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e-mail: support@smart-scm.org

тел.: (063) 593-30-41
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# INTRODUCTION

We are happy to invite you to get acquainted with the first issue of the new scientific and practical publication "Intellectualization of Logistics and Supply Chain Management".

We strongly believe that the launch of this magazine indicates the objective need to rethink a wide range of issues related to the development of theory and practice in logistics and supply chain management, awareness of the need to unite the scientific community and logistics practitioners, dissemination of modern knowledge and best practices for innovative development of the logistics services market.

The first issue of the magazine is published at a difficult time. The global coronavirus pandemic and the deep economic crisis have significantly worsened business activity in the world. Currently, global supply chains are collapsing, international trade is declining, and competition between global and regional logistics operators is intensifying. The most common thesis is that the world will never be the same again. Industry experts predict the emergence of new, more flexible and adaptive supply chain management strategies and approaches to logistics business process management. The trend towards collaborations, cooperation and unification of services is emerging, comprehensive proposals for clients are being developed. There is increasing talk about the need to build bimodal supply chains, which involves the development of different decision-making scenarios: the traditional approach - cost-effective efficiency, low risk, high predictability; a new approach "second mode" - rapid recognition of opportunities, adaptability, willingness to solve unexpected problems and look for new opportunities.

Radical transformations of the global and national markets for logistics services require appropriate scientific support. Logistics science has a special role to play in this process. Initiating the emergence of a new journal, we decided to focus on its coverage of problematic aspects of the formation and development of logistics systems at the micro, mezo and macro levels, supply chain management, digitization of logistics, methods and tools for optimizing processes in logistics and supply chains, sociopsychology relations and network interaction of enterprises using cloud technologies, artificial intelligence, e-learning, neural business process management systems, etc.

Therefore, we invite scientists, researchers and business representatives, as well as our colleagues from abroad, to cooperate and present the results of scientific research, to discus and debate on them, to work together to develop the scientific theory of logistics and promote mutual intellectual enrichment.

We hope that the new scientific publication will become a theoretical guide for young researchers and representatives of other fields.

***HRYHORAK Mariia***
*Chief Editor*

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**Bugayko D.O.** PhD in Economics, Associate Professor, Acting Director International Cooperation and Education Institute, Instructor of ICAO Institute of National Aviation University (Ukraine)

**ORCID** – 0000-0001-9901-4792
**Researcher ID** –
**Scopus author id:** –

**Shevchenko O.R.** PhD in Economics, Director of International Cooperation and Education Institute, National Aviation University (Ukraine)

**ORCID** –
**Researcher ID** –
**Scopus author id:** –

# INDICATORS OF AVIATION TRANSPORT SUSTAINABLE DEVELOPMENT SAFETY

***Dmytro Bugayko, Olha Shevchenko "Indicators of air transport sustainable development".*** *World leaders gathered at the United Nations (UN) and adopted the 2030 Agenda for Sustainable Development. It is a plan of action aimed at achieving global sustainable development in economic, social and environmental areas, which ensures that no UN member state is left behind. The 17 sustainable development goals on the 2030 Agenda can be used as benchmarks for the coordinated development of UN member states. Aviation safety is an important component of the concept of general national security, the system of personal security, ecological and public safety and transport safety from external and internal threats. Maintaining an acceptable level of national aviation safety is a priority for the industry. The aviation transport is a part of the transport complex of Ukraine, which is an important component in the structure of the national economy and a link between all components of economic security to ensure the basic conditions of life and development of the state and society. The assessment of economic, technological, safety, social and ecological hazards is an integral part of all the logical blocks of the structural and functional scheme of strategic management of aviation safety in terms of sustainable development of the national economy. The task of the article is to determine and substantiate the main indicators of economic and technological development, safety, social and environmental components of air transport and assess their level. In the article the authors propose and present the dynamics in the period from 2010 to 2020 of 29 indicators of sustainable development of air transport of Ukraine, such us share of aviation transport in the gross value added (transport and communications); level of investment in aviation transport; level of export services of air transport; level of import services of aviation transport; level of shadowing of aviation transport; coefficient of manufacturability of aviation transport; capital utilization coefficient; level of shadow capital load; level of use of passenger capacity of aircraft and helicopters; level of renewal of fixed assets; cargo transport capacity of GDP by aviation transport; passenger transport capacity of GDP by aviation transport; average distance of cargo aviation transportation; average distance of passenger aviation transportation; ratio of domestic and international aviation transportation; catastrophes, accidents,*

*serious coefficients for regular commercial/irregular commercial/non-commercial flights and execution of aviation works/training flights; level of wages in the production of aviation transport; level of employment in air transport; coefficient of population mobility; level of official GVA created by shadow wages; level of shadow employment; level of CO2 emissions of aviation transport of Ukraine to GDP; level of emissions of pollutants into the atmosphere; level of environmental costs of aviation transport. Authors determine their threshold and optimal values. Indicators are given in groups in the above areas. Indicators are divided into stimulants (indicators that contribute to the sustainable development of air transport and the national economy) and disincentives (indicators that hinder the sustainable development of air transport and the national economy). The solution of this problem will make it possible to conduct a comprehensive assessment of the current state of air transport in Ukraine on the basis of a systematic approach.*

***Keywords**:* aviation transport, aviation safety, hazards, disincentives indicators, risks, stimulants indicators, sustainable development.

***Дмитро Бугайко, Ольга Шевченко "Показники сталого розвитку повітряного транспорту".*** *Світові лідери зібрались в Організації Об'єднаних Націй (ООН) та прийняли Порядок денний сталого розвитку до 2030 року. Це план дій, спрямований на досягнення глобального сталого розвитку в економічній, соціальній та екологічній сферах, який гарантує, що жодна держава-член ООН не залишиться позаду. 17 цілей сталого розвитку, викладених у Повістці дня на 2030 рік, можуть бути використані як орієнтири для скоординованого розвитку держав-членів ООН. Безпека авіації є важливою складовою концепції загальної національної безпеки, системи особистої безпеки, екологічної та громадської безпеки та безпеки транспорту від зовнішніх та внутрішніх загроз. Підтримання прийнятного рівня національної авіаційної безпеки є пріоритетом для галузі. Авіаційний транспорт є частиною транспортного комплексу України та важливою складовою в структурі економіки країни та сполучною ланкою між усіма складовими економічної безпеки для забезпечення основних умов життя та розвитку держави та суспільства. Оцінка економічних, технологічних, соціальних та екологічних загроз є невід'ємною частиною всіх логічних блоків структурно-функціональної схеми стратегічного управління авіаційною безпекою з точки зору сталого розвитку національної економіки. Завдання статті - визначити та обґрунтувати основні індикатори економічного та технологічного розвитку, безпеки, соціальних та екологічних складових повітряного транспорту та оцінити їх рівень. У статті автори пропонують та представляють динаміку за період з 2010 по 2020 роки 29 показників сталого розвитку повітряного транспорту України, визначають їх порогові та оптимальні значення. Показники наводяться групами у вищезазначених областях. Показники поділяються на стимулятори (показники, що сприяють сталому розвитку повітряного транспорту та національної економіки) та де стимулятори (показники, що заважають сталому розвитку повітряного транспорту та національної економіки). Вирішення цієї проблеми надасть можливість провести комплексну оцінку сучасного стану повітряного транспорту в Україні на основі системного підходу.*

***Ключові слова:*** авіаційний транспорт, безпека авіації, загрози, індикатори стимулятори, ризики, індикатори дестимулятори.

***Дмитрий Бугайко, Ольга Шевченко "Показатели устойчивого развития воздушного транспорта".*** *Мировые лидеры собрались в Организации Объединенных Наций (ООН) и приняли Повестку дня устойчивого развития до 2030 года. Это план действий, направленный на достижение глобального устойчивого развития в экономической, социальной и экологической сферах, который гарантирует, что ни одно государство-член ООН не останется позади. 17 целей устойчивого развития, изложенных в Повестке дня к 2030 году, могут быть использованы в качестве ориентиров для скоординированного развития государств-членов ООН. Безопасность авиации является важной составляющей концепции общей национальной безопасности, системы личной безопасности, экологической и общественной безопасности и безопасности транспорта от внешних и внутренних угроз. Поддержание приемлемого уровня национальной авиационной безопасности является приоритетом для отрасли. Авиационный транспорт является частью транспортного*

*комплекса Украины и важной составляющей в структуре экономики страны и связующим звеном между всеми составляющими экономической безопасности для обеспечения основных условий жизни и развития государства и общества. Оценка экономических, технологических, социальных и экологических угроз является неотъемлемой частью всех логических блоков структурно-функциональной схемы стратегического управления авиационной безопасностью с точки зрения устойчивого развития национальной экономики. Задача статьи - определить и обосновать основные показатели экономического и технологического развития, безопасности, социальных и экологических составляющих воздушного транспорта и оценить их уровень. В статье авторы предлагают и представляют динамику за период с 2010 по 2020 годы 29 показателей устойчивого развития воздушного транспорта Украины, определяют их пороговые и оптимальные значения. Показатели приводятся группами в вышеупомянутых областях. Показатели делятся на стимуляторы (показатели, способствующие устойчивому развитию воздушного транспорта и национальной экономики) и дестимуляторы (показатели, мешающие устойчивому развитию воздушного транспорта и национальной экономики). Решение этой проблемы позволит провести комплексную оценку современного состояния воздушного транспорта в Украине на основе системного подхода.*

***Ключевые слова:*** авиационный транспорт, безопасность авиации, угрозы, индикаторы стимуляторы, риски, индикаторы дестимуляторы.

**1. Introduction.** The 17 sustainable development goals on the 2030 Agenda can be used as benchmarks for the coordinated development of UN member states [1]. The aviation industry is an open system that is affected by a wide range of ecological, technical, natural, human and economic hazards. For its part, it itself is a generator of significant threats to the environment. Therefore, we cannot imagine the aviation industry outside the search for answers to the latest global challenges. The main challenges for aviation are to develop air transportations at the national, regional and global levels, in order to ensure economic, social and environmental priorities [2, 3].

Figure 1 shows a Structure of Strategic Management of Aviation Transport in the conditions of sustainable development of national economy.

The article is a logical continuation of a number of publications devoted to the introduction of a systematic approach to determining the level of sustainable development and development of advanced risk management system for air transport safety management of Ukrainian scientists D. Bugayko [4 - 6], YM Kharazishvili [4 - 7], A. Antonova [6], M. Hryhorak [5], Poland (Z. Zamiar [5 - 6]) and other countries. Statistical data for the calculation of indicators of sustainable development of aviation transport are taken from the following statistical sources of the State Statistics Service [8], Ministry of Infrastructure [9], the Civil Aviation Authorities [10] and National Bureau for the Investigation of Aviation Accidents and Incidents with Civil Aircraft of Ukraine [11-17].

**2. The purpose of the article** is to determine and substantiate the main indicators of economic and technological development, social and environmental components of air transport and assess their level. Indicators are given in groups in the above areas. Indicators are divided into stimulants (indicators that contribute to the sustainable development of air transport and the national economy) and disincentives (indicators that hinder the sustainable development of air transport and the national economy). The solution of this problem will make it possible to conduct a comprehensive assessment of the current state of air transport in Ukraine on the basis of a systematic approach.

**3. Indicators of sustainable development of air transport.**

**3.1. Economic and technological development of aviation transport**

**3.1.1. Economic development of aviation transport**

*(1S)*. The share of aviation transport in the gross value added (transport and communications), %. *This indicator is a stimulant*. The growing share of aviation transport in the transport and communications indicates the development of population mobility and aviation logistics. The indicator is a catalyst for the tourism sphere, industry, services.

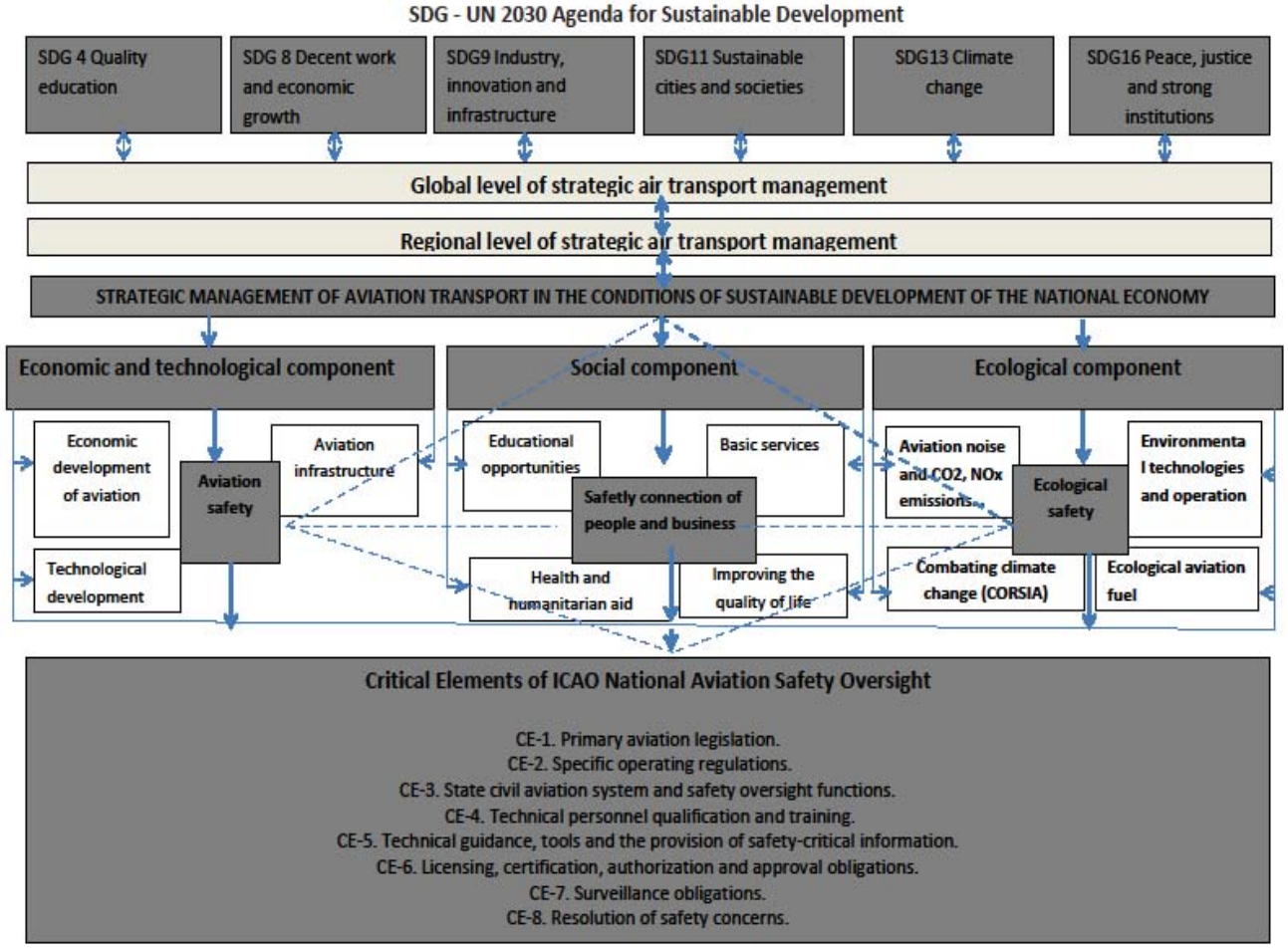


**Figure 1. Structure of Strategic Management of Aviation Transport in the conditions of sustainable development of national economy.**

Source: Bugayko D.O., Kharazishvili Yu.M. Theoretical bases of aviation branch strategic safety management in the context of maintenance of sustainable development of national economy. Bulletin of Economic Science of Ukraine. 2020. № 1 (38). Pp. 166-175. Institute of Industrial Economics of the National Academy of Sciences of Ukraine, Academy of Economic Sciences of Ukraine. doi: https://doi.org/10.37405/1729-7206.2020.1(38).166-175 10 [3].

*(2S)*. The level of investment in aviation transport, share of air transport in the transport and communications, %. *This indicator is a stimulant*. Air transport is a high-tech mode of transport that requires significant investment, primarily for the renewal of the modern fleet of aircraft and the development of air transport. This indicator is especially important during the crisis related to the COVID 19 coronavirus pandemic.

*(3S)*. Level of export services of aviation transport, % of total exports of transport services. *This indicator is a stimulant*. The growth of air transport export services is a guarantee of synergistic growth of the export potential of the national economy, primarily

such as tourism, international logistics and supply-chain management. The indicator promotes the development of population mobility and expansion of domestic goods in foreign markets.

*(4D)*. Level of import services of aviation transport, % of total import of transport services. *This indicator is disincentive*. The growth of imported air transport services actually increases the level of entry of foreign goods into the domestic market and the growth of the national level of imported services. On the other hand, it has hidden positive aspects, such as the development of national tourism and services in the country. Thus, the classical attitude to this indicator, as a one hundred percent distimulator, is seen as somewhat biased, but entitled to life.

*(5D)*. Level of shadowing of aviation transport, % of official gross value added. *This indicator is disincentive*. Unfortunately, the shadowing phenomena cause undeniable damage to the national financial system and require the development of adequate measures to counteract this negative phenomenon.

The dynamics of indicators of economic development of air transport in the period from 2010 to 2020, as well as their threshold and optimal values are shown in Table 1.

