

Assessment of Perspective Development of Transport and Logistics Systems at Macro and Micro Level under the Conditions of Industry 4.0 Integration

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Summary

The change of the development of transport and logistics systems occurs with the active change of technology and the advent of the era of Industry 4.0. It requires modernization of approaches to the development of transport and logistics systems at the macro and micro levels. The present study aims to identify perspective directions of development and evolution, find out the existing obstacles in the integration of technological solutions of transport and logistics systems at the macro and micro levels. This study is based on a quantitative and qualitative methodology for assessing the level of integration of technologies into transport and logistics systems to study the prospects for their development at the micro level. Macroeconomic indicators of transport and logistics in the context of different regions of the world were used to quantify the development prospects. For a qualitative assessment of the development of the transport and logistics system, the case study method was used. The object of the study was selected logistics company Sensco Logistics Inc., Austin TX. At the macro level, countries with more innovative logistics sectors have stronger mechanisms for coordinating private sector activities. Simplification of administrative procedures of control and regulation by the public sector in order to facilitate trade between countries is a promising direction for the development of transport and logistics systems. Such reforms are more effective in developing a “rigid” transport infrastructure. The integration of Industry 4.0 technology solutions into the international logistics sector is defined by political and legal barriers, especially in developing countries. In low-income countries, hard and soft infrastructure reforms are hindering the development of logistics companies that provide transport services. This determines the national level of development of transport and logistics systems, and in general the global level of development of transport and logistics. In developed countries, the legal barriers to the development of new technological logistics are environmental requirements for the integration of technologies into the transport system. These trends are slowing down the development of

International Logistics, which, compared to other industries, is slower to integrate Industry 4.0 technologies.

This study combines macroeconomic factors that determine the prospects for the development of transport and logistics systems at the micro level.

Key words:

Transport and Logistics System, Logistics 4.0, Integration of Technologies into Logistics, Technological Solutions of Logistics Companies.

1. Introduction

The development of transportation and logistics systems at the macro and micro levels is associated with the rapid integration of technologies of the fourth industrial revolution (Industry 4.0). Organizations are transforming operational business models through the introduction of ICT tools and tools into transport and logistics management subsystems. Industry 4.0 has contributed to the introduction of innovations in the supply chain by changing the business architecture, technologies, and processes. This made it possible to increase the level of productivity in logistics, the level of flexibility and scale of operation of transport and logistics systems, to introduce analytics and smart things in the supply chain [1]. Startups are radically changing existing operating business models using a business-oriented approach. Logistics is part of supply chain management (SCM), which allows you to effectively plan, implement, control the flow of goods and services, transfer information between companies, partners and customers to meet customer requirements [2]. The logistical dimensions of Industry 4.0's potential in this sector are the management system, material flows and information flows. In these dimensions can be integrated software products, technological solutions Industry 4.0 [3].

Taking into account certain trends in the transformation of transport and logistics systems, it is advisable to identify

promising areas of development and evolution, existing obstacles in the integration of technological solutions at the micro level in terms of integration of technological solutions of Industry 4.0.

The present study aims to identify perspective directions of development and evolution, find out the existing obstacles in the integration of technological solutions of transport and logistics systems at the macro and micro levels.

2. Literature Review

In the scientific literature, the development of transport and logistics systems is considered at the macro and micro levels. Mainly, the problems of transport and logistics functioning at the International and national levels are studied through the examining of the dynamics of the Logistic Performance Index (LPI) developed in 2007 by the World Bank [4].

The analysis of scientific literature indicates an emphasis on the potential for the development of transport and logistics systems through the transformation of organizations at the micro level. The methodology of such research includes the development of maturity models for logistics organizations to assess the level of integration of various technologies [5; 6; 7].

Another category of research is the assessment of logistics development at the macro level, which is based on indicators of logistics development and indicators of the development of technical and technological factors that determine the development of the international logistics sector.

