

Electronic scientific and practical journal

INTELLECTUALIZATION OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

#4 (2020)
December '20



WWW.SMART-SCM.ORG

ISSN 2708-3195

DOI.ORG/10.46783/SMART-SCM/2020-4

ISSN 2708-3195





Electronic scientific and practical publication in economic sciences

ISSN 2708-3195

DOI: <https://doi.org/10.46783/smart-scm/2020-4>

Released 6 times a year

№ 4 (2020)
December 2020

Kyiv - 2020

Founder: Viold Limited Liability Company

Editor in Chief: Hryhorak M. Yu. – Doctor of Economics, Ass. Professor.

Deputy editors-in-chief: Koulyk V. A. – PhD (Economics), Professor.
Marchuk V. Ye. – Doctor of Tech. Sci., Ass. Professor.

Technical editor: Harmash O. M. – PhD (Economics), Ass. Professor.

Executive Secretary: Davidenko V. V. – PhD (Economics), Ass. Professor.

Members of the Editorial Board:

SWIEKATOWSKI Ryszard – Doctor of Economics, Professor (Poland);

POSTAN M. Ya. – Doctor of Economics, Professor;

TRUSHKINA N. V. – PhD (Economics), Corresponding Member of the Academy;

KOLOSOK V. M. – Doctor of Economics, Professor;

ILCHENKO N. B. – Doctor of Economics, Ass. Professor;

SOLOMON D. I. – Doctor of Economics, Professor (Moldova);

ALKEMA V. H. – Doctor of Economics, Professor;

Henryk DŹWIGOŁ – PhD (Economics), Professor (Poland);

SUMETS O. M. – Doctor of Economics, Ass. Professor;

STRELCOVÁ Stanislava – PhD (Economics), Ass. Professor, (Slovakia);

RISTVEJ Jozef (Mr.) PhD (Economics), Professor, (Slovakia);

ZAMIAR Zenon – Doctor of Economics, Professor, (Poland);

SMERICHEVSKA S. V. – Doctor of Economics, Professor;

GRITSENKO S. I. – Doctor of Economics, Professor;

KARPENKO O. O. – Doctor of Economics, Professor;

PATKOVSKYI S. A. – Business practitioner.

The electronic scientific and practical journal is registered in international scientometric data bases, repositories and search engines. The main characteristic of the edition is the index of scientometric data bases, which reflects the importance and effectiveness of scientific publications using indicators such as quotation index, h-index and factor impact (the number of quotations within two years after publishing).

In 2020, the International Center for Periodicals (ISSN International Center, Paris) included the Electronic Scientific and Practical Edition "Intellectualization of Supply Chain Management" in the international register of periodicals and provided it with a numerical code of international identification: ISSN 2708-3195 (Online).

Recommended for dissemination on the Internet by the Academic Council of the Department of Logistics NAU (No. 7 of February 26, 2020). Released 6 times a year. Editions references are required. The view of the editorial board does not always coincide with that of the authors.

t.me/smart_scm
facebook.com/Smart.SCM.org
twitter.com/ScmSmart

DOI: <https://doi.org/10.46783/smart-scm/2020-4>
e-mail: support@smart-scm.org

тел.: (063) 593-30-41
<https://smart-scm.org>

Contents

INTRODUCTION	5
BUGAYKO D. O. PhD in Economics, Associate Professor, Acting Director International Cooperation and Education Institute, Instructor of ICAO Institute of National Aviation University (Ukraine), SHEVCHENKO O.R. PhD in Economics, Director of International Cooperation and Education Institute, National Aviation University (Ukraine) <i>INDICATORS OF AVIATION TRANSPORT SUSTAINABLE DEVELOPMENT SAFETY</i>	6 – 18
KOSTIUCHENKO L. V. PhD in Economics, Associate Professor, Associate Professor of Department of National Aviation University (Ukraine) <i>THE MULTISOURCING MODEL OF SAFE SUPPLY CHAIN MANAGEMENT</i>	19 – 26
HRYHORAK M.Yu. Doctor of Economics, Associate Professor, Head of Logistics Department National Aviation University (Ukraine), 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) <i>DEVELOPMENT OF THE LOGISTICS SYSTEM OF THE ECONOMIC REGION "POLISSYA" IN THE CONTEXT OF THE GREEN ECONOMY: ECOLOGICAL PROBLEMS AND PERSPECTIVES</i>	27 – 40
KARPUN O.V. PhD in Economics, Associate Professor, Associate Professor of Logistics Department National Aviation University (Ukraine) <i>CONCEPTUAL MODEL OF FLORICULTURE SUPPLY CHAIN MANAGEMENT</i>	41 – 52
GRITSENKO S.I. , Doctor of Economics, Professor, Professor of Logistics Department National Aviation University (Ukraine), VINICHENKO I.A. Project Manager, Dudka Agency (Ukraine) (Ukraine) <i>PROSPECTS AND OPPORTUNITIES FOR USING FOREIGN EXPERIENCE FOR THE DEVELOPMENT OF INTELLECTUAL TRANSPORTATION SYSTEMS IN UKRAINE</i>	53 – 61

UDC 656.7.072 (045)

DOI: <https://doi.org/10.46783/smart-scm/2020-4-1>

JEL Classification: M12, M21.