Table 1. Dynamics of indicators of air transport economic development in the period from 2010 to 2020, their threshold and optimal values.

| | 1-S | 2-S | 3-S | 4-D | 5-D |
|---|---|---|---|---|---|
| | Share of aviation transport in the gross value added, % | The level of investment in aviation transport, % | Level of export services of aviation transport, % | Level of import services of aviation transport, % | Level of shadowing of aviation transport, % |
| 2010 | 2,0776 | 18,3535 | 15,0849 | 37,9686 | 1,26 |
| 2011 | 2,4491 | 16,9168 | 16,5847 | 43,0896 | 8,62 |
| 2012 | 2,7161 | 13,4484 | 17,7067 | 37,1248 | 12,59 |
| 2013 | 2,4436 | 10,0576 | 16,0511 | 37,4934 | 15,04 |
| 2014 | 2,5658 | 7,3576 | 17,5562 | 31,3140 | 23,42 |
| 2015 | 2,6871 | 8,1554 | 16,2189 | 40,4835 | 22,56 |
| 2016 | 3,5170 | 5,1096 | 16,6454 | 36,1331 | 31,28 |
| 2017 | 4,4651 | 6,9949 | 18,6265 | 37,2936 | 32,91 |
| 2018 | 5,6342 | 5,4952 | 20,8772 | 47,4959 | 38,38 |
| 2019 | 6,8826 | 4,3890 | 18,4932 | 45,5090 | 41,29 |
| 2020 | 4,3698 | 5,0256 | 18,6567 | 44,4444 | 41,01 |
| Lower threshold | 5 | 11,60 | 19 | 36 | 25 |
| The lower optimal | 6,6 | 12,8 | 24,5 | 29 | 15 |
| The top optimal | 8,5 | 14,6 | 39,5 | 16 | 10 |
| Upper threshold | 10,8 | 17,7 | 48,6 | 10,8 | 5 |
| Ratioing factor | 11 | 20 | 50 | 50 | 50 |

**3.1.2. Technological development of aviation transport**

*(1S)*. Coefficient of manufacturability of aviation transport. *This indicator is a stimulant*.

The growth of manufacturability is the key to improving operational efficiency.

*(2S)*. Capital utilization coefficient. *This indicator is a stimulant*. The loading of capital is the basis for the development of new activities of air transport, updating its material and technical base.

*(3D)*. Level of shadow capital load, % of official load. *This indicator is disincentive*.

*(4S)*. The level of use of passenger capacity of aircraft and helicopters, % *This indicator is a stimulant*. The level of use of passenger capacity of aircraft and helicopters is one of the key indicators of the economy of air transport. It indicates the load factor, which directly affects the economic result of each individual flight, and the complex activities of air carriers. Along with the yield factor, it is the main tariff-forming factor in the airline's commercial operation.

*(5S)*. The level of renewal of fixed assets, %. *This indicator is a stimulant*. As already mentioned, air transport is a high-tech mode of transport that requires constant updating of fixed assets. In aviation, this process is much faster, as modern fixed assets are the key to improving efficiency and reducing the cost of air transportation.

The dynamics of indicators of technological development of air transport in the period from 2010 to 2020, as well as their threshold and optimal values are shown in Table 2.

Table 2. Dynamics of indicators of technological development of aviation transport in the period from 2010 to 2020, their threshold and optimal values

| | 1-S | 2-S | 3-D | 4-S | 5-S |
|---|---|---|---|---|---|
| | Coefficient of manufacturability, non-dim | Capital utilization coefficient, non-dim | Level of shadow capital load, % | The level of use of passenger capacity, % | The level of renewal of fixed assets, % |
| 2010 | 0,513209 | 0,8337 | 0,5960 | 71 | 11,552 |
| 2011 | 0,500918 | 1,051 | 4,2508 | 74 | 14,106 |
| 2012 | 0,465701 | 1,1422 | 5,9649 | 77 | 11,046 |
| 2013 | 0,475095 | 0,9753 | 7,4540 | 81 | 7,334 |
| 2014 | 0,464306 | 0,8981 | 12,5418 | 76 | 5,272 |
| 2015 | 0,456612 | 0,9401 | 11,7851 | 82 | 7,767 |
| 2016 | 0,457196 | 1,1713 | 19,3369 | 82 | 5,302 |
| 2017 | 0,458502 | 1,4885 | 21,1926 | 83 | 9,698 |
| 2018 | 0,460573 | 1,6949 | 29,5071 | 84 | 9,170 |
| 2019 | 0,458 | 1,8122 | 45,8017 | 87 | 8,554 |
| 2020 | 0,458002 | 1,021 | 41,9747 | 56 | 5,206 |
| Lower threshold | 0,47 | 0,87 | 17 | 70 | 4 |
| The lower optimal | 0,51 | 1,1 | 10 | 80 | 6,6 |
| The top optimal | 0,56 | 1,44 | 7 | 90 | 10 |
| Upper threshold | 0,65 | 2,1 | 3,5 | 100 | 15 |
| Ratioing factor | 0,65 | 2,1 | 50 | 100 | 15 |

3.1.3. Aviation infrastructure

*(1S)*. Cargo transport capacity of GDP by aviation transport (the ratio of air transport turnover to GDP). *This indicator is a stimulant*. In the air freight forecasting model, ICAO indicates a direct link between cargo turnover

and national GDP. The growth of air traffic is a catalyst for the growth of the runway due to the development of export / import operations and the logistics sector of the state.

*(2S)*. Passenger transport capacity of GDP by aviation transport (ratio of passenger turnover to GDP). *This indicator is a stimulant*. The growth of air passenger traffic is also a catalyst for the growth of GDP, including through the development of business, international relations, tourism, services.

*(3S)*. Average distance of cargo aviation transportation (ratio of cargo turnover to volume of cargo transportation). *This indicator is a stimulant*. The increase in the average distance of cargo transportation indicates the development of the geography of freight traffic and, indirectly, the growth of revenue due to the establishment of higher tariffs for longer-distance transportation.

*(4S)*. Average distance of passenger aviation transportation (ratio of passenger turnover to the volume of passenger transportation). *This indicator is a stimulant*. The growth of the average distance of passenger transportation indicates the development of the geography of passenger traffic and, indirectly, the growth of revenue due to the establishment of higher tariffs for longer-distance transportation.

*(5S)*. Ratio of domestic and international aviation transportation. *This indicator is a stimulant*. The development of domestic transport indicates an increase in population mobility, increasing public confidence in air transport. Creation of a national regional airline relies on the strategy of revival of domestic aircraft construction for the period up to 2030.

The dynamics of aviation infrastructure indicators in the period from 2010 to 2020, as well as their threshold and optimal values are shown in Table 3.

Table 3. Dynamics of aviation infrastructure indicators in the period from 2010 to 2020, their threshold and optimal values

| | 1-D | 2-D | 3-S | 4-S | 5-S |
|---|---|---|---|---|---|
| | Cargo aviation transport capacity of GDP t.km / $ | Passenger aviation transport capacity of GDP pass.km / $ | Average distance of cargo aviation transportation km | Average distance of passenger aviation transportation km | Ratio of domestic and international aviation transport-tation non-dim |
| 2010 | 0,002941 | 0,080882 | 4315 | 1794 | 0,187042 |
| 2011 | 0,002448 | 0,084443 | 4023 | 1835 | 0,125 |
| 2012 | 0,002276 | 0,08192 | 2960 | 1777 | 0,1375 |
| 2013 | 0,001637 | 0,068736 | 2753 | 1547 | 0,1754506 |
| 2014 | 0,001499 | 0,086914 | 3044 | 1789 | 0,1109719 |
| 2015 | 0,002197 | 0,125205 | 3053 | 1803 | 0,1100211 |
| 2016 | 0,002142 | 0,166023 | 3048 | 1876 | 0,1073521 |
| 2017 | 0,002674 | 0,181837 | 3325 | 1928 | 0,0978834 |
| 2018 | 0,002596 | 0,197949 | 3428 | 2066 | 0,0946086 |
| 2019 | 0,001885 | 0,193933 | 3192 | 2219 | 0,092126 |
| 2020 | 0,001577 | 0,078542 | 3022 | 1142 | 0,0921168 |
| Lower threshold | 0,001824 | 0,07978 | 2475 | 1800 | 0,1274 |
| The lower optimal | 0,001552 | 0,06686 | 2963 | 1900 | 0,1774 |
| The top optimal | 0,001108 | 0,03634 | 3665 | 2200 | 0,2429 |
| Upper threshold | 0,000611 | 0,01875 | 4462 | 2300 | 0,3126 |
| Ratioing factor | 0,0032 | 0,22 | 4500 | 2300 | 0,32 |

### 3.1.4. Aviation safety

#### 3.1.4.1. Regular commercial, non-scheduled commercial and non-commercial flights

For regular commercial, irregular commercial and non-commercial flights accident rates are calculated by the formula:

$$Kt = N \times 100\,000 / T \quad (1)$$

where,

N - number of aviation events;

T - flight of hours for the analyzed period;

100,000 - comparison criterion, 100,000 flight hours [11 - 17].

*(1D).* Catastrophes coefficient (regular commercial, irregular commercial and non-commercial flights (Ukraine)). *This indicator is disincentive.*

*(2D).* Accidents coefficient (regular commercial, non-scheduled commercial and non-commercial flights (Ukraine)). *This indicator is disincentive.*

*(3D).* Serious incidents coefficient (serious incidents) (regular commercial, non-scheduled commercial and non-commercial flights) (Ukraine)). *This indicator is disincentive.*

Catastrophes, accident and serious incidents coefficients for regular commercial, non-scheduled commercial and non-commercial flights are unambiguous negative indicators, the very presence of which confirms the saying that, unfortunately, aviation transport is not an ideal system in which we cannot talk about the absolute, but only about an acceptable level of safety. In terms of the scale of the negative impact, they are increasing from 3 D to 1 D, but the increase in the number of serious incidents creates the basis for probable accidents and catastrophes. These indicators are carefully researched on an ongoing basis by the National Bureau for the Investigation of Aviation Incidents and Incidents with Civil Aircraft of Ukraine.

Dynamics of aviation safety indicators for commercial, irregular commercial and non-commercial flights in the period from 2010 to 2020, as well as their threshold and optimal values are shown in Table 4.

Table 4. Dynamics of indicators of aviation safety indicators for regular commercial, irregular commercial and non-commercial flights in the period from 2010 to 2020, their threshold and optimal values [11 - 17].

| | 1-D | 2-D | 3-D |
|---|---|---|---|
| | **Catastrophes coefficient, non-dim** | **Accidents coefficient non-dim** | **Serious incidents coefficient, non-dim** |
| 2010 | 0,3500 | 0,3500 | 2,3024 |
| 2011 | 0,3500 | 0,3500 | 1,8151 |
| 2012 | 0,3500 | 0,3500 | 2,1488 |
| 2013 | 0,7565 | 1,1629 | 0,8165 |
| 2014 | 0,8375 | 0,3500 | 2,8476 |
| 2015 | 0,3500 | 0,3500 | 0,4100 |
| 2016 | 0,3500 | 0,3500 | 2,1132 |
| 2017 | 0,3500 | 0,7226 | 1,5278 |
| 2018 | 0,6920 | 0,6920 | 1,7779 |
| 2019 | 0,6882 | 0,6882 | 1,0864 |
| 2020 | 1,1118 | 0,3500 | 0,4100 |
| Lower threshold | 1,1561 | 1,5592 | 2,4254 |
| The lower optimal | 0,7531 | 0,7531 | 0,8131 |
| The top optimal | 0,3500 | 0,3500 | 0,4100 |
| Upper threshold | 0,3500 | 0,3500 | 0,4100 |
| **Ratioing factor** | **1,2** | **1,6** | **3** |

**3.1.4.2. Execution of aviation works and training flights**

For aviation work and training flights accident rates are calculated by the formula:

$$Kt = N \times 10\,000 / T \quad (2)$$

where,

N - number of aviation events;

T - flight of hours for the analyzed period;

10,000 - comparison criterion, 10,000 hours.

*(1D).* Catastrophes coefficient (aviation works and training flights (Ukraine)). *This indicator is disincentive.*

*(2D).* Accidents coefficient (aviation works and training flights (Ukraine). *This indicator is disincentive.*

*(3D).* Serious incidents coefficient (serious incidents) (aviation works and training flights) (Ukraine*). This indicator is disincentive.*

Catastrophes, accident and serious incidents coefficients for aviation works and training flights are unambiguous negative indicators, the very presence of which confirms the saying that, unfortunately, aviation transport is not an ideal system in which we cannot talk about the absolute, but only about an acceptable level of safety. In terms of the scale of the negative impact, they are increasing from 3 D to 1 D, but the increase in the number of serious incidents creates the basis for probable accidents and catastrophes. These indicators are carefully researched on an ongoing basis by the National Bureau for the Investigation of Aviation Incidents and Incidents with Civil Aircraft of Ukraine.

Dynamics of aviation safety indicators for aviation works and training flights in the period from 2010 to 2020, as well as their threshold and optimal values are shown in Table 5.

Table 5. Dynamics of indicators of aviation safety indicators for aviation works and training flights in the period from 2010 to 2020, their threshold and optimal values [11 - 17].

| | **1-D** | **2-D** | **3-D** |
|---|---|---|---|
| | **Catastrophes coefficient non-dim** | **Accidents coefficient non-dim** | **Serious incidents coefficient non-dim** |
| 2010 | 8,0980 | 16,0952 | 6,0986 |
| 2011 | 4,1336 | 10,2345 | 4,1336 |
| 2012 | 4,1654 | 4,1654 | 2,1000 |
| 2013 | 2,1000 | 9,5281 | 4,5760 |
| 2014 | 2,1000 | 2,1000 | 2,1000 |
| 2015 | 2,1000 | 7,5975 | 13,0951 |
| 2016 | 2,1000 | 16,2894 | 2,1000 |
| 2017 | 12,1351 | 7,1176 | 7,1176 |
| 2018 | 6,9914 | 11,8828 | 2,1000 |
| 2019 | 5,2944 | 8,4888 | 5,2944 |
| 2020 | 10,7806 | 10,7806 | 2,1000 |
| Lower threshold | 11,3013 | 14,3684 | 17,4355 |
| The lower optimal | 8,2342 | 11,3013 | 8,2342 |
| The top optimal | 5,1671 | 5,1671 | 5,1671 |
| Upper threshold | 2,1000 | 2,1000 | 2,1000 |
| **Ratioing factor** | **13,0** | **17,5** | **20,0** |

**3.2. Social component of air transport**

*(1S).* The level of wages in the production of aviation transport, Ukraine. *This indicator is a stimulant.* In Ukraine, the level of wages in air transport is one of the highest in the country. This is due to the need for a high level of competence of aviation workers and plays an important social role. People whose lives and the health of others depend on should be socially protected, which indirectly increases the overall level of safety of the air transport system.

*(2S).* The level of employment in air transport (Percentage of the average number of full-time employees of air transport in relation to the total average number of full-time employees (transport, warehousing, postal and courier activities)). *This indicator is a stimulant.* The level of employment in air transport indicates the development of a high-tech labor market with high demands on the competence of workers. This is one of the social levers of sustainable development of modern society.

*(3S).* Coefficient of population mobility. *This indicator is a stimulant.* Population mobility is a catalyst for business, tourism and services and has a positive synergy effect for the sustainable development of the national economy.

*(4D)* Level of official GVA created by shadow wages, % of official gross value added (GVA) of air transport. *This indicator is a clear disincentive,* which causes direct damage to the state due to tax non-compliance and the general imbalance of the national economy.

*(5D)* Level of shadow employment, % of official employment. *This indicator is an unambiguous disincentive,* which causes direct damage to the state due to tax non-compliance and the general imbalance of the national economy.

The dynamics of indicators of the social component of air transport in the period from 2010 to 2020, as well as their threshold and optimal values are shown in Table 6.

Table 6. Dynamics of indicators of the social component of air transport in the period from 2010 to 2020, their threshold and optimal values

| | 1-S | 2-S | 3-S | 4-D | 5-D |
|---|---|---|---|---|---|
| | The level of wages in the production of aviation trans-port, non-dim | The level of employment in air transport, % | Coefficient of population mobility, transporatatio ns by person | Level of official GVA created by shadow wages, % | Level of shadow employment, % |
| 2010 | 0,3754 | 86,0465 | 0,13 | 0,01 | 1,8335 |
| 2011 | 0,3374 | 86,5672 | 0,16 | 0,72 | 9,1352 |
| 2012 | 0,3207 | 86,8217 | 0,18 | 1,42 | 11,6860 |
| 2013 | 0,3068 | 87,1560 | 0,18 | 2,06 | 14,1800 |
| 2014 | 0,2630 | 86,9048 | 0,15 | 5,68 | 22,4336 |
| 2015 | 0,2693 | 79,3103 | 0,15 | 5,44 | 20,8515 |
| 2016 | 0,2126 | 78,8889 | 0,19 | 14,96 | 31,1688 |
| 2017 | 0,2002 | 78,8462 | 0,25 | 17,35 | 33,6208 |
| 2018 | 0,1519 | 79,4118 | 0,3 | 31,12 | 43,0105 |
| 2019 | 0,0790 | 80,8081 | 0,33 | 64,16 | 55,8723 |
| 2020 | 0,0938 | 73,1481 | 0,2 | 56,67 | 53,4945 |
| Lower threshold | 0,2 | 80 | 0,2 | 15 | 23 |
| The lower optimal | 0,26 | 90 | 0,6145 | 8 | 14 |
| The top optimal | 0,32 | 98 | 1,3 | 5 | 6,5 |
| Upper threshold | 0,382 | 100 | 2,775 | 3 | 3,0 |
| Ratioing factor | 0,382 | 100 | 3 | 70 | 60 |

### 3.5. Ecological component of air transport

*(1D)*. Level of CO2 emissions of aviation transport of Ukraine to GDP. *This indicator is disincentive*. In order to counter climate change, ICAO is working to reduce CO2 emissions on a global scale and has proposed a compensation system and carbon reduction scheme (The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)). Regional organizations and national aviation authorities are joining forces to implement this concept through the direct implementation of environmental approaches to aviation transport development [2,6].

*(2D)*. The level of emissions of pollutants into the atmosphere. Similar measures are taken to reduce the level of emissions of other pollutants into the atmosphere. *This indicator is also disincentive* [6].