“Logistics is the planning, organizing and coordinating of the flow of materials, information, energy, money and values inside a logistic system” [8]. In today's environment, the main purpose of transport and logistics systems - product delivery on time. Technologies ensure timely delivery flexibility, planning and coordination, reducing interaction between producer and end consumer. Forasmuch as Industry 4.0 technology applications are integrated into transport and logistics systems to provide flexibility, competitiveness and speed, the term “Logistic 4.0” is increasingly discussed in the scientific literature. “The Logistic 4.0 connects production with consumption using artificial intelligence and digitizes the supply chain” [9]. Logistic 4.0 is the basis of the “smart supply chain”; “Smart solutions” are integrated into transport and logistics systems, ensuring the development of national logistics as a branch of the economy. As a result, entire national and international transport markets are being formed [10].

“The drive towards Logistics 4.0 as an element of Industry 4.0 gives possibilities for new business models” [11]. Automated solutions (Applications), instant information exchange, real-time big data are the main features of Logistic 4.0 that enable new business models growth.

It is expected that the further development of Industry 4.0 will lead to the integration of “destructive innovations” in transport and logistics systems. The possibilities of using Industry 4.0 in production logistics depend on the development of factors of the production environment [11]. Technology integration of Industry 4.0 determines the financial and economic condition of logistics organizations [12]. Technology is replacing many business processes related to management, coordination, material and information flows [13]. Logistics companies are transforming businesses through the following most common technologies: e-commerce, electronic data interchange (EDI), Internet, web search applications [14], mobile systems, big data, cyber-physical systems [15], Internet of Things application [2], blockchain applications [16], Social networking applications, Email and E-branding programs [17], Application control [12].

3. METHODOLOGY

This study is based on a quantitative and qualitative methodology for assessing the level of integration of technologies into transport and logistics systems to study the prospects for their development at the micro level. Macroeconomic indicators of transport and logistics in terms of different regions of the world were used to quantify the development prospects. To qualitatively assess the development of the transport and logistics system, a case study technique was used, which provides a “detailed and in-depth study of a specific case” [18]. The object of the study was selected by the logistics company Sensco Logisitics Inc., Austin TX, which is part of the international transport and logistics system. Qualitative methodology also included content analysis of the website of Sensco Logisitics Inc., Austin TX to study the state of integration of technologies into activities, the effects of the implementation of technological solutions.

To assess the prospects for the development of transport and logistics systems, the following macroeconomic indicators were analyzed:

- Logistics performance index: Overall (1 = low to 5 = high) and sub-indices for 2007-2018 according to the World Bank to analyze the current state of transport and logistics systems.
- The Global Internet of Things (IoT) value in the logistics market to study the factors that affect the prospects for transport and logistics in different regions.
- The market share and CAGR of IoT segments.
- GDP growth annual, %.
- Transport services (% of commercial service exports).
- Transport services (% of commercial service imports).

4. RESULTS

Enterprises, operating on the international market, face various logistical constraints and opportunities. The main trends include:

- change of production system: from production for a warehouse (Make-to-Stock) to production to order (Make-to-Order). For managers of manufacturing companies operating around the world, the main task is to master the production of the product in accordance with individual customer requirements;
- change in the distribution of goods. At this level there is a coordination of the traditional structure of sellers with direct sales through the logistics company;
- mergers and consolidation of trade and suppliers. Logistics plays an important role in realizing the potential synergy effect in the field of procurement, supply, receipt of goods, distribution or e-logistics;

– quantitative trends, namely a decrease in the number of suppliers. Three-quarters of international companies plan to reduce the number of their suppliers in the next five years. During sales, the reduction of delivery times remains relevant;

– impact of e-business on logistics. Business processes within the B2C concept involve the automation of more intensive delivery, because customers' expectations to reduce delivery times are higher than with conventional methods of ordering.

In general, in 2007-2018, logistics productivity increased by 0.126 globally (Table 1) [19].

Different dynamics were observed in different regions of the world: the most progressive development of logistics took place in North America (index 3.8), Eurozone (3.5) and European Union (3.5). However, logistics averages 2,866 (2018) and show a significant gap between developed countries, developing countries and the least developed countries, where the LPI is 2,388.