Received: 12 December 2020

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 as 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 прийняттого 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.

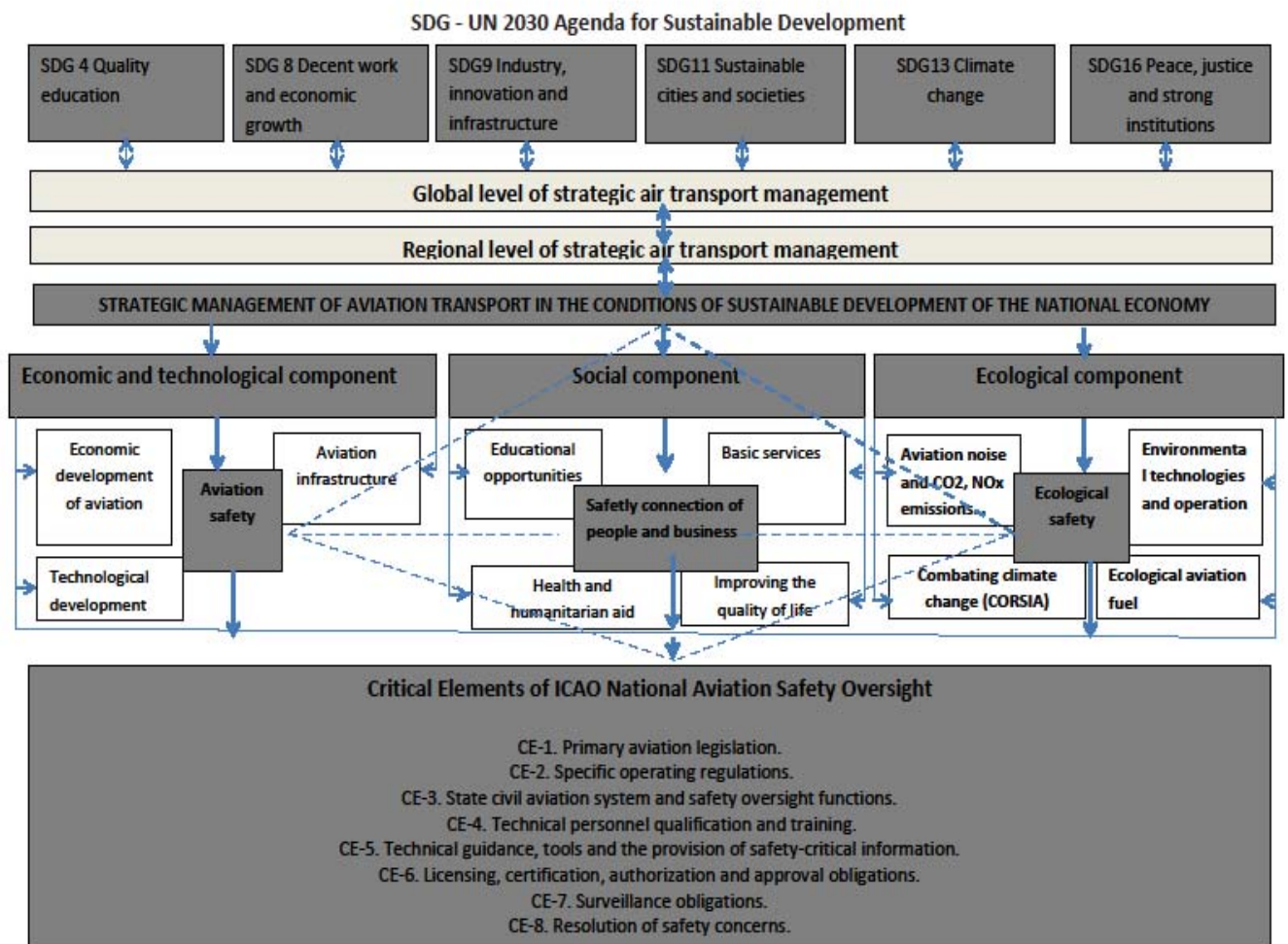


Figure 1. Structure of Strategic Management of Aviation Transport in the conditions of sustainable development of national economy.

