 2, we present the top five most developed countries in terms of logistics and the aggregate rating of Ukraine by estimated components [1]. Table 2 also includes rating indicators of countries bordering Ukraine, since neighboring countries are often participants in regional competition for global transit flows.

The Aggregated LPI indicates Ukraine's mediocre position among Eastern European countries, as it is inferior to Poland, Hungary, Slovakia and Romania, but ahead of post-Soviet countries-Russia, Belarus, and Moldova. The world ranking of Aggregated LPI is headed by Germany, which has efficient customs and border clearance (4.09), as well as the best infrastructure (4.38), while Belgium is characterized by extreme ease of organizing international transport (3.97) and timely delivery of goods (4.40).

Among non-European countries, Singapore has a high LPI rating (4.05 points, 5th place), and Afghanistan (2.04), Haiti (2.02) and Somalia (2.00) are recognized as the most unfavorable countries for logistics and forwarding companies, which close the global list.

Table 2. The ranking of countries (selectively) in terms of Aggregated LPI 2012-2018

Country	Place in the ranking	**Logistic Performance Index (LPI)**	**Customs**	**Infrastructure**	**International shipments**	**Logistics competence**	**Tracking & tracing**	**Timeliness**
Germany	1	4.19	4.09	4.38	3.83	4.26	4.22	4.40
Netherlands	2	4.07	3.97	4.23	3.76	4.12	4.08	4.30
Sweden	3	4.07	3.95	4.22	3.88	4.04	4.02	4.32
Belgium	4	4.05	3.74	4.03	3.97	4.10	4.11	4.40
Singapore	5	4.05	4.00	4.14	3.72	4.08	4.05	4.34
Poland	…31	3.50	3.26	3.17	3.57	3.49	3.49	3.94
Hungary	32	3.41	3.18	3.31	3.29	3.27	3.61	3.82
Slovak Republic	…47	3.17	2.94	3.09	3.19	3.13	3.02	3.45
Romania	…50	3.10	2.73	2.86	3.15	3.01	3.19	3.61
Ukraine	**…69**	**2.83**	**2.46**	**2.38**	**2.77**	**2.76**	**3.08**	**3.45**
Russia	…85	2.69	2.25	2.64	2.59	2.74	2.67	3.23
Belarus	…110	2.54	2.29	2.39	2.47	2.53	2.44	3.10
Moldova	…113	2.52	2.31	2.21	2.69	2.39	2.36	3.10

Source: Prepared by the authors based on (LPI. Global Rankings, 2018).

Therefore, the LPI indicator is an integral result of the functioning of logistics chains, which is estimated in the context of all components (Customs, Infrastructure, International shipments, Logistics competence, Tracking & tracing, Timelessness) and to increase it, it is necessary to use the appropriate reserves.

By reserves, we mean the difference between the actual result of the activity and its theoretical value, which is possible if the available resource potential is used as efficiently as possible. The reason for this gap is the influence of many factors that are internal and external to the object of study. Along with this, the combination of certain factors forms specific sources of reserves, which are identified by the results of economic analysis. The analytical study determines the factors that led to the deviation of the result, and identifies the most important directions for improving the system in relation to specific operating conditions.

The influence of factors in production and sales systems is characterized not only by direct, but also by indirect action through a system of more complex factors, which makes it necessary to divide them into explicit and hidden (latent). This section is also related to the complexity of cause-and-effect relationships that determine the nature of their detection. If the amount of explicit reserves can be set based on accounting, statistical and other reporting materials, then the amount of latent reserves, which are much larger, is based on the regular, system and complex analysis of changes in quantitative and qualitative parameters of production through the prism of cause-and-effect relationships.

Reserves are characterized by high dynamism, inexhaustibility and are inherent in all levels of the supply chain. The manifestation of the system properties occurs under the influence of numerous factors that are carriers of influence on the system, causing changes in its indicators.