Table 1: Logistics performance index: Overall (1=low to 5=high)

Region	2007	2010	2012	2014	2016	2018	Growth, +/-
Central Europe and the Baltics	2,965	3,094	3,093	3,317	3,303	3,215	0,250
East Asia & Pacific	3,024	3,112	3,139	3,184	3,137	3,148	0,124
Europe & Central Asia	3,081	3,192	3,187	3,257	3,226	3,240	0,160
Eurozone	3,491	3,508	3,483	3,578	3,658	3,531	0,040
European Union	3,407	3,443	3,450	3,543	3,593	3,519	0,112
Latin America & Caribbean	2,570	2,741	2,708	2,769	2,664	2,664	0,095
Least developed countries: UN classification	2,250	2,379	2,363	2,402	2,385	2,388	0,138
Middle East & North Africa	2,686	2,849	2,798	2,814	2,887	2,784	0,098
North America	3,880	3,865	3,890	3,887	3,961	3,810	-0,070
South Asia	2,296	2,488	2,581	2,607	2,623	2,510	0,214
Sub-Saharan Africa	2,347	2,422	2,456	2,461	2,470	2,450	0,102
World	2,740	2,866	2,871	2,894	2,884	2,866	0,126

The dynamics of LPI depends on various factors. Competence in the provision of logistics services and the quality of services affect the international logistics sector as a whole, identifying strengths and weaknesses. The countries of North America, the Eurozone and the European Union, Europe and Central Asia are characterized by a high value of the sub-index "Competence and quality of logistics

services". East Asia and the Pacific have also improved the quality of services and the level of competence in logistics over ten years.

Among the influencing factors the dynamics of LPI: economic growth, development of transport services (Table 2) [20].

Table 2: Dynamics of annual GDP growth in terms of regions of the world, 2007-2019

Country Group	2007	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change, 2019-2007, +/-
Central Europe and the Baltics	6,39	1,57	3,25	0,77	1,25	3,04	3,93	3,05	4,79	4,42	3,69	-2,70
East Asia & Pacific	6,48	7,07	4,61	4,69	4,77	4,19	4,20	4,09	4,76	4,17	3,76	-2,72
Europe & Central Asia	3,68	2,62	2,40	0,32	0,90	1,83	2,08	1,92	2,77	2,17	1,50	-2,17
Eurozone	3,00	2,13	1,69	-0,89	-0,25	1,40	2,11	1,91	2,54	1,92	1,28	-1,72
European Union	3,15	2,20	1,84	-0,74	-0,06	1,58	2,36	2,05	2,73	2,15	1,52	-1,63
Latin America & Caribbean	5,51	5,85	4,37	2,78	2,78	0,99	0,09	-0,34	1,77	1,57	0,83	-4,68
Least developed countries: UN classification	8,26	5,93	4,35	4,77	5,81	5,59	3,63	4,02	4,86	4,42	4,41	-3,85
Middle East & North Africa	5,17	5,05	3,68	3,89	2,71	2,91	2,38	4,96	1,72	2,38	1,81	-3,36
North America	2,34	2,61	1,70	2,20	1,89	2,49	2,66	1,51	2,31	2,84	2,27	-0,07
South Asia	7,33	7,70	5,14	5,50	6,09	6,99	7,48	7,78	6,83	6,10	4,83	-2,50
Sub-Saharan Africa	6,56	5,40	4,74	3,96	5,00	4,66	2,84	1,24	2,55	2,41	2,28	-4,28
World	4,32	4,30	3,14	2,52	2,66	2,85	2,88	2,59	3,26	3,04	2,48	-1,85

Economic growth had slowed during 2007-2019, particularly within Europe, Central Asia, especially the countries of Eurozone (up to 1.28% in 2019) and EU (1.52% in 2019), Latin America, North America, the Middle East & North Africa. Instead, the least developed countries, the countries of South Asia, show higher and stable GDP growth rates (4.41% and 4.83%, respectively, in 2019). Along with the economic slowdown, the share of exports of transport services from commercial exports of services has decreased (Table 3) [21; 22]. Herewith, the

share has decreased by an average of 4.88% due to a decrease in East Asia & Pacific, Europe & Central Asia, Eurozone, European Union, Latin America & Caribbean, Middle East & North Africa, North America and South Asia. Instead, in the least developed countries, the indicator increased to 15.26% in 2018. Such dynamics will determine the geography of location of transport and logistics systems in the future: developing countries will ensure the growth of services due to low transport costs.