*(3S)*. The level of environmental costs of aviation transport However, environmental safety measures require not only political but also resource support from the state. *Therefore, this indicator is a stimulant* [6].

The dynamics of indicators of the environmental component of air transport in the period from 2010 to 2020, as well as their threshold and optimal values are shown in Table 7.

Table 7. Dynamics of indicators of the social component of air transport in the period from 2010 to 2020, their threshold and optimal values

| | 1-D | 2-D | 3-S |
|---|---|---|---|
| | Level of CO2 emissions, Kg/USD | The level of emissions of pollutants. non-dim | The level of environmental costs of aviation transport, non-dim |
| 2010 | 4,755948 | 0,0671651 | 0,178231 |
| 2011 | 2,947878 | 0,0431963 | 0,197168 |
| 2012 | 2,491729 | 0,0386886 | 0,212251 |
| 2013 | 2,315328 | 0,0389478 | 0,203509 |
| 2014 | 2,95397 | 0,042318 | 0,221626 |
| 2015 | 1,626471 | 0,0343303 | 0,182712 |
| 2016 | 1,208049 | 0,0210556 | 0,208137 |
| 2017 | 0,876968 | 0,0140365 | 0,138206 |
| 2018 | 0,694275 | 0,0092381 | 0,150444 |
| 2019 | 0,55842 | 0,0059522 | 0,139455 |
| 2020 | 0,710605 | 0,009282 | 0,111311 |
| Lower threshold | 0,82 | 0,0123 | 0,15 |
| The lower optimal | 0,51 | 0,0076 | 0,17 |
| The top optimal | 0,32 | 0,0048 | 0,2 |
| Upper threshold | 0,2 | 0,003 | 0,26 |
| Ratioing factor | 5 | 0,08 | 0,3 |

**Conclusions.** The aviation transport is a part of the transport complex of Ukraine, which is an important component in the structure of the national economy and a link between all components of economic security to ensure the basic conditions of life and development of the state and society. The assessment of economic, technological, safety, social and ecological hazards is an integral part of all the logical blocks of the structural and functional scheme of strategic management of aviation safety in terms of sustainable development of the national economy.

In the article determined and substantiated the main indicators of economic and technological development, safety, social and environmental components of air transport and assess their level. In the article the authors propose and present the dynamics in the period from 2010 to 2020 of 29 indicators of sustainable development of air transport of Ukraine, such us share of aviation transport in the gross value added (transport and communications); level of investment in aviation transport; level of export services of air transport; level of import services of aviation transport; level of shadowing of aviation transport; coefficient of manufacturability of aviation transport; capital utilization coefficient; level of shadow capital load; level of use of passenger capacity of aircraft and helicopters; level of renewal of fixed assets; cargo transport capacity of GDP by aviation transport; passenger transport capacity of GDP by aviation transport; average distance of cargo aviation transportation; average distance of passenger aviation transportation; ratio of domestic and international aviation transportation; catastrophes, accidents, serious coefficients for regular commercial/irregular commercial/non-commercial flights and execution of aviation works/training flights; level of wages in the production of aviation transport; level of employment in air transport; coefficient of population mobility; level of official GVA created by shadow wages; level of shadow employment; level of CO2 emissions of aviation transport of Ukraine to GDP; level of emissions of pollutants into the atmosphere; level of environmental costs of aviation transport. Authors determined their threshold and optimal values. Indicators are given in groups in the above areas. Indicators are divided into stimulants (indicators that contribute to the sustainable development of air transport and the national economy) and disincentives (indicators that hinder the sustainable development of air transport and the national economy). The solution of this problem will make it possible to conduct a comprehensive assessment of the current state of air transport in Ukraine on the basis of a systematic approach, which will be presented in subsequent publications of the authors.

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**Kostiuchenko L. V.** PhD in Economics, Associate Professor, Associate Professor of Department of National Aviation University (Ukraine)

**ORCID** – 0000-0002-7635-5153
**Researcher ID** – S-7795-2018
**Scopus author id:** –

# THE MULTISOURCING MODEL OF SAFE SUPPLY CHAIN MANAGEMENT

***Lesia Kostiuchenko «The multisourcing model of safe supply chain management».*** *The logistics outsourcing concept is to address the feasibility of using its own capabilities and sources of supply to perform certain logistics functions that the company can entrust to an external partner. However, in the current context of rapid change, it is important to make a quick and efficient decision on sources of supply: regardless of the sourcing model of the company. That is, what is the usual supply strategy for the company. Security (reliability and stability) of supplies is at the first place. Therefore, a quick decision on the optimal source of supply is the optimal solution. More precisely is the optimal combination of the use of internal resources of the company and the resources of external suppliers.*

*Multisourcing is a type of outsourcing used by many companies in conditions of frequent changes. Unlike traditional outsourcing, the multisourcing model involves the use of several different vendors for the same product at different times. The decision depends on the level of security. For example, with multiple sources, a company can choose the best supplier for a particular task. By outsourcing certain operations, a company can perform critical tasks on its own. These actions can achieve optimization of operating costs. However, when deciding on multisourcing, it is important to assess the risks.*

*It is important to estimate the cost of supply according to different options. You should compare the results of calculations and compare with the risks. These actions can ensure security of supply. So, the proposed economic and mathematical model is able to help to make the right decision of the rational choice of supply channel from several alternatives and, as a consequence, to achieve the following main goals: improving the quality of supply management; reduction of the logistics cycle; reduction of supply costs; increase the reliability of supply*

***Keywords****:* supply model, supply chain management, outsourcing, multisourcing, security of supply, costs of secure supply management.

***Леся Костюченко "Мультисорсингова модель безпечного управління ланцюгами постачання".*** *Концепція логістичного аутсорсингу полягає у вирішенні питання доцільності використання власних можливостей та ресурсів для виконання окремих логістичних функцій, які підприємство може довірити зовнішньому партнерові. Однак за нинішніх умов швидких змін важливим є прийняття швидкого та ефективного рішення щодо джерел постачання: незалежно від того, за якої сорсингової моделі працює компанія. Тобто, яка стратегія постачання є звичною. На вершину цілей ставиться безпека (надійність та стабільність) поставок. Тому оптимальним є*

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*оперативність прийняття рішення щодо оптимального джерела постачання. Точніше – оптимальне поєднання використання внутрішніх ресурсів компанії та ресурсів зовнішніх постачальників.*

*Мультисорсинг – це вид аутсорсингу, який використовує багато компаній в умовах частих змін. На відміну від традиційного аутсорсингу, модель мультисорсингу передбачає використання декількох різних постачальників одного і того ж продукту в різний час. Рішення залежить від рівня безпеки. Запропонована економіко-математична модель спроможна допомогти у прийнятті правильного рішення щодо раціонального вибору каналу постачання з декількох альтернативних і, як наслідок, досягти таких основних цілей: підвищити якість управління постачаннями; скоротити логістичний цикл; зменшити витрати на постачання; підвищити надійність постачань.*

***Ключові слова:*** модель постачання, управління ланцюгом постачання, аутсорсинг, мультисорсинг, безпека постачання, витрати на безпечне управління постачанням.

***Леся Костюченко «Мультисорсинговая модель безопасного управления цепями поставок».*** *Концепция логистического аутсорсинга заключается в поиске решения вопроса о целесообразности использования собственных возможностей и ресурсов для выполнения отдельных логистических функций, которые организация может доверить внешнему партнеру. Однако при современных условиях частых и резких изменений важным является принятие быстрого эффективного решения об источниках снабжения: независимо от того, при какой сорсинговой модели организация работает. Т.е., какая стратегия снабжения избрана. На вершину целеполагания ставится безопасность (надежность и стабильность) поставок. Поэтому оптимальным является оперативность принятия решения касательно оптимального источника поставок. Точнее – оптимальное объединение использования внутренних ресурсов организации, а также ресурсов внешних поставщиков.*

*Мультисорсинг является видом аутсорсинга, который используется многими организациями в условиях частых изменений. В отличии от традиционного аутсорсинга, модель мультисорсинга предусматривает использование нескольких разных поставщиков (источников) одного и того же продукта в разное время. Решение зависит от уровня безопасности. Предложенная экономико-математическая модель может поспособствовать принятию правильного решения о рациональном выборе канала снабжения с нескольких альтернативных и впоследствии достичь следующих основных целей: повысить качество управления поставками; сократить логистический цикл; уменьшить затраты на снабжение; повысить надежность поставок.*

***Ключевые слова:*** модель снабжения, управление цепями поставок, аутсорсинг, мультисорсинг, безопасность поставок, затраты на безопасное управление поставками.

**Introduction.** Multisourcing is an effective combination of different sources of supply. It allows you to economically and quickly achieve delivery of goods from around the world. The choice of multisourcing is determined by its cost-effectiveness, time savings and risk reduction. This type of transportation takes into account the specifics of the conditions of the transported goods, which increases the level of reliability of supply. Thus, it is possible to find the optimal source and delivery route.

**Analysis of recent researches and publications.** is to determine and substantiate the main indicators of economic and technological development, social and environmental components of air transport and assess their level. Indicators are given in groups in the above areas. Indicators are divided into stimulants (indicators that contribute to the sustainable development of air transport and the national economy) and disincentives (indicators that hinder the sustainable development of air transport and the national economy). The solution of this problem will make it possible to conduct a comprehensive assessment of the current state of air transport in Ukraine on the basis of a systematic approach.

Table 1. Classification of supply (sourcing) models

| Sign of classification | Name of sourcing models |
|---|---|
| By number of suppliers | Single Sourcing<br>Modular Sourcing |
| On a regional-territorial basis | Global Sourcing<br>Regional Sourcing<br>National Sourcing<br>Domestic Sourcing |
| In the presence of intermediaries in the logistics channel "supplier-consumer" | Straight<br>Indirect (different levels) |
| By source of supply | Insourcing<br>Outsourcing |
| By the complexity of the delivery option | One-level<br>Multilevel |
| On the scale (depth) of the combination of resources | Best-of-breed consortium<br>Prime contractor<br>Joint venture (JV);<br>Full outsourcing |
| Using IT technologies | e-sourcing<br>Multisourcing / Selective sourcing |

*Source: [2; 3]*

A multiple sourcing definition is outsourcing several of the company's most important operations to several different vendors instead of using a single source [5]. According to the author of [6], "the multisourcing approach contrasts with fully in-house IT provisioning and sole-source outsourcing models. Multisourcing (multi-sourcing) is an approach to outsourcing in which IT operations and technology infrastructure are contracted to a number of vendors, usually in combination with some internally provided elements of information technology" [6].

Multiple sourcing, which more commonly is referred to as multi-sourcing, is a type of outsourcing used by many companies. Unlike traditional outsourcing, where a single vendor handles IT responsibilities and other company operations, multi-sourcing makes use of several different vendors. Usually, the company will handle some IT tasks in-house and then outsource the rest [5].

Margaret Rouse in [6] writes that the purpose of the multisourcing was to maximize the effectiveness of an enterprise's IT by ensuring that various elements were sourced to the best possible providers, while allowing the enterprise to maintain its focus on core competencies. She highlights the following benefits of multisourcing supply:

1) Multisourcing can aid enterprise risk management programs by diversifying risk in vendor operations;

2) It can as well:

a) promote competition among various providers,

b) cut costs related to repetitive service contracts

c) improve quality, collaboration and innovation among a group of IT providers.

"Often, a company's IT vendor management office will oversee its multisourcing arrangements with input and guidance from its legal team, IT staff and other executive leadership. A good starting point is to select service-delivery providers with similar corporate cultures. In addition, organizations pursuing a multisourcing arrangement should craft strong internal

corporate governance strategies with regard to IT vendor relationships and share the details with all of their service providers to promote better cooperation and more seamless delivery of services across organizational lines." [6].

The authors of [5] give the following advice on choosing and implementing a multisorving strategy:

- "when choosing the multi-sourcing strategy, you should make sure that someone in your IT office is monitoring arrangements with vendors (there will be an entire office dedicated to this task);
- when dealing with vendors, input from your company's IT professionals, as well as your legal team, can be helpful;
- one of the best ways to choose IT vendors is to look for companies with a corporate culture similar to your own;
- before developing arrangements with IT vendors, you need to develop a strong internal strategy for monitoring and maintaining relationships with vendors;
- you should share details of this strategy with all of your service providers to make sure that everyone is on the same page" [5].

"The cost of retaining multiple supply locations must be seen more as a cost of doing business, rather than an inefficiency. … Brexit, the U.S.-China trade war, a general geopolitical trend toward nationalization, the COVID-19 pandemic have changed the priorities of many supply chain leaders. They now need to balance cost and operational efficiency with greater resilience." [7].

On the other hand, the author emphasizes another important aspect – safe (reliability and stability). "Only 21% of respondents stated that they have a highly resilient network today, meaning good visibility and the agility to shift sourcing, manufacturing and distribution activities around fairly rapidly. It suggests that increasing resilience will be a priority for many as they emerge from the current crisis. More than half expect to be highly resilient within two to three years inefficiency." [7].

"In 2011, major natural disasters in Japan and Thailand disrupted supply chains across the world and exposed companies' reliance on single sources of supply. In the automotive industry, nearly finished cars could not be shipped to customers because of missing, and often inexpensive, components. Multisourcing is an obvious way to mitigate this risk." [7]. So Sarah Hippold offers "to craft a multisourcing strategy, supply chain leaders must know their supplier networks in detail and be able to categorize suppliers not just by spend, but also by revenue impact if a disruptive event occurs". Author proves that "diversification can be achieved by awarding business to additional suppliers or working with an existing single- or sole-source supplier that is able to produce out of several locations" [7].

However beyond multisourcing, some companies want to reduce geographic dependence in their global networks and shorten cycle times for finished products. It can be nearshoring. Regional or local supply chains can be more expensive, because they add more players and complexity to the ecosystem, but they allow for more control over inventory and move the product closer to the end consumer [7].

Multi-sourcing is significantly different from handling IT operations completely within the company or outsourcing these duties to a single vendor. Making IT operations more effective is the idea behind multi-sourcing. With multi-sourcing, a company can choose the best vendor for a given IT task. By outsourcing certain IT operations, the company can handle the most important responsibilities internally. It can provide several other benefits to companies that choose this strategy and there are several factors that can determine the benefits and drawbacks a company can experience from multiple sourcing. [5]

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Based on the results of the research we can present such advantages of multimodal transportation as show in the Table 2

Table 2. Factors and reasons for the benefits and shortcomings of multisourcing

| Benefits of multisourcing | Shortcomings of multisourcing |
|---|---|
| Sparking competition between vendors | The complexity of the arrangement |
| Lowering the costs and improving the quality of service contracts | The availability of unique materials. |
| Allowing IT providers to innovate and collaborate | The using of necessary Bill of Materials of a product |
| It can help to protect a company from the risk of demand variability | Weakening the concentration of attention on a particular supplier (supply chain can be easily disrupted) |

*Source: revised by the author on the basis of [2; 4; 5]*

However, keep in mind that the biggest drawback of multi-sourcing is that your supply chain can be easily disrupted because you'll be working with multiple vendors. Because "every supplier that you use will have a much lower volume of business transactions than with single-source outsourcing, they will not be as motivated to maintain efficiency and to make sure there are no bottlenecks in the supply chain. Obviously, this increases the risk for the company that purchases the supplier's services." [5].

Factors and reasons for the benefits and shortcomings of multisourcing which are given in the table 2 we can be explained as follows [5]:

1) With multi-sourcing, your company will need to be much more proactive about managing your relationships with vendors so that you can avoid frequent disruptions of your supply chain.

2) The biggest strength of multiple sourcing is that you will not be overly reliant on a single supplier. If one of your vendors is frequently experiencing supply chain disruptions that are affecting your business, you can shift that vendor's responsibilities to another supplier. Choosing a multi-sourcing strategy means you'll be able to lower the risks of supply disruption and will make sure that you're not dependent on one vendor.

3) Multi-sourcing can also help to protect your company from the risk of demand variability. When you have relationships with multiple vendors and demand sharply increases, you can spread this demand among all of your vendors, ensuring you can meet customer demand without overwhelming your suppliers. Many companies use multi-sourcing to help lower their prices. By using multiple vendors, you may be able to spark a bidding war for your contract, which can result in you paying a much lower price than you would when working with a single vendor.

4) In most cases, a company can replace a supplier without affecting any of its other contracts. Depending on the service provided by the supplier, however, a company may need to change their arrangements with the remaining suppliers when ending a supplier relationship. When you need to end a supplier relationship and update your relationship with your other suppliers, you should alert your customers so that they can prepare for any changes in their IT support. If the management of company wants to keep your costs as low as possible, you should make sure that you aren't duplicating tasks across your vendors and within your company. On the other hand, task duplication is a common way to lose money.

The importance of determining and evaluating the criteria for choosing a rational supply channel is described in detail and proved in the monograph [1, p.451 – 453].

**The purpose and objectives of the study**. Analysis of the publications of the above authors shows that views on the essence and content of multi-resources for practical logisticians and academic experts do not differ. However, the studied publications do not have ways to assess the level of risks and total costs of supply chain management process taking into account the level of security.

That is why the purpose of this study is to find a scientifically sound mathematical model for calculating the total cost of supply management, taking into account the level of security.

**Basic material and results.** Based on the study and in accordance with its purpose, we propose an economic and mathematical model for determining the total cost of supply chain management for a certain period of time, taking into account the security of multisourcing supply:

$$\sum C_{SCM} = \sum_{i\in I}\sum_{j\in J}\sum_{k\in K}\sum_{t\in T}(C_{C\,ijkt}\cdot N_{SC\,ijkt}\cdot y_{Sf\,ijkt} + C_{CA\,ijkt}\cdot N_{Cl\,ijkt}) \Rightarrow \min, \quad (1)$$

where: $\sum C_{SCM\ t}$ – total costs of supply chain management for the *t*-th period of time;

$C_{Cijkt}$ – costs for ensuring the supply of the *i*-th batch taking into account the *j*-th need *k*-th supply channel for the *t*-th period of time;

$N_{SCijkt}$ – the number of deliveries of the *i*-th batch taking into account the *j*-th need *k*-th supply channel for the *t*-th period of time;

$y_{Sf\,ijkt}$ – variable that reflects the level of safe (reliability, stability) in the supply of the *i*-th batch, taking into account the *j*-th need *k*-th supply channel for the *t*-th period of time;

$C_{CAijkt}$ – costs of claims activity related to the supply of the *i*-th batch, taking into account the *j*-th need *k*-th supply channel for the *t*-th period of time;

$N_{Clijkt}$ – the number of claims for the supply of the *i*-th batch, taking into account the *j*-th need *k*-th supply channel for the *t*-th period of time.

