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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
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INSTITUTIONAL MEASURES OF AIR TRANSPORT SAFETY STRATEGIC MANAGEMENT AT THE LEVEL OF STATE REGULATION

Dmytro Bugayko, Yuliya Ierkovska "Institutional Measures of Air Transport Safety Strategic Management at the Level of State Regulation". *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. According to the concept of national aviation risk management developed by the authors, risk can be assessed as a mutual combination of hazarad, vulnerability and consequences. The application of this concept in relation to the air transport of Ukraine allowed to identify the main hazards, vulnerabilities, consequences and risks. The next step in the implementation of the concept is to develop institutional measures to neutralize threats in the field of aviation safety, which is actually a set of risk reduction measures for further sustainable development of the national economy. This article summarizes the hazards, vulnerabilities, consequences, risks, and institutional arrangements for strategic aviation safety management. Among the priority measures are: harmonization of national regulation of air transport with the requirements of global and regional levels, development of mechanisms for commercial protection of domestic air transport enterprises in the COVID-19 pandemic, implementation of strategic scenarios for sustainable development of air transport in Ukraine until 2030. The implementation of the proposed institutional measures will ensure an appropriate level of safety, efficiency and regularity of the national air transport of Ukraine.

Keywords*:* air transport, state regulation, aviation safety, hazards, risks, institutional measures.

Дмитро Бугайко, Юлія Єрковська "Інституційні заходи стратегічного управління безпекою авіаційного транспорту на рівні державного регулювання". *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 безпеки авіації є пріоритетом для галузі. Авіаційно-транспортна галузь є системою відкритого типу, на яку впливає широкий спектр технічних, природних, людських та економічних небезпек. Кожна небезпека спричиняє створення низки ризиків.*

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. Згідно з розробленою авторами концепцією національного управління ризиками ризик можна оцінити як взаємне поєднання загрози, вразливості та наслідків. Застосування цієї концепції по відношенню до авіаційного транспорту України дозволило виявити основні загрози, вразливості наслідки та ризики. Наступний крок реалізації концепції полягає в розробленні інституційних заходів нейтралізації загроз у сфері безпеки авіації, що фактично є комплексом заходів зменшення ризиків з метою подальшого сталого розвитку національної економіки. Зведену інформацію про загрози, вразливості, наслідки, ризики та інституційні заходи щодо стратегічного управління безпекою авіаційного транспорту наведено у цій статті. Серед першочергових заходів можливо виділити: гармонізацію національного регулювання авіаційного транспорту з вимогами світового та регіонального рівнів, розроблення механізмів комерційного захисту вітчизняних підприємств авіаційного транспорту в умовах пандемії COVID-19, імплементацію стратегічних сценаріїв сталого розвитку авіаційного транспорту України в безпековому вимірі на період до 2030 року. Реалізація запропонованих інституційних заходів дозволить забезпечити відповідний рівень безпеки, ефективності та регулярності національного авіаційного транспорту України.

Ключові слова: авіаційний транспорт, державне регулювання, безпека авіації, загрози, ризики, інституційні заходи.

Дмитрий Бугайко, Юлия Ерковская "Институциональные мероприятия стратегического управления безопасностью авиационного транспорта на уровне государственного регулирования". *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, гарантирующий, что ни одно государство-член ООН не останется позади. 17 целей устойчивого развития, изложенных в Повестке дня на 2030 год, 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 и безопасности транспорта от внешних и внутренних угроз. Поддержание приемлемого уровня национальной безопасности авиации является приоритетом отрасли. Авиационная транспортная отрасль является системой открытого типа, на которую влияет широкий спектр технических, природных, человеческих и экономических опасностей. Каждая опасность влечет за собой создание ряда рисков.*

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. Согласно разработанной авторами концепции национального управления рисками риск можно оценить как взаимное сочетание угрозы, уязвимости и последствий. Применение этой концепции по отношению к авиационному транспорту Украины позволило выявить основные угрозы, уязвимости, последствия и риски. Следующий шаг реализации концепции заключается в разработке институциональных мер нейтрализации угроз в сфере безопасности авиации, что фактически является комплексом мер по уменьшению рисков с целью дальнейшего устойчивого развития национальной экономики. Сводная информация об угрозах, уязвимости, последствиях, рисках и институциональных мерах по стратегическому управлению безопасностью авиационного транспорта приведена в этой статье. Среди первоочередных мер можно выделить: гармонизацию национального регулирования авиационного транспорта с требованиями мирового и регионального уровней, разработку механизмов коммерческой защиты отечественных предприятий авиационного транспорта в условиях пандемии COVID-19, имплементацию стратегических сценариев устойчивого развития авиационного транспорта Украины в измерении безопасности на период до 2030 года. Реализация предложенных институциональных мер позволит обеспечить соответствующий уровень безопасности, эффективности и регулярности национального авиационного транспорта Украины.*

Ключевые слова: авиационный транспорт, государственное регулирование, безопасность авиации, угрозы, риски, институциональные меры.

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 aviation transport risk assessment 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].

The purpose of the article is to develop at the level of state regulation of institutional measures to neutralize current hazards in the field of air transport safety, which is actually a set of proactive risk reduction measures to support further sustainable development of the national economy.

Presentation of the main results. The air transport is an open system that is affected by a wide range of technical, natural, human and economic hazards. Each hazard creates a number of risks. According to the concept of national aviation risk management developed by the authors, risk can be assessed as a mutual combination of hazard, vulnerability and consequences. The application of this concept in relation to the air transport of Ukraine allowed identifying the main hazard, vulnerabilities, consequences and risks.

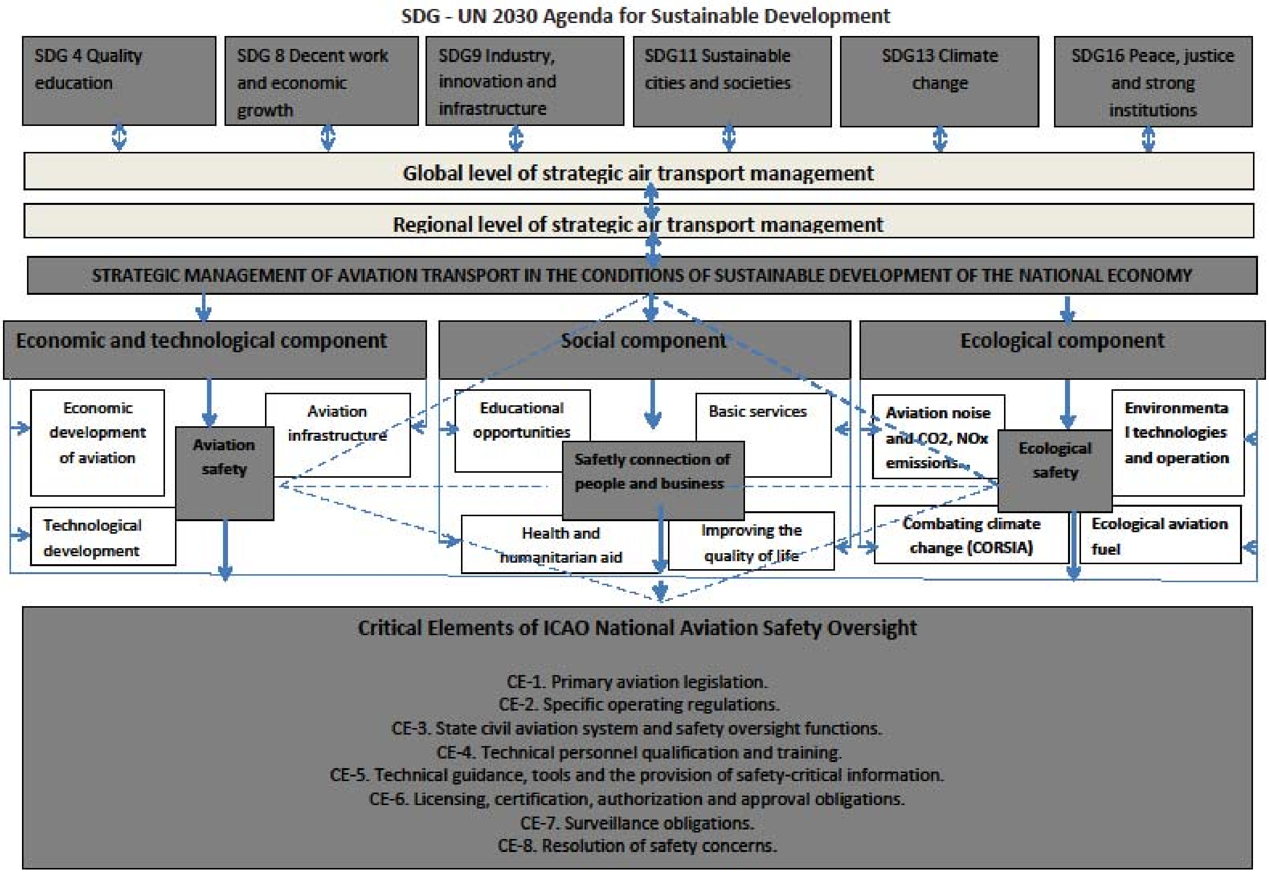

Figure 1. Structure of Strategic Management of Aviation Transport in the conditions of sustainable development of national economy

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].

The next step in the implementation of the concept is to develop institutional measures to neutralize hazards in the field of aviation safety, which is actually a set of risk reduction measures for further sustainable development of the national economy. Summary information on hazards, vulnerabilities, consequences, risks and institutional measures for strategic management of air safety is given in table1.

In accordance with the provisions of Annex 19 "Safety Management" to the ICAO Convention on International Civil Aviation (Chicago Convention 1944), at the national level, strategic aviation safety management is implemented within the State Aviation Safety Program (SSP) [18]. As of the 2021 in Ukraine, this area is regulated by the Civil Aviation Safety Program of Ukraine, which was approved at the meeting of the Aviation Safety Council of the State Aviation Service of Ukraine on March 27, 2018. The program has a structure in accordance with ICAO requirements. However, its main drawback is the level of its signatories. Unlike most countries in the world, where this program has been approved at the level of the legislature (parliament), in some cases the Cabinet of Ministers or the National Security and Defense Council, in Ukraine it is published at the regulatory level.

Thus, the basis of this program - resource security of air transport of the state. Only when the program receives real state support, it is possible to claim its effectiveness. Currently, the issue of development and approval of the State Program on Air Transport Safety on the basis of standards and recommended practices of the International Civil Aviation Organization is included in the Program of Activities of the Cabinet of Ministers of Ukraine. According to the announced indicators of the Civil Aviation Safety Program of Ukraine of the State Aviation Service, by 2022 the country should ensure a 100% level of implementation of the State Aviation Safety Program, which as of the first quarter of the year does not actually exist. This is a significant risk of strategic aviation safety management, which may adversely affect the results of the next ICAO audit.

The program has to contain the following structural components:

1. State policy, goals and resources in the field of aviation safety. It consists of the following elements: basic aviation legislation; specific rules of operation; state system and functions; qualified technical staff; technical instructional material, tools and provision of information important from the point of view of flight safety.

2. Management of risk factors for aviation safety at the state level. States must identify potential safety factors inherent in the aviation system. To do this, the state should supplement its traditional methods of analyzing the causes of an aviation accident or incident with proactive processes. Proactive processes make it possible to identify predictors of aviation events and the factors that contribute to them, to take appropriate measures, as well as to strategically manage resources in the field of flight safety in order to maximize the level of flight safety.

3. Ensuring of aviation safety at the state level. The state's activities to ensure flight safety are designed to ensure that its functions lead to the achievement of goals and target levels in the field of aviation safety. State aviation safety management actions under the State Aviation Safety Program ensure that its aviation safety processes work effectively and that the state is on track to achieve its safety objectives through the collective efforts of aviation actors and state.

4. Promotion of aviation safety issues at the state level. The need to implement internal and external measures to promote safety at the state level is set out in Annex 19 as one of the components of the state's responsibilities in the field of safety management. Mechanisms should be established to provide up-to-date safety information to national aviation community in order to promote the formation of culture and, consequently, the effectiveness and efficiency of the State Aviation Safety Program.

The main structural part of the State Aviation Safety Program should be the critical elements (CE) of the national aviation safety control ICAO, namely:

CE 1. Basic aviation legislation;

CE 2. Specific regulations on operation;

CE 3. State system of civil aviation and state functions of control over aviation safety,

CE 4. Qualification and training of personnel;

CE 5. Technical instructional material, tools and information in terms of aviation safety;

CE 6. Obligations to issue certificates, certification, authorization and approval;

CE 7. Obligations to supervise;

CE 8. Solving aviation safety problems.

This is the basis for the state to maintain a national acceptable level of aviation safety.

State program to counteract the negative impact of COVID-19 on air transport in order to support the sustainable development of the national economy. Successfully addressing the challenges posed by the COVID-19 pandemic requires assessing and managing risk factors that go beyond safety risk management. National civil aviation authorities should take into account the possible consequences of their decisions for the risks faced by other public authorities.

Table 1 - Institutional measures for strategic management of air transport safety in Ukraine

Classification of hazards	Vulnerability of protection systems (GAP Analysis)	Consequences	Risks	Institutional measures
1. Problems of air transport regulation: 1.1 Changes in aviation safety regulation at the global and regional levels. 1.2 Changes in multilateral and bilateral regulation of the air transportation market. 1.3 Changing the mechanisms of destination of air carriers	**1. Imperfection of national aviation legislation:** 1.1 Lack of program development and implementation of Safety State Programme (SSP). 1.2 Imperfection of mechanisms of protectionism of national airlines by the state. 1.3 Lack of preferences for state and mixed airlines	**1. Insufficiently effective national regulation of air transport safety:** 1.1 Discretion of management actions and insufficient level of resource provision of air transport safety. 1.2 Financial imbalance of national airlines, complicated by conditions of fierce competition. 1.3 Redistribution of segmentation of the national air transportation market	**1. Reducing the level of efficiency and safety of national air transport:** 1.1 Problems with maintaining a nationally acceptable level of aviation safety. 1.2 Bankruptcy of national airlines. 1. Obtaining the national market by the airlines with 100% foreign capital and control	**1. Harmonization of national regulation of air transport with the requirements of world and regional levels:** 1.1 Development and implementation of the National Aviation Safety Program (SSP). 1.2 Development of mechanisms for protectionism of national airlines by the state. 1.3 Development of the state mechanism of preferences for airlines of state and mixed forms of ownership. 1.4 Development and implementation of a national aviation training program
2. Challenges of the COVID-19 pandemic: 2.1 Reducing the volume of export-import operations in a recession. 2.2 Reducing the number of flights. 2.3 Reduction of air passenger traffic. 2.4 Under crowding of commercial activity level of airports and infrastructure	**2. Vulnerabilities of the national aviation safety management system in a pandemic:** 2.1 Imperfection of compensatory state mechanisms of air transport protection and national economy in the conditions of pandemic COVID-19. 2.2 Unprepared system of strategic financial management and economic security of air transport enterprises in conditions of the unpredictable impact of crisis phenomena	**2. Total financial crisis at the general system level of air transport of Ukraine, as well as at the level of its hierarchical components: aviation infrastructure, airlines, airports, air navigation service provider and general aviation**	**2. Bankruptcy and destruction of the national air transport system at the general system level, as well as at the level of its hierarchical components: aviation infrastructure, airlines, airports, air navigation service provider and general aviation**	**2. Development of mechanisms for commercial protection of domestic air transport enterprises in the context of the COVID-19 pandemic:** 2.1 On the part of the state at the level of its hierarchical components: aviation infrastructure, airlines, airports, air navigation service provider and general aviation. 2.2 At the level of systems of strategic financial management and economic security of air transport enterprises of Ukraine

Source: developed by the authors

It is proposed to pay special attention to the following priority measures to counter the COVID-19 pandemic:

– risk assessment and prioritization based on data collection and analysis;

– application of aviation safety management principles in decision-making based on risk analysis;

– process management and monitoring of decisions of civil aviation agencies, taking into account the flexibility that must be shown within the aviation system to continue safe operations.