Reserves act as the degree of possible or actual mobilization of individual factors, and this gives grounds to assert that the classification of factors is the basis for the classification of reserves.

Analysis of the effectiveness of logistics systems in the grain production complex of agro-industrial complex includes a set of elements that are interconnected and interdependent through the logistics chain and focus their activities on obtaining a synergistic effect. At the same time, there are too many mediocre or direct factors and their excessive detail will only complicate the study, without significantly affecting the final result.

To justify our approach in the process of detailing factors, we turn to such a concept of synergetics as a fractal [6, p. 35], that is," ... an object in which the parts are in some way similar to the whole, that is, the individual component parts are self-similar. An example of such an object is a tree branch: while each branch and each successively reduced branch are different, they are qualitatively similar in their structure to the entire tree. Such an object has a fractal dimension." Since the dimension depends on specific conditions, we consider the level of detail chosen by us sufficient for the organization of system studies of structures and functions in the grain production complex of the agro-industrial complex.

Conditionally, all the factors that influence the efficiency of the logistics chains in the grain production complex of the agro-industrial complex can be divided into unmanaged ones that are formed at the macro-and meso-level and require the company to adapt accordingly and managed from the management position of the business entity (micro-level) (Fig. 2).

In the structure of branches of the Ukrainian economy, the grain product subcomplex of the agro-industrial complex is an element of a higher-level system, which is characterized by relationships, structural and organizational integrity. Based on this, it is necessary to find out the set of external factors that affect the efficiency of the logistics chains. The most characteristic factors of influence include (Fig. 2.):

- efficiency of state regulation;
- degree of integration of the subcomplex into global logistics systems;
- level of development of infrastructure support for the grain subcomplex of the agro-industrial complex;

The legislative field regulates the boundaries and competencies of the logistics system and its elements. Indirectly, this factor determines the degree of integration of the national grain subcomplex into the world's logistics systems. The ratification of international agreements and the adoption of legislation adapted to world practice contributes to the international standardization of goods and services and, consequently, the integration of logistics elements into global logistics systems.

The effectiveness of state regulation also includes the state policy of licensing and quotas for foreign economic activity, as well as international obligations and policies of foreign countries regarding preferences for Ukrainian products. The high level of corruption in passing licensing procedures in Ukraine, based on existing legislative contradictions, requires reforming the public administration system, improving the legislative process and distancing it from business, as well as improving the effectiveness of numerous anti-corruption agencies in Ukraine, strengthening the personal responsibility of violators of current legislation and enhancing public control over the activities of customs and border services.

As you know, difficult socio-economic conditions in Ukraine in 2014 against the backdrop of a tense military-political situation and the annexation of Crimea, loss of control over the peninsula's grain terminals and instability and fighting in the South-Eastern regions of the state caused a temporary opening of the European market for Ukrainian

products. The European Union, according to the statement of the European Commission dated 11.03.2014, unilaterally granted Ukraine Autonomous trade preferences and the purpose of these measures was to unilaterally reduce or cancel EU customs duties on goods from Ukraine. The application of Autonomous trade preferences began in may 2014 and continued until November 1, 2014 and was extended until December 2015,until the Ukraine – EU free trade area Agreement has not entered into force as a part of the economic part of the Association Agreement between Ukraine and the European Union.

This friendly step of the European Union gave a significant boost to the development of Ukraine's export potential, especially the export of grain and products of its processing. In particular, in 2014, Ukraine ranked second among the world's countries in terms of grain exports, behind only the United States, and the domestic agricultural sector came out on top in terms of foreign exchange revenues to the state budget, ahead of the traditionally export-oriented metallurgical industry.