This model reaches its maximum value subject to such restrictions:

– by reliability (stability) of the k-th supply channel for the *t*-th period at purchase *i*- th batch, taking into account the *j*-th need (with $t = T_{\mathrm{L}}$ (lower limit); $T = T_{\mathrm{H}}$ (upper limit)):

$$\sum_{k\in K}\sum_{t\in T} N_{SC\,kt} \le \sum_{k\in K}\sum_{t\in T} N_{Cl\,kt}\cdot y_{kt}, \quad (2)$$

where: $N_{SCkt}$ – possible number of deliveries by the *k*-th supply channel for the *t*-th period;

– on the flexibility of procurement policy (procurement frequency planning):

$$12 \le \sum_{j\in J}\sum_{k\in K} N_{SC\,kt} \le 48 \text{ (the number per year);}$$

– by the amount of supply chain management funding for the *t*-th period of time:

$$\sum_{k\in K} y_{Sf\,kt}\cdot C_{SCM\,kt} \le \sum_{t\in T} C_{SCM\,t}, \quad (3)$$

where: $\sum C_{SCM\ kt}$ – total costs of supply chain management for the *k*-th supply channel for the *t*-th period of time;

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– on the reliability (stability) of the *k*-th supply channel for the *t*-th period according to the previous one:

$$N_{SCM\,kt} = N_{SCM\,kt-1} \cdot y_{kt-1};$$

– as well as under such next conditions: $i \in I; j \in J; k \in K; t \in T$.

Variable that reflects the increase in reliability (stability) of the *k*-th supply channel for the *t*-th period of time ($y_{Sf\,kt}$) determines by the formula:

$$y_{Sf\,kt} = \frac{N_{SCM\,kt} K_{\text{unev}}}{t}, \qquad (4)$$

where: $K_{\text{unev}}$ – coefficient of uneven supply, which is calculated by the formula:

$$K_{\text{нер}} = k_{\text{доб}} \cdot k_{\text{год}}, \qquad (5)$$

where: $k_{\text{year/season}}$ – macro indicator relative to *t* – year/season coefficient of non-uniformity,

$$k_{\text{year/ season}} \rightarrow (1{,}3\text{-}1{,}9);$$

$k_{\text{day}}$ – micro indicator relative to *t* – day coefficient of non-uniformity,

$$k_{\text{day}} \rightarrow (2{,}0\text{-}4{,}0).$$

The proposed economic and mathematical model will allow to make the right decision of the rational choice of supply channel from several alternatives and, as a consequence, to achieve the following main goals:

1) improving the quality of supply management;
2) reduction of the logistics cycle;
3) reduction of supply costs;
4) increase the reliability of supply ($N_{SCM} \rightarrow opt,\ y_{Saf} \rightarrow \max$).

**Conclusions.** Scientific analysis of key steps and elements of creating a mathematical model for calculating the total cost of supply management, taking into account the level of security, gives the following conclusions:

1. The proposed economic and mathematical model reaches its maximum value subject to certain limitations that must be taken into account.
2. This model will allow making the right decision of the rational choice of supply channel from several alternatives.
3. The proposed economic and mathematical model will allow to make the right decision of the rational choice of supply channel from several alternatives and, as a consequence, to achieve the following main goals: improving the quality of supply management; reduction of the logistics cycle; reduction of supply costs; increase the reliability of supply.

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**Hryhorak M.Yu**. Doctor of Economics, Associate Professor, Head of Logistics Department National Aviation University (Ukraine),

**ORCID** – 0000-0002-5023-8602
**Researcher ID** –
**Scopus author id:** – 57208222758

**Trushkina N.V.** PhD (Economics), Associate Professor, Senior Research Fellow, Regulatory Policy and Entrepreneurship Development Institute of Industrial Economics of the National Academy of Sciences of Ukraine (Ukraine),

**ORCID** – 0000-0002-6741-7738
**Researcher ID** – C-1441-2018
**Scopus author id:** –

# DEVELOPMENT OF THE LOGISTICS SYSTEM OF THE ECONOMIC REGION "POLISSYA" IN THE CONTEXT OF THE GREEN ECONOMY: ECOLOGICAL PROBLEMS AND PERSPECTIVES

***Mariia Hryhorak, Nataliia Trushkina. «Development of the logistics system of the economic region "polissya" in the context of the green economy: ecological problems and perspectives».*** *Modern business conditions require the implementation of the financial support mechanism for the transformation of transport and logistics systems using non-traditional sources of funding, including "green" investments. The key instruments of "green" financing for transport infrastructure modernization, which are effectively used in different countries, include: "green" bonds, "green" loans, grants, guarantees, technical assistance, money of "green" investment funds.*

*This paper is devoted to the analyzes of the dynamics of environmental indicators of the regional logistics system taking as an example the economic region "Polissya". On this basis, modern environmental problems of the district's logistics system have been identified. An analysis of the development of world markets for "green" bonds, "green" loans and sustainable investment assets is made. Peculiarities and characteristic features of "green" financing instruments for the development of logistics systems of different levels are considered. As a result of the research it is established that in the Ukrainian realities it is expedient to apply the advanced international experience of realization of the "green" financing of infrastructure projects mechanism in economic areas. This will successfully transform regional logistics systems in the context of the green economy and achieve sustainable development of transport infrastructure.*

***Keywords****:* regional economy, economic region, logistics system, ecological component of logistics, green economy concept, transformation, modernization, "green" investment, financing instruments, "green" projects, foreign practice.

***Марія Григорак, Наталія Трушкіна."Розвиток логістичної системи економічного району «полісся» в контексті зеленої економіки: екологічні проблеми та перспективи".*** *Сучасні умови господарювання вимагають реалізації механізму фінансового забезпечення трансформації*

*транспортно-логістичних систем з використанням нетрадиційних джерел фінансування, серед яких «зелені» інвестиції. До ключових інструментів «зеленого» фінансування модернізації транспортної інфраструктури, які ефективно використовуються у різних країнах світу, віднесено: «зелені» облігації, «зелені» кредити, гранти, гарантії, технічна допомога, кошти «зелених» інвестиційних фондів.*

*У статті проаналізовано динаміку екологічних показників розвитку регіональної логістичної системи на прикладі економічного району «Полісся». На цій основі виявлено сучасні екологічні проблеми функціонування логістичної системи району. Виконано аналіз розвитку світових ринків «зелених» облігацій, «зелених» позик і активів сталого інвестування. Розглянуто особливості та виявлено характерні риси інструментів «зеленого» фінансування розвитку логістичних систем різного рівня. У результаті дослідження встановлено, що в українських реаліях доцільно застосовувати передовий міжнародний досвід реалізації механізму «зеленого» фінансування інфраструктурних проектів в економічних районах. Це дозволить успішно трансформувати регіональні логістичні системи в контексті зеленої економіки й досягти сталого розвитку транспортної інфраструктури.*

***Ключові слова:*** регіональна економіка, економічний район, логістична система, екологічна складова логістики, концепція зеленої економіки, трансформація, модернізація, «зелене» інвестування, інструменти фінансування, «зелені» проекти, зарубіжна практика.

***Мария Григорак, Наталия Трушкина. «Развитие логистической системы экономического района «Полесье» в контексте зеленой экономики: экологические проблемы и перспективы».*** *Современные условия хозяйствования требуют реализации механизма финансового обеспечения трансформации транспортно-логистических систем с использованием нетрадиционных источников финансирования, среди которых «зеленые» инвестиции. К ключевым инструментам «зеленого» финансирования модернизации транспортной инфраструктуры, которые эффективно используются в разных странах мира, отнесены: «зеленые» облигации, «зеленые» кредиты, гранты, гарантии, техническая помощь, средства «зеленых» инвестиционных фондов.*

*В статье проанализирована динамика экологических показателей развития региональной логистической системы на примере экономического района «Полесье». На этой основе выявлены современные экологические проблемы функционирования логистической системы района. Выполнен анализ развития мировых рынков «зеленых» облигаций, «зеленых» займов и активов устойчивого инвестирования. Рассмотрены особенности и выявлены характерные черты инструментов «зеленого» финансирования развития логистических систем различного уровня. В результате исследования установлено, что в украинских реалиях целесообразно применять передовой международный опыт реализации механизма «зеленого» финансирования инфраструктурных проектов в экономических районах. Это позволит успешно трансформировать региональные логистические системы в контексте зеленой экономики и достичь устойчивого развития транспортной инфраструктуры.*

***Ключевые слова:*** региональная экономика, экономический район, логистическая система, экологическая составляющая логистики, концепция зеленой экономики, трансформация, модернизация, «зеленые» инвестирования, инструменты финансирования, «зеленые» проекты, зарубежная практика.

**Introduction.** At present, modern economic conditions require the modernization of regional logistics systems in the context of the green economy and the introduction of a mechanism for sustainable development.

This is due to the fact that the field of transport and logistics, on the one hand, has a negative impact on the environment (third in the world in terms of carbon emissions), and on the other - has significant potential for the model of "green" growth [1; 2].

Annually, the total loss from the negative effects of the transport industry is 7-10% of GDP. For example, vehicles generate about 25% of the total greenhouse gas emissions in the European Union. According to official Eurostat data, air pollution from road

transport causes more than 400,000 premature deaths each year. Therefore, EU countries are actively implementing large-scale investment programs to modernize transport and infrastructure by "greening" them in order to minimize the negative impact on the environment and to maintain a competitive position. Such programs are usually based on the technologies of the third and fourth industrial revolutions. The significant advantages of the third industrial revolution include the "greening" of transport systems through the transition to hydrogen and electric transport, which contributes to a dramatic improvement in the quality of the environment. The EU Transport Strategy envisages a reduction of greenhouse gas emissions by approximately 20% of their level in 2008, and in general by 2050 - by 80-95% below the level of 1990 [3].

It should be noted that the modernization of logistics systems of various levels in Ukraine should be carried out within the framework of the European transport policy TEN-T, aimed primarily at resource efficiency and reduction of greenhouse gas emissions. This corresponds to the main provisions of Chapter 7 "Transport" of the Association Agreement between Ukraine and the EU, Sustainable Development Strategy "Ukraine - 2020" (transport infrastructure reform and environmental protection program), 2030 Sustainable Development Goals in Ukraine (creation of sustainable infrastructure), State Regional Development Strategy for the period 2021-2027 (formation of a cohesive country in social, economic, environmental and spatial dimensions).

According to the National Transport Strategy of Ukraine for the period up to 2030, it is necessary to take into account such a global trend of transport development as the usage of "green" modes of transport, priority of environmental protection and preservation of valuable protected areas during transport infrastructure development. The strategy records the plan to reduce greenhouse gas emissions into the air from mobile sources to 60% of the 1990 level. However, it should be noted that the share of capital investment and current expenditures on air protection and prevention of climate change in most regions of Ukraine has been reduced. Consider this on the example of the economic district "Polissya", which includes Zhytomyr, Kyiv, Cherkasy, Chernihiv regions.

**Analysis of recent researches and publications.** In the scientific literature there are many approaches to the environmental component of logistics. The concept of green logistics began to form in the world in the mid-80's of XX century with the emergence of the terms "sustainable development" and "corporate social responsibility". Researchers have proven that the origin, formation and subsequent structuring of green logistics is closely intertwined with logistics principles. Actually the greening of logistics activities in the future will be a key vector of business development, as most consumers prioritize those companies that carry out carriage of freight with "green" transport and use technologies that conserve natural resources. The use of "green" technologies in logistics has become as necessary as the introduction of a quality management system. As a result, according to The Green Trends Survey in Towards Sustainable Logistics [4], 59% of businesses estimated that green transportation of their products was considered a crucial factor in attracting consumers. Based on a survey by PE International (UK) [5] identified key benefits in implementing the concept of green logistics, which include reducing emissions (33% of managers and top managers of companies); attracting new customers or developing new products (26% of respondents).

Based on the analysis of literature sources (Janbo, Songxian [6]; Brdulak, Michniewska [7]; Sbihi, Eglese [8]; Mesjasz-Lech [9]; Ubeda et al. [10]; Lai, Wong [11]; Dekker et al. [12]; Ćirović et al. [13]; Harris et al. [14]; Jedliński [15]; Seroka-Stolka [16]; Zhang et al. [17]) generalized scientific views on the interpretation of the essence and the

meaning of the concept of "green logistics". As a rule, scientists understand this term as: scientific direction and one of the factors of environmental protection; a new direction, which involves the use of advanced logistics technologies and modern equipment to minimize pollution; logistics based on resource-saving and environmentally friendly technologies; type of logistics, in which scientific and practical activities take into account environmental aspects at all stages of the movement of material and other relevant flows in order to reduce the destructive effects on the environment and optimize the use of natural resources; an effective approach to resource flow management in order to reduce environmental and economic losses; a set of actions related to the assessment and minimization of environmental consequences of logistics activities; increasing environmental responsibility in the transport and logistics sector, etc.

In addition, to date, researchers and practitioners have not identified a single approach to the classification of funding instruments for "green" projects, including those in the transport sector. Therefore, it is extremely important and necessary to develop and implement a mechanism for financial support for the transformation of global, national, regional and local logistics systems using non-traditional sources of funding (eg, "green" investment), marketing tools, qualitatively new management approaches, digital technologies in the context of Industry. 4.0 [18-31].

**The aim of the article** is to analyze the features of the logistics system of the economic region "Polissya" development and determine the prospects for its further operation, taking into account the environmental component.

**The main material.** According to statistical analysis, emissions of pollutants from mobile sources in the economic region increased by 20% in 2000-2019 as a result of an increase in volumes in Kyiv region by 50.3% and Zhytomyr region - by 27%. But the emissions of pollutants from mobile sources in the Chernihiv region decreased by 13% and Cherkasy - by 3.7%. During this period, the share of emissions in Kyiv region increased by 8.9 percentage points or from 35.5 to 44.4% of total emissions of pollutants from mobile sources in the economic region of "Polissya", and in Zhytomyr - by 1.2 percentage point or from 20.2 to 21.4%. However, the share of emissions in Cherkasy region decreased by 5.2 percentage points or from 26.3 to 21.1% of these emissions in the district, and in Chernihiv - by 4.9 percentage points or from 18 to 13.1% (Table 1).

Table1– Dynamics of pollutant emissions from mobile sources in the "Polissya" economic region, thousand tons

| Year | "Polissya" economic region | *Including region:* | | | |
|---|---|---|---|---|---|
| | | Zhytomyr | Kyiv | Cherkasy | Chernihiv |
| 2000 | 244,5 | 49,5 | 86,7 | 64,3 | 44,0 |
| 2005 | 265,1 | 59,1 | 97,0 | 63,1 | 45,9 |
| 2010 | 358,0 | 69,1 | 162,2 | 77,4 | 49,3 |
| 2011 | 359,3 | 67,8 | 165,0 | 78,0 | 48,5 |
| 2012 | 370,5 | 67,2 | 178,6 | 77,0 | 47,7 |
| 2013 | 360,8 | 71,2 | 165,4 | 76,9 | 47,3 |
| 2014 | 337,8 | 66,5 | 155,9 | 69,9 | 45,5 |
| 2015 | 288,4 | 60,7 | 125,5 | 62,8 | 39,4 |
| 2016 | 274,9 | 61,2 | 112,0 | 62,6 | 39,1 |
| 2017 | 276,7 | 61,8 | 113,8 | 62,3 | 38,8 |
| 2018 | 278,8 | 62,4 | 115,7 | 62,1 | 38,6 |
| 2019 | 293,4 | 62,9 | 130,3 | 61,9 | 38,3 |

*Compiled on the basis of information materials of the Main Departments of Statistics in Zhytomyr, Kyiv, Cherkasy, Chernihiv regions.*

During 2017-2019, the volume of emissions of pollutants into the atmosphere from the activities of the transport and warehousing decreased by 18.3% in the economic region. This is due to a decrease in emissions in Zhytomyr region by 24.9%, Chernihiv region - by 23.5%, Cherkasy region - by 22.7%, Kyiv region - by 12.1% (Table 2).

Table 2 –Emissions of pollutants into the atmosphere from the activities of transport and warehousing in the "Polissya" economic region, tonnes

| Regions | Year | | |
|---|---|---|---|
| | 2017 | 2018 | 2019 |
| "Polissya" economic region | 8368,8 | 10425,9 | 6839,3 |
| *including:* Zhytomyr region | 1097,1 | 1449,5 | 823,5 |
| Kyiv region | 3819,8 | 3878,2 | 3357,5 |
| Cherkasy region | 2400,0 | 3953,3 | 1854,1 |
| Chernihiv region | 1051,9 | 1144,9 | 804,2 |

*Compiled on the basis of information materials of the Main Departments of Statistics in Zhytomyr, Kyiv, Cherkasy, Chernihiv regions*.

For the researched period, the amount of carbon dioxide emissions into the atmosphere from the activities of transport and warehousing in the economic region increased by 27.1% due to an increase in emissions in Cherkasy region by 127%, Kyiv - by 13.4%, Chernihiv - by 13.3%. However, the volume of such emissions in the Zhytomyr region decreased by 53.5% (Table 3).