Table 3. Dynamics of exports and imports of transport services of regions of the world, in terms of 2007-2019

Transport services (% of commercial service exports)	2007	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change, 2019-2007, +/-
Central Europe and the Baltics	25,92	26,68	26,62	26,85	27,35	27,14	27,20	27,07	27,65	27,32	1,39
East Asia & Pacific	30,75	24,63	24,93	23,22	21,95	21,29	19,12	19,58	19,13	18,98	-11,77
Europe & Central Asia	24,21	23,32	22,79	21,93	21,75	21,53	21,03	21,31	21,53	21,20	-3,01
Eurozone	23,07	21,73	21,01	19,70	18,89	18,70	18,01	18,35	18,67	18,35	-4,73
European Union	24,07	22,74	22,14	20,98	20,27	20,02	19,26	19,55	19,86	19,57	-4,50
Latin America & Caribbean	20,76	19,83	18,57	18,66	17,51	17,58	17,36	14,95	15,30	12,86	-7,90
Least developed countries: UN classification	11,27	14,03	13,40	15,35	14,72	17,16	15,71	15,10	15,26	-	-
Middle East & North Africa	-	32,47	31,45	29,00	27,19	23,89	27,65	27,97	-	-	-
North America	14,81	13,93	13,78	13,35	13,15	12,53	12,12	12,10	12,17	11,80	-3,01
South Asia	15,61	17,02	16,55	15,71	15,48	12,87	12,43	11,63	11,82	11,35	-4,26
Sub-Saharan Africa	31,46	29,75	28,50	27,18	25,28	29,02	26,06	19,34	18,69	-	-

World	24,85	22,93	22,61	21,51	20,82	20,33	19,50	19,47	19,39	18,75	-6,10
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Similar dynamics of exports of transport services: the share of commercial exports of services decreased overall by 7.49% , in particular the largest reduction occurred in the following countries: East Asia & Pacific, Europe & Central

Asia, Euro area, European Union, Latin America & Caribbean, South Asia. The share of the least developed countries increased to 52.32% (Table 4).

Table 4: Dynamics of imports of transport services by region of the world, in terms of 2007-2019

Transport services (% of commercial service imports)	2007	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change, 2019-2007, +/-
Central Europe and the Baltics	25,20	24,22	24,62	23,87	24,26	23,92	23,86	24,63	25,25	25,18	-0,02
East Asia & Pacific	33,20	30,67	29,96	28,40	25,57	23,81	22,33	22,95	23,12	21,99	-11,20
Europe & Central Asia	24,52	23,60	23,26	21,50	20,69	20,01	19,96	20,07	20,45	19,77	-4,75
Eurozone	24,32	23,75	23,23	21,87	20,91	20,44	20,16	20,27	20,51	19,90	-4,41
European Union	24,91	24,03	23,65	22,41	21,53	21,05	20,71	20,86	21,11	20,58	-4,33
Latin America & Caribbean	38,72	35,75	35,20	34,37	34,43	32,13	31,05	31,48	32,58	31,83	-6,89
Least developed countries: UN classification	50,24	53,10	53,77	53,28	51,77	54,89	52,01	52,93	52,32	-	-
Middle East & North Africa		38,48	39,91	38,96	36,76	35,73	33,85	-	-	-	-
North America	23,15	20,54	20,22	20,74	20,53	20,49	19,78	19,61	20,15	19,57	-3,58
South Asia	46,68	29,26	27,37	26,14	27,57	26,38	22,03	22,04	22,32	23,68	-23,00
Sub-Saharan Africa	42,18	41,31	44,61	44,25	43,30	43,12	42,41	38,80	39,92	-	-
World	29,13	26,90	26,54	25,25	24,05	23,07	22,25	22,31	22,65	21,63	-7,49