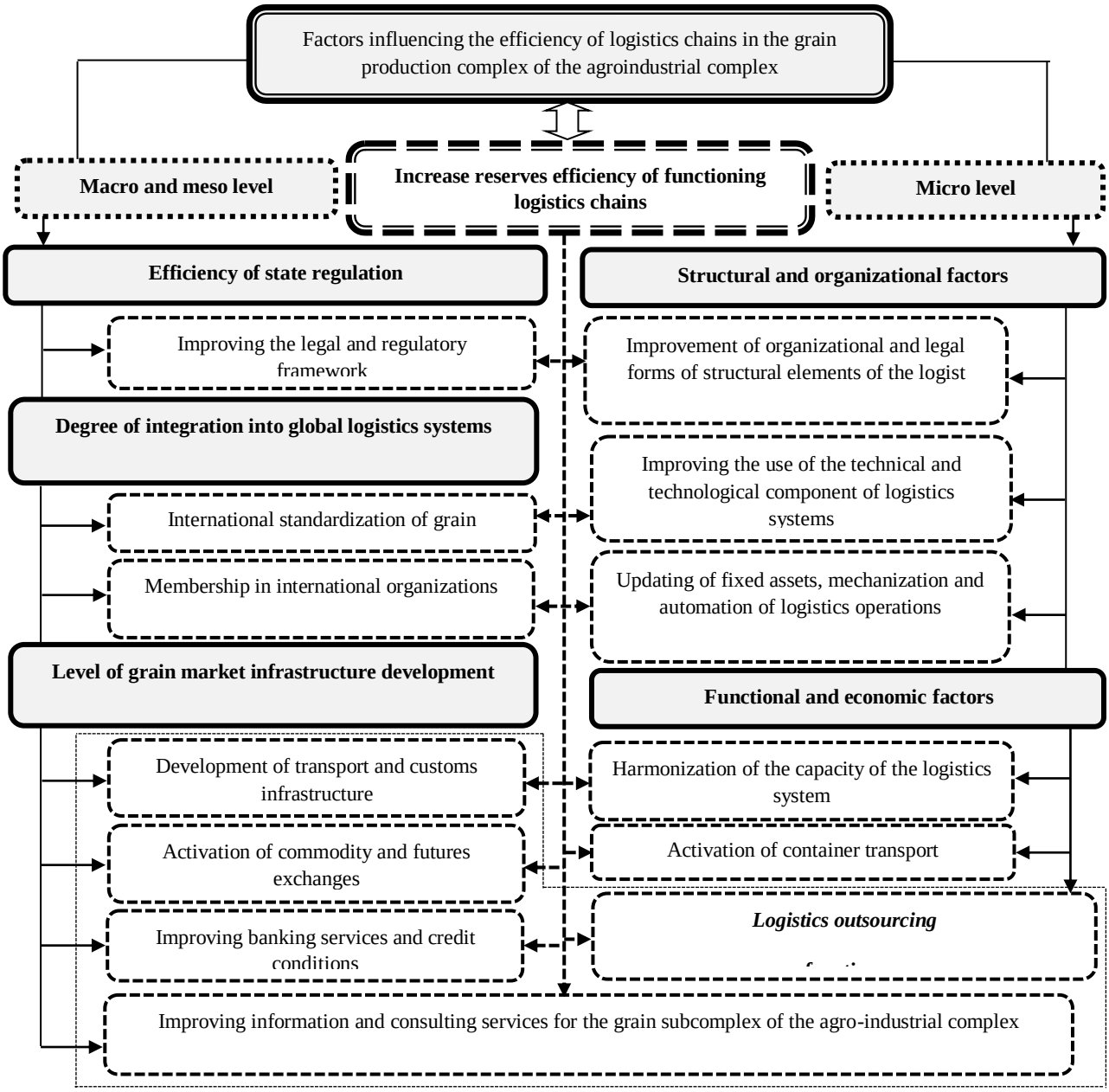

Fig.2. Factors of influence and reserves for improving the efficiency of logistics chains in the grain production complex of the agroindustrial complex
Source: created by authors.