Table 3 – Emissions of carbon dioxide into the atmosphere from the activities of transport and warehousing in the "Polissya" economic region, tonnes

| Regions | Year | | |
|---|---|---|---|
| | 2017 | 2018 | 2019 |
| "Polissya" economic region | 584322,2 | 630111,4 | 742501,2 |
| *including:* Zhytomyr region | 52336,5 | 67474,6 | 24361,7 |
| Kyiv region | 396718,6 | 390688,7 | 449908,7 |
| Cherkasy region | 101091,3 | 128504,7 | 229509,4 |
| Chernihiv region | 34175,8 | 43443,4 | 38721,4 |

*Compiled on the basis of information materials of the Main Departments of Statistics in Zhytomyr, Kyiv, Cherkasy, Chernihiv regions*.

The analysis shows that the share of current expenditures on environmental protection in the field of transport and warehousing in the economic region in 2019 was only 0.4% of the total Ukrainian expenditures (in 2010 - 0.2%). At the same time, the share of current expenditures on environmental protection in the field of transport and warehousing in Kyiv region increased by 15.3 percentage points or from 78.6 to 93.9% of total current expenditures in the region. Meanwhile, there is a reduction in the share of these costs in the Zhytomyr region by 8.7 percentage points (from 9.8 to 1.1%), Cherkasy - by 4.7 percentage points (from 8.3 to 3.6%), Chernihiv - by 1.9 percentage points (from 3.3 to 1.4% of total current expenditures in the economic region). In addition, the share of capital investment in environmental protection in the field of transport and warehousing in the economic region is insignificant and in 2019 amounted

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to 0.7% of all-Ukrainian capital investment in this area (in 2010 - 0.8%). Investments in environmental protection in the field of transport and warehousing took place only in Kyiv region, but to a small extent (Table 4).

Table 4 – Current expenditures and capital investments for environmental protection in the field of transport and warehousing in the "Polissya" economic region, UAH thousand (at actual prices)

| Indicators / Regions | Year | | |
|---|---|---|---|
| | 2017 | 2018 | 2019 |
| Current expenditures | | | |
| "Polissya" economic region | 1272,0 | 2533,3 | 2712,4 |
| *including:* Zhytomyr region | 125,0 | 587,6 | 29,5 |
| Kyiv region | 999,7 | 1773,5 | 2547,2 |
| Cherkasy region | 105,3 | 123,1 | 97,0 |
| Chernihiv region | 42,0 | 49,1 | 38,7 |
| Capital investments | | | |
| "Polissya" economic region | 529,2 | 498,7 | 468,2 |
| *including:* Zhytomyr region | No data | | |
| Kyiv region | 529,2 | 498,7 | 468,2 |
| Cherkasy region | – | – | – |
| Chernihiv region | – | – | – |

*Compiled on the basis of information materials of the Main Departments of Statistics in Zhytomyr, Kyiv, Cherkasy, Chernihiv regions*.

In the "Polissya" economic region the situation with investment in measures aimed at protecting the air and climate change is deteriorating. Thus, according to the State Statistics Service of Ukraine, the share of capital investment in air protection and climate change in the economic region in 2019 was only 0.12% of total capital investment in all types of environmental measures, down compared to 2010 almost by 21 percentage points. The relative share of capital investments in the region decreased in 2010-2019 by 2.2 percentage points or from 2.4 to 0.2% of the total volume of capital investments in the relevant type of environmental measures. The largest share of capital investment in air protection and climate change is in the Kyiv region (76.8% of the total in the region); followed by Chernihiv region (17.1%) and Cherkasy region (6.1%). In the Zhytomyr region, the value of this indicator in 2010 was 4% of the volume of capital investment in air protection and climate change in the "Polissya" economic region. And starting from 2018, the investment of this environmental measure in the region was not carried out. The relative share of capital investments in air protection and climate change in the Kyiv region decreased by 12.3 percentage points or from 12.4 to 0.1% of the volume of capital investments for all types of environmental measures in the region; in Cherkasy - by 42.4 percentage points or from 43.9 to 1.5%; in Chernihiv - by 10.2 percentage points or from 13 to 2.8% (Table 5).

During 2010-2019, the share of current expenditures on air protection and climate change in the economic region decreased by 8.1 percentage points or from 11.6 to 3.5% of total current expenditures for all types of environmental measures. For this period, the relative share of current expenditures in the area decreased by 2.5 percentage points or from 4.7 to 2.2% of the total Ukrainian current expenditures for the relevant type of environmental measures. The largest share of current expenditures on air protection and

climate change problems falls on the Chernihiv region (61.8% of the total in the region); followed by Kyiv region (30.4%), Zhytomyr region (4.2%) and Cherkasy region (3.6%).

Table 5 – Capital investments in air protection and climate change problems in the "Polissya" economic region, UAH thousand

| Regions | Volume of capital investments by years | | | |
|---|---|---|---|---|
| | for all types of environmental measures | | *including* air protection and climate change | |
| | 2010 | 2019 | 2010 | 2019 |
| "Polissya" economic region | 128186,3 | 7035373,3 | 27110,2 | 8200,2 |
| *including:* Zhytomyr region | 11507,4 | 6864,9 | 1077,3 | – |
| Kyiv region | 53400,0 | 6945708,4 | 6622,4 | 6300,2 |
| Cherkasy region | 36114,6 | 33100,0 | 15876,3 | 500,0 |
| Chernihiv region | 27164,3 | 49700,0 | 3534,2 | 1400,0 |

*Compiled according to data: [32, p. 169, 187].*

The share of current expenditures on air protection and climate change in the Chernihiv region decreased by 14.5 percentage points or from 25.8 to 11.3% of the unit costs for all types of environmental measures in the region; in Kyiv - by 3.6 percentage points or from 5.6 to 2%; in Zhytomyr - by 2.5 percentage points or from 4 to 1.5%; in Cherkasy - by 1.1 percentage points or from 1.7 to 0.6% (Table 6).

Table 6 – Current expenditures on air protection and climate change problems in the "Polissya" economic region, UAH thousand

| Regions | Current expenses by years | | | |
|---|---|---|---|---|
| | for all types of environmental measures | | *including* air protection and climate change | |
| | 2010 | 2019 | 2010 | 2019 |
| "Polissya" economic region | 534688,9 | 1853695,1 | 61858,1 | 64412,5 |
| *including:* Zhytomyr region | 59028,0 | 181573,9 | 2361,9 | 2724,5 |
| Kyiv region | 239400,0 | 965021,2 | 13517,8 | 19589,0 |
| Cherkasy region | 61962,9 | 354600,0 | 1028,0 | 2300,0 |
| Chernihiv region | 174298,0 | 352500,0 | 44950,4 | 39800,0 |

*Compiled according to data: [32, c. 172, 188].*

The relative share of investments in capital repairs of fixed assets for environmental protection in the "Polissya" economic region decreased in 2019 compared to 2010 by 6.8 percentage points or from 9.2 to 2.4% of the total volume of such investments in Ukraine. At the same time, the share of investments in capital repairs of fixed assets for environmental protection in Cherkasy region increased by 40.2 percentage points or from 36.6 to 76.8% of their volume in the economic region, and in Chernihiv - by 4.1 percentage points or from 11.4 to 15.5%. But the share of investment in the major maintenance of fixed assets in Kyiv region, by contrast, decreased by 33.6 percentage points or from 37.3 to 3.7%, and in Zhytomyr - by 10.7 percentage points or from 14.7 to 4% of their volume in the economic region (Table 7).

To date, Regional Development Strategies until 2027 have been developed and approved, in which the creation of a safe living environment and increasing the level of environmental safety are mostly recognized as priorities.

Table 7 – Investments in capital repairs of fixed assets for environmental protection in the "Polissya" economic region, UAH million

| Year | "Polissya" economic region | *Including regions:* | | | |
|---|---|---|---|---|---|
| | | Zhytomyr | Kyiv | Cherkasy | Chernihiv |
| 2010 | 45,6 | 6,7 | 17,0 | 16,7 | 5,2 |
| 2015 | 34,1 | 17,9 | 1,0 | 14,9 | 0,3 |
| 2017 | 11,5 | 3,0 | 3,3 | 4,2 | 1,0 |
| 2018 | 25,0 | 6,4 | 3,6 | 12,6 | 2,4 |
| 2019 | 35,4 | 1,4 | 1,3 | 27,2 | 5,5 |

*Compiled according to data: [32, c. 182].*

These strategic documents are consistent with the main aspects of regional development, namely: the approximation of life quality to European standards and the development of human potential; increasing the competitiveness of the region's economy; sustainable development territories of settlements and communities (Table 8).

Table 8 – Analysis of regional development strategies for the period up to 2027 in terms of environmental aspects in the field of transport and logistics

| Region | Strategic goal | Operational goal |
|---|---|---|
| Zhytomyr | Creating a modern comfortable and safe living environment in local communities | High-quality local roads (bridges and overpasses), proper landscaping, clean and safe environment |
| Kyiv | Development of human potential, approximation the life quality closer to European standards. | Ecological safety and environmental protection. |
| | Sustainable development of settlements and communities | Development of region road and transport infrastructure |
| Cherkasy | High quality of life: ecology, safety, infrastructure | Environmental safety and environmental protection.<br>Infrastructure development and modernization |
| Chernihiv | Comfortable and safe living conditions | Development of transport infrastructure.<br>Protecting ecosystems and preserving the environment on the basis of sustainable development |

*Compiled by the authors*

As emphasized in the Development Strategy of Zhytomyr region for the period up to 2027, the choice of the operational goal "High-quality local roads (bridges and overpasses), proper improvement, clean and safe environment" determined the content of the following tasks to achieve it: local roads construction, reconstruction and repair; ensuring the quality of landscaping elements; optimization of waste management; involvement of community residents in solving landscaping problems and improving their environmental culture; ensuring the ecological and economic balance of communities. The Development Strategy of the Kyiv region for 2021-2027 states on effective waste management; support for innovative developments and introduction of the latest technologies in the field of waste processing and return of resource-intensive materials to economic circulation; ecological monitoring and informing the population

about the state of the environment; development of ecological network and recreational areas; introduction of environmentally friendly modes of transport.

The key tasks set out in the Cherkasy region Development Strategy for the period 2021-2027 include the following: implementation of comprehensive environmental monitoring systems; introduction of modern mechanisms of waste management; increasing transport accessibility, development of logistics potential of the region.

The Strategy of Sustainable Development of Chernihiv region for the period up to 2027 refers to the development of high-quality and accessible transport infrastructure, including environmentally friendly modes of transport; protection of the natural environment, preservation and development of protected areas; creating conditions for safe living and livelihoods of the population; formation of ecological consciousness and ecological culture of citizens. Thus, the results of previous studies [33-39] and the conducted statistical analysis indicate inefficient modernization of the regional logistics system in the "Polissya" economic region in the context of green economy and sustainable development. This is primarily due to limited funding for the creation of transport infrastructure and insufficient implementation of green technologies. Given that, it is advisable to develop and implement a mechanism for "green" investment in infrastructure projects, which means financing investments that provide environmental benefits in the broad context of environmentally sustainable development of various areas of economic activity. According to expert estimates, only 1% of global bonds are marked as "green", while 1% of investments of institutional investors belong to the category of "green" infrastructure assets [40].

To date, among foreign and domestic researchers and practitioners there is no single approach to the classification of funding instruments for "green" projects, including the transport sector (Table 9).

Table 9 – Approaches to the classification of funding instruments for "green" projects proposed by various scientific schools

| Scientific schools representatives | Types of funding instruments |
|---|---|
| S. Venugopal<br>A. Srivastava<br>C. Polycarp<br>E. Taylor [41] | - mechanisms of public support;<br>- public financing instruments: loans, share capital, investment instruments that exclude risks |
| N. Lindenberg [42] | - instruments through which direct financing is carried out: shares, credit lines, loans and grants;<br>- instruments that do not provide direct funding, but can transfer knowledge or reduce risks: guarantees and technical assistance;<br>- instruments used to attract additional private resources transferred to "green" projects through one of the above instruments: green bonds and structured funds |
| M. Voica<br>M. Panait<br>I. Radulescu [43] | - green shares;<br>- green bonds |
| V. Kazlauskiene<br>A. Draksaite<br>L. Melnyk [44] | - green bonds;<br>- green shares;<br>- green loans;<br>- budget financing instruments |
| O. Nykyforuk<br>N. Kudrytska<br>I. Dulska [45] | - taxation;<br>- infrastructure: corporate or municipal bonds; mechanism of concession relations;<br>- securitization of assets;<br>- crowdfunding: royalties, public lending, equity crowdfunding |

*Compiled by the authors*

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Thus, the key instruments for "green" financing the modernization of transport infrastructure, which are effectively used in different countries around the world, include:

"green" bonds - bonds of any type, income from the placement of which are aimed exclusively at full or partial financing or refinancing of new and launched "green" projects that meet the established requirements (France, Brazil, China);

"green" loans - loans of any type, provided exclusively for full or partial financing or refinancing of new and launched "green" projects that meet the established requirements;

green investment funds - a mutual investment fund or other investment mechanism that provides investments only in companies that are considered socially conscious in terms of their business activities or directly contribute to the development of social responsibility using standardized "green" assets (France, Switzerland, United Kingdom).

Statistical analysis shows that the global volume of sustainable financing assets increased in 2016-2018 by 34.1%, including in Europe - by 17.5%, the United States - by 37.9%, Canada - by 54.5% , Australia and New Zealand - by 40%. The largest share of sustainable financing assets falls on Europe (45.9% of global assets) and the United States (39.1%) [46] (Table 10).

Table 10 – Global distribution of sustainable investment assets, trillion dollars USA

| Regions | Year | |
|---|---|---|
| | 2016 | 2018 |
| Europe | 12,0 | 14,1 |
| USA | 8,7 | 12,0 |
| Japan | 0,5 | 2,2 |
| Canada | 1,1 | 1,7 |
| Australia and New Zealand | 0,5 | 0,7 |
| Total | 22,9 | 30,7 |

*Compiled according to data: [46].*

At the same time, as noted in the analytical report [47], in European countries, the most widely used investment approach is "negative screening"; in the USA, Canada, Australia and New Zealand - "integration of ESG-factors"; in Japan - "corporate interaction and shareholder action". There is a growing trend of investment in some "green" investment approaches in the world. Thus, the volume of thematic sustainable investment increased 3.7 times in 2016-2018; positive screening - 2.3 times; targeted investment - 2 times; integration of ESG-factors - 1.7 times; negative screening - 1.3 times; corporate management and actions of shareholders - 1.2 times (Table 11).

Table 11 – Volumes of investment in some "green" investment approaches in the world, billion dollars USA

| Approaches | Year | |
|---|---|---|
| | 2016 | 2018 |
| Targeted investment | 224,5 | 444,3 |
| Thematic sustainable investment | 276,2 | 1017,7 |
| Positive screening | 818,0 | 1841,9 |
| Screening within normal limits | 6195,4 | 4679,4 |
| Corporate management and actions of shareholders | 8385,2 | 9834,6 |
| Integration of ESG-factors | 10353,2 | 17543,8 |
| Negative screening | 15063,6 | 19771,0 |

*Compiled according to data: [46].*

**Conclusions.** Thus, based on the above, we can conclude that it is appropriate to apply in modern Ukrainian realities the best international experience in implementing the mechanism of "green" investment in infrastructure projects. This will successfully transform regional logistics systems in the economic regions of Ukraine in the context of the green economy and achieve sustainable development of transport infrastructure through the implementation of investment-attractive "green" projects.

To do this, it is necessary to make changes and supplements to the National Transport Strategy of Ukraine 2030 and the State Regional Development Strategy for the period 2021-2027.

Prospects for further research are to analyze and generalize conceptual approaches to the definition of "circular economy" and "green logistics", as well as to determine the prerequisites for the development of the concept of circular logistics.

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**Karpun O.V.** PhD in Economics, Associate Professor, Associate Professor of Logistics Department National Aviation University (Ukraine)

**ORCID** – 0000-0003-2058-9070
**Researcher ID** – S-6428-2018
**Scopus author id:** –

# CONCEPTUAL MODEL OF FLORICULTURE SUPPLY CHAIN MANAGEMENT

***Olga Karpun. «Conceptual model of floriculture supply chain management».*** *The flower industry today is a fairly dynamic international industry. Proof of this is the significant growth rates achieved in recent years in this area. Thus transportation of perishable goods is one of the most difficult types of delivery, and transportation of flowers is even more difficult. Because it is necessary not only to strictly adhere to the temperature regime, but also to preserve the appearance of such a demanding cargo.*

*Conducted analysis of the flower industry has shown that market demand is stagnant, while supply is in surplus. In part, this is due to the fact that flowers are highly correlated with income, not being essential commodities. Although on the other hand, consumer demand is becoming more demanding and differentiated. The main factors influencing the market of floriculture products were identified and studied.*

*It was noted that the market of floriculture products in Ukraine is relatively small and young, but promising and growing rapidly. In addition, it is one of the most complex and time-consuming, due to its features. First of all, the floriculture market is represented by a significant number of participants that have different basic and current resources, goals for the market, needs, and so on.*

*Studies have shown that the floriculture industry can suffer huge losses, mainly due to the lack of proper infrastructure for storage and transportation, as well as due to the lack of control over the conditions of supply. Lack of visibility in supply chains leads to quality problems, which leads to product loss, product returns, rising costs, and time delays. In addition, changing consumer demands, an active lifestyle and an open economy are forcing manufacturers and suppliers to produce higher quality goods and constantly look for ways to optimize costs.*

*The proposed conceptual model of floriculture supply chain management will make it possible to form a new infrastructure that will unite all the subjects of the floriculture market into a single system. Thus, we can say that the priority areas of infrastructure development of the floriculture market should be determined in terms of a systematic approach and consist in the interaction of elements of production, intermediary, floristic, design, marketing, financial, information and agricultural components. Each part of the chain must perform its function effectively in order to maintain the optimal conditions of the environment in which the products of floriculture are located, during its supply from the manufacturers to the final consumers. To this end, a combination of innovative technologies that help to manage the supply of floriculture products in real time through the supply chain was proposed.*

*Therefore, in order to satisfy consumers, it is necessary to form an effective supply chain for floriculture products, all parts of which must work in a whole, so that end consumers can get high quality products.*

***Keywords**:* floriculture products, temperature regime, conceptual model, supply chain management, innovative technologies.