Methods of cooperation, interaction and communication (cooperate, collaborate and communicate) are the most important elements of action of many countries in a global crisis. Civil aviation authorities should recognize that these existing functions also on an ongoing basis contribute to the effective implementation of the State Aviation Safety Program and play an important role in managing aviation safety risks, including the risks of COVID-19 impacts on the aviation system. The program recommends defining mechanisms for state protectionism and granting preferences to airlines of state and mixed ownership of Ukraine and supporting the airport network during a pandemic.

Thus, air transport is one of the sectors of the economy that has been most affected by the pandemic. Crisis phenomena of air transport, in turn, can negatively affect the state of sustainable development of the national economy of Ukraine. Counteraction to them should be based on the implementation of measures to anticipate the integrated risks of air transport.

National aviation training program. One of the most effective tools for the protection of air transport is the training, retraining and advanced training of aviation specialists, which is based on modern competency-based approaches to solving problems of aviation safety.

According to the forecasts of the world's leading civil aviation organizations, every 15-20 years there is a double increase in the number of flights. In 10 years, global passenger traffic will reach 14 billion. This necessitates the training of more than 491,000 pilots, 100,000 air traffic controllers, 1 million flight attendants and more than 500,000 aircraft maintenance personnel in the next 20 years. According to experts, in the period up to 2036, the air transport industry will create 15.5 million direct jobs and attract 1.5 trillion dollars GDP for the world economy. At the same time, the existing, and most importantly projected, capacity of aviation training centers is far from the demand for training of aviation specialists.

According to ICAO's Global Safety Plan, the global level of critical aviation safety oversight element 4, which includes the availability of qualified aviation technical personnel, is only 52 %. It is the lowest of all 8 critical elements and one of the major GAPs in global aviation.

According to ICAO's strategies, the implementation of the aviation safety management system is regulated at three hierarchical levels - global, regional-international and national.

The global level is based on the standards and recommended practices (SARPS) of the International Civil Aviation Organization (ICAO), published in the annexes to the Convention on International Civil Aviation (Chicago Convention). ICAO's aviation safety management system is based on management commitments and aims to address safety and cost-effectiveness issues.

The regional and international level is based on the activities of regional aviation organizations, such as EUROCONTROL, the European Civil Aviation Conference (ECAC), the European Aviation Safety Agency (EASA) and adapts ICAO standards and recommended practices to regional specifics and requirements.

The national level is based on the activities of national aviation organizations, such as the National Supervisory Authorities

(NSA), the Civil Aviation Authorities (CAA), the State Aviation Administration (SAA), and the National Aviation and Transport Universities (National Aviation University, Kyiv).

The global, regional, international and national levels are hierarchically interconnected and coherent.

It should be noted that higher education and research institutions play an important role in the developed curricula, technologies and rules. The National Aviation University of the Ministry of Education and Science of Ukraine pays special attention to aviation safety issues and has been developing joint scientific and educational activities in this field for many years. Content of coordination of training and retraining of aviation safety specialists in 2003 The ICAO Institute was established at the National Aviation University. The institute includes the ICAO European Regional Training Center for Aviation Safety, the ICAO European Regional Training Center for the Training of State Inspectors for Air Safety and Airworthiness of Aircraft, as well as national training centers. Since 2003, about 20.5 thousand employees of aviation administrations, airlines, airports, aviation enterprises, aero clubs and aviation educational institutions of Ukraine and 77 countries have been trained and retrained in the training centers of the institute [19].

However, the needs of the aviation sector are not met only by aviation personnel - cyber security, environmental safety, biotechnology (for example, for biofuel production), economics and management, international aviation law also requires highly qualified specialists. Multidisciplinary is the hallmark of international aviation education in the period of globalization. This creates a need to train 50-60 million professionals in related economic sectors (induced and catalytic business), which are related to the activities of the aviation industry. And almost the entire list can be found in the names of specialties in which students of the National Aviation University study today. If we consider further - the prospects for the development of the industry globally indicate a significant increase in demand for both the latest technology and aviation personnel, as well as in the catalytic age of related sectors, special tourism and logistics.

It follows that higher education and research institutions play an important role in the developed curricula, technologies and rules. Specialists of the National Aviation University and the Institute of Industrial Economics of the National Academy of Sciences of Ukraine have paid special attention to aviation safety and have been developing scientific and educational activities in this field for many years. Their cooperation is of great importance in improving the safety of air transport.

Institutional measures of strategic security management at the level of interaction between the state and airlines of Ukraine. The level of competitiveness of Ukrainian air transport enterprises is significantly influenced by current trends in the development of world civil aviation. Over the last decade, there have been significant changes in the field of civil aviation that need to be taken into account. The most important of them are: changes in air transport regulation, liberalization policy, changes in the structure of the industry, the emergence of new sales channels, the development of alliances between airlines, the emergence of new business models of airlines, privatization of airlines, fierce competition between carriers, especially international levels, problems of updating the fleet of aircraft, rising fuel prices. Today, the issue of increasing the competitiveness of airlines in the current trends of civil aviation, the COVID-19 pandemic and fierce market competition remains unresolved. An urgent problem is the search for new ways to increase the commercial operation of international airlines.

One of the most important trends in the field of air transport is the liberalization of regulation of international wind routes. Today, more and more states are becoming parties to agreements on widespread market access. At the national level, states have begun the process of reviewing their air transport policy in the light of the global trend towards greater liberalization. Some of these concepts aim to liberalize air services in whole or in part unilaterally without requirements instead of comparable rights from partners in bilateral agreements. Others focus on liberalizing domestic air transport markets and also allowing more carriers to operate international routes.

At the bilateral level, more than 70% of bilateral air services agreements recently concluded or revised contained forms of arrangements that liberalized some aspects of aviation cooperation, such as unrestricted commercial rights (rights of the third, fourth and in some cases fifth freedoms), the appointment of several carriers with or without restrictions on routes, the free introduction of capacity, liberal modes of tariff setting and freer criteria for the ownership and control of air carriers.

An important change is the significant increase in the number of open skies agreements, which provide full market access without restrictions on destinations, routes, capacity, frequencies, code sharing and tariffs. These agreements included not only developed countries, but also a growing number of developing countries (which participate in more than 60% of agreements).

Other more general regulatory measures also apply to air transport. Such measures include the adoption of competition laws, the introduction of various taxes, the expansion of the responsibility of airlines for compliance with the requirements for entry into the country (especially for passengers who do not have the right to do so), the introduction of more stringent health requirements. entry into the country, as well as national drug control programs.

Another trend in global civil aviation today is changes in the structure of the air transport industry, which traditionally stem from the need to meet the growing demand for air transport services in markets with increasing competition and in a more globalized economic environment.

Megacarriers in the United States use a new operational approach: the use of large "complexes" of connecting flights to maximize the number of pairs of cities that can be served by each flight. This approach arose from the perceived need to use multiple hub airports and achieve "critical mass" (sufficient to save size and frequency to influence market conditions to maximize revenue and provide seats efficiently).

The unit of control of specific revenues has allowed long-standing airlines with high costs in some cases to selectively compete with low-cost airlines (Low Cost Airlines, Discounters Airlines), which often rely on low fares to enter the market.

An important change in the sale and sale of airline services, which combines the use of computers and personal communication systems, is direct sales to consumers, including through the Internet. Although much of the airline ticket sales are still made through traditional travel agencies, the share of direct online sales over the Internet is growing rapidly, especially in countries with high Internet and credit card spreads. This course of events created not only new opportunities, but also new problems for airlines and computer reservation service providers. Many airlines have begun to increase online sales as a way to reduce sales costs. Some have teamed up to create relevant web pages to maximize the benefits of e-commerce. Four global computer reservation systems (Amadeus, Galileo, Saber and World Span) have also taken steps to adapt to the new commercial environment and have begun to explore the Internet market through various strategic decisions, becoming global distribution systems that offer comprehensive information, booking services and methods. e-commerce for travel and tourism (air travel, car rental, development of other modes of transport, hotel, places of rest).

Airlines are increasingly using innovative technology-based measures to increase productivity and optimize revenue, including the use of automated systems to manage profit rates, marketing, sales and communication.

First, the creation of advanced computer-based rate management systems allows airlines to operate on each flight with high (normal) and low (special) fares to maximize revenue and provide seats efficiently.

The privatization of state-owned airlines has been one of the outstanding transformations in the field of international air transport, where, with the exception of a few states, airlines have until recently been state-owned. The motives for privatization were different - from purely economic considerations or to increase operational efficiency and competitiveness to the intention to reduce the financial burden of the state to finance investments in new equipment.

The latest trend is due to the large number of reduced direct routes and dosing landings, making flights more comfortable for passengers. As the speed of aircraft increased and the number of stops decreased, the total flight time of passengers decreased, especially on routes consisting of many stages of flight. In response to increasing demand for air transportation, factors such as economic development, airlines are spending at no cost to increase the frequency of flights and introduce non-stop cities between a large numbers of pairs.

As for air cargo, these are highly organized airlines/parcel delivery companies, which have developed significantly over the last decade, continue to expand this specialized type of service. These companies use large jet fleets combined through ground delivery systems to ensure the delivery of strategic high-end airport hubs the next day on continental flights and the next day on intercontinental flights. This concept was also chosen near postal administrations.

Today in the global aviation industry there are negative trends that affect the decline in demand for air transportation, namely: financial instability in the world, inflation, rising prices and unemployment. In addition, the problem of fleet modernization has recently become more acute. Many airlines need a fleet because their upgrades are moral and do not meet aviation safety standards. Solving the problems facing the aviation industry at the present stage will be a step forward in the development of global air transport.

The competitiveness of Ukrainian air transport enterprises can increase both at the state level and at the airline level (Fig. 2).

In order to assess the effectiveness of the use of these methods in the activities of the airline, it is necessary to consider them in more detail.

1. At the state level, increasing the competitiveness of airlines can be done using the following methods:

1.1 Introduction of a protectionist policy that will limit the activities of foreign airlines in the air transportation market of Ukraine.

1.2 Creating conditions for the formation of flagship and regional (feeder) air carriers.

1.3 Implementation of regulatory policy to build a harmonized infrastructure in the field of civil aviation of Ukraine (creation of an effective network of aviation enterprises). The use of internal measures by the air transport companies of Ukraine is more effective due to their clear focus and direct consideration of the interests of the airline. Modern airlines aim to distinguish their own service among the many offers of competitors and use a number of methods. Their introduction will increase the efficiency of both domestic and international markets; provide its own transportation service with new properties that will help increase competitiveness.

2. At the level of air transport enterprises of Ukraine the following methods of increasing competitiveness may be introduced:

2.1 Introduction of new technologies. Technological methods of increasing the attractiveness of own transportation services are widespread in the transportation market.

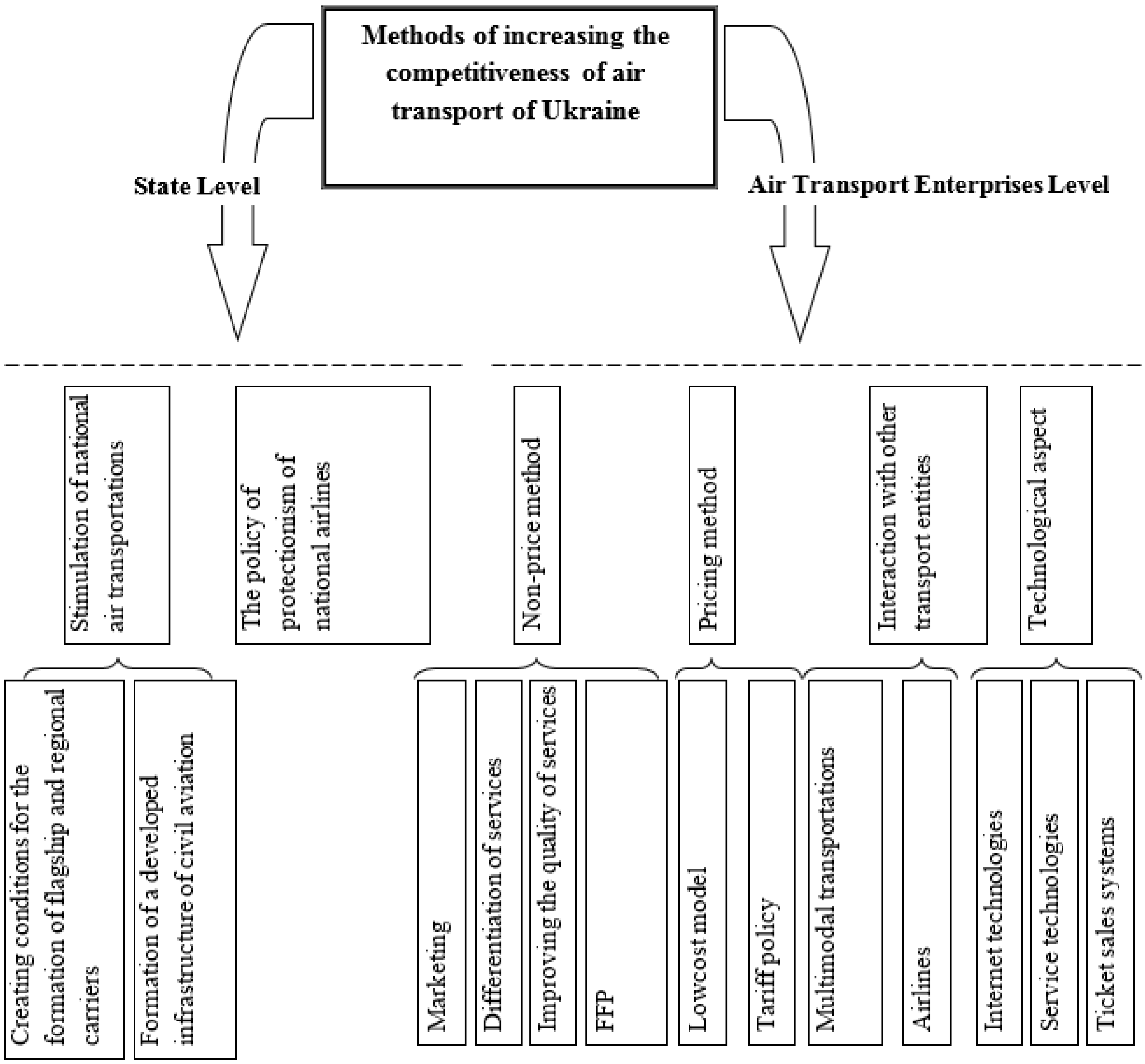

Figure 2. Methodology of increasing competitiveness air transport of Ukraine
Source: compiled according to data [63, p. 195, 198].

Modern technological solutions in the field of civil aviation include:

– use of the Internet at all stages of the service life cycle - from the sale of transportation to online registration;

– service "registration in the city";

– landing in the aircraft by means of telescopic gates.