But if in 2014 Ukraine exported 33.4 million tons of grain and products of its processing, in 2015 – 38.3, in 2016-41.5, in 2017 the volume of exports increased to 42.5 million tons [2, p. 40] and this despite the fact that the potential of domestic grain production shows a positive trend: in 2014, 63.9 million tons of cereals and legumes were produced, and in 2016 – 66.1 million tons., and in 2019, the grain harvest grew to a record 74 million tons, and the total revenue amounted to 18 billion US dollars. In calendar year 2018, Ukraine exported grain worth $ 7.2 billion, which is also a record figure and, naturally, the load on the logistics chain has significantly increased.

Full integration of Ukraine's grain market logistics into the global grain market is impossible if the international institutional environment and current rules are ignored, which requires bringing national standards into line with European standards for grain quality assessment.

To unify the quality indicators in the industry section, the corn trade Association was established in 1878, which is now known as the grain and feed trade Association (GAFTA), which defined international rules and principles of grain trade that helped to protect the interests of all participants in trading operations. The uniform rules of the organization are clear and acceptable for both sellers and buyers, and do not require discussions during each transaction. Today, 80 % of the world's grain and feed trade takes place using standard GAFTA contract forms, and the Association itself unites 1,700 members from 90 countries of the world. The principle of the GAFTA system approach to the organization and operation of logistics systems is implemented by the trade security system (GTAS), which covers the entire supply chain - from the agricultural enterprise to the final consumer in any country of the world and establishes uniform rules, thus providing a common international platform for international trade in grain and feed. Since the grain and feed trade Association (GAFTA) plays an important regulatory and supporting role for its members in the system of global grain flows, joining this organization will give national traders a qualitatively new level of functioning of logistics chains [14].

The efficiency of a logistics system depends on the level of development of its infrastructure environment. The infrastructure elements of the grain market and its processing products include transport, commodity and futures exchanges, banking institutions and structures that provide information and consulting services for the grain subcomplex of the agro-industrial complex, as well as insurance, consulting companies, logistics centers, trading houses, road facilities, customs crossings, port and railway infrastructure, and so on. However, the quality of trade and transport infrastructure, which positions Ukraine on the 119th place of the global LPI rating (Table. 1), is the least developed component of domestic logistics. The efficiency of logistics chains is hampered by significant wear and tear and an insufficient number of vehicles and infrastructure facilities.

For example, railway transport is dominant in providing internal grain flows in 2018, 14.5 thousand grain wagons (hoppers) were estimated, with an average age of approximately 26.4 years and only 84% are in satisfactory working condition. The average annual level of cargo routing in Ukraine is only 11 %, which ensures the turnover of wagons within four days and satisfies only 50-60 % of agrotrader requests during peak loads on the grain market. For example, in the United States, the level of rail routing for grain shipments reaches 95 % [18]. The shortage of hoppers forces traders to use road transport to ensure port transshipment of grain, but the average cost of transporting a ton of grain, compared to rail transport, will increase from $ 10 to $ 41.3, and the use of modern heavy grain carriers and the practice of overloading other vehicles significantly destroys Ukrainian roads, since 74 % of them are designed for a maximum load on the car's axle of 6 tons and a total weight of no more than 24 tons. As a result, the problematic issues of functioning of logistics chains are the poor quality of roads, of which 51.1 % do not meet the requirements of international

standards for evenness, 39.2 % - strength, and the average speed of traffic on roads is 2-3 times lower than in Western European countries [16]. One of the reasons for this is that Ukraine provides for an administrative fine of $ 63 for exceeding the weight parameters of vehicles, while in Romania - $ 519-927, Hungary - $ 1,113, and in the UK - $ 6,862 and the carrier in Ukraine is more profitable to save on cyclical traffic by paying a low fine. But in addition to the destruction of roads, the overload of worn-out vehicles increases the risk of their operation and the anthropogenic impact on the environment [11].