***Ольга Карпунь. "Концептуальна модель управління ланцюгами постачання продукції квітникарства".*** *Квіткова індустрія сьогодні є досить динамічною міжнародної галуззю. Доказом цього є досягнуті за останні роки значні темпи зростання в даній сфері. При цьому транспортування швидкопсувних вантажів є одним з найскладніших видів доставки, а перевезення квітів ще складніше через те, що потрібно не тільки строго дотримуватися температурного режиму, а й зберігати зовнішній вигляд такого вибагливого вантажу.*

*Проведено аналіз квіткової галузі, який показав, що попит на ринку знаходиться в стані стагнації, в той час як пропозиція – в надлишку. Почасти це пов'язано з тим, що квіти мають високу кореляцію з отримуваним доходом, не будучи товаром першої необхідності. Хоча з іншого боку, споживчий попит стає все більш вимогливим і диференційованим. Були визначені та досліджені основні чинники, які здійснюють вплив на ринок продукції квітникарства.*

*Було зазначено, що в Україні ринок продукції квітникарства є відносно невеликим за обсягом і молодим, але при цьому перспективним і швидко зростаючим. Крім того він є одним із найскладніших та трудомістких, що зумовлено його особливостями. Насамперед, ринок квітникарства представлений значною кількістю суб'єктів (учасників), що мають різні основні та оборотні ресурси, цілі щодо роботи на ринку, потреби тощо.*

*Проведено дослідження, які показали, що індустрія квітникарства може зазнавати величезних втрат, головним чином, через відсутність належної інфраструктури для зберігання та транспортування, а також через відсутність контролю за умовами постачання. Відсутність видимості в ланцюгах постачання призводить до проблем із якістю, що призводить до втрати продукції, повернення продукції, зростання її вартості, а також затримок у часі. На додачу до цього мінливі запити споживачів, активний спосіб життя та відкрита економіка фактично змушують виробників і постачальників виробляти товари вищої якості та постійно шукати шляхи оптимізації витрат.*

*Запропонована концептуальна модель управління ланцюгами постачання продукції квітникарства дасть можливість сформувати нову інфраструктуру, яка поєднає в єдину систему всіх суб'єктів ринку квітникарства. Таким чином, можемо стверджувати, що пріоритетні напрями розвитку інфраструктури ринку квітникарства мають визначатися з погляду системного підходу і полягати у взаємодії елементів виробничої, посередницької, флористичної, дизайнерської, маркетингової, фінансової, інформаційної та агросервісної складових. Кожна частина ланцюга повинна ефективно виконувати свою функцію задля підтримання оптимальних умов середовища, в якому знаходиться продукція квітникарства, під час її постачання від виробників до кінцевих споживачів. Задля цього запропоновано поєднання інноваційних технологій, які допомагають реалізувати управління постачанням продукції квітникарства в реальному часі через ланцюжок поставок.*

*Отже, щоб задовольнити споживачів, необхідно сформувати ефективний ланцюг постачання продукції квітникарства, усі ланки якого повинні працювати як єдине ціле, щоб в результаті кінцеві клієнти отримали товар високої якості.*

***Ключові слова:*** продукція квітникарства, температурний режим, концептуальна модель, управління ланцюгами постачання, інноваційні технології.

***Ольга Карпунь. «Концептуальная модель управления цепями поставок продукций цветоводства».*** *Цветочная индустрия сегодня является достаточно динамичной международной отраслью. Доказательством этого являются достигнутые за последние годы значительные темпы роста в данной сфере. При этом транспортировка скоропортящихся грузов является одним из самых сложных видов доставки, а перевозка цветов еще сложнее из-за того, что нужно не только строго соблюдать температурный режим, но и сохранять внешний вид такого привередливого груза.*

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*Был проведен анализ цветочной отрасли, который показал, что спрос на рынке находится в состоянии стагнации, в то время как предложение - в избытке. Отчасти это связано с тем, что цветы имеют высокую корреляцию с получаемым доходом, не будучи товаром первой необходимости. Хотя с другой стороны, потребительский спрос становится все более требовательным и дифференцированным. Были определены и исследованы основные факторы, которые оказывают влияние на рынок продукции цветоводства.*

*Было отмечено, что в Украине рынок продукции цветоводства является относительно небольшим по объему и молодым, но при этом перспективным и быстро растущим. Кроме того, он является одним из самых сложных и трудоемких, что обусловлено его особенностями. Прежде всего, рынок цветоводства представлен значительным количеством субъектов (участников), имеющих различные основные и оборотные ресурсы, цели по работе на рынке, потребности и тому подобное.*

*Проведены исследования, которые показали, что индустрия цветоводства может нести огромные потери, главным образом, из-за отсутствия надлежащей инфраструктуры для хранения и транспортировки, а также из-за отсутствия контроля за условиями поставки. Отсутствие видимости в цепях поставок приводит к проблемам с качеством, что приводит к потере продукции, возврату продукции, росту ее стоимости, а также задержка во времени. В дополнение к этому меняющиеся запросы потребителей, активный образ жизни и открытая экономика фактически заставляют производителей и поставщиков производить товары более высокого качества и постоянно искать пути оптимизации расходов.*

*Предложенная концептуальная модель управления цепями поставок продукции цветоводства даст возможность сформировать новую инфраструктуру, которая соединит в единую систему всех субъектов рынка цветоводства. Таким образом, можно утверждать, что приоритетные направления развития инфраструктуры рынка цветоводства должны определяться с точки зрения системного подхода и заключаться во взаимодействии элементов производственной, посреднической, флористической, дизайнерской, маркетинговой, финансовой, информационной и агросервисных составляющих. Каждая часть цепи должна эффективно выполнять свою функцию для поддержания оптимальных условий среды, в которой находится продукция цветоводства, во время ее поставки от производителей до конечных потребителей. Для этого предложено сочетание инновационных технологий, которые помогают реализовать управление поставками продукции цветоводства в реальном времени через цепочку поставок.*

*Итак, чтобы удовлетворить потребителей, необходимо сформировать эффективную цепь поставки продукции цветоводства, все звенья которой должны работать как единое целое, чтобы в результате конечные клиенты получили товар высокого качества.*

***Ключевые слова:*** продукция цветоводства, температурный режим, концептуальная модель, управление цепочками поставок, инновационные технологии.

**Introduction.** Transportation of perishable goods is one of the most difficult types of delivery, and transportation of flowers is even more difficult. Because it is necessary not only to strictly adhere to the temperature regime, but also to preserve the appearance of such a demanding cargo. Taking into account these reasons, carriers allocate them to a separate group of goods with special conditions of carriage and use special transport for their carriage. The main methods of delivery of fresh flowers are road and air transport. Logistics companies that organize international and domestic transportation of fresh flowers should do so using refrigerated flower semi-trailers that maintain the set temperature, humidity and ventilation throughout the journey.

The next important point to consider when transporting flowers is the speed of delivery. The main task when transporting freshly cut flowers is to deliver the goods to the customer in the shortest possible time. Based on this, flowers should be transported over long distances exclusively by air and only by direct flight.

It should also be remembered that the international transportation of plants requires a number of permits (phytosanitary documents and certificates). Without them,

most countries do not allow plants and flowers into their territory. Therefore it is necessary to specify the legislation of the country where cargo is imported.

There are many nuances when transporting flowers. For example, when transporting cut or planted in pots of flowers and bulbs should take into account the peculiarities of transportation of a particular species of plant. There are also subtleties during customs clearance.

As we can see, transporting plants is a much more difficult task than it may seem at first glance. Its trouble-free solution requires the experience of professional logisticians in the field of such transportation and the availability of special equipment for transportation. For today, there are some scientific developments in the formation of Fresh Supply Chain [4] and in particular Floral Supply Chain [2, 3, 11, 12, 14]. However, they lack an integrated approach to building a model of effective floriculture supply chain management.

**The purpose and objectives of the research.** It consists in substantiating the theoretical and practical foundations and developing of scientific and methodological recommendations for the formation of a conceptual model of floriculture supply chain management which will help to increase its efficiency.

**The main material and results of the research.** The flower industry today is a fairly dynamic international industry. Proof of this is the significant growth rates achieved in recent years in this area. Europe and North America dominate the flower trade, while producer countries are closer to the equator. For the past ten years, the list of leading exporters of flowers includes the Netherlands, Colombia, Kenya, Ecuador and Israel [1, 8]. Relatively recently, a country like Ethiopia has joined the list, while Israel's position has weakened. Thus, one of the major structural changes currently taking place in the world of the flower industry is the intensification of international competition. Due to a combination of local production and imported flowers, the Netherlands is the leading central market in this sector (Fig. 1).

In addition, there is a general opinion that today the industry is facing drastic changes, reacting sharply to the problems associated with modern economic conditions. Market demand is stagnant, while supply is in surplus. In part, this is due to the fact that flowers are highly correlated with income, not being essential commodities. Although on the other hand, consumer demand is becoming more demanding and differentiated. Interestingly, even factors such as religious and cultural characteristics of people also play an important role in the flower trade.

Over the past few years, the Ukrainian flower market has experienced a downturn as a result of the economic crisis in Ukraine. Thus, after falling by more than 58% in the period 2013-2015, the market began to recover, and over the next 2 years grew by 40%. In 2018 and 2019, there was also a trend towards recovery [8].

The analysis showed that this was facilitated by the following factors [1, 8]:

1. Macroeconomic indicators. At the time of the crisis, imported flowers accounted for the vast majority of the market, so the sharp fall in the hryvnia collapsed it. In recent years, the exchange rate has stabilized, and local producers have increased their market position. This and the improvement of the economy in general contributed to the recovery of the flower market in Ukraine.

2. High share of imported products in the market. Analysis of the flower market showed that most flowers are of imported origin. With the onset of the crisis, of course, Ukrainian producers were forced to raise prices due to rising costs of consumables (seeds, fertilizers, greenhouses and logistics). However, thanks to a more affordable, compared to foreign partners, pricing policy and flexibility in cooperation, network retail and large sellers are refocusing on cooperation with Ukrainian producers of flowers and seeds.

3. The market is characterized by seasonality. The number of imported flowers increases in the winter-spring period, and in the summer-autumn period the number of domestic flowers increases. Although growing flowers in greenhouses is possible, in winter the cost increases significantly. Therefore, imported plants have growing potential for competition, and their share is increasing.

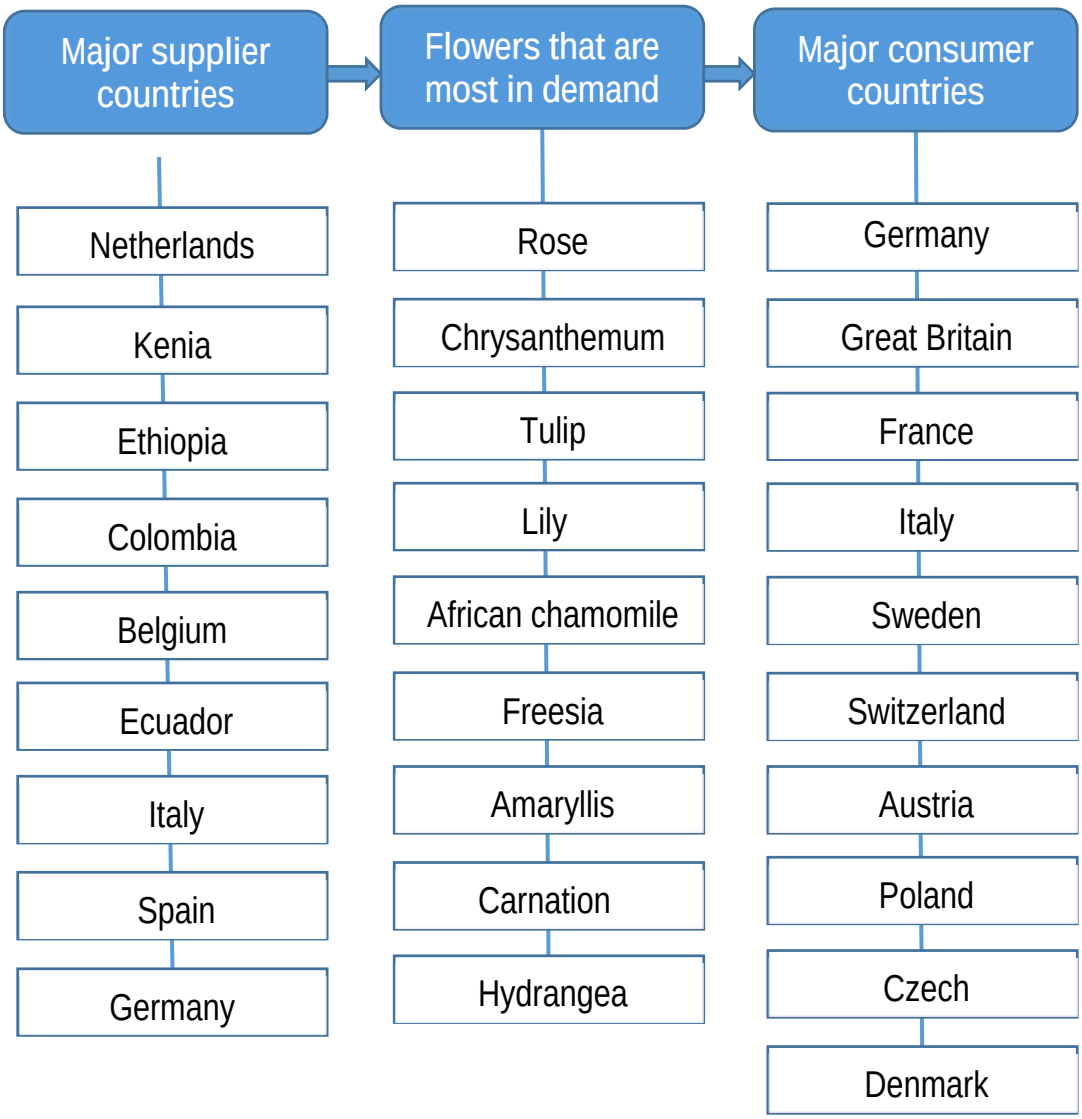


Figure 1 – The main suppliers, buyers and the most popular flowers of the "flower market" [based on 5, 9]

Analysis of the flower market in Ukraine has shown that it is most diverse in the capital. Regional wholesale bases are replenished with flowers about once a week, and the smaller the settlement, the fewer outlets and a narrower range of flowers. For today, there is a redistribution of demand, but the market structure by price segment remains. The lowest price segment is currently the most popular.

In Ukraine, the market for floricultural products is relatively small and young, but growing rapidly. In addition, it is one of the most complex and time-consuming, due to its features. First of all, the floriculture market is represented by a significant number of

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participants that have different basic and current resources, goals for the market, needs, and so on. Today, there are two main groups of participants in the market: sellers, which include manufacturers, processing companies and intermediaries, and buyers (Fig. 2).

The subjects of the market are enterprises of various forms of ownership and management, which usually offer a very wide range of products. The offer of the floriculture market is formed by domestic and imported products (live cut flowers, potted plants, planting material, ornamental plants of open and closed soils, etc.) and processed products (flower arrangements, bouquets, floral wreaths, collages, etc.).

Consider the goals and requests of each subject of the flower market.

The main goals of customers.

Because cut flowers are a luxury product, consumers demand a certain level of quality, as well as value for money. The main aspects of quality are color, freshness, stem length, absence of pests, aroma and life expectancy in the vase. The analysis shows that color, freshness, disease-free status and good appearance are the main factors when making a purchase decision. And this can be achieved only by floriculture supply chain management.

The main goals of flower shops.