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](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 transportation 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:

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

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:

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

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 disincensive.*

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

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

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 transport, 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 CO ₂ 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 as 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.

References

1. Resolution adopted by the General Assembly (UN) on 25 September 2015 A / RES / 70/1. Transforming our world: the 2030 Agenda for Sustainable Development.
2. Aviation Benefits Report 2019, ICAO (Report based on material from ACI, CANSO, IATA, ICAO, ICCAIA, ATAG).
3. Convention on International Civil Aviation (Doc 7300), signed at Chicago on December 7, 1944.
4. D. Bugayko, Yu. Kharazishvili. Theoretical principles of strategic aviation safety management in the context of ensuring sustainable development of the national economy. Bulletin of Economic Science of Ukraine. 2020. № 1 (38). P. 166-175. Institute of Industrial Economics of the National Academy of Sciences of Ukraine, Academy of Economic Sciences of Ukraine.
5. D. Bugayko, Yu. Kharazishvili, M. Hryhorak, Z. Zamiar. (2020). Economic Risk Management of Civil Aviation in the Context of Ensuring Sustainable Development of the National Economy. *Logistics and Transport – Wrocław: International School of Logistics and Transport in Wrocław*. 2020. Vol.1-2(45-46). P.71– 82.

6. D. Bugayko, Yu. Kharazishvili, A. Antonova, Z. Zamiar. (2020). Identification of Air Transport Ecological Component Level in the Context of Ensuring Sustainable Development of the National Economy. *Intellectualization of Logistics and Supply Chain Management. The electronic scientifically and practical journal, Vol.3 (2020) October 2020* P.38 – 53, available at: https://smart-scm.org/wp-content/uploads/3_20_titul_j_full.pdf. DOI: <https://doi.org/10.46783/smart-scm/2020-3>.
7. Kharazishvili Yu.M. (2019). Systemic security of sustainable development: assessment tools, reserves and strategic scenarios of implementation: *monograph. NAS of Ukraine, Institute of Industrial Economics. Ki-ate*, 2019. - 304 p.
8. Statistical collection "Transport and Communications of Ukraine" 2018, available at: http://www.ukrstat.gov.ua/druk/publicat/kat_u/publ8_u.htm
9. Report of the Head of the State Aviation Service of Ukraine for 2019, available at: https://www.kmu.gov.ua/storage/app/sites/1/17-civik-2018/zvit_2019/zvit-2019-avia.pdf
10. The results of the aviation industry of Ukraine for 9 months of 2017, available at: <https://avia.gov.ua/wp-content/uploads/2017/04/Pidsumky-roboty-2016.pdf>
11. "Analysis of the state of aviation safety based on the results of the investigation of aviation accident and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2013". *National Bureau for Investigation of Aviation Accident and Incidents with Civil Aircraft*, available at: http://www.nbaai.gov.ua/uploads/pdf/Analysis_2013.pdf
12. "Analysis of the state of aviation safety based on the results of the investigation of aviation accident and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2014". *National Bureau for Investigation of Aviation Accident and Incidents with Civil Aircraft*, available at: http://www.nbaai.gov.ua/uploads/pdf/Analysis_2014.pdf
13. "Analysis of the state of aviation safety based on the results of the investigation of aviation accident and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2015". *National Bureau for Investigation of Aviation Accident and Incidents with Civil Aircraft*, available at: http://www.nbaai.gov.ua/uploads/pdf/Analysis_2015.pdf
14. "Analysis of the state of aviation safety based on the results of the investigation of aviation accident and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2016". *National Bureau for Investigation of Aviation Accident and Incidents with Civil Aircraft*, available at: http://www.nbaai.gov.ua/uploads/pdf/Analysis_2016.pdf
15. "Analysis of the state of aviation safety based on the results of the investigation of aviation accident and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2017". *National Bureau for Investigation of Aviation Accident and Incidents with Civil Aircraft*, available at: http://www.nbaai.gov.ua/uploads/pdf/Analysis_2017.pdf
16. "Analysis of the state of aviation safety based on the results of the investigation of aviation accident and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2018". *National Bureau for Investigation of Aviation Accident and Incidents with Civil Aircraft*, available at: <http://www.nbaai.gov.ua/uploads/pdf/Analysis2018.pdf>
17. "Analysis of the state of aviation safety based on the results of the investigation of aviation accident and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2019". *National Bureau for Investigation of Aviation Accident and Incidents with Civil Aircraft*, available at: http://www.nbaai.gov.ua/uploads/pdf/Analysis_2019.pdf