2.2 Non-price method of increasing competitiveness - these methods are widespread among airlines around the world (British Airways, Lufthansa, Delta Airlines, etc.). There are the following measures:

– programs for passengers who fly frequently;

– differentiation of services;

– provision of additional services;

– improving the quality of services;

– other marketing activities (advertising, company image, a certain positioning of the service in the market).

These measures are becoming increasingly important in a saturated air transportation market. Since all air transport companies provide the same service in the general concept - air transportation, the use of such methods allows providing the service with certain special characteristics, properties that will distinguish it from the service of competitors. In addition, most non-price methods are aimed at attracting regular customers (for example, programs for passengers who fly frequently). The formation of this category of passengers is one of the airline's top priorities.

However, the expansion of the non-price method is limited, because the study of various methods of increasing competitiveness found that in times of economic downturn, not all methods of non-price policy are appropriate for use. For example, the provision of additional free services to passengers increases the cost of the carrier and has a low incentive function due to the general decline in financial activity.

2.3 The price method of increasing competitiveness is one of the most influential factors in the demand for air transportation, which includes two instruments:

– tariff policy;

– use of the principles of the mechanism of activity of low-cost airlines. Since the demand for air transportation services is characterized by high elasticity, ie even with slight fluctuations in the price of transportation, the magnitude of demand varies significantly, it is important to study the tariff policy of the airline.

2.4 Cooperation, interaction with other subjects of the transportation market:

– joining global aviation alliances;

– creation of alliances between regional airlines;

– creation of alliances between air carriers of Ukraine;

– creation of alliances of airlines with carriers of automobile, railway and other types of transport.

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.

Thus, the fruitful international cooperation of leading aviation and transport universities, such as the National Aviation University, as well as cooperation with leading national centers of economics, such as the Institute of Industrial Economics of the National Academy of Science of Ukraine, formed recommendations for three levels of civil aviation regulation.

For the global level, it is the creation of international standards and recommendations in the field of aviation and the exchange of leading experience.

For the regional level - recommendations for adapting standards to regional features and requirements.

For the national level - the direct implementation of global and regional standards in the process of training a new generation of aviation professionals, as well as the development of new innovative areas of training of related economic sectors.

Research and innovation activities of universities are aimed at the introduction of innovative technologies in the field of air transport, and the training of highly qualified specialists is the basis for its further development. Under such conditions, the development of the State Aviation Training Program under the auspices of the Ministry of Education and Science of Ukraine, the National Academy of Sciences of Ukraine, the Ministry of Infrastructure of Ukraine, the State Aviation Service of Ukraine, the State Aviation Department of the Ministry of Defense of Ukraine is relevant. transport for the sustainable development of the national economy.

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LOSSES IN PHARMACEUTICAL SUPPLY CHAINS: CHALLENGES IN EFFICIENT VACCINE DISTRIBUTION AND UTILIZATION

Oksana Pozniak, Valentina Khmylievska, Ishimwe Marie Jeanne. "Losses in Pharmaceutical Supply Chains: challenges in efficient vaccine distribution and utilization". *The article is devoted to the research the problems that arise in pharmaceutical vaccine supply chains. Slow vaccination leads to global economic losses, and the lack of free access to vaccines in many developing countries is a problem not so much in the economic category as in the cost of human life category, which is confirmed by the research of the International Monetary Fund (IMF) and the United Nations (UN). Pharmaceutical vaccine supply chains are subject to special organization and flow management requirements to avoid waste. In the context of the Covid-19 pandemic, bottlenecks inevitably arise that lead to economic, social, human losses, potential and real losses of vaccines and an increasing pressure on reverse logistics. The main bottlenecks at each stage of the supply chain have been identified, which indicate a shift in the main problems in the pharmaceutical supply chain to the distribution and last mile logistics. A detailed analysis of the vaccine distribution system in the city of Kiev was carried out with the help of sites that cover information on used vaccines and losses based on the types of vaccination points of different forms of ownership. Vaccination sites were ranked according to the degree of effective use of vaccines. As a result, the problems of insufficient information support of the vaccination campaign by government agencies were identified, which leads to the loss of vaccines. The role of the state in solving these problems was assumed by public organizations. To accomplish these tasks, an interactive vaccination map was launched, which makes it possible to find the nearest vaccination point, see how many vaccinations were given in a particular medical institution and how many vaccine doses were potentially lost. For the study, empirical research, data analysis and synthesis, expert assessments and generalization methods were used. Calculated the amount of real and potential monetary losses from vaccines that have been disposed* *of. Recommendations on the use of innovative tools such as Blockchain to prevent potential and manage existing problems in pharmaceutical vaccine supply chains were provided.*

***Keywords**:* pharmaceutical supply chain, vaccine, COVID-19, losses, distribution and last mile logistics, Blockchain.

Оксана Позняк, Валентина Хмілевська, Ішимбе Марі Жанна. «Втрати у фармацевтичних ланцюгах постачання: проблеми ефективного розподілу та використання вакцин». *Стаття присвячена дослідженню проблем, що виникають у фармацевтичних ланцюгах постачання вакцин. Обґрунтовано, що повільна вакцинація призводить до глобальних втрат економіки, а в умовах відсутності вільного доступу до вакцин у багатьох країнах, що розвиваються, проблеми втрат - це не стільки економічна категорія, скільки категорія ціни людського життя. Отже, до фармацевтичних ланцюгів поставок вакцин пред'являються спеціальні вимоги організації та управління потоками, щоб уникнути втрат. Однак, в умовах пандемії COVID-19, неминуче виникають "вузькі місця", що призводять до виникнення економічних, соціальних, людських втрат, потенційних і реальних втрат вакцин і зростаючого навантаження на зворотну логістику. Визначено основні "вузькі місця" на кожному етапі ланцюга поставок, які вказують на переміщення акцентів основних проблем у фармацевтичних ланцюгах поставок до сфери дистрибуції та логістики "останньої милі". Проведено детальний аналіз системи дистрибуції вакцин у місті Києві за допомогою сайтів, які охоплюють інформацію щодо використаних вакцин та втрат за кожним типом пунктів вакцинації. Проведено ранжування пунктів вакцинації за ступенем ефективного використанням вакцин. Для проведення дослідження були використані емпіричні дослідження, аналіз та синтез даних, експертні оцінки та методи узагальнення. Підраховано суму реальних та потенційних грошових втрат від вакцин, що були утилізовані. Наведено рекомендації щодо використання інноваційних інструментів, таких як Blockchain, для запобігання потенційних та управління існуючими проблемами у фармацевтичних ланцюгах постачання вакцин.*

Ключові слова: фармацевтичний ланцюг поставок, вакцина, COVID-19, втрати, розподіл та логістика останньої милі, Blockchain.

Оксана Позняк, Валентина Хмилевская, Ишимбе Мари Жанна. «Потери в фармацевтических цепях поставок: проблемы эффективного распределения и использования вакцин». *Статья посвящена исследованию проблем, которые возникают в фармацевтических цепях поставок вакцин. Обосновано, что медленная вакцинация приводит в глобальным потерям экономики, а в условиях отсутствия свободного доступа к вакцинам во многих развивающихся странах, проблемы потерь - это не столько экономическая категория, сколько категория цены человеческой жизни. Следовательно, к фармацевтическим цепям поставок вакцин предъявляются особые требования организации и управления потоками, чтоб избежать потерь. Однако, в условиях пандемии COVID-19, неизбежно возникают "узкие места" которые приводят к возникновению экономических, социальных, человеческим потерям, потенциальным и реальным потерям вакцин и возрастающей нагрузке на обратную логистику. Определены основные "узкие места" на каждом этапе цепи поставок, которые указывают на смещение основных проблем в фармацевтических цепях поставок в сферу дистрибуции и логистики последней мили. Проведен детальный анализ системы дистрибуции вакцин в городе Киеве с помощью сайтов, которые охватывают информацию по использованным вакцинам и потерям исходя из типов пунктов вакцинации разных форм собственности. Проведено ранжирование пунктов вакцинации по степени эффективного использования вакцин. Для проведения исследования были использованы эмпирические исследования, анализ и синтез данных, экспертные оценки и методы обобщения. Подсчитано сумму реальных и потенциальных денежных потерь от вакцин, которые были утилизированы. Даны рекомендации по использованию инновационных инструментов, таких как Blockchain, для предотвращения потенциальных и управления существующими проблемами в фармацевтических цепях поставок вакцин.*

Ключевые слова: фармацевтическая цепь поставок, вакцина, COVID-19, потери, распределение и логистика последней мили, Blockchain.

Introduction. The losses caused by the coronavirus are difficult to fully assess since they caused a complete restructuring of the entire global ecosystem of humanity. According to IMF forecasts, the losses of the world economy have amounted to $ 3.5 trillion and in the next 5 years will increase by another $ 5 trillion. [12]. According to the World Bank, at least 88 million people will cross the poverty line in the wake of the pandemic crisis, and income losses due to education problems will reach $ 10 trillion. [16]. Inflation and higher commodity prices and global transportation costs now add another 1.5% to annual inflation. Unemployment, which led to a decrease in the income of the population, had a negative impact on retail trade, aviation, the restaurant business, and tourism. Entire spheres of small business were closed forever, which further increased unemployment and the need for financial support from the population, as a result of an increase in state budget spending. In addition, the costs for the formation and management of pharmaceutical supply chains, medical support for patient care, re-equipment of medical institutions, financial support for staff work, and vaccination are constantly increasing.

Events have made it clear that it is a common problem and that the pandemic will not end anywhere until it ends everywhere. The only way out, according to the IMF chief specialist Gita Gopinat, is to actively vaccinate the world's population. Accelerating vaccination of the world's population remains a top political priority, after which large-scale testing and investment in disease treatment should be pushed. Fewer than 5% of developing countries are now fully vaccinated, compared with about 58% of those in the richest countries. According to the forecast of the Organization for Economic Cooperation and Development, slow vaccination slows down the country's economy and the development of all industries [15].

So, in countries whereby the middle of 2022 the vaccination level of the population will not reach 60%, the cumulative decrease in GDP will be $ 2.3 trillion in the period from 2022 to 2025. Asia will suffer the largest cumulative losses among regions due to slow vaccination - by $ 1.7 trillion. But in terms of the size of the economy, sub-Saharan Africa will suffer the most significant losses - 3% of the projected GDP for 2022–2025 [11].

Slow progress in global vaccination and the spread of new viral mutations will result in weaker recovery and greater job losses. Governments need to ensure that all necessary resources are used to roll out vaccinations as quickly as possible around the world to save lives, preserve income and control the virus. A more determined international effort is needed to provide low-income countries with the resources they need to vaccinate their populations - both for their own benefit and to accelerate global recovery from the crisis, economists emphasize [15].

Since the world is now divided into those who have free access to vaccines and those who do not, the problem of reducing losses in pharmaceutical supply chains in the distribution system and efficient use of vaccines is not only an economic problem but also a problem of human survival.

Analysis of recent research and publications. The impact of the covid-19 issues on the pharmaceutical industry and pharmaceutical supply chains has led to the emergence of many kinds of research, provide by individual scientists and groups of researchers, companies, and international organizations such as WHO and the EU.

WHO developed "Guidance on developing a national deployment and vaccination plan for COVID-19 vaccines" (2020) [8]. This document is intended to guide national governments in developing and updating their national deployment and vaccination plan (NDVP) for COVID-19 vaccines. The guidance is built upon existing documents and the core principles of the WHO Strategic Advisory Group of Experts (SAGE) values framework for the allocation and prioritization of COVID-19 vaccination, the prioritization roadmap, and the Fair allocation mechanism for COVID-19 vaccines through the COVAX Facility and will be continually shaped by the vaccine-specific recommendations.

The Organization for Economic Co-operation and Development (OECD) provide research "OECD Policy Responses to Coronavirus (COVID-19) Using trade to fight COVID-19: Manufacturing and distributing vaccines" (2021) [14] that discusses trade and trade policy considerations underpinning access to the final and intermediate goods needed to effectively produce, deliver and administer COVID-19 vaccines. It focuses on the international aspects of the vaccine supply chain, discussing the sourcing, production, distribution and need to expedite international border crossing and transportation (including in the context of the cold supply chain).

The group of researchers in collaboration with the Center for Global Development provided the survey "A Path to Resiliency: Mitigating the Impacts of COVID-19 on Essential Medicines Supply Chains" (2021) [2]. The paper highlights that data-driven approaches should be considered to make supply chains more robust, solutions must account for the political and institutional landscape, price surges benefit the wealthiest, and local solutions are often needed to manage global shocks.

Another group of researchers analyzed short and long term impacts of COVID-19 on the pharmaceutical sector (2020) [4]. According to their survey, short-term impacts of COVID-19 pandemic includes demand changes, regulation revisions, research and development process changes and the shift towards tele-communication and tele-medicine. In addition, industry growth slow-down, approval delays, moving towards self-sufficiency in pharm-production supply chain and trend changes in consumption of health-market products along with ethical dilemma could be anticipated as long-term impacts of COVID-19 pandemic on pharmaceutical sector in both global and local levels.

Pharmaceutical Industry Consultant Keith Coleman and Anne Marie Gaffney (2021) identified factors affecting the resilience of pharmaceutical supply chains and provided guidance on how to overcome challenges and manage risks in the COVID-19 environment [17].

DHL, as a leading logistics provider, has teamed up with McKinsey & Company as an analytics partner to publish a white paper on building a resilient supply chain for vaccines and health products during Covid-19, aligning the interests of all market players and defining future crises in the field. health care. The importance of this study is that it identifies pain points that lead to losses in pharmaceutical supply chains [6].

According to the International Air Transport Association (IATA), currently, about a quarter of the vaccine cargo gets degraded due to shipping-related oversights, such as pallets being left out of cold storage for too long. Additionally, about 20% of the temperature-sensitive vaccine shipments also deteriorate during transportation. A COVID-19 vaccine comes with certain prerequisites in terms of temperature and shelf life. Hence, it is crucial to have a robust supply chain management with real-time logistics [3].

The range of publications that identify the problems of the impact of coronavirus on all spheres of human life, and the pharmaceutical industry, in particular, are not limited to the publications reviewed. New ones are added to the existing problems, with which methods of struggle and prevention have not been developed yet. Therefore, the authors draw attention to the insufficient number of researches in the field of ineffective organization of the vaccine distribution system, which leads to vaccine losses, economic losses, potential human losses, and an increasing burden on reverse logistics.

Objectives statement. The purpose of this article is to identify the root causes of problems in Pharmaceutical Supply Chain and specific problems in the vaccine distribution chain that lead to inefficient use of existing stocks and an increased burden on reverse logistics.

Basic material and results. Producing a medicine is only the first step towards getting it to the patient who needs it. The pharma industry, with its stringent requirements for product security and stability, has one of the most complex logistical chains in the world today. High-tech logistics are not just an expense, they are an investment in better access to medicines, and – used efficiently – they can bring down overall healthcare costs and improve patient care [7]. This becomes especially relevant in the context of the global covid-19 pandemic.

Getting vaccines to where they are needed requires a debugged subjective-streaming interaction in Pharmaceutical Supply Chain because lives can be at stake if anything works less than perfectly. WHO says it is critical that "no weak link exists in the supply chain" [5] and all processes in PSC must be organized without gaps, lack of transparency, and traceability. Although logistics is only one step in the pharma supply chain, these shipping processes can represent nearly 40 percent of total operating expenses [9].