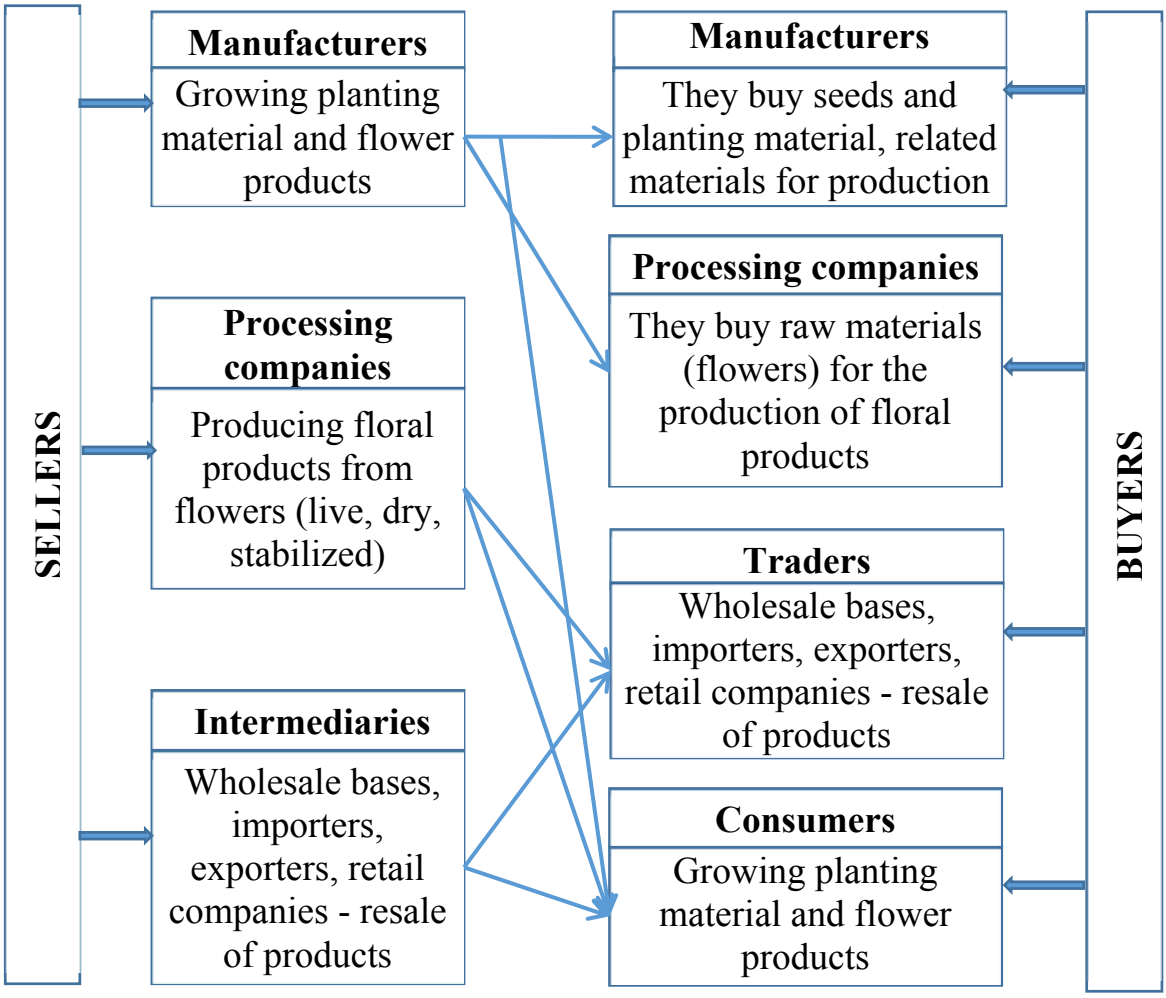


Figure 2 – Relationships of the main participants in the market of floricultural products [based on 2]

Today, flowers are sold in a wide range of outlets. Many retailers now sell a wide range of goods, tending to become a department store and occupy a larger share of the retail market. This means that flowers have appeared in supermarkets, gas stations, corner shops and wine shops. An increasing number of floriculture products are sold by phone and online. Everyone usually has a specific target market.

Supermarkets usually want large single line deliveries at constant prices and delivery dates. This puts pressure on manufacturers to meet these requirements.

Flower shops work directly with the consumer and receive direct feedback. They are also more responsible for quality than wholesale retailers and supermarkets. Flower shops need a wider range of goods to decorate bouquets. They want to differentiate their products from other retailers, such as supermarkets. This may mean that manufacturers or wholesalers may offer different packaging and labeling. Otherwise, they have to repack the flowers in a new package.

The main goals of wholesalers. The wholesaler reflects the needs and requests of consumers:

– value for money;
– stable product;
– availability over a long period;
– variety of products and colors;
– life expectancy in a vase;
– quality;
– cool chain that is maintained from the manufacturer to the shelf.

Although wholesalers can get some types of flowers all year round, in some seasons the life of vases is bad. Tulips in summer have a bad life in a vase and are not worth the stock. Wholesalers would like to better show the life of vases in different seasons.

The main goals of exporters.

Exporters range from people who only sell their own products to others who deal with many manufacturers and a large number of buyers in many countries. They are in constant contact with buyers in major markets and must respond to market signals. Importers want:

– what was ordered;
– timely delivery;
– commodity in a good condition;
– a product with the correct documentation.

Today, the flower business needs a new infrastructure that would unite all the subjects of the floriculture market into a single system. One of the most important components of such infrastructure should be a network of wholesale and retail enterprises of floriculture products. In addition, the infrastructure system of the floriculture market should include enterprises and institutions whose activities support economic relationships in the flower business, ensure the process of growing flower and decorative products and continuous trade. Studies have shown that, in addition to marketing, financial and information components, the infrastructure of the floristic market should include agricultural enterprises that provide logistics (seeds and planting material, mechanization and chemicalization, construction materials, fuels and lubricants, etc.) and those enterprises that offer a wide range of additional services (equipment repair and maintenance, agrochemical maintenance, transport maintenance, etc.) on the market.

The current state of the floriculture products market is characterized by the slow formation of market infrastructure, which should ensure effective promotion of products from producer to consumer, reduce losses of floricultural products, improve its quality and flowering time, promote optimal market prices. The following factors must be taken into account when making decisions about the location and development of the subjects of this market:

– location and concentration of producers;

– location and concentration of potential consumers;

– location and concentration of large importers;

– export prospects;

– available and possible transport communications.

The most important problems that need to be addressed in the process of forming a market for floriculture products are:

– commercialization of sales;

– slow filling of goods flows;

– consumer orientation on imported products;

– insufficient use of regulation and monitoring of supply and demand;

– restraint of the export potential of floriculture and ornamental horticulture (due to underdeveloped market infrastructure and state protectionism, non-adaptation of the market to the norms of international systems and the requirements of the World Trade Organization).

Studies have shown that the floriculture industry can suffer huge losses, mainly due to the lack of proper infrastructure for storage and transportation, as well as due to lack of control over supply conditions. Lack of visibility in supply chains leads to quality problems, which leads to product loss, product returns, rising costs, and time delays. In addition, changing consumer demands, an active lifestyle and an open economy are forcing manufacturers and suppliers to produce higher quality goods and constantly look for ways to optimize costs.

To form an effective model of supply chain management for floriculture products, the following steps must be performed [based on 10]:

– explore and plan the range of varieties of flowers that will result in the best profit;

– to ensure their cultivation in accordance with the requirements of consumers or to choose a flower supplier who will be able to provide this;

– plan flowering or purchase at the right time;

– collect at the right stage, avoiding old flowers, as this will only worsen the condition of fresh flowers;

– collect early in the morning, especially in summer, immediately put them in water to keep their temperature and humidity;

– keep them in the shade or in an isolated vehicle;

– quickly deliver them to storage;

– carefully treat / disinfect flowers to ensure insect-free condition;

– cut to uniform length, sort to uniform lines by color, size and shape;

– place flowers in a sleeve / box of the required size; cool quickly to +2 ° C and move to the market in insulated or refrigerated trucks - maintaining a temperature of about +2 ° C;

– immediately move the flowers to the cool room of the wholesaler / exporter / florist;

– deliver flowers to florists / outlets / consumers in isolated or refrigerated trucks or vans;

– ensure that the exporter quickly and directly transfers flowers from its warehouse to the foreign consumer, maintaining a cool temperature.

At each stage we need to make sure that the product is homogeneous. Because, one bad flower can destroy an entire party.

Here are some factors that determine the emphasis on such floriculture supply chain management (SCM):

– the access and availability of information between different actors in the supply chain make it easy to establish connections that allow the use of network delays;

– the level of competition in both domestic and international markets requires organizations to be fast, agile and flexible;

– consumer expectations and requirements become much more stringent.

Thus, we can say that the priority areas of infrastructure development of the floriculture market should be determined in terms of a systematic approach and consist in the interaction of elements of production,

intermediary, floristic, design, marketing, financial, information and agricultural components. Therefore, in order to satisfy consumers, SCM must work with two main goals – timeliness and quality.

Quality factors are important for optimizing of floriculture supply chain management. This requires a combination of innovative technologies to implement real-time supply management of floriculture products through the supply chain. They combine technologies in tracking and tracing, such as RFID, quality monitoring, wireless sensor networks, and the Internet, such as cloud computing and web services.

Virtual objects play a central role in the management of supply chains for floriculture products. Virtual objects are digital images of objects that are stored, processed, and transmitted over the Internet. Thus, virtual objects serve as central hubs of information about objects on the Internet, which integrate data about objects from different sources. In virtual supply chains, objects are transferred between many different partners from the main production to the market.

There are three groups of technologies that provide this approach to managing virtual objects [based on 14]:

1. Identification, reading and communication technologies, which include technologies for automatic identification and data collection.

2. Intermediate software technologies that allow the unimpeded exchange of information about objects between different participants in the supply chain.

3. Programs that provide specific functionality for different users of the supply chain based on information about the virtual object, available through the intermediate level.

Thus, we can offer the basic information systems architecture needed to provide virtual floriculture supply chain management (Fig. 3).

According to this architecture, the level of reading objects is engaged in collecting information from physical objects. The level of data exchange ensures efficient and secure data transmission of the object. The information layer processes the information received from networks and turns it into useful information. The application service layer provides specific content services based on processed information for different users.

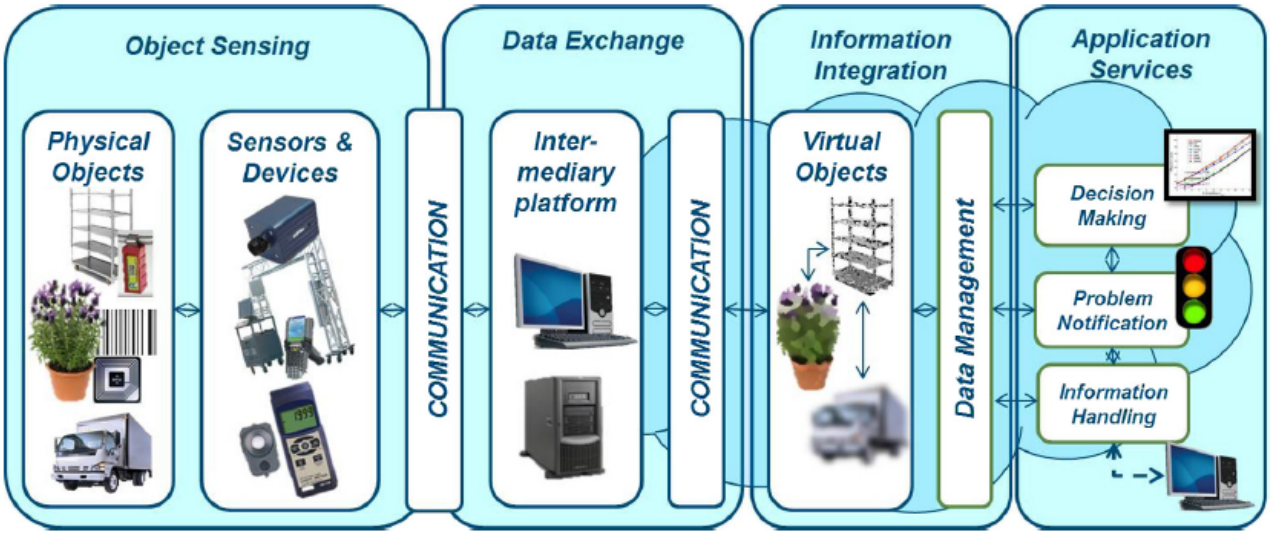


Figure 3 – Architecture of information systems for providing virtual floriculture supply chain management [14]

This is very important because different flowers require different conditions of storage and transportation. It should be noted that in this category of goods there are three subcategories, each of which has its own requirements for temperature [6]:

– bulbs and seeds of plants (temperature of transportation from +4 to +10 ° C);

– cut flowers (temperature from +1 to +8 ° C);

– planted plants, which include plants in the soil and garden plants (transport temperature from 0 to +2 ° C).


Figure 4 – Effects of the proposed model of floriculture supply chain management

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Thus, we can see that plants in the process of transportation require the creation of a special, natural environment for their existence. Often different subcategories need to be transported separately from each other. It is extremely important that other loads are not transported in the body with flowers to avoid mixing odors.

For these purposes, specially equipped compartments with built-in climate controllers and temperature recorders (a device that records temperature fluctuations throughout the movement) are used [6, 7].

In addition to controlling climatic conditions during transportation, it is necessary to approach responsibly to packing and fastening of plants in a body of motor transport or in the container. If there are no special packaging rules for seeds, the plants must be carefully packaged. Flowers should be packed in special boxes, cases or carts, and a protective film should be used. Boxes or cases must be marked with appropriate signs. It is important to achieve tightness and give each plant enough free space.

Flower pots must be transported in special containers. Planted plants in pots should be tightly installed in specially equipped trays with recesses. Spread plants should be wrapped in paper and fastened with wire. Flower buds, to avoid breakage, should be easily wrapped with thread or fixed with an elastic band.

Flowers should be carefully watered before sending, cut plants should be packed together with sponges soaked in water. Houseplants or plants in the soil are very easily damaged during transportation due to improper mounting or careless delivery. Therefore, the above measures can protect the fragile load from kinks, crumpled leaves, damage or death of the plant [7].

Thus, the availability of a rationally developed infrastructure of flower markets and effective floriculture supply chain management will provide the following opportunities (Fig. 4).

At all stages of flower delivery, quality and freshness are expected, which can only be obtained by maintaining cool temperatures throughout the supply chain. Each part of the chain must do its job. Emphasis should be placed on the constant content of flowers at a temperature of +2 ° C. All links in the supply chain must take responsibility for their product, so that the end customer receives a high quality product.

**Conclusions.** Thus, research has shown that flower market participants continue to search for innovative solutions in supply chain management. As the industry becomes more global and competitive, dedicated supply chains will become more important in controlling the risks associated with affordability, quality, ethical issues and price. In order for such a supply chain to function smoothly, a single strong "facilitator" is needed; because chains with many intermediaries are becoming "obsolete." Such facilitators are already appearing. For example, in 2014, Bouqs introduced its new supply chain model [13]. By applying a direct supply chain to the customer, they can reduce costs and delivery time. This model allows suppliers to cut only the flowers they use and place them in place, saving time and disposing of waste.

Of course, at each stage of the supply chain there is a risk that the flowers will be exposed to higher temperatures, which will lead to their deterioration ahead of time. The right logistics company helps keep both cost and temperature under control, so the flowers will arrive fresh and stay that way for much longer.

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**Gritsenko S.I.** Doctor of Economics, Professor, Professor of Logistics Department National Aviation University (Ukraine)

**ORCID** – 0000-0002-3322-3986
**Researcher ID** –
**Scopus author id:** –

**Vinichenko I.A.** Project Manager, Dudka Agency, Kyiv (Ukraine)

**ORCID** –
**Researcher ID** –
**Scopus author id:** –

# PROSPECTS AND OPPORTUNITIES FOR USING FOREIGN EXPERIENCE FOR THE DEVELOPMENT OF INTELLECTUAL TRANSPORTATION SYSTEMS IN UKRAINE

***Sergiy Gritsenko, Iryna Vinichenko. «Prospects and opportunities for using foreign experience for the development of intellectual transportation systems in Ukraine».*** *The study aims to determine the prospects and possibilities of using foreign experience for the development of intelligent transport systems in Ukraine. The article deals with the history of the emergence of intelligent transport systems in the world. We have investigated the prerequisites and promising directions for developing the global market of intelligent transport systems: traffic management, road safety, and supervision; cargo management; automotive telematics; parking management; automated vehicles. The main players in the field of business in this market have been identified. It is systematized for the adaptation of countries that are developing due to the features of the European ITS architecture, the US ITS architecture, the Japanese national ITS architecture, which are designed to improve the lives of citizens. Variants of using information and navigation systems in the framework of European projects on the example of cities are proposed. In the example of the European Union, the stages of implementation of the ITS architecture are considered, and how this affects the congestion of roads in large cities. The creation of a unified architecture of ITS allows you to control: the level of transport safety in transport and road traffic; energy consumption and environmental impact; networks of logistics systems for passenger service and cargo handling; management of transport, road construction, and repair works, parking places, collection of road tolls, equipment for improving personal services of road users. We have substantiated the necessity of using an integrated approach to improve the digitalization and intellectualization of transport systems, taking into account their advantages and disadvantages, has been substantiated. Conceptual approaches to the digitization of transport are generalized, closely related to logistics IT systems and the network of local roads. The theoretical basis of the level of intellectualization of the Ukrainian transport systems in comparison with foreign ones has been studied, the expediency of the possibility of developing this sphere in Ukraine with the implementation of the project "Transparent infrastructure" has been proved. The organizational and economic principles of the use of intelligent transport systems of the countries of the world for solving a wide range of*

*problems have been determined: transmission of information in real-time for travelers, namely, traffic schedules, information on delays; entrance fee for the passage of vehicles to the area of the city; accident management; an electronic collection of duties. The legislative framework and the National Transport Strategy of Ukraine for the period up to 2030 are considered. The real results of the development of transport systems that are already being implemented in Ukrainian cities are displayed. A network of "smart roads" will be built in Ukraine. To implement this task, high-quality fiber-optic communications are needed, which will pass along the roads, which will allow the introduction of intelligent transport systems. The use of the world's leading experience in the implementation of intelligent transport systems is strategic for Ukraine, determines its competitiveness in the world market, and meets the requirements of integrating the national transport network into the Trans-European transport network.*

***Keywords**:* intelligent transport systems, transport strategy, innovations, automated control systems, traffic jams.

***Сергій Гриценко, Ірина Вінніченко. "Перспективи та можливості використання зарубіжного досвіду для розвитку в Україні інтелектуальних транспортних систем".*** *Метою дослідження є визначення перспектив та можливостей використання зарубіжного досвіду для розвитку в Україні інтелектуальних транспортних систем. У статті розглянуто історію виникнення інтелектуальних транспортних систем у світі. Досліджено передумови та визначено перспективні напрямки розвитку глобального ринку інтелектуальних транспортних систем: управління дорожнім рухом; дорожня безпека та нагляд; управління вантажами; автомобільна телематика; управління паркуванням; автоматизовані транспортні засоби. Ідентифіковано основних гравців у сфері бізнесу на цьому ринку. Систематизовано для адаптації країн, що розвиваються, особливості Європейської архітектури ІТС, архітектури ІТС США, японської національної архітектури ІТС, які покликані служити для поліпшення життя містян. Запропоновано варіанти використання інформаційно-навігаційних систем у рамках європейських проектів на прикладі міст. На прикладі Європейського Союзу розглянуто етапи імплементації архітектури ІТС, так як це впливає на завантаженість доріг у крупних містах. Створення єдиної архітектури ІТС дозволяє контролювати: рівень безпеки перевезень на транспорті та дорожнього руху; обсяг споживання енергії та вплив на довкілля; мережі логістичних систем для обслуговування пасажирів та обробки вантажів; управління транспортом, дорожнім будівництвом і ремонтними роботами, місцями паркування, збором дорожньої плати, обладнанням для поліпшення персональних сервісів учасників дорожнього руху. Обґрунтовано необхідність використання комплексного підходу до удосконалення системи діджиталізації та інтелектуалізації транспортних систем з урахуванням їх переваг та недоліків. Узагальнено концептуальні підходи до оцифровки транспорту, які тісно пов'язані з логістичними ІТ-системами та мережею автодоріг місцевого значення. Досліджено теоретичне підґрунтя рівня інтелектуалізації українських транспортних систем в порівняні з зарубіжними, доведена доцільність можливості розвитку цієї сфери в Україні з впровадженням проекту «Прозора інфраструктура». Визначено організаційно-економічні засади використання інтелектуальних транспортних систем країн світу для вирішення широкого кола проблем: передача інформації в режимі реального часу для мандрівників, а саме розкладу руху транспорту, інформації про затримки; вступний внесок на проїзд транспортних засобів у район міста; управління аваріями; електронне стягнення мита. Розглянуто законодавчу базу та Національну транспортну стратегію України на період до 2030 року та відображено реальні результати розвитку транспортних систем, які вже впроваджуються в українських містах. В Україні будуватимуть мережу «розумних доріг». Для реалізації цього завдання потрібний якісний волоконно-оптичний зв'язок, який проходитиме уздовж автодоріг, що дозволить впроваджувати інтелектуальні транспортні системи. Використання провідного світового досвіду в області впровадження інтелектуальних транспортних систем має стратегічний характер для України, визначає її конкурентоспроможність на світовому ринку, відповідає вимогам інтеграції національної транспортної мережі в Транс'європейську транспортну мережу.*

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***Ключові слова:*** інтелектуальні транспортні системи, транспортна стратегія, інновації, автоматизовані системи управління, затори.