Therefore, economic growth and convergence in the level of economic development of countries contributes to the development of transport and logistics systems and logistics in general. Ease of delivery at competitive prices is determined by technological factors, including the level of use of Industry 4.0 applications. This sub-index as a whole is 2,830 in the world; in North America, Europe and Central Asia, the Eurozone and the European Union, this figure is the highest, while in North America it is declining. The frequency with which goods arrive at the consignee during the planned or expected time, compared to other sub-indices, varies in the context of regions to a higher value. The highest indicator is observed in North America, Eurozone, European Union, Europe and Central Asia. Over the past ten years, the figure fell in the Eurozone by 0.070 points, as well as in North America by -0.130 points. The ability to track consignments is a key indicator of the ability of Industry 4.0 applications to develop international logistics. In general, the indicator is growing and is 2,901, which indicates the average level of logistics efficiency in the context of providing information about goods. In developed

countries, the rate is growing, but weakly, while in developing countries, it is growing faster. The efficiency of the customs clearance process is also determined by the ability of Industry 4.0 applications and technologies to influence the efficiency of international logistics. In general, developed countries are characterized by a higher level of efficiency of the customs control process, while developing countries are characterized by weak development. In general, it can be concluded that developed countries are more progressive in the use of technologies and applications of Industry 4.0, but the dynamics of logistics efficiency in developed countries is very weak. While developing countries, especially Asia, have had higher growth rates in the last ten years. The convergence of countries in terms of logistics efficiency took place in 2007-2014 due to the improvement of infrastructure, which is more supportive of trade in low-income countries. In high-income countries, there is less convergence, including convergence in customs and border control and logistics services. In 2016, the gap between developed and developing countries widened. The

efficiency of logistics is determined by the reliability of the supply chain. The recipient wants to have confidence in the supply chain in a global environment. Many shippers may pay more for a higher level of reliability, which can reduce delivery speeds. This means that the predictability of the supply chain depends on the cost, time and quality of delivery.

Analysis of macroeconomic trends allows us to understand the reasons for the development of transport and logistics as industries that are slowly integrating technology (including IoT) compared to other industries. Business process automation ensures the development of logistics and quality of transport services. This determines the level of productivity of logistics companies, forming new competitive advantages and innovative business models. However, the main barriers to the development of transport and logistics systems are the cost of technology integration, the cost of application integration and the cost of maintenance [23]. This significantly hinders the development of technology logistics companies and systems. IoT costs in 2015 were \$10 billion for transportation and logistics companies. Transparency market research promoted by the manufacturer's PR service indicates that the "Global Internet of Things (IoT) in the logistics market is projected to reach \$ 63,728.6 million by

2026. USA, due to the exponential growth of the use of IoT applications in logistics" [24].

The global growth of IoT integration in the logistics sector is segmented by categories: software, hardware, organization size, application types and regions. The software market is divided into traffic management and fleet management, energy and resource monitoring, security and other segments. The equipment includes such segments as RFID tags, screen / display, beacons and others. Depending on the size, logistics organizations are divided into large, medium and small organizations. The application segment includes warehouse, cargo, fleet, site and others. The logistics market is also segmented into North and South America, Asia-Pacific, Europe, the Middle East and Africa. According to the global connected logistics market report 2016 by Technavio, "the global connected logistics market" will grow by 30% for CAGR [25]. In 2015, software services accounted for 37.41% of the total market and CAGR is expected to account for 29.88% by 2020 (Figure 1). In 2015, the hardware segment accounted for 29.86% of the global connected logistics market, and is expected to grow by 25.64% in 2020. In 2015, IT services took second place after software services with a total cost share of 32.73%, the share of IT services will be the fastest growing segment until 2020 with a CAGR of 32.8%.