Therefore, it is very important for each country, when shaping the vaccine delivery chain, to prioritize the most important areas that need to be addressed (by industry, regulators, and other key stakeholders) to create a sustainable and reliable drug value chain that faces unprecedented pressures. and crashes. It is also critically important to review the structure of the value chain, evaluating each step to see where there is a chance of failure and to determine where more flexibility is needed. This approach makes it possible to identify bottlenecks at each stage of the pharmaceutical supply chain based on [1,6], which are shown in Figure 1.

At the beginning of the covid-19 pandemic, the main problems were concentrated in the production sphere, since there were not enough components for the production of vaccines, demand exceeded supply, etc., then as the market was saturated with vaccines from different manufacturers, problems in pharmaceutical supply chains shifted to the sphere of transport and logistics services, among which the main ones were highlighted and reflected in fig.1:

1. Transportation and consolidation in sourcing country:
   – Local quality checks and non-steady supply;
   – Transportation capacity bottleneck;
   – Limited transparency with high variance in quality.
2. Inbound transport:
   – Limited and volatile freight capacity;
   – Extraordinary time pressure.
3. Inbound transport:
   – Limited and volatile freight capacity;
   – Extraordinary time pressure.
4. Custom and regulation:
   – Lack of coordination fast track;
   – Supplier certification and qualification;
   – Frequent import regulation changes and country variations.
5. Quality check:
   – Substantial amount of disqualified products due to arrival-only quality check.
6. Warehousing:
   – Limited storage capacity and lack of routine;
   – Suboptimal SKU formats and imprecise product information;
   – Lack of expertise and sophistication in storage of different types of vaccine.
7. Distribution and Last Mile:
   – Limited transparency on stock levels and demand;
   – Challenging transportation planning and carrier management;
   – Disruption of any of the connected components can lead to potential drug delays;
   – High demand and delay in procurement can result in shortage of stock and lead to potential increase the number of cases;

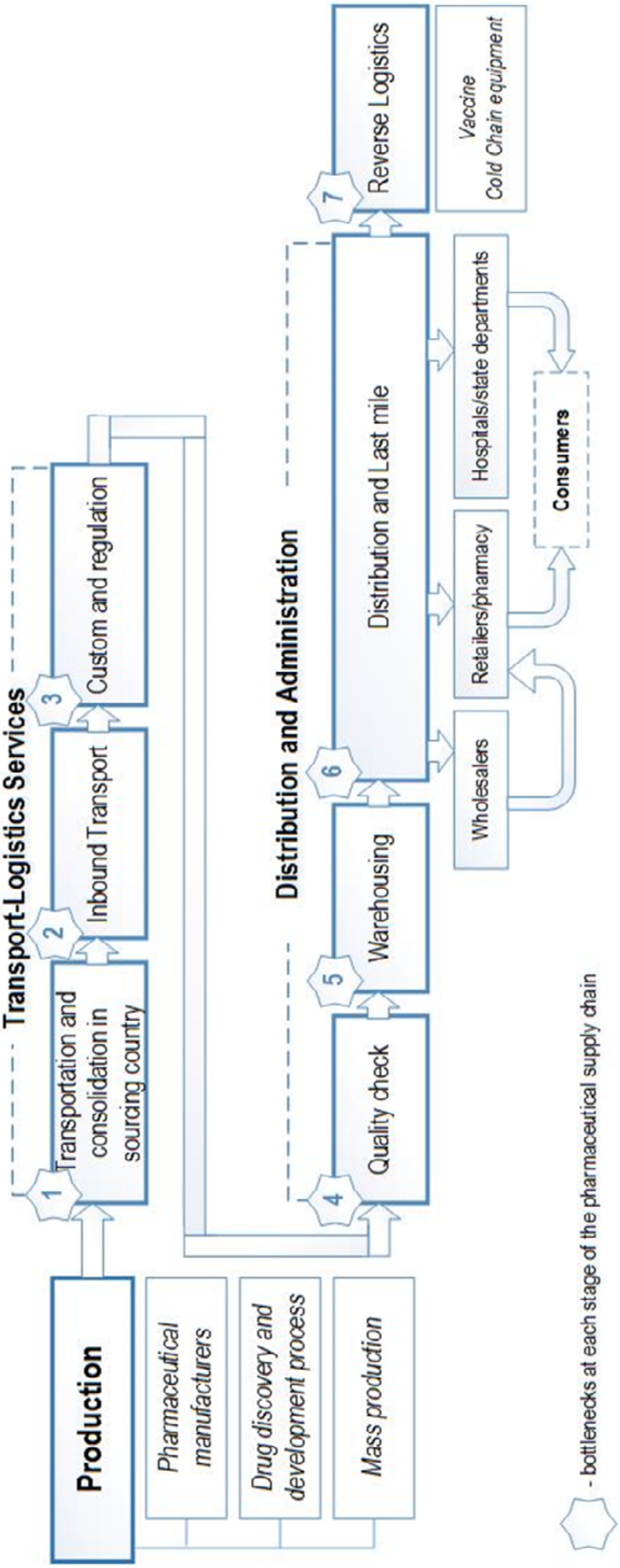

Figure 1 –Bottlenecks in Pharmaceutical Supply Chain

Source: developed by the authors

– Increase in number of patient and high demand for vaccine are contributing to short-term supply shortages;

– Violation of storage conditions for vaccines;

– Lack of Cold Chain equipment for vaccine`s storage;

– Lack of traceability of vaccine storage conditions at all stages of the supply chain;

– Ineffective information campaign that has led to an increase in the number of unused vaccines with shelf life;

– Information flow management problems in the field of vaccine availability and vaccine residues at each vaccination site.

8. Reverse Logistics:

– Problems in returning Cold Chain equipment;

– Disposal of expired vaccines;

– Disposal of unused vaccines.

It should be noted that the main problems in pharmaceutical supply chains have moved to the last part of the chain - distribution and logistics of the last mile. This is due to the fact that manufacturers and operators of the logistics services have balanced and agreed upon the main problems and conflicts in export-import activities. The involvement of state institutions in Ukraine in the regulation of the distribution of vaccines among vaccination points, which at the moment cannot be considered effective, leads to large losses of vaccines.

According to the official data of the Ministry of Health of Ukraine, there is the following data on the number of disposed of vaccines [13]:

– 500 thousand doses of AstraZeneca coronavirus vaccine due to expiration date;

– 34,036 doses of Pfizer vaccines due to thermal disturbance when shipped in early summer;

– potentially 800 thousand doses of AstraZeneca (both the first and second doses) are disposed of due to the expiration date in November.

At the moment, the Ministry of Health cannot name the exact number of disposed of vaccines. But even based on these data, it is possible to calculate the losses of the state from the disposal of a given volume of vaccines. If we take the cost of the Pfizer vaccine, which ranges from $ 15.5 to $ 19.5, then the sum of losses will be from $ 527 558 to $ 663 702. The losses from 500 thousand doses of AstraZeneca coronavirus vaccine amounted to $ 2.4 million if we take the cost of $ 4.8, potential losses from 800 thousand doses of AstraZeneca will amount to $ 3,840,000. That is, the real losses of the state of Ukraine ranged from $ 2,927,558 to $ 3,063,702. If we add potential losses, the amount will double.

There are many subjective and objective reasons, but the failure of the informational vaccination company, the lack of an information base for informing the population about the existing vaccination sites, the availability of vaccines in them in a real-time system, informing the population registered in "Diya" in real-time about the possibility of making a vaccine (especially this relevant for the AstraZeneca vaccine). The role of the state in solving these problems was assumed by public organizations.

To fulfil these issues, the public organization "Anti-Corruption Headquarters", with the support of the French Embassy in Ukraine, has launched an interactive vaccination map. Everyone can find in this map the nearest vaccination point, see how many vaccinations a particular medical facility has received and how many doses of vaccine are potentially lost.

Moreover, this information was used for analyzing the effectiveness of certain channels - vaccination points. Based on this data [10], information about vaccination points of all forms of ownership in the city of Kyiv, that displays the effectiveness of each vaccine distribution channel within the logistics of the last mile was summarized in table 1.

This information characterizes the activities of each vaccination point for

October 2021, before mandatory vaccination for certain groups of the population of Ukraine was introduced. The proportion of unused (lost) vaccines for each vaccination point was calculated using the following formula: the number of unused (lost) vaccines for each vaccination point is divided by the total number of unused (lost) vaccines and multiplied by 100%. The largest share of this indicator is among individual entrepreneurs, who have 6 times more vaccines disposed of than used ones. The second place in the ranking of ineffective vaccination points is taken by private enterprises providing medical services in Kiev, where the number of disposed vaccines is 2.5 times more than those used.

Table 1 - Analysis of vaccine losses, depending on the type of vaccination point in Kyiv

№	Type of an enterprise	Number of vaccinated	Number of unused (lost) dosses of vaccines	Share of unused (lost) vaccines, %
1	Municipal non-profit district enterprises, providing medical services in Kyiv	96 481	10 449	10,83
2	Municipal non-profit enterprises of the executive committee of the Kyiv city Council (Kyiv city State Administration)	5 505	665	12,08
3	State institution "TERRITORIAL MEDICAL ASSOCIATION" of the Ministry of Internal Affairs of Ukraine in Kyiv region	4 178	182	4,36
4	Individual entrepreneurs providing medical services in Kyiv	104	656	630,77
5	Limited liability companies providing medical services in Kyiv	2 118	2 512	118,60
6	Private enterprises providing medical services in Kyiv	82	208	253,65
	Total	108 468	14 672	

Source: compiled by the authors

The performed calculations show the inefficiency of non-governmental vaccination point, information on the location of which was not communicated to potential consumers of their services. This applies not only to non-state vaccination points. The problem of wide information coverage of the vaccination company has not yet been resolved, and when opening vaccination centers, the logistic principles of flow management are not taken into account, which leads to losses.

The ranking of the vaccination points of the population, according to the degree of vaccine loss is shown on the following chart (Fig. 2).

The solution of the problems that were mentioned above cannot be postponed, since it is too early to talk about the end of the pandemic. Therefore, it is necessary to think about using innovative tools for managing flows, primarily informational ones. It is proposed to use Bockchain-based solutions for managing secure databases to manage the COVID-19 vaccine supply chain. Implementing this technology, along with Internet of Things (IoT) solutions such as real-time monitoring and asset tracking, can ensure a successful vaccine deployment.

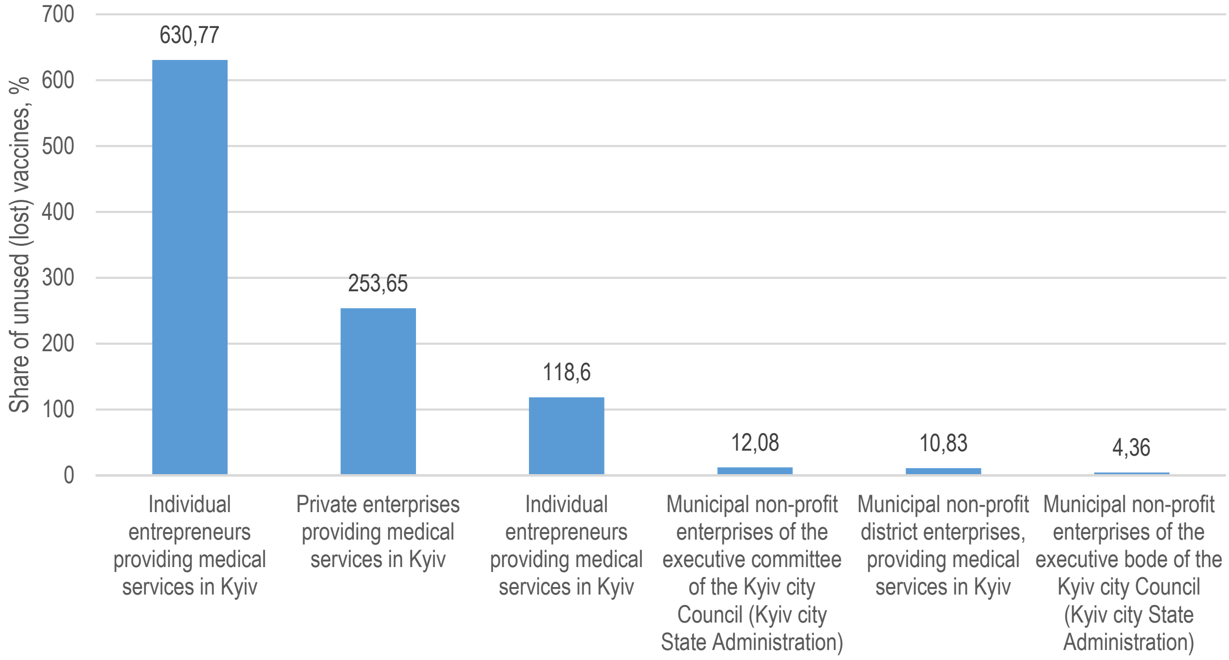

Figure 2 – Vaccination points ranking by ineffective vaccine use

Source: compiled by the authors

As shown in Figure 3, combining the two technologies has a synergistic effect, that is, one technology enhances the impact of the other on the efficiency of the pharmaceutical supply chain. Moreover, their use in such large-scale events can ensure the optimal use of resources to save precious lives without compromising quality and safety standards, which are fundamental principles of the state's humanitarian policy.

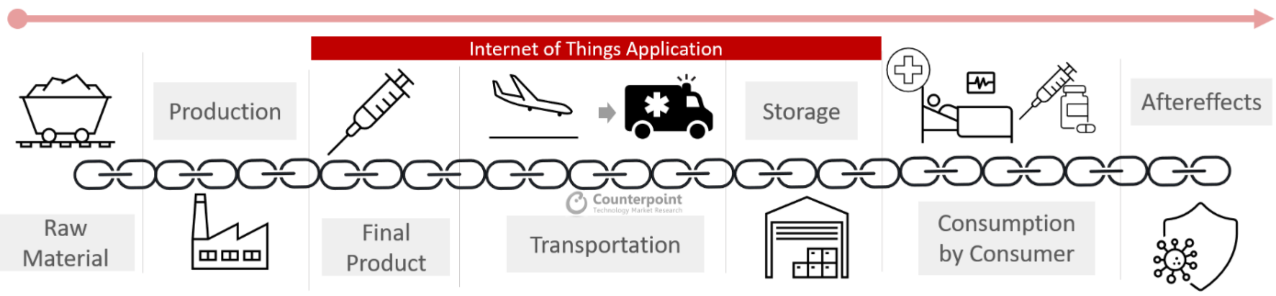

Figure 3 – COVID 19 Vaccine Supply Chain based on Blockchain and Internet of Things [3]

Since some companies, and even countries, have already begun implementation Blockchain technology to optimize supply chain processes, it can be assumed that the introduction of this technology to manage processes in vaccine supply chains could lead to the same results. Among the main potential positive results, especially in distribution and last mile logistics, are the following:

1. Support direct or indirect communication protocol for secure real-time monitoring of the vaccine in transit as well as at the source and destination.

2. Transparency of the standards that are followed at every stage, by creating an exact copy of the registry at every node of the network.

3. Transparency of processes in the vaccine supply chain.

4. Ensuring the identity of health care workers, maintaining medical records and tracking the effects of treatment.

5. Monitoring health centers to check for cases when employees use their authority or compromise their responsibility.

6. Using IoT sensors embedded in trays or boxes for cooling vaccines together with a communication module to collect and analyze data on lighting, humidity and temperature and transmit them to the vaccine distribution authority.