The effective use of railway transport in logistics chains on the grain market, especially in ensuring international transit flows and high transport speeds, is hampered by the technological features of the national railway. In Ukraine, the width of railway tracks is 1,520 mm, while in Western Europe the track has 1,435 mm, which requires reloading or replacing the wheels of cars and this causes additional organizational difficulties, time delay and additional costs.

The construction of Euro-tracks in Ukraine is hampered by the following problems:

1)lack of appropriate rolling stock for the width of the European tracks (1,435 mm), as well as a fleet of corresponding locomotives, repair facilities for European track and adapted locomotive depots;

2) the length of domestic rails does not allow to develop high speeds, since the Azovstal Metallurgical plant still produces 25-meter rails, while in Europe the average length of the rail is 100 meters. According to the Ukrainian Institute of the future [7], in order to switch to the European standard, only the Azovstal Metallurgical plant in Ukraine should work on this project for 15-20 years. Thus, the project to build the Euro-track together with the rolling stock will cost $18 billion, which is extremely expensive for the national economy.

The transition of material flows from a dynamic state to a static state is provided by grain storage capacities, which is an integral element of logistics systems. Table 3 presents the logistics characteristics of certified elevators in the regions of Ukraine, which includes storage technologies and physical parameters of cargo transportation in the context of transport modes that provide the dynamics of logistics chains.

The physical and moral obsolescence of the majority of domestic elevators built during the Soviet era significantly hinders the development of logistics in Ukraine and reduces the capacity of logistics chains. For example, in the grain market, most elevators use floor-mounted grain storage technology compared to the tower (Table 3), and this significantly limits the intensity of cargo handling of grain masses. Thus, the average intensity of loading grain into railway cars at large grain elevators in Ukraine is about 12 cars per day, while the optimal one is 54 cars or more [8]. Another problem with elevators is outdated receiving devices that are not able to accept heavy-duty grain trucks, which increases the harvesting time.

So, the factors of macro-and mesolevels functioning of logistics chains create an appropriate environment in which specific economic entities implement their logistics functions. The most significant groups of intra-system factors that influence the efficiency of logistics chains in the grain production complex of the agro-industrial complex include structural, organizational, and functional-economic factors (Fig.1).

The logistics system is formed by organizational structures that are in functional relationships with each other and ensure the movement of material, information, financial and service flows along the logistics chains. The degree of coherence of the entire system depends on the organizational and legal forms of the elements of the formed chain, since various corporations, cooperative associations, vertically integrated agricultural holdings, financial and industrial groups, etc. in addition, there are also structures consolidated around certain ideas or resources that provide end-to-end control of entire functional areas of the material flow from the primary source of raw materials to the final consumer of the finished product. Low-power

enterprises, on the contrary, are more prone to disorganization in system interaction with other elements of the system, since input and output flows for them are predominantly stochastic.

Table. 3. Logistics characteristics of certified grain-saving capacities in Ukraine -Total capacity, of which Storage (t), (as of 01.01.2018)

Region	**Total capacity, thousand tons**	**Storage, thousand tons**		
		outdoor	in silos	in bags
Crimea	988,100	256,400	731,700	0
Vinnytsia	2,376,480	1,043,590	1,302,890	30,000
Volyn	286,820	170,420	116,400	0
Dnipropetrovsk	2,139,430	933,650	1,205,780	0
Donetsk	1,155,033	357,000	798,033	0
Zhytomyr	574,200	214,500	359,700	0
Zakarpattia	19,800	19,800	0	0
Zaporizhzhia	1,356,500	700,850	655,650	0
Ivano-Frankivsk	112,900	40,100	72,800	0
Kyiv	1,498,754	601,150	897,604	0
Kirovohrad	1,621,820	809,700	789,120	23,000
Luhansk	947,900	459,300	488,600	0
Lviv	328,000	199,450	128,550	0
Mykolaiv	1,977,481	1121935	855,546	0
Odesa	2,860,134	1,130,550	1,728,384	1,200
Poltava	2,696,471	993,900	1,656,593	45,978
Rivne	366,500	100,500	266,000	0
Sumy	1,515,440	629,680	848,760	37,000
Ternopil	709,800	333,300	370,700	5,800
Kharkiv	2,201,700	1,021,900	1,179,800	0
Kherson	1,470,921	762,901	708,020	0
Khmelnytskiy	1,053,400	526,400	480,000	47,000
Cherkasy	1,829,823	874,713	890,110	65,000
Chernivtsi	203,700	58,200	65,500	80,000
Chernihiv	1,196,700	600,465	406.235	190,000
Total	**31,487,807**	**13,960,354**	**17,002,475**	**524,978**