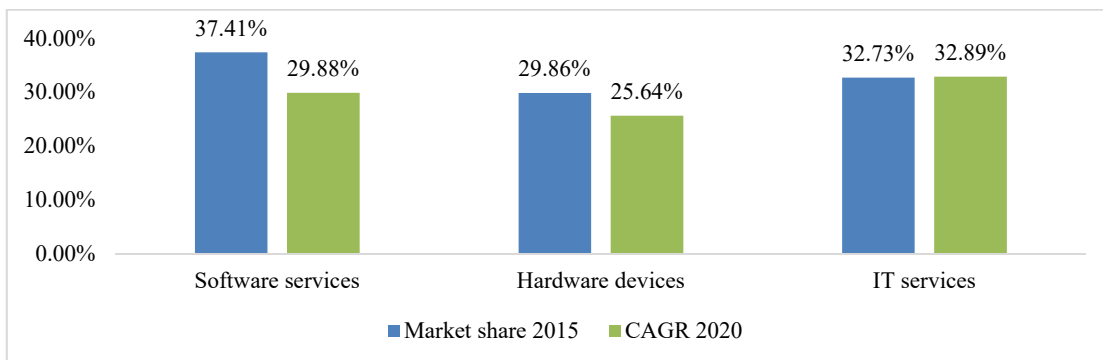


Figure 1. The market share and CAGR of IoT segments

North America is expected to lead the Global Internet of Things (IoT) market in the logistics market. The Internet of Things requires active and flexible IT support, which is available to most logistics companies in the region. This factor will be the basic one in the development of transport and logistics systems. North America dominates the global IoT logistics market, primarily due to the wider adoption of logistics solutions. The Asia-Pacific IoT logistics market is expected to grow rapidly due to increased internet usage and increased digitalization. In addition, the markets of Europe, the Middle East, Africa and South America are expected to show strong growth.

The Global Internet of Things (IoT) in the logistics market is largely determined by alliances between industry players. For example, in October 2017, IBM acquired Vivant Digital, a small digital consulting firm in Sydney. The acquisition met the growing needs of customers looking to deliver digital transformation through innovative business models and improved customer service. The key players presented in the report include Cisco Systems Inc., Octonion SA, Kaa IoT Technologies, LLC., NEC Corporation, Honeywell International, Novire Technologies, SAP SE, Intel Corporation, Oracle Corporation, Bosch Software Innovations GmbH, Rockwell Automation, Inc, BICS SA /

NV, Amazon Web Services, International Business Machine (IBM) Corporation and PTC Inc. [26].

One of the drivers for the growing of the logistics market and transport services is the increasing level of using the Internet of things and intelligent applications, the growing demand for the ability to effectively manage temperature-sensitive products, and, accordingly, high levels of waste. The future of the global connected logistics market is the Internet of things, integrated solutions, data and mobility. Sensco Logisitcs Inc. was founded in 2017 and is part of the freight forwarding services industry. Sensco Logistics Inc. has 2 employees in all its locations and generates 0.116297 million annual sales (US dollars). The company offers integrated solutions and provides value to the consumer based on an approach to sustainability. The company provides freight forwarding and customs brokerage services and organizes transportation without owning equipment or assets. The US freight forwarding industry is fragmented into: the 50 largest companies account for about a third of revenue. Average growth of the industry in 2014–2019: 3.6%. The market size is 146 billion dollars, and the number of enterprises is 115,699.

Compared to competitors, the company's share in market income is very small. The US freight forwarding industry includes about 21,000 institutions (single-place firms and multi-place divisions) with total annual revenues of about 60 billion dollars.

Sensco Logisitcs Inc. operates in a competitive US freight forwarding market, and various factors have a positive effect on the company's activities.

The analysis of Industry 4.0 indicators that affect the company's performance is based on an analysis of the content of the company's website, which contains information about the technologies used to provide customers with integrated solutions and Value-Added Services. The following Industry 4.0 technologies were identified:

- E-mail application;
- ERP system;
- Cloud technology;
- Electronic commerce based on Web-site;
- Network Management solution based on custom-developed technology.

The company cooperates with shippers in the food and beverage industry, consumer and industrial goods, paper and packaging, etc. The company connects customers with the sales team. Technological Solutions for Supply Chain Management help customers manage transport and logistics processes during forwarding services via various communication routes (air, sea, rail, and road).

The company's advantages include automated online ranking and routing tools, relationships with experienced carriers and contract management, shipment visibility, and management reporting. The Network Management solution includes full online tracking of products from the place of departure to the destination and a complete document visualization system for instant access to all customs documents (Table 5).