7. Protect data that is sent to a Blockchain system in the cloud, or cryptographic printing that combines NFC chips with a Blockchain to track and protect distribution.

8. Monitoring information about urgent requirement for pallet-sized cooling boxes embedded with temperature sensors in distribution and last mile logistics and information about movements of these instruments via reverse logistics.

Conclusions. Challenges in the pharmaceutical vaccine supply chain are linked to the course of the Covid-19 pandemic. In the early stages, when the vaccine was just being developed, the main problems in the supply chain were in ensuring the production of necessary components, which were mainly shipped from Asian countries. With the advent of vaccines on the market, there was a problem with the formation of the necessary infrastructure to ensure the delivery of vaccines, since there is a certain temperature regime for each vaccine. After saturation of the market with vaccines, the problem of efficient regional distribution of vaccines turned into a solution to the problems with the distribution of vaccination in each settlement and the last mile logistics of, reverse logistics. In research has been found that problems exist at every stage of the pharmaceutical vaccine supply chain and affect not only the efficiency of the entire supply chain, but also the economy, humanitarian policy, and most importantly, the lives of people. Identifying problems allows to develop certain standards for their solution, and the use of new technologies, such as Blockchain and the Internet of Things, give an opportunity to bring flow management in pharmaceutical supply chains to a completely new level, which makes it possible to avoids unnecessary losses, such as vaccine losses, economic losses, potential human losses, and an increasing burden on reverse logistics

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MODELING DAILY DYNAMICS OF SPEED AND FUEL CONSUMPTION FOR URBAN DELIVERY MEANS

Lidiia Savchenko, Miroslava Semeriahina, Irina Shevchenko. "Modeling daily dynamics of speed and fuel consumption for urban delivery means". *Road transport is one of the most important elements of the functioning of a modern city. Maneuverability, mobility, speed of delivery of goods and other criteria have provided him with a special and leading place in urban logistics. However, along with the benefits of a developed transport network for society, its progress is accompanied by negative consequences for the environment and the population of the city. High rates of growth in the number of cars, especially in large cities, cause an increase in emissions of harmful products into the atmosphere, which, accordingly, negatively affects the health of the population. Consequently, the problem of environmental pollution in large cities from harmful emissions from vehicles requires an urgent solution.*

The increase in emissions of harmful substances is affected by an increase in the consumption of fuel materials due to a decrease in speed because of an increase in traffic density in the city. The frequency, duration, prevalence of congestion is increasing along with the urbanization of the population and the increase in the number of cars in cities. The dense development of the central historical districts of the city exacerbates the problem of unhindered passage of individual, public and freight vehicles. In addition, a decrease in the speed of city traffic affects the speed of delivery of goods, correspondence, etc., which negatively affects the speed of business processes, and ultimately worsens the level of logistics services for customers.

The purpose of this study is to analyze the current situation in terms of the dynamics of the average speed of the city's traffic flow by hours of the day and to obtain a mathematical model of the dependence of the speed of movement on the consumption of fuel materials for various environmentally friendly means of urban delivery (car, motorcycle, bicycle and pedestrian courier).

The research was carried out in two stages. At the first, the study of the dependence of the average speed of movement in the city on the time of day (for all means of city delivery) was carried out. At the second stage, the study of the dependence of the average consumption of fuel materials in the city (which, accordingly, is a function of the speed of movement) on the time of day for motorized urban delivery vehicles was done. In the course of the study, at each stage, an equation of the trend lines was obtained with a sufficient approximation accuracy.

In conclusion, the study proposes an algorithm for determining the average speed and average amount of fuel consumption when delivering small consignments in an urban environment using four urban logistics means - a car, a motorcycle, a bicycle, and a pedestrian courier (with the possibility of using public transport). The proposed algorithm can be applied in any delivery conditions in the city.

Keywords: urban logistics, urban congestion, traffic speed, vehicle emissions, dynamics of traffic speed in a city, average fuel consumption, trend line equation.

Лідія Савченко, Мирослава Семерягіна, Ірина Шевченко. «Моделювання денної динаміки швидкості і витрат палива засобів міської доставки». *Автомобільний транспорт є одним з найважливіших елементів функціонування сучасного великого міста. Маневреність, мобільність, швидкість доставки вантажів та інші критерії забезпечили йому особливе та лідируюче місце у міській логістиці. Проте, разом з перевагами, що забезпечує суспільству розвинута транспортна мережа, її прогрес супроводжується негативними наслідками для навколишнього природного середовища та населення міста. Високі темпи росту кількості автомобілів, особливо у великих містах, зумовлюють зростання викидів шкідливих продуктів в атмосферу, що відповідно негативно впливає на стан здоров'я населення. Отже, проблема забруднення довкілля великих міст від шкідливих викидів автотранспорту вимагає невідкладного вирішення.*

На збільшення викидів шкідливих речовин впливає збільшення витрат паливних матеріалів за рахунок зниження швидкості через зростання щільності руху в місті. Частота, тривалість, розповсюдженість вуличних заторів зростають разом з урбанізацією населення та збільшенням кількості автомобілів у містах. Щільна забудова центральних історичних районів міста загострюють проблему безперешкодного проїзду індивідуального, громадського та вантажного автотранспорту. Крім того, зниження швидкості міського руху впливає на швидкість доставки вантажів, кореспонденції тощо, а це негативно позначається на швидкості бізнес-процесів, а у кінцевому рахунку погіршує рівень логістичного сервісу для клієнтів.

Метою даного дослідження є аналіз існуючої ситуації щодо динаміки середньої швидкості транспортного потоку міста за годинами доби та отримання математичної моделі залежності швидкості руху від витрат паливних матеріалів для різних екологічно дружніх засобів міської доставки (легковий автомобіль, мотоцикл, велосипед і пішохідний кур'єр).

Дослідження проводилося у два етапи. На першому проводилося вивчення залежності середньої швидкості руху містом від часу доби (для всіх засобів міської доставки). На другому - вивчення залежності середньої витрати паливних матеріалів у місті (які, відповідно, є функцією швидкості руху) від часу доби для моторизованих засобів міської доставки. Під час дослідження на кожному етапі отримано рівняння ліній тренду з достатньою точністю апроксимації.

На заключення у дослідженні запропоновано алгоритм визначення середньої швидкості та середньої кількості витрат паливних матеріалів під час доставки невеликих партій у міському середовищі за допомогою чотирьох засобів міської логістики – легкового автомобіля, мотоцикла, велосипеда та пішого кур'єра (з можливістю використання громадського транспорту). Запропонований алгоритм може бути застосовний у будь-яких умовах доставки містом.

Ключові слова: міська логістика, міські затори, швидкість руху, викиди автомобільного транспорту, динаміка швидкості руху в місті, середні витрати палива, рівняння лінії тренду.

Лидия Савченко, Мирослава Семерягина, Ирина Шевченко. «Моделирование дневной динамики скорости и расхода топлива средств городской доставки». *Автомобильный транспорт является одним из важнейших элементов функционирования современного города. Маневренность, мобильность, быстрота доставки грузов и другие критерии обеспечили ему особое и лидирующее место в городской логистике. Однако, вместе с преимуществами, обеспечивающими* *обществу развитая транспортная сеть, ее прогресс сопровождается негативными последствиями для окружающей природной среды и населения города. Высокие темпы роста количества автомобилей, особенно в крупных городах, обуславливают рост выбросов вредных продуктов в атмосферу, что соответственно отрицательно сказывается на состоянии здоровья населения. Следовательно, проблема загрязнения окружающей среды крупных городов от вредных выбросов автотранспорта требует безотлагательного решения.*

На увеличение выбросов вредных веществ влияет увеличение расхода топливных материалов за счет снижения скорости из-за роста плотности движения в городе. Частота, продолжительность, распространенность уличных пробок возрастают вместе с урбанизацией населения и увеличением количества автомобилей в городах. Плотная застройка центральных исторических районов города обостряет проблему беспрепятственного проезда индивидуального, общественного и грузового автотранспорта. Кроме того, снижение скорости городского движения влияет на скорость доставки грузов, корреспонденции и т.п., что негативно сказывается на скорости бизнес-процессов, а в конечном счете ухудшает уровень логистического сервиса для клиентов.

Целью данного исследования является анализ существующей ситуации по динамике средней скорости транспортного потока города по часам суток и получению математической модели зависимости скорости движения от расхода топливных материалов для разных экологически дружественных средств городской доставки (легковой автомобиль, мотоцикл, велосипед и пешеходный курьер).

Исследование проводилось в два этапа. На первом проводилось изучение зависимости средней скорости движения по городу от времени суток (для всех средств городской доставки). На втором – изучение зависимости среднего расхода топливных материалов в городе (что, соответственно, является функцией скорости движения) от времени суток для моторизованных средств городской доставки. В ходе исследования на каждом этапе получено уравнение линий тренда с достаточной точностью аппроксимации.

В заключение в исследовании предложен алгоритм определения средней скорости и среднего количества расхода топливных материалов при доставке небольших партий в городской среде с помощью четырех средств городской логистики – легкового автомобиля, мотоцикла, велосипеда и пешего курьера (с возможностью использования общественного транспорта). Предлагаемый алгоритм может быть применим в любых условиях доставки по городу.

Ключевые слова: городская логистика, городские пробки, скорость движения, выбросы автомобильного транспорта, динамика скорости движения в городе, средние расходы топлива, уравнение линии тренда.

Introduction. A decrease in speed due to growth in traffic density in the city leads to an increase in fuel consumption, and as a result, to an increase in emissions of harmful substances into the environment, which negatively affects the health of residents, green spaces, pollutes the facades of houses and infrastructure facilities. From an economic point of view, a decrease in the speed of city traffic is reflected in the speed of delivery of goods, correspondence, the speed of movement of workers, often at the expense of working time. A direct negative effect is increased fuel consumption on the commercial route. Road traffic emissions have dramatic local and global effects. Pollutants such as Nitrogen Oxides (NOx) and Particulate Matter (PM) have known detrimental impacts on human health, including respiratory and cardiovascular diseases [1], while Carbon Dioxide (CO2) emissions greatly contribute to global warming. Accurate trafficrelated emission estimations are thus crucial to assess their evolutions over several years, and to quantify the environmental impact of sustainable transportation policies such as lowemission zones and traffic regulation strategies [2].

Congestion is a major issue for cities and often a determining factor of connectivity within urban areas and intra-city interactions. It is a repercussion of the massive adoption of cars as the main transport mode and an externality related to the nature of cities as it represents the negative aspect of agglomeration, the major driving force of growth in cites [3].

According to the results of 2020, the capital of Ukraine was in seventh place in terms of congestion in the world [4].

Analysis of recent researches and publications. The report [5] analyses the factors influencing fuel consumption and CO2 emissions of passenger cars in real-world operating conditions. An extensive literature review has been performed, showing that the most important in-use factors affecting the difference between real-world and certification performance are the use of air conditioning devices, ambient temperature and environmental conditions, roof add-ons, driving style, tyre pressure and the increase of vehicle weight. For each factor a simulation scenario was designed to better investigate its effect. The authors emphasis that traffic conditions s (average speed, maximum speed, presence of traffic lights, free flow, etc.) affect the actual movement of the vehicle, average and max speed, accelerations, start and stop incidents, prolonged travel time, etc., that can have a very negative impact on fuel consumption.

The article [2] investigates the sensitivity of COPERT to the mean speed definition, and how COPERT emission functions can be adapted to cope with vehicle dynamics related to congestion. The research focuses on the urban area, because urban road traffic generates the highest emissions, caused by rapid speed variations and congestions [6, 7].

COPERT is the EU standard vehicle emissions calculator. It uses vehicle population, mileage, speed and other data such as ambient temperature and calculates emissions and energy consumption for a specific country or region. COPERT is internationally recognized — used by many European countries for reporting official emissions data. It calculates emissions at a national, regional or local scale, and for annual to daily estimates. COPERT's methodology is published and peer-reviewed by experts of the UNECE LRTAP Convention and includes all main pollutants: greenhouse gases, air pollutants and toxic species [8].

COPERT emissions are very sensitive to mean speed definition. Using a degraded speed definition leads to an underestimation ranging from -13% to -25% for fuel consumption during congested periods (from -17% to -36% respectively for NOx emissions). The mean speed definition has a considerable impact on COPERT fuel consumption and NOx emissions, even at the network scale [2].

Figure 1 shows the effect of vehicle speed on the rate of fuel consumption. It is obvious that as the velocity of the vehicle increases the air velocity around the vehicle will increase causing increases in the aerodynamic drag. The increase of the vehicle speed will create many separated flow regions on the curved surfaces of the vehicle body that will increase the overall drag, and consequently the rate of fuel consumption will be increased. It is noticed from Figure 1 that an increase in vehicle speed by 4% has increased the rate of fuel consumption by nearly 40%, which shows that both parameters are proportional [9]. An experimental work was conducted on four different vehicles, corresponding to different engine sizes (i.e. LADA 1.3cc, LADA 1.6cc, VW 1.3cc and Subaru 1.6cc).

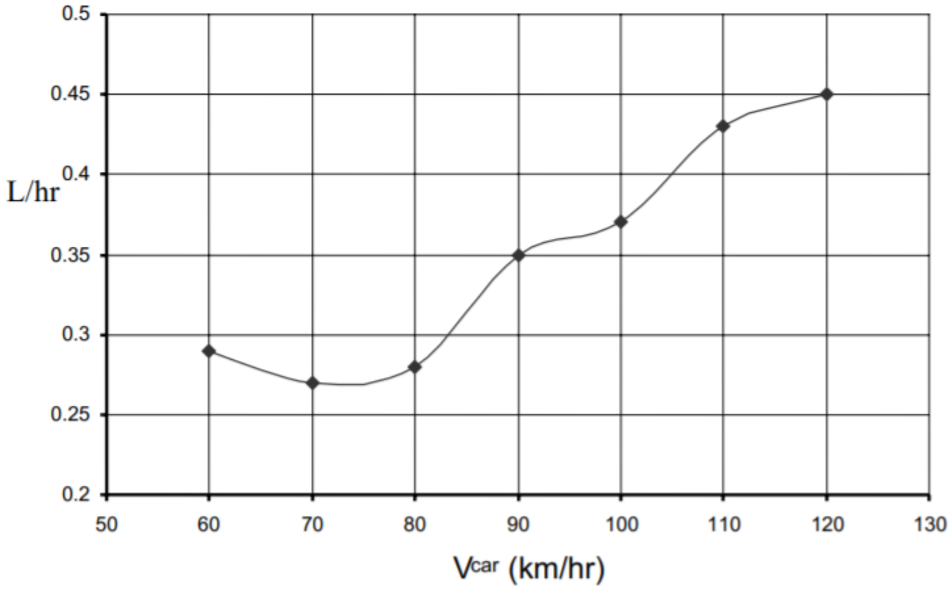


Figure 7. The effect of vehicle speed on the rate of fuel consumption [9]

The authors of [10] investigated that the effect of time-of-day on congestion duration depends on the day-of-the-week (Fig. 2).