***Сергей Гриценко, Ирина Винниченко. «Перспективы и возможности использования зарубежного опыта для развития в Украине интеллектуальных транспортных систем».*** *Целью исследования является определение перспектив и возможностей использования зарубежного опыта для развития в Украине интеллектуальных транспортных систем. В статье рассмотрена история возникновения интеллектуальных транспортных систем в мире. Исследованы предпосылки и определены перспективные направления развития глобального рынка интеллектуальных транспортных систем: управление дорожным движением; дорожная безопасность и надзор; управление грузами; автомобильная телематика; управление парковкой; автоматизированные транспортные средства. Идентифицированы основные игроки в сфере бизнеса на этом рынке. Систематизировано для адаптации стран, что развиваются, особенности Европейской архитектуры ИТС, архитектуры ИТС США, японской национальной архитектуры ИТС, какие призваны служить для улучшения жизни горожан. Предложены варианты использования информационно-навигационных систем в рамках европейских проектов на примере городов. На примере Европейского Союза рассмотрены этапы имплементации архитектуры ИТС, так как это влияет на загруженность дорог в крупных городах. Создание единой архитектуры ИТС позволяет контролировать: уровень безопасности перевозок на транспорте и дорожного движения; объем потребления энергии и влияние на окружающую среду; сети логистических систем для обслуживания пассажиров и обработки грузов; управление транспортом, дорожным строительством и ремонтными работами, местами парковки, сбором дорожной платы, оборудованием для улучшения персональных сервисов участников дорожного движения. Обоснована необходимость использования комплексного подхода к усовершенствованию системы диджитализации и интеллектуализации транспортных систем с учетом их преимуществ и недостатков. Обобщены концептуальные подходы к оцифровке транспорта, которые тесно связаны с логистическими IT-системами и сетью автодорог местного значения. Исследована теоретическая основа уровня интеллектуализации украинских транспортных систем в сравнении с зарубежными, доказана целесообразность возможности развития этой сферы в Украине с внедрением проекта «Прозрачная инфраструктура». Определены организационно-экономические принципы использования интеллектуальных транспортных систем стран мира для решения широкого круга проблем: передача информации в режиме реального времени для путешественников, а именно расписания движения транспорта, информации о задержках; вступительный взнос на проезд транспортных средств в район города; управление авариями; электронное взыскание пошлины. Рассмотрена законодательная база и Национальная транспортная стратегия Украины на период до 2030 года и отображены реальные результаты развития транспортных систем, которые уже внедряются в украинских городах. В Украине будут строить сеть «умных дорог». Для реализации этого задания нужна качественная волоконно-оптическая связь, которая будет проходить вдоль автодорог, что позволит внедрять интеллектуальные транспортные системы. Использование ведущего мирового опыта в области внедрения интеллектуальных транспортных систем имеет стратегический характер для Украины, определяет ее конкурентоспособность на мировом рынке, отвечает требованиям интеграции национальной транспортной сети в Трансъевропейскую транспортную сеть.*

***Ключевые слова:*** интеллектуальные транспортные системы, транспортная стратегия, инновации, автоматизированные системы управления, пробки.

**Introduction.** The use of information systems in traffic management is associated with the rapid development of modern cities, increasing the number of rolling stock on the streets, new routes, and others. As a result, the amount of information needed for analysis and operational decision-making has grown significantly. The information component has become an integral part of urban life. Therefore, computers and special programs came to the rescue in this area. When organizing and regulating the work of land

transport, means of communication and computer control are used. The level of use of information systems in Ukraine is shallow. Further development of urban transport is not possible without computer technology, namely without intelligent transport systems (ITS). Many cities relied on the experience of developed countries in planning and implementing ITS. However, cities can develop their own approaches that match their own unique characteristics. They have a unique opportunity to use someone's experience and make a short leap forward to use it more effectively. Therefore, it is necessary to form new approaches to understanding intelligent transport systems and study ITS's phenomenon as an economic resource of transport users in the provision of transport services in cities, the development of regional industrial and logistics infrastructure.

**The purpose and objectives of the study:** to analyze the global intelligent transportation system; to analyze the global and regions market potential and to substantiate the advantage, opportunity, and challenge, restraints, and risks; to analyze the prospects of development in the Ukrainian market intelligent transport system.

**Basic material and results.** The transport system has a complex, multifactorial, non-stationary flow processes (passenger, material, information, financial), which require research, description, and subsequent optimization based on the use of analytical modeling, adapted to logistics administration [1].

The increase in cities has led to a rapid increase in passenger traffic. The needs of people to move are usually unpredictable, so planning, and in particular forecasting passenger traffic, is one of the most challenging tasks in transport.

ITS is essentially a mix of computers, information technology, and telecommunications with knowledge in the automotive and transportation sectors. Key ITS technologies are emerging from significant developments in these sectors. Thus, ITS can be defined as the application of computer, information, and communication technologies to manage vehicles and networks in real-time, including the movement of people and goods.

ITS covers all functional components: traffic management, commercial vehicle management, vehicle monitoring and control, transit management, emergency services, driver and passenger services, electronic payment services, data archiving, and maintenance and construction management [2].

The global market for intelligent transport systems by 2026 may reach about 78 billion dollars. USA, and in the forecast period from 2019 to 2026 it will grow with an average annual growth rate of about 12%.

The origin of intelligent transportation systems dates back to the 1960s when the Electronic Route Guidance System was developed in the U.S. However, the ITS World Congress in Paris in 1994 accelerated the development and deployment of intelligent transportation systems to enhance the traffic control systems across the globe. Since then, numerous ITS applications have been developed by various organizations worldwide and customized as per specific needs. It has become a global phenomenon, garnering attention from the automotive industry, transportation professionals, and political decision-makers alike. While the conventional ITS stage was focused on creating a technical foundation, the present stage is characterized by the development of feasible ITS products.

Global Intelligent Transportation System Market can be divided into such directions: Traffic Management, Road Safety & Surveillance, Freight Management, Road User Charging, Parking Management, Automotive Telematics, Automated Vehicles.

Key market players operating in the global intelligent transportation system market include WS Atkins PLC, Siemens AG, Thales Group, Nuance Communications

Incorporation, Garmin International Inc., Hitachi Ltd., EFKON AG, Iteris Inc., Telenav Inc., TomTom NV [3].

The development of European ITS architecture results from two projects funded by the European Commission – KAREN (started in 1999) and FRAME [4]. The first European ITS Framework Architecture was produced in November 2000 by the KAREN Project, funded by the European Commission. EU Member States are currently using the European Framework Architecture as a basis for the development of their local, regional, and national ITS architectures. The purpose of the FRAME Projects, launched in the Summer of 2001, is to refine the first version of the Framework Architecture and provide support to its development and application. The aim is to give active assistance to all EU Member States (and applicant countries) wishing to develop their own architectures and to provide an opportunity for them to exchange experience [5].

Frame project includes initial ideas of European ITS framework architecture with the following documentation: European ITS functional architecture; European ITS physical architecture; European ITS communication architecture; European ITS cost-benefit analysis; European ITS implementation study; ITS implementation model [6].

The European ITS Framework Architecture is designed to provide a flexible framework that individual countries can tailor to their requirements. National ITS Architecture projects based on the European ITS Framework Architecture, such as ACTIF (France), ARTIST (Italy), TTS-A (Austria), and TEAM (Czech Republic), therefore have a common approach and methodology. Still, each has been able to focus on local importance aspects and develop them in more detail [7]. The project frame has continued as the E-FRAME FP7 project. There are significant differences between approaches in designing the ITS architecture. US ITS Architecture is based on the physical viewpoint, European architecture relies mostly on users' needs and functional view, while Japanese national ITS architecture uses object-oriented methodology.

The action plan for ITS deployment can be considered the document that initiated stronger and more focused ITS development in the European Union. Although there was a high level of harmonization in strategic research supported by the European Technology Platforms ERTRAC and ERTICO-ITS, the framework for ITS deployment in road transport was still designed [8]. The action plan's preparation included stakeholders' consultation, workshops, online survey (public debate), and discussion groups.

The use of information and navigation systems within the framework of European projects can be shown in the example of the following cities: Bristol (CONCERT - TFIS for better use of the Park and Ride system); Brussels (CAPITALS - TFIS as part of a superior traffic management system in tunnels on the inner ring of the city); London (CLEOPATRA - Determination of the influence of TFIS in the identification of crash sites on the choice of drivers along with the road network and the efficiency of transport in the network); Lyon (CLEOPATRA - information strategy for TFIS in automatic mode using data obtained from measurements carried out on the road network); Munich (TABASCO - TFIS for Park and Ride); Piraeus (COSMOS - strategy to change the direction of traffic flows in the seaport area); Southampton (EUROSCOPE - integrated crash site identification and parking management); Toulouse (CLEOPATRA - a general strategy for changing the direction of traffic flows); Turin (CLEOPATRA - the TFIS strategy together with the city's traffic management strategy) [9].

Considering the European Union's expertise in the development of transport systems, we must take into account the course of Germany called "Industry 4.0", which is a course of industrial deployment with extensive use of cyber-physical systems. The method of revolutionary development "Industry 4.0", popularized in the European

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Union, transfers the standardization of transport systems through digitization and the creation of innovative environmentally friendly technologies. There are now two major innovative transformations of EU transport systems:

1. Smart transport through digitalization. This is done with the help of artificial intelligence, namely digital vision and Big Data technologies because it allows you to track and monitor each vehicle that affects the unloading of traffic flows and affects safety and reduces the number of accidents. The digitalization of smart transport is closely linked to logistics IT systems. Because, using modern "cloud" logistics IT-systems, you can not only quickly find a customer, calculate the most cost-effective route, but also choose the associated cargo on the way back.

2. Implementation of ITS (intelligent transport systems) and ITM (intelligent transport networks). The focus of both European and global automotive markets are intelligent transport systems. Already today, many smart solutions are being created, such as even "smart" highways, wherewith the help of transponders, you can quickly adjust the density of traffic flows and make contactless payments for travel on roads. The most famous car manufacturers globally (Audi, BMW, General Motors, Cadillac, Toyota, Google, Continental, Mercedes-Benz, Volvo, Tesla Motors) have been working intensively unmanned vehicle control technologies in recent years [10].

However, the trend of intellectualization and digitalization of transport systems causes specific problems (Table 1).

Table 1 - Advantages and disadvantages of intellectualization and digitalization of EU transport systems

| Advantages | Disadvantages |
|---|---|
| Overall road safety is increased through better control and monitoring | The cost of electric cars is higher than usual |
| A single integrated system with other control and monitoring services is being created | Payments for violations are reduced and revenues to the state treasury are reduced |
| Reducing the cost of transportation | Loss of jobs for drivers, controllers, cashiers |
| Save time due to absence need to drive a car | The issue of cybersecurity is exacerbated |
| Reducing emissions of harmful substances and improving the welfare of the population | The problem of disposal of electric batteries and their service |

All over the world, intelligent transport systems have long been used to solve a wide range of problems, namely:

Transmission of real-time information for travelers, namely the schedule of traffic, information about delays. Objective: To help travelers make a choice in favor of intelligent transport and make public transport more attractive. Examples: Hong Kong, Brisbane, London, and Berlin.

Entrance fee to the city area. Objective: To reduce the demand for vehicle travel and reduce traffic jams throughout the territory, a toll is applied. Public transport is given priority; it uses tax-free lanes. Examples: Stockholm, London, Singapore. Similar technologies are used in different cities in Italy and Norway.

Accident management. Objective: To ensure the central point's operation to reduce

the consequences of emergencies on the road and in the public transport system. Examples: Beijing, London, Madrid, Sydney, Singapore.

Freight transport management. Objective: To improve the efficiency of the fleet. Examples: the United Kingdom, the United States, Japan, Austria, Germany, Switzerland, and Australia.

Electronic payment collection. Objective: Smart cards are used as a form of e-wallet. These cards can be topped up at payment stations (banks, small shops) or online, and then they can be used to pay for goods and services. Examples: London, Bangkok, Kuala Lumpur, Bogota, Hong Kong, Singapore, Madrid. The use of such a volume and input-based access system is planned in Mumbai and Bangalore, India.

Electronic toll collection. Objective: Electronic toll collection (ETC) helps make payment more convenient, requires fewer stops, reduces toll collection costs, and minimizes revenue gains due to corruption compared to manual toll collection systems. Examples: CityLink, Melbourne; highways in Malaysia and toll roads, Brazil.

Security control systems. Objective: Safety control systems are designed to reduce the number of accidents by increasing drivers' attention in unusual road conditions—for example, Europe, China, and the USA [2].

The development of intelligent transport systems in the transport infrastructure of Ukraine has not become widespread. It is more limited to the use of satellite navigation and obsolete traffic control equipment.

Examples of Ukrainian ITS testing began in 2008, in Kyiv, a system such as "Smart Traffic Light" was introduced. In Kyiv, 478 traffic lights were connected to the mobile Internet. They are equipped with an automated control system that can respond to the situation on the road. The essence of the course is to create a "green wave." The use of green waves to control traffic is considered a promising way to reduce delays and emissions.

Kharkiv has progressed further along the path of introducing an intelligent urban transport system in Ukraine. Before the 2012 European Championships, Kharkivpastrans developed several computerization programs: a single road, a GPS navigation system, and a single urban transport system.

In 2011, Kharkiv set a course for a comprehensive GPS navigation system on all public vehicles. From the middle of the year on all mobile phones, Miskelektrotrans the GPS-navigator works. Besides, the transport infrastructure is gradually approaching the creation of a simple transport system in the city, which allows you to efficiently and effectively regulate passenger traffic and respond to any situation on the roads [11].

Today, Ukraine has already developed a National Strategy for the Development of the Transport System in Ukraine until 2030. This document covers the following tasks:

- introduction of new technologies and intelligent transport systems (ITS) to improve the quality of transport services, information systems on services provided, the introduction of electronic and integrated automatic fare payment system;

- creation of a network of multimodal transport and logistics clusters and primary logistics centers, "dry ports," terminals, specialized transshipment complexes, etc. [12].

Also, one of the latest achievements in the field of ITS development in Ukraine is that the Ministry of Infrastructure of Ukraine is initiating a project to digitize the local highway network to collect geo-coordinates of roads, as well as create a separate database and service for local network certification, which will be available to all regional administrations.

Besides, together with TAPAS, the Ministry of Infrastructure works on the project "Transparent Infrastructure." This project will allow for effective on-site monitoring and the formation of automatic reports and visualizations on maps of road repair facilities [13].

In conclusion, we note that the intensive implementation and use of intelligent transport systems for Ukraine should be only with the support of the government and taking into account the following conditions:

1. The real direction of improving the efficiency of the transport system of Ukraine is to ensure greater openness for new transport companies, attract private capital, develop competition in all sectors of transport (including railway rolling stock), leaving state market regulation only for elements that cannot be eliminated. structures) and which are necessary to ensure an adequate level of transport safety. To do this, it is worth using the experience of other countries to open markets for transport systems for private capital.

2. The state should monitor the efficiency of all modes of transport and prevent asymmetries in competition between them.

3. Analyze the legal system that regulates transport and transport-related construction, environmental and other issues regarding their compliance with international standards.

4. Transport policy should form the basis for local authorities' action on the establishment of integrated public transport systems for the use of intelligent transport systems [14].

5. Intelligent transport systems can be effectively used in a network of multimodal transport and logistics clusters [15, c. 347-350].

**Conclusions.** The domestic transport system is of international importance, as the transport routes passing through Ukraine connect Asia, Western and Central Europe. Ukraine has the prerequisites for building a transport and logistics system similar to the European one.

Today, the approved National Transport Strategy of Ukraine for the period up to 2030 sets the task of introducing new technologies and intelligent transport systems for unhindered mobility, interregional integration, and improving the quality of transport services. Implementing the provisions of the strategy will make it possible to create an effectively functioning transport complex of Ukraine, taking into account the progressive world experience of development and implementation of intelligent transport systems.

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