Table 5. Industry 4.0 Application (devices and solutions implementation)

	Level of implementation	Effect
E-mail Application	Integrated	Fast automated connection with customers
ERP system	Integrated	Automated control of contract and sales
Cloud technology	Integrated	Automated
Electronic commerce (Web site)	Managing	Automated documents saving, quick access to documents and information anywhere
Network Management solution based on custom-developed technology	Managing	Improving information flow and freight control
Complete online tracking from origin to destination	Integrated	Automated freight control
Complete document imaging system for instant access to all customs documents	Integrated	Automated access to documents

Based on a literature review and analysis of the company's website, financial performance, and market performance, the industry maturity model 4.0 was developed. Almost all digital solutions are integrated into business processes, which ensures efficiency and revenue growth. Since the beginning of its activity, the company's revenue has been stable and amounts to 116,297 thousand dollars annually (see Figure 2).

Research of the state of development of the transport and logistics system on the example of Sensco Logisitcs Inc. at the micro level, makes it possible to draw the following conclusions:

1. Industry 4.0 improves company productivity by fully integrating technology into the company's business processes.

2. Industry 4.0 is changing the business models of logistics companies by introducing technologies into the management system, business processes related to material and information flows.

3. Thanks to the introduction of technologies in the logistics company, efficiency increases and costs are reduced.

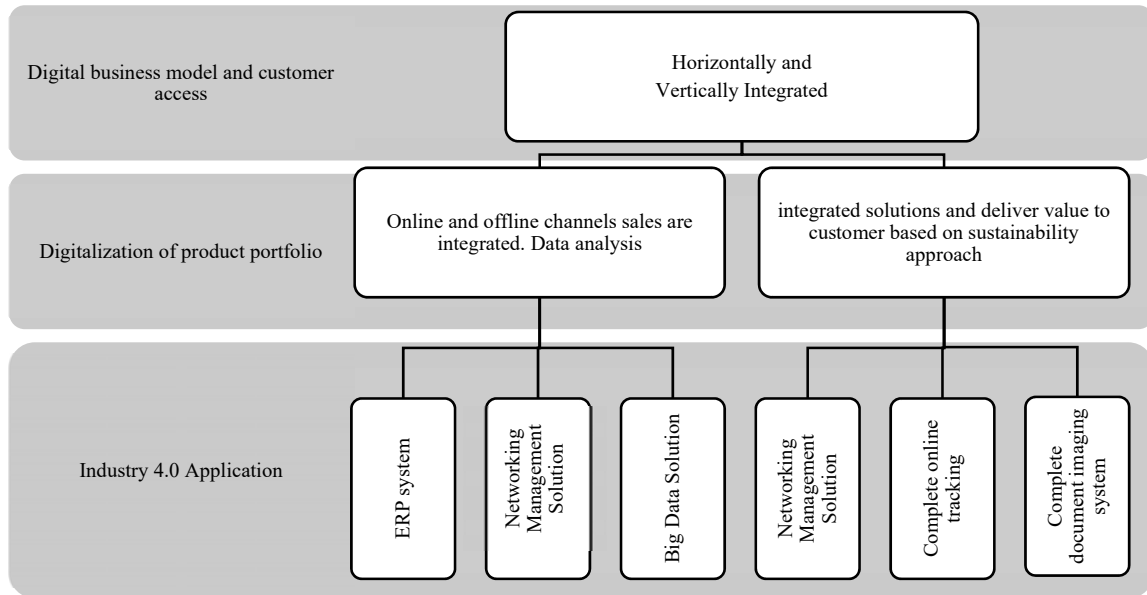


Fig. 2. Industry 4.0 application model for Sensco Logisites Inc.

4. Activities of Sensco Logisites Inc. characterized by income stability due to the following factors: investment, growth of trade agreements, increase in freight traffic, sale of e-commerce, industrial production, increased consumer spending, rapid digitization, logistics solutions.

5. Sensco Logisites Inc. fully integrated Industry 4.0 programs. As a result, a new operating business model was formed, which fully ensures revenue stability and automation of business processes.