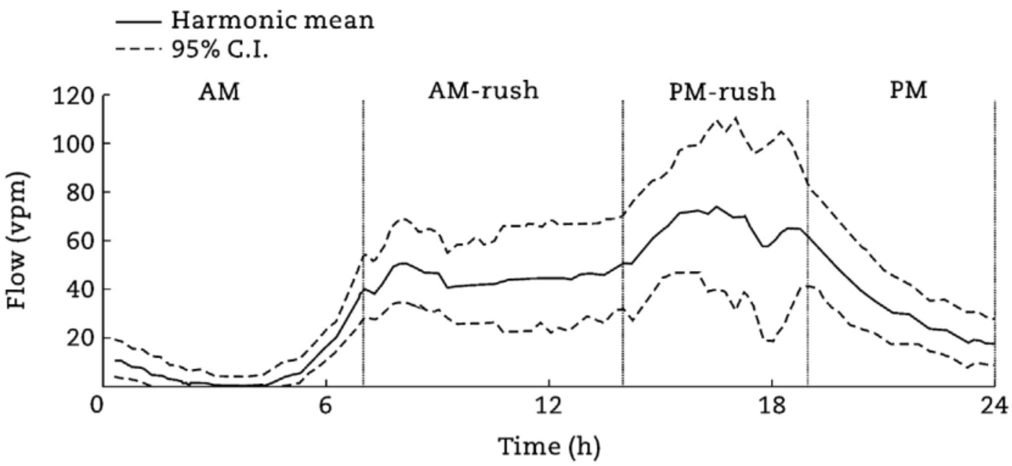


Figure 2. Average flow and variability by time-of-day [10]

The time-of-day measure was a categorical variable distinguishing between two time sectors: AM-rush (7 a.m.-2 p.m.) and PM-rush (2 p.m.-7 p.m.). The vast majority, more than 90%, of congestion events occur between 7 a.m. and 7 p.m. Within these 12 h, the AM-rush and PM-rush periods were distinguished based on a visual comparison of average flows throughout the day (Fig. 1). In a study [11] identified 3 p.m. as a natural break between midday and afternoon peak periods. In an analysis of recurring congestion, [12] identified AM- and PM-peak periods 5 a.m. - 8 a.m. and 3 p.m. - 7 p.m., respectively.

Authors [13] described the pattern of traffic flow in dependence with time of day (Fig. 3).

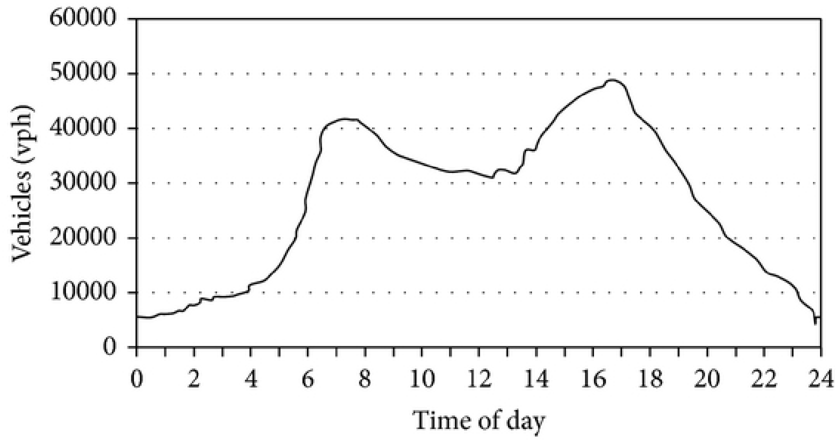
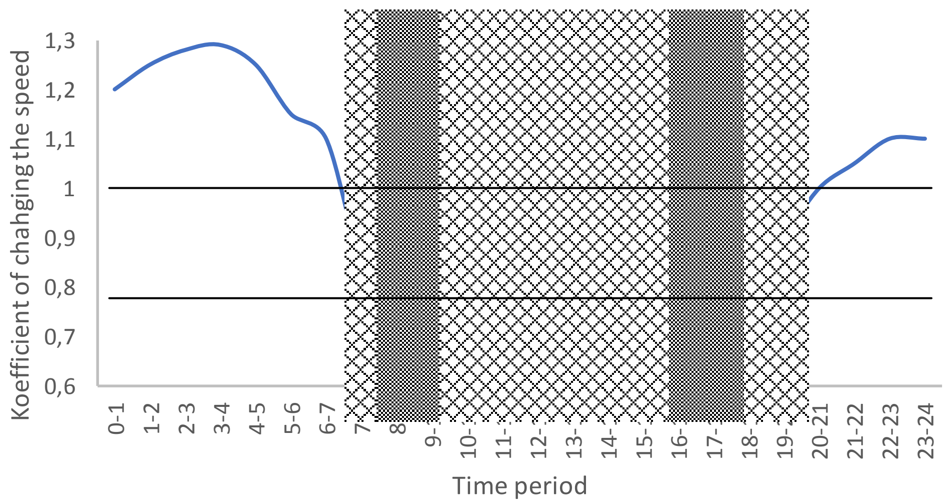


Figure 3. Typical traffic flow versus time of day [13]

A similar pattern can be found in the work [14], where typical dynamics of urban traffic speed is shown, with a significant decrease in speed in the morning and evening rush hours, the highest values at night, and obstructed movement during the day (Fig. 4).



Free flow Little congestion Big congestion

Figure 4. The coefficients of change in speed of movement depending on the time of day (completed based on [14])

The impact of congestion was measured with the help of the relevant TomTom indicators that provide very detailed information on the variation of speed during the day at road link level. Surprisingly, Seville has only one clear peak period, during the morning hours (Fig. 5). Working hours seem to play a role, most activities (distribution, work, school, shops) start between 6:00 am and 10:00 am, but return trips seem to cover a much wider period (from 2:00 pm to 11:00 pm) [15].

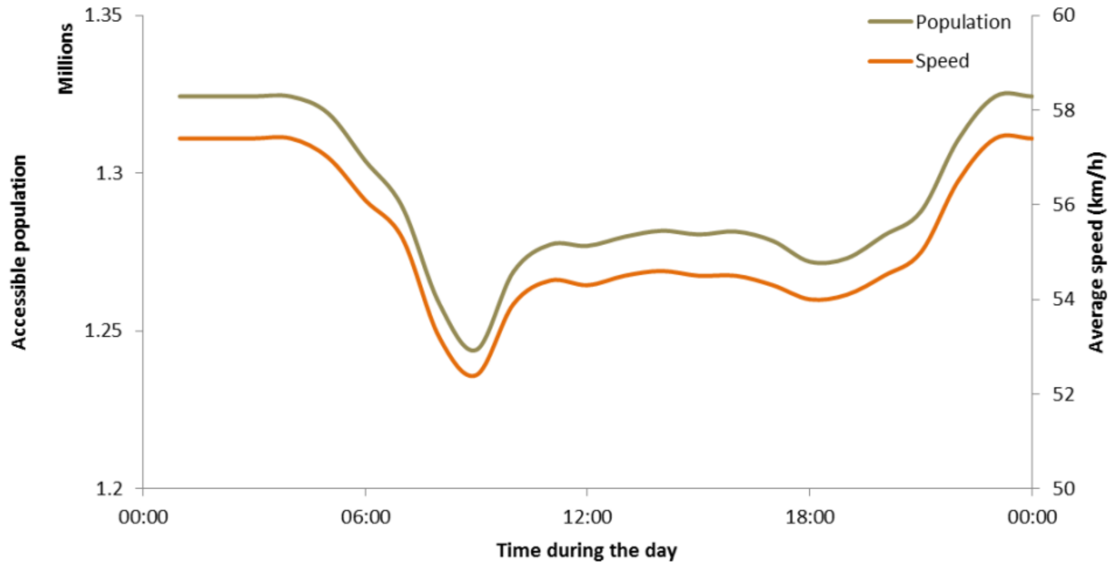


Figure 5. Hourly variation of absolute accessibility and speed during a day in Seville [15]

The urgency of the problem for Kyiv is caused by the fact that in Europe, Kyiv is the second most congested, behind Moscow and Istanbul (Fig. 6).

RANK BY FILTER	WORLD RANK ▼	CITY	DAYS WITH LOW TRAFFIC ▼	CONGESTION MONTH BY MONTH	CONGESTION LEVEL 2020 ▼
1	1	Moscow region (oblast) Russia	66 days		54%
2	2	Mumbai India	133 days		53%
3	3	Bogota Colombia	116 days		53%
4	4	Manila Philippines	128 days		53%
5	5	Istanbul Turkey	80 days		51%
6	6	Bengaluru India	147 days		51%
7	7	Kyiv Ukraine	48 days		51%
8	8	New Delhi India	64 days		47%
9	9	Novosibirsk Russia	15 days		45%
10	10	Bangkok Thailand	44 days		44%

Figure 6. The world's most congested cities in 2020 [4]

During 2020 alone, the congestion of Kyiv's roads increased by 2%. According to the authors of the rating, Kyivans and guests of the city lose about half an hour on the roads every day.

Kyiv roads are currently congested 3-4 times, according to the Kyiv City Administration. In 2020, 1.2 million cars were registered in Kyiv, of which 20% were trucks. At the same time, Kyiv is designed to use 300-400 thousand cars daily. Last year, the number of cars in the city increased by another 30% [16].

Thus, understanding the relationship "vehicle flow density - travel speed - fuel consumption" will effectively manage:

1) internal organizational logistics processes (for example, introducing off-peak, night-time delivery);

2) urban flows of vehicles and passengers, in order to reduce peak loads on road infrastructure (for example, by limiting the entry of cars to the busiest parts of the city, introducing high parking fees in certain areas, increasing the interval of public transport, etc.).

The purpose and objectives of the study. The purpose of this study is to analyze and obtain a mathematical model of the relationship between the speed of movement and fuel consumption for various means of urban delivery at different times of the day. A car, a motorcycle, a bicycle and a courier on foot (with the ability to use public transport) are considered as urban delivery means (UDM).

Basic material and results. The article discusses the dynamics of changes in speed and fuel consumption for such urban small cargo delivery vehicles:

- automobile;
- motorbike;
- bicycle;
- a courier on foot (with the possibility of using public transport).

The study will be divided into two parts - 1) to study the dependence of the average speed of movement in the city on the time of day (for all considered UDM); 2) to study the dependence of the average fuel consumption in the city on the time of day (for motorized UDM).

1. Average speed

To understand the conditions of the movements, data on the traffic flow by time of day is needed, namely, the speed and density of the vehicle movement [17].

Vehicle speed directly depends on the time of day and traffic congestion. At the same time, the speed of a motorcyclist depends on road congestion by only 33%, and of bicycles - by 20% [18]. Accordingly, the decrease in speed will be greatest for a car, and the least for a bicycle.

With regard to on-foot delivery, the distance between customers will affect the choice of courier movement. If the distance between clients is more than 1 km, the courier will use public transport, the speed of which is taken as 50% of a car speed (taking into account transfers, stops, waiting times, etc.).

In Kyiv, the movement of public transport occurs in the range of 7-23 hours, thus, we can observe the dynamics of speed during the day (Fig. 7).

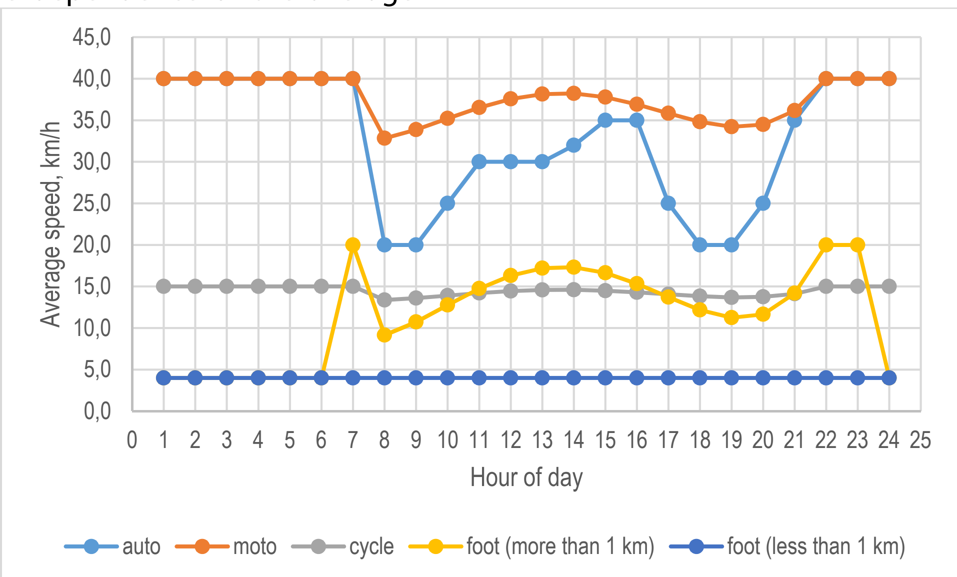


Figure 7. Dynamics of average speed at different urban delivery means

Given the real working conditions of the internet-store, the delivery of which is the object of work, the following work shifts were analyzed:

– 1st shift - 9.00-15.30;
– 2nd shift - 15.30-22.00.

Since all delivery means speed according to the methodology can be determined based on the speed of car deliver, the first step was to determine the function that most accurately describes the dynamics of the car and motorbike speed in Kyiv (Fig. 8).

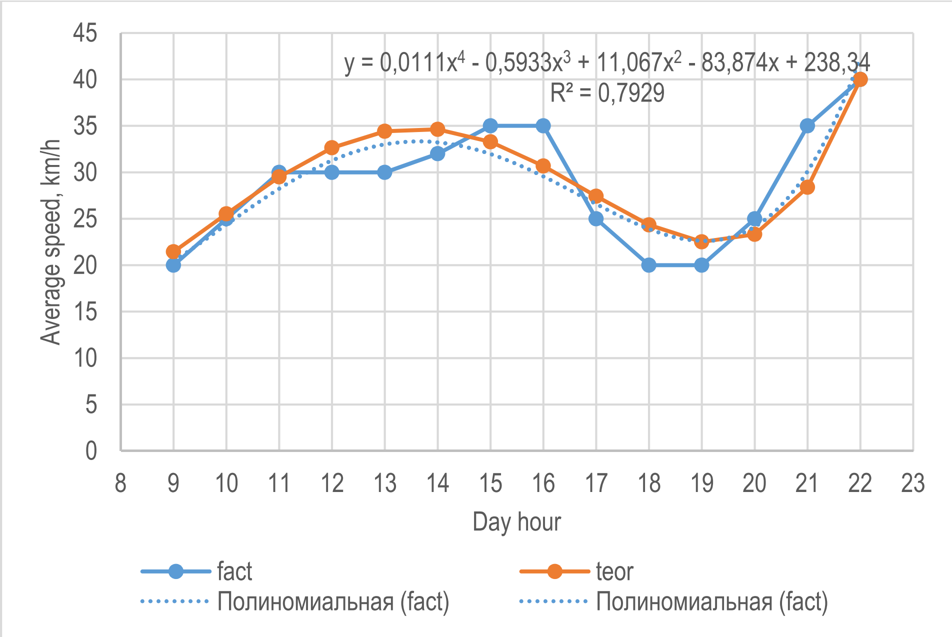


Figure 8. Dynamics of the average speed of delivery by car

The polynomial was chosen as such a function:

$$V(t) = 0{,}0111t^4 - 0{,}5933t^3 + 11{,}067t^2 - 83{,}874t + 238{,}34\,.$$

The accuracy is about 79%, which is an acceptable result.

Further, the dynamics of the speeds of other means were obtained (Fig. 9)..