Source: Compiled from reports of enterprises.

The presented features explain the desire of dynamically developing companies to take control of all enterprises that ensure the movement of material flow through logistics chains. Over time, the owner of a processing plant will become increasingly interested in controlling the supply of raw materials for its own production by building branches or purchasing complete enterprises, or controlling their activities through the acquisition of equity stakes in the stock market. On the other hand, the position of the processor in the market will be more definite and predictable if it has its own sales network. Thus, the growth of the Corporation's scale of activity is due to attracting new investors by issuing, placing and selling shares, or through the mechanism of reorganization of the joint-stock company by merging or joining, it is motivated by the desire of corporate owners to gain maximum control over all enterprises that are involved in moving the material flow from the raw material base to the final consumer through the system of processing, storage, distribution, and trade. Accordingly, the effectiveness of the logistics system will depend on the degree of coherence of its constituent elements, and this degree is largely determined by the organizational and legal form of each participant in the logistics chain.

The material and technical base of enterprises and the degree of its use has a significant impact on production efficiency. The process of improving and developing the material and technical base can be extensive by building the capacity of fixed assets and intensive – by improving the efficiency of their use.

Among the functional and economic factors (Fig. 1) improving the efficiency of logistics activities in the grain production complex of the agro-industrial complex, we allocate

reserves related to the harmonization of the capacity of the logistics system, activation of container transport and outsourcing of logistics functions.

Table 4. Logistics characteristics of certified grain-saving capacities in Ukraine -Reception capacity (t), (as of 01.01.2018)

Region	**Receiving power, thousand tons / day**	**Reception, thousand tons / day**			
		Road transport	railway transport	ships	barges
Crimea	66,140	40,410	26,700	2,000	6,000
Vinnytsia	115,490	101,600	24,460	0	0
Volyn	15,190	10,350	5,540	0	0
Dnipropetrovsk	92,970	63,730	30,140	0	0
Donetsk	62,280	41,590	30,650	0	0
Zhytomyr	25,170	22,300	5,620	0	0
Zakarpattia	570	150	420	0	0
Zaporizhzhia	61,238	47,080	15,408	0	0
Ivano-Frankivsk	5,800	3,800	2,000	0	0
Kyiv	87,236	56,656	23,420	0	0
Kirovohrad	71,390	62,050	15,290	0	0
Luhansk	27,000	18,720	11,270	0	0
Lviv	13,530	9,730	4,160	0	0
Mykolaiv	149,070	94,450	37,420	10,000	11,000
Odesa	256,170	133,890	153,120	18,500	8,500
Poltava	135,032	116,092	25,940	0	0
Rivne	19,920	13,800	6,520	0	0
Sumy	64,690	50,710	15,980	0	0
Ternopil	26,350	21,650	4,840	0	0
Kharkiv	85,435	62,340	25,395	0	0
Kherson	65,930	50,370	14,060	800	2,900
Khmelnytskiy	53,170	41,920	13,860	0	0
Cherkasy	84,841	72,251	15,990	0	2,000
Chernivtsi	6,930	4,000	2,030	0	0
Chernihiv	41,490	30,930	11,160	0	0
Total	**1,633,032**	**1,170,569**	**521,393**	**31,300**	**30,400**

Source: Compiled from reports of enterprises.