5. DISCUSSION

Innovative technologies in logistics are developing rapidly. Various innovations are aimed at improving the management of logistics processes, reaching a higher level of cooperation with consumers, meeting their needs, as well as reducing costs [1]. The main objective of Industry 4.0 is to radically transform traditional procedures into smart procedures. In particular, the goal in the logistics and transport system is aimed at creating communication within the new open networks, where data is exchanged not only among people, but also among technology without human intervention. Today, storage and transportation systems are being improved in many countries around the world, and new system programs for operations management are being created [9]. Some technologies in logistics can pose both

opportunities and threats, forasmuch as the different areas in it are interconnected without clear boundaries between them. The most important advantages of the implementation of Industry 4.0 are as follows: increased flexibility, quality standards, efficiency and productivity. Merenkov includes the following basic principles of digital technology development in the transport and logistics system through the prism of Industry 4.0, namely: ensuring free flow of information; complexity of services; development of a service ecosystem in transport; new services for operators and carriers; changes in delivery services.

Despite the rapid integration of Industry 4.0 applications into international logistics, there are many obstacles to the implementation of technologies related to technological readiness, institutional readiness, infrastructure development and other areas. For example, blockchain integration requires the following demands: (i) taking into account gradual changes rather than radical disruptions in implementation teams; (ii) excluding high-volume data and transactional uses, as this will slow down the blockchain and reduce its efficiency; and (iii) creating a “sandbox” for pilot implementation and risk understanding of blockchain projects [27]. Twydell S. identifies common factors in the transport and logistics system that are barriers to progress, namely: unions that advocate for the labor

rights of those who are fired due to business automation; tax authorities and governments that aim to raise taxes if people work fewer hours. Obstacles to the development of the transport and logistics system in the context of the integration of Industry 4.0 can be overcome by creating a technology platform. There is also a need to develop a comprehensive basis taking into account the interests of all areas of the transport sector.

Despite recent advances in various technologies, supporting Industry 4.0, transport and logistics companies should take the following steps to reduce risks, namely:

- in case of cyberattacks the widespread use of digital devices should be applied that exchange data through various operating and information systems; it can be vulnerable to cyberattacks;

- incorrect data - innovative operating devices are able to probe, collect, exchange, analyze data, etc., however, interference in their system may fail, which leads to a violation of the transport and logistics system at the macro level;

- safety rules - the use of advanced robotics and automated controlled vehicles in production, robotic systems in automated warehousing and search operations, as well as autonomous trucks and drones in delivery operations require the safety of workers and the public;

- privacy issues - the use of sensors, which in many places record visual images, sounds, movements of different people; they need to be regulated at the legislative level in order to carry out the collection and storage of confidential data for public safety.

Ben-Daya, Hassini & Bahroun summarized the main problems of development of transport and logistics systems related to Internet of Things technologies: the scalability of the Internet, identification and access to billions of “things”, heterogeneity of “things” and service paradigms; security and privacy issues; issues of management and trust; resource efficiency in terms of computing and energy consumption in addition to the classic scalability issues [28]. Therefore, technology Industry 4.0 in the international logistics sector solve many problems in the field of logistics, but there are new threats and challenges. The integration of applied technologies of Industry 4.0 requires the development of infrastructure, legislation, institutions at the national level. At the organizational level, all subsystems of integrated technologies must be coordinated. The presence of many factors, obstacles, and challenges for the integration of Industry 4.0 technology applications makes it difficult to assess their capabilities in the field of international logistics.

6. CONCLUSION

At the macro and micro levels, countries with more innovative logistics sectors have stronger mechanisms for coordinating private sector activities. Therefore, in developed countries, the productivity of material and technical support of transport and logistics systems is high. The competitiveness of transport and logistics, the ability to integrate Industry 4.0 technologies depend on the influence of the public sector through the development of the institutional environment. At the same time, the private sector provides a large share of logistics services. Simplification of administrative procedures of control and regulation by the public sector in order to facilitate trade between countries is a promising direction for the development of transport and logistics systems. Technological solutions of Industry 4.0. will contribute to this. Such reforms are more effective in developing a “rigid” transport infrastructure.

The integration of Industry 4.0 technology solutions into the international logistics sector is determined by political and legal barriers, especially in developing countries. In low-income countries, hard and soft infrastructure reforms are hindering the development of logistics companies that provide transport services. This determines the national level of development of transport and logistics systems, and in general the global level of development of transport and logistics. In developed countries, the legal barriers to the development of new technological logistics are environmental requirements for the integration of technologies into the transport system. These trends are slowing down the development of international logistics, which, in comparison with other industries, is slower to integrate Industry 4.0 technologies.

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