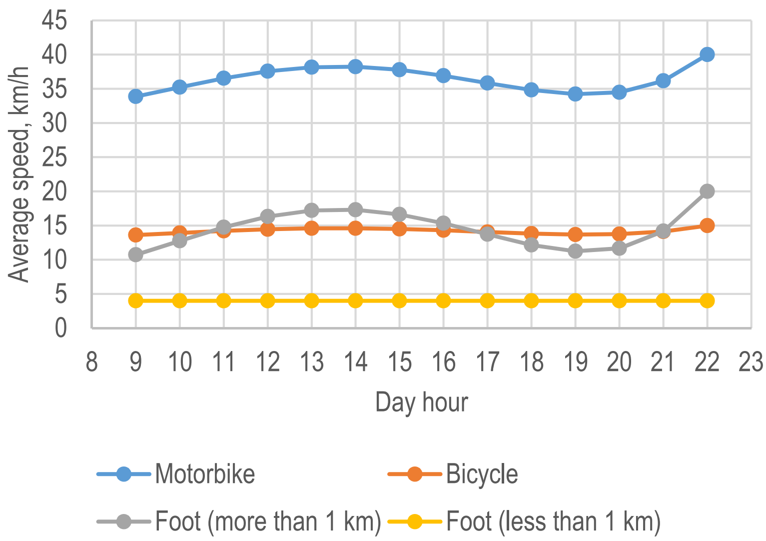


Figure 9. Dynamics of the average speed at different types of delivery (delivery hours 9.00-22.00)

Given the hourly change in traffic congestion, the calculation should be carried out in stages, in dynamics. However, to simplify the methodology, we took the average speeds for the shift, obtained as the arithmetic average of the speeds of each its hour. The final values of the average speeds of various means during shifts are shown in Table. 1.

Table 1. Average speeds for different types of delivery during a shift, km/h

Shift number	Automobile	Motorbike	Bicycle	Foot delivery (public transport)	Foot delivery (without public transport)
1	30,21	36,77	14,27	15,10	4,00
2	28,10	36,07	14,11	14,05	4,00

2. Average fuel consumption

Fuel costs are included in economic and environmental costs for only two of the four UDM involved in the analysis - car and motorcycle.

Fuel consumption for automobile delivery in the city is directly dependent on the speed of movement, which, in turn, is related to the density of urban traffic.

The cost of fuel on the route can be obtained based on the length of the route and fuel consumption per 100 km (considering the corresponding correction factor).

The fuel consumption on a route is influenced by the speed on the route. To calculate fuel consumption, it is proposed to use approximate trend lines that allow to describe the speed of movement depending on the time of day for each type of delivery vehicle V(t)i.

To obtain fuel consumption depending on the time of day, its dependence on the speed of movement for an average car and motorcycle in the city was studied (Fig. 10). We will restrict ourselves to the speed range of 10-50 km / h as the most probable, taking into account the limitations of the maximum speed in urban conditions by the traffic regulations.

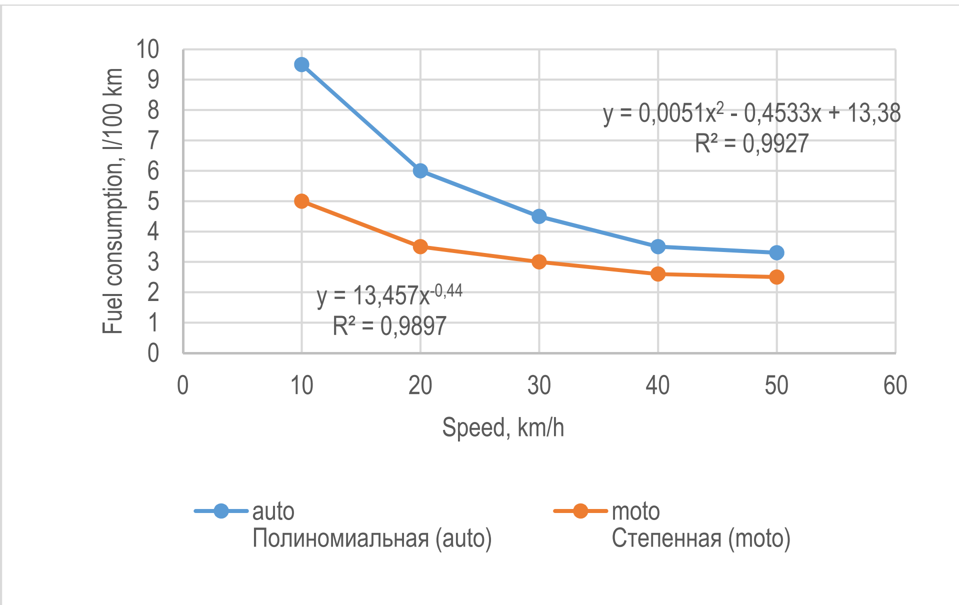


Figure 10. Dependence of fuel consumption on speed for an average car and a motorcycle with an engine capacity of 150-250 cm^3 (based on [13])

To simplify the calculations, the average values of fuel consumption per work shift can be obtained (Table 2). To do this, we find the arithmetic average of fuel consumption in each hour of the shift, having previously obtained these values using the trend line equations:

- for a car:

$$f_a(V) = 0,0051V^2 - 0,4533V + 13,38,$$

- for a motorcycle:

$$f_m(V) = 13,457V^{0,44}.$$

As we can see, MS Excel has selected a polynomial of the second order to describe the relationship for fuel consumption by a car and a power-law one - for fuel consumption by a motorcycle. Both models give excellent quality of approximation - R2 0.9927 and 0.9897, respectively.

Table 2 - Average fuel consumption for different types of delivery [l / 100 km]

Working Shift	Car	Motorbike	Bicycle	On foot / transit
1 (9 am to 3.5 pm)	4,63	2.78	-	-
2 (3.5 pm to 10 pm)	4,56	2.78	-	-

Conclusions. Thus, it is possible to propose an algorithm for determining the average speed and average fuel consumption when delivering small consignments in an urban environment using four means of urban logistics - a car, a motorcycle, a bicycle and an on-foot courier (with the possibility of using public transport) (Fig. 11).

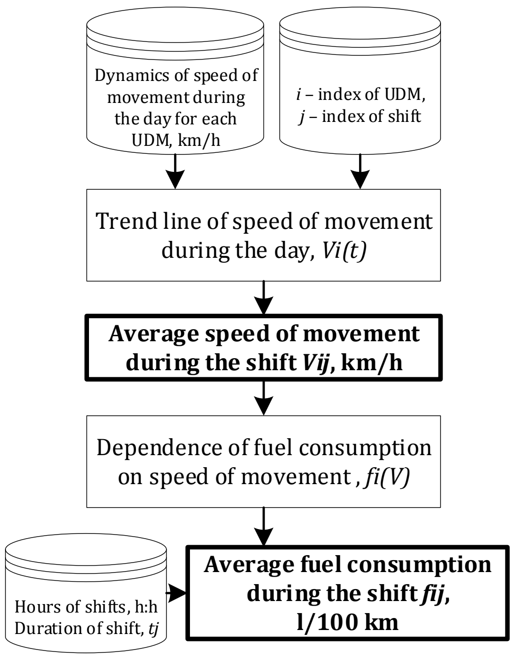


Figure 11. Algorithm for determining the average speed and average fuel consumption on urban delivery means

It should be noted that the numerical values obtained in the article are based on statistical data collected in a specific city (Kyiv) and cannot be automatically extended to all possible urban deliveries in the world. However, the proposed algorithm is applicable for any conditions of city delivery. One of its advantages is the absence of the need for special computer programs and the corresponding skills of a logistics manager. As an additional tool that facilitates calculations, a widespread program, usually present in any office, is offered - MS Excel.

As restrictions, it should be noted that the work does not take into account the number of customers on the route and the time spent at the moment of transfer of the shipment to a customer and for related operations. However, the authors believe that this simplification is acceptable for estimating the average speed of movement in the traffic flow, without taking into account stops and maneuvers at the place of delivery.

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DEVELOPMENT OF RECYCLING INFRASTRUCTURE IN UKRAINE

Lesia Kostiuchenko, Volodymyr Marchuk, Oleg Harmash. "Development of recycling infrastructure in Ukraine". *Today, household waste occupies a large area of legal and illegal landfills, and existing recycling plants are not operating at full capacity due to lack of recyclables. Responsible waste management is a key issue for the entire recycling industry in Ukraine. The study of trends in the development of solid waste recycling infrastructure in developed countries is the basis for the formation of its own recycling system in Ukraine. This explains the fact that in a difficult environmental situation on a global scale, the issue of recycling is gaining priority today.*

Modern enterprises that provide services for the removal of household waste, their sorting and further processing today especially need the participation of the state to create market conditions for the development of a competitive environment. After all, in addition to the processing of waste into secondary raw materials, biogas extraction systems are installed at landfills in Ukraine and installations for electricity production are operated. So in parallel with solving the problem of pollution, we have an additional source of alternative energy.

At the legislative level, the executive bodies of village, settlement and city councils have the right to address the issues of collection, transportation, utilization and disposal of household waste, setting tariffs for the service of household waste management, organization of separate collection of useful components of this waste. In order to create a proper system and build infrastructure for efficient waste management, it is important to unite local communities. In addition, it is critical to apply a systematic approach to the organization of the execution chain of all stages of recycling by forming the interaction of all infrastructure elements.

Keywords: recycling, recycling infrastructure, waste management, solid waste recycling, secondary resources, household waste management.

Леся Костюченко, Володимир Марчук, Олег Гармаш. «Розвиток інфраструктури рециклінгу в Україні». *Побутові відходи сьогодні займають чималу територію на законних та незаконних полігонах, а наявні заводи з переробки працюють не на повну потужність через брак вторсировини. Відповідальне поводження з відходами – ключове питання для всієї рециклінгової галузі в Україні. Дослідження тенденцій розвитку інфраструктури рециклінгу твердих побутових відходів розвинених країн є базою для формування власної системи рециклінгу в Україні. Це пояснює той факт, що в умовах складної екологічної ситуації в глобальному масштабі питання рециклінгу сьогодні набуває пріоритетності.*

Сучасні підприємства які надають послуги з вивезення побутових відходів, їх сортування та подальшої переробки сьогодні особливо потребують участі держави щодо створення ринкових умов для розвитку конкурентного середовища. Адже, окрім переробки відходів на вторинну сировину, на полігонах України облаштовано системи вилучення біогазу та експлуатуються установки для виробництва електроенергії. Отже паралельно з вирішенням питання забруднення, маємо додаткове джерело альтернативної енергії.

На законодавчому рівні вирішення питань збирання, транспортування, утилізації та знешкодження побутових відходів, встановлення тарифів на послугу з поводження з побутовими відходами, організація роздільного збирання корисних компонентів цих відходів мають право виконавчі органи сільських, селищних та міських рад. З метою створення належної системи та будівництва інфраструктури для ефективного поводження з відходами важливим кроком доцільно виконати об'єднання територіальних громад. Крім того, критично необхідним є застосування системного підходу до організації ланцюга виконання усіх етапів рециклінгу шляхом формування взаємодії роботи усіх інфраструктурних елементів.

Ключові слова: рециклінг, інфраструктура рециклінгу, управління відходами, рециклін твердих побутових відходів, вторинні ресурси, поводження з побутовими відходами.

Леся Костюченко, Владимир Марчук, Олег Гармаш. «Развитие инфраструктуры рециклинга в Украине». *Бытовые отходы сегодня занимают немалую территорию на законных и незаконных полигонах, а имеющиеся заводы по переработке работают не в полную мощность из-за нехватки вторсырья. Ответственное обращение с отходами – ключевой вопрос всей рециклинговой отрасли в Украине. Исследование тенденций развития инфраструктуры рециклинга твердых бытовых отходов в развитых странах является базой для формирования собственной системы рециклинга в Украине. Это объясняет тот факт, что в условиях сложной экологической ситуации в глобальном масштабе вопрос рециклинга сегодня приобретает приоритетность.*

Современные предприятия, предоставляющие услуги по вывозу бытовых отходов, их сортировке и последующей переработке сегодня особенно нуждаются в участии государства в создании рыночных условий для развития конкурентной среды. Ведь кроме переработки отходов на вторичное сырье, полигоны Украины обустроены системами извлечения биогаза, а также эксплуатируются установки для производства электроэнергии. Таким образом, параллельно с решением вопроса загрязнения, имеем дополнительный источник альтернативной энергии.

На законодательном уровне решение вопросов касательно сбора, транспортировки, утилизации и обезвреживания бытовых отходов, установление тарифов на услугу обращения с бытовыми отходами, организация раздельного сбора полезных компонентов этих отходов имеют полномочия исполнительные органы сельских, поселковых и городских советов. С целью создания надлежащей системы и строительства инфраструктуры для эффективного обращения с отходами важным шагом рекомендуется объединение территориальных общин. Кроме того, критически необходимым является применение системного подхода к организации цепочки выполнения всех этапов рециклинга путем формирования взаимодействия работы всех инфраструктурных элементов.

Ключевые слова: рециклинг, инфраструктура рециклинга, управление отходами, переработка твердых отходов, вторичные ресурсы, управление бытовыми отходами.

Introduction. In a difficult environmental situation on a global scale, the issue of recycling is becoming a priority. Today, environmental issues fill the agenda of many international meetings of various levels and areas: political, scientific, industrial, medical, economic, narrowly specialized, and so on. The study of trends in the development of solid waste recycling infrastructure in developed countries is the basis for the formation of its own recycling system in Ukraine

Analysis of recent researches and publications. Leading countries around the world have developed a five-step hierarchy of waste management, which is based on the priority of waste prevention. And if it cannot be prevented, efforts are made to reuse, if not possible as a recycling (recycling of waste into products, materials or substances) [3]. In the general, recycling is the phenomenon of returning to industrial production of some materials contained in industrial, construction and household waste [4, c. 103].

According to the Ministry of Community and Territorial Development of Ukraine, recycling includes the recycling of organic material, but does not include energy recovery or recycling into materials to be used as fuel or backfill materials. In the event that recycling is not possible, energy recovery or recycling operations are used to be used as fuel or backfill materials. In this case, backfilling is a recovery procedure, when suitable waste (except hazardous) is used to fill voids or for engineering purposes in landscape work, where waste replaces materials that are not waste. If all these operations have already been performed or cannot be performed - waste can be removed (including buried, placed in special landfills, incinerated, dissolved, etc.). Ukraine has also adopted such a hierarchy, approving the National Waste Management Strategy in 2017[3].

Today, household waste occupies a large area of legal and illegal landfills, and existing recycling plants are not operating at full capacity due to lack of recyclables. Responsible waste management is a key issue for the entire recycling industry in Ukraine. As a result, during 2020, Ukraine generated more than 54 million m2 of household waste, or more than 10 million tons, which are disposed of in 6,000 landfills and landfills with a total area of almost 9,000 hectares [5]. In addition, there are uncontrolled illegal accumulations of garbage in Ukraine. At the same time, the periodic shortage of high-quality sorted raw materials at processing enterprises leads to the need to purchase it abroad.

The purpose and objectives of the study. Analysis of the publications of the above authors shows that views on the nature and content of recycling practitioners and academic experts do not differ. However, the researched publications do not have enough information on the formation of infrastructure for a recycling system within the country. That is why the purpose of this study is to study current trends in the development of recycling infrastructure in Ukraine.

Basic material and results. Studies have shown that in 2019 in Ukraine separate collection of solid waste is carried out in 1462 settlements (except for the territories of the Autonomous Republic of Crimea, Sevastopol), which is 281 settlements more than in 2018. The largest share of settlements in which separate collection of solid household waste is introduced (see Table 1), in the total number of settlements in the region - in the Zakarpattian region (19.7%), the second place went to Ternopil (18.7%), third - Kharkiv region (12.3%), in fourth place - Chernivtsi (8.4%), Volyn (8.3%), Ivano-Frankivsk region (8.1%). [6]

Table 1. – Share of settlements in which separate collection of solid household waste is introduced, from the total number of settlements of the region, %.