The formation of logistics chains creates favorable conditions for the consolidation of efforts of all elements in the direction of creating a synergistic effect. The implementation of system functions will be effective if the nominal power of the entire system is provided. The total capacity of the system according to the “limiting factor " principle is determined by the parameters of the weakest link, and if in the logistics chain that provides the production of raw materials, their transportation, storage, processing, and sale of processed products, there are capacity constraints due to a lack of technical resources, organizational failures, or administrative barriers, then the entire system will certainly reduce its potential to the parameters of a weak link.

In the process of analyzing material flows, it is necessary to distinguish between their characteristics such as power and intensity. If power is determined by the volume of output that is moved per unit of time, then the intensity is the intensity of its movement. The first indicator depends on the capacity of the weakest link in the logistics system, and in conditions of discrete material flows, it is possible to increase the capacity of the system by increasing its intensity. For example, if the load capacity of vehicles does not provide transportation of all cargo volumes, it is necessary to increase the frequency of shipments. So, to evaluate the logistics system in the grain subcomplex of the agro-industrial complex, we introduce the concept of functional capacity, this means that it is

possible to move the corresponding amount of material flow due to the nominal power of the system components, or if it is insufficient – by increasing the cyclical movement of flows.

Table 5. Logistics characteristics of certified grain-saving capacities in Ukraine -Shipment capacity (t), (as of 01.01.2018)

Region	**Capacity of shipment, thousand tons / day**	**Shipment, thousand tons / day**			
		Road transport	railway transport	ships	barges
Crimea	65,805	16,675	17,820	37,000	7,000
Vinnytsia	82,500	46,230	42,340	0	0
Volyn	12,140	8,200	4,440	0	0
Dnipropetrovsk	83,845	43,260	41,585	3,000	3,000
Donetsk	57,190	23,880	25,410	13,000	3,000
Zhytomyr	24,280	15,330	11,180	0	0
Zakarpattia	350	150	200	0	0
Zaporizhzhia	53,848	31,320	21,568	2,160	5,960
Ivano-Frankivsk	3,800	1,860	1,940	0	0
Kyiv	80,083	38,765	47,198	0	0
Kirovohrad	62,290	41,010	28,940	0	0
Luhansk	22,545	12,725	12,730	0	0
Lviv	12,760	7,350	6,280	0	0
Mykolaiv	188,030	31,930	30,890	90,000	58,500
Odesa	300,870	82,630	109,740	201,600	26,500
Poltava	112,212	76,662	76,860	0	11,000
Rivne	16,460	8,650	8,110	0	0
Sumy	52,748	26,460	27,268	0	0
Ternopil	20,600	11,620	9,380	0	0
Kharkiv	70,564	31,964	42,050	0	0
Kherson	68,331	27,000	19,181	18,400	0
Khmelnytskiy	34,390	20,060	22,550	0	0
Cherkasy	74,881	43,511	33,970	0	5,000
Chernivtsi	5,110	2,380	2,730	0	0
Chernihiv	35,540	18,820	18,130	0	0
Total	**1,541,172**	**668,442**	**662,490**	**365,160**	**141,660**

Source: Compiled from reports of enterprises.

Ensuring optimal functional capacity of logistics chains can be achieved by using container transport of grain cargo using twenty - (TEUis a conditional global unit of measurement of the capacity of cargo vehicles) or forty-foot containers. We remind that one TEU is equivalent to the useful volume of a standard intermodal ISO container 20 feet long (6.1 m), 8 feet wide (2.44 m), and 8.25 feet high (2.59 m).

According to the operational data of the Ukrainian Sea Ports Authority (USPA), 1 million 3.5 thousand TEU containers were handled in the ports during the whole of 2019, which is more than 18% higher than in 2018, and for the second year in a row, Ukraine shows significant growth, this is several times higher than the global average in the container transport market.

According to USPA data, export and import of containers in 2019 were distributed almost equally, with a small advantage of imports – 48.6% and 46.8%, respectively. The positive dynamics of exports is provided by the containerization of food products and, first of all, grain cargoes. This is also facilitated by the introduction of an electronic consignment note and the launch of other digital services that can significantly speed up the speed of cargo transportation, as well as the inclusion of Ukrainian ports in the routes of ocean services (Bosphours Express Service, ZIM Med Pacific, ECUMED, Middle East).

The ports of Odesa, Pivdennyi and Chornomorsk became the leaders in container

transshipment, while the port of Pivdennyi increased the transshipment of container cargo in 2018 by 75%, and the port of Odesa-by 15%. In 2019, 15 powerful global shipping companies were present in Ukrainian seaports, with a total share of 99.5% in the global container shipping market. The top three are Maersk Line, CMA CGM, and MSC, which provided 53.5% of the total container market in Ukraine.

Ukraine ranks 61st in the world in terms of Logistics competence (Table 1), which is caused by the lack of competence of transport operators and customs brokers, as well as the underdevelopment of logistics outsourcing in the country. Qualitative changes in the information infrastructure have expanded the range of use of management tools, which is called the PL (*Party Logistics* – logistics side) concept, which is based on the degree of involvement of other companies to solve business problems in the interests and on behalf of the customer of logistics services.

The following functions are outsourced in international practice: warehousing – 73.7%; external transportation-68.4 %; cargo/payment processing – 61.4 %; internal transportation –56.1 %; cargo consolidation/distribution – 40.4%; direct transportation-38.6%.

In General, foreign industrial and commercial enterprises annually spend 120-140 billion euros on contract logistics, which indicates the scale of logistics outsourcing in the international economy.

In Ukraine, there are almost no 4PL and 5PL operators of logistics services, which is due to the non-availability of logistics outsourcing. In particular, in the state, 89% of the outsourcing market consists of transport services, 8% – storage, and only 3% – forwarding and supply chain management [19]. In the development of 4PL-and in the future 5PL-operators of logistics services, which are practically absent in Ukraine, as well as in improving educational services in the field of logistics, we see a way to improve the Logistics competence component in particular, and LPI-in General.

The implementation of the functional capacity of logistics chains is provided by the use of special systems for transport management, in particular, TMS (Transport Management System). This system provides comprehensive automation of transport management and helps to move cargo much more efficiently, and in combination with the warehouse management system, you can get a full-fledged supply chain management system that is necessary for making the right decisions that stimulate further reduction of logistics costs.

CONCLUSIONS

A linearly ordered set of participants in the logistics process forms logistics chains, the effectiveness of management of which is determined by the ability to implement the target function of the logistics system – to deliver to the consumer the necessary quantity of products of appropriate quality in a certain place and at a set time with the specified logistics costs.

To assess the effectiveness of logistics chain management, it is advisable to use an internationally recognized evaluation indicator - the logistics efficiency index (LPI), which was developed and implemented by the world Bank. The methodology takes into account the evaluation of six indicators: "*Customs*"; "*Infrastructure*"; "*International shipments*"; "*Logistics competence*"; "*Tracking & tracing*"; "*Timeliness*". The higher the country's LPI, the more developed its integrated logistics system is and the more efficient its logistics chains are. The most attractive components of the domestic logistics system are the ability to lay routes and track the passage of goods, and, accordingly, the timeliness of their deliveries, but there is a relatively insufficient quality of trade and transport infrastructure.

The development of measures to improve the efficiency of logistics chains in grain products subcomplex of agroindustrial complex must be preceded by an assessment of possibilities and ways of influence of factors macro-, meso – and microlevels of a system of generators

of its formation, which may result in an improvement in its performance. The factors selected on the basis of using heuristic methods for justifying decisions have a fractal dimension and, by aggregating key influences on the logistics system, are sufficient for organizing system studies of structures and logistics functions in the corresponding chain of the grain-product sub - complex of the agro-industrial complex.

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