Name of the region	2018	2019	Deviations until 2018,+/-
Vinnytsia	4,9	7,9	+3
Volyn	1,2	8,3	+7,1
Dnepropetrovsk	3,1	3,3	+0,2
Donetsk	1,5	4	+2,5
Zhytomyr	1,2	1,2	0
Zakarpattia	29,6	19,7	-9,9
Zaporozhye	1,7	1,7	0
Ivano-Frankivsk	12,6	8,1	-4,5
Kyiv	3,6	2,2	-1,4
Kirovograd	0,8	1,6	+0,8
Luhansk	1,3	1,1	-0,2
Lviv	5	7,3	+2,3
Mykolayiv	1,9	1,9	0
Odessa	1,6	2,6	+1
Poltava	1,2	2	+0,8
Rivne	3,8	6,9	+3,1
Sumy	0,5	3	+2,5
Ternopil	14,7	18,7	+4
Kharkiv	10,9	12,3	+1,4
Kherson	2,4	3,9	+1,5
Khmelnytsky	1	1,2	+0,2
Cherkasy	0,9	1,3	+0,4
Chernivtsi	7,4	8,4	+1
Chernihiv	1,9	2,2	+0,3
In general, in Ukraine	4,1	5,1	+1

Source: [6]

The change in the dynamics of the share of settlements in which separate collection of solid household waste has been introduced in recent years is shown in Fig. 1.

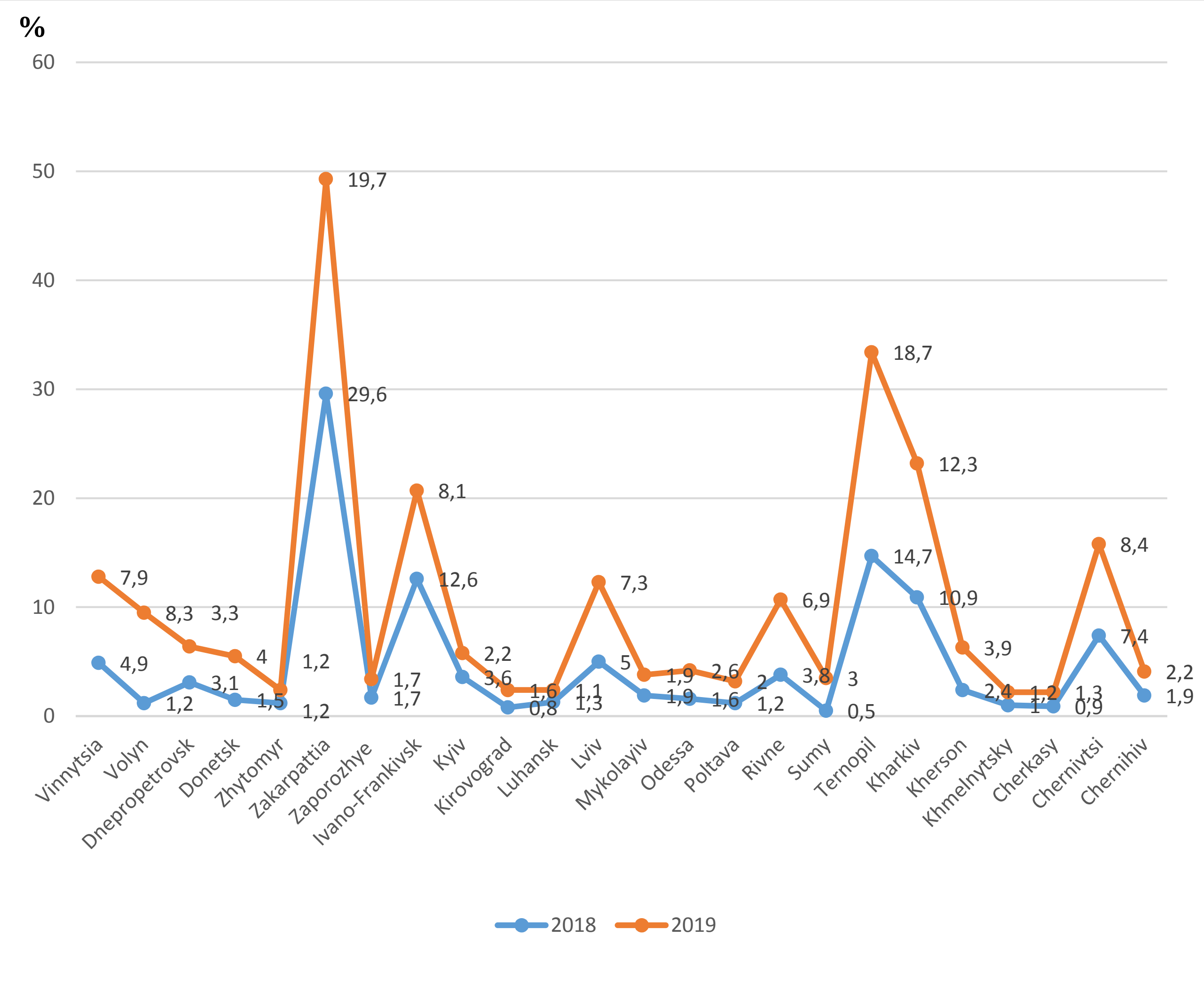

Figure 1. The dynamics of the share of settlements in which separate collection of solid household waste has been introduced

Source: [6]

The Law of Ukraine "On Housing and Communal Services" dated 09.11.2017 № 2189-VIII (entered into force on 01.05.2019) powers on the processing and disposal of household waste, as well as the establishment of tariffs for household waste management transferred to local governments, which caused demonopolization of the market of services for processing and disposal of household waste. However, the non-adoption at the legislative level of the introduction of extended liability of producers and importers of goods currently hinders the development of the field of household waste management.

According to the Ministry of Development of Communities and Territories of Ukraine [3], today in about 1,200 settlements separate collection of household waste is being introduced, which is one and a half times more than last year. There are 26 garbage sorting lines in 21 settlements, garbage sorting complexes are being built in 18 settlements. Annually, 700 thousand tons of cardboard and paper products, 120 thousand tons of polymers, 50 thousand tons of PET bottles, 460 thousand tons of cullet get to the waste processing enterprises of Ukraine. As of today, there are 91 processing enterprises in Ukraine, namely 17 waste paper processing enterprises, 39 polymer processing enterprises, 19 plastic bottle processing enterprises, and 16 cullet processing plants. They are loaded at 50-70% of their capacity (see Fig. 2).

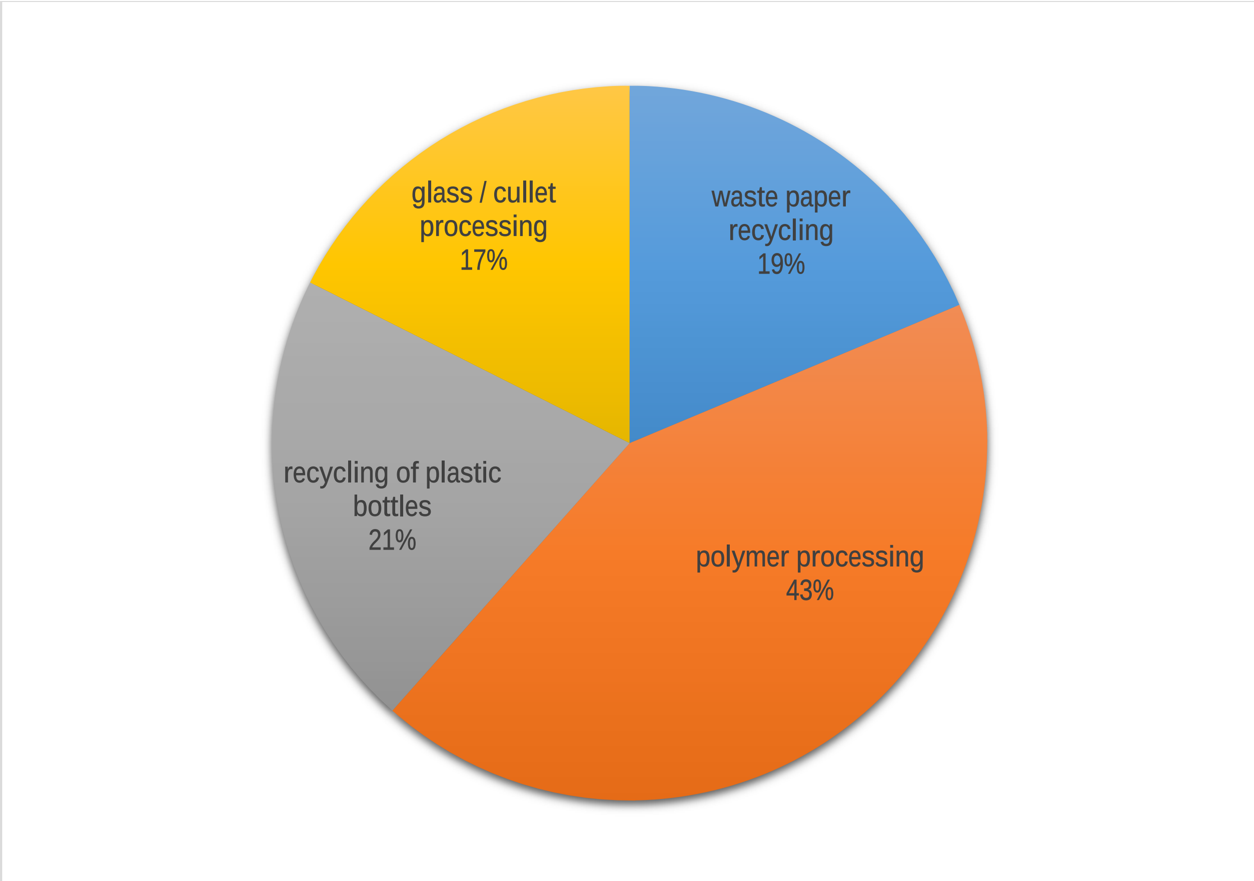

Figure 1 Structure of solid waste processing in Ukraine
Source: [3; 5]

Due to the separate collection of household waste by the population, the operation of sorting lines at landfills and collection points for secondary raw materials, the amount of collected valuable resource components is only 40% of the capacity of waste processing plants. As a result, the volume of forced imports of secondary raw materials for the operation of existing processing enterprises amounted to 400 thousand tons. It should be noted that in 2018, in order to provide quality services for the removal of household waste and cover the entire population, this service provided for the purchase of more than 172 million hryvnias more than 36 thousand containers for household waste, including more than 7 thousand containers for separate collection of household waste, and 181 specially equipped vehicles worth UAH 400 million. The purchase of containers and garbage trucks was carried out at the expense of local budgets, from the funds of regional development and environmental protection and at the expense of private enterprises. In addition, a biogas extraction system has been installed at 28 landfills and cogeneration units with a capacity of 45.2 MW are in operation. The amount of electricity produced according to the NCRECP for 2018 as of November 1, 2018 is more than 144 million kWh. [5]

Among the recycling complexes a special place is occupied by waste incineration plants. This is the most common type of waste processing plant in developed countries. The first such manufactory was built in Nottingham near London in 1874 using the simplest technology as a waste disposal by incineration. Today's incinerators are a classic example of alternative energy. There are more than 2,500 of them in the world. In the USA, for example, there are about 500 productions, in Germany and France more than 100 in each. Among the world's megacities, the largest number of such plants in Beijing – 32. There were 5 incinerators in Ukraine at different times (Kyiv, Dnipro, Kharkiv, Rivne and Sevastopol (is occupied today)), of which only the Energia plant in Kyiv operates. Today, the issue of chemical flue gas cleaning is acute at the enterprise. Similar problems are common to all incinerators. The products of waste combustion contain almost all the elements of the periodic table, the most dangerous heavy metals, acids and sulfur dioxide. Modern flue gas cleaning technologies can completely neutralize the negative effects of these substances. Therefore, in developed countries there are no restrictions on the location of incinerators. There are many examples of such companies located even in the city center, for example Tokyo, Zurich, or Lyon. The most textbook example is the Spittelau plant in Vienna, located in the center of the Austrian capital. Of course, ensuring the environmental safety of incinerators and the introduction of modern methods of purification of exhaust gases significantly increase the cost of construction of such enterprises. In the structure of the total construction cost, such costs can be up to 50%. The cost of building a new plant for processing 500 thousand tons of waste per year ranges from 300 to 400 million dollars. Concentrating such funds is a daunting task for most local governments. Therefore, many of them are actively looking for investors to build incinerators. [2]

In 2020, Ukraine generated more than 54 million m3 of household waste, or more than 10 million tons, which are disposed of in 6,000 landfills and landfills with a total area of almost 9 thousand hectares. Almost 79% of the population of Ukraine is covered by household waste disposal services. The worst rate of coverage of the population with services for the removal of household waste in Kirovohrad region (64.8%) and in Zhytomyr region (65.3%). Due to the introduction, in 1725 settlements of separate household waste collection, operation of 34 waste sorting lines, 1 incinerator and 3 incinerators recycled and disposed of about 6.3% of household waste, of which: 1.7% incinerated and 4.6% household waste got to the procurement points of secondary raw materials and waste processing lines. [7]

According to expert estimates, biogas extraction systems have been installed at 26 landfills in Ukraine, and installations for the production of electricity with a capacity of 30 MW are in operation. The amount of utilized biogas in 2020 amounted to 64.0 million m3 (50% methane). The amount of electricity produced in 2020 is 112.3 GWh. However, the number of overloaded landfills is 261 units. (4.3%), and 868 units. (14%) do not meet environmental safety standards. Improper work on certification and reclamation of landfills. Of the 1,542 landfills that need certification, in 2020, 93 units were actually certified (23.9% of the total number of landfills need certification). The largest number of landfills that require certification is in Zhytomyr oblast - 243 units, in Dnipropetrovsk oblast - 147 units and in Chernihiv oblast - 132 units. [7]

According to data [7], out of 424 landfills in need of reclamation, 24 were actually reclaimed. The largest number of landfills in need of reclamation is in Odesa oblast - 82 units and in Zakarpattia oblast - 59 units. The need for construction of new landfills is 318 units. The greatest need for construction of new landfills in Dnipropetrovsk region is 42 units. Due to the improper system of solid waste management in settlements, usually in the private sector, in the reporting year 22.6 thousand unauthorized landfills covering an area of 0.56 thousand hectares were identified, of which 21.7 thousand were liquidated in 2020. unauthorized landfills with an area of 0.53 thousand hectares [7].

Businesses that provide household waste disposal services, which include companies that provide sanitation services, today especially need the participation of the state to create market conditions for the development of a competitive environment. According to [7], in 2020, 1190 organizations provided sanitation services including 264 privately owned (22%). The largest number of privately owned enterprises in this area is in Kyiv (94%) and Zakarpattia region (55%). The number of employees in the field of household waste management is more than 18.4 thousand people. The total number of specially equipped vehicles is almost 3.9 thousand units. The average wear of special vehicles in 2020 is 62%. The lowest percentage of worn-out garbage trucks in Poltava and Rivne regions is 45% [7].

In 2020, almost UAH 1 billion was allocated for subsidized financing of the development and maintenance of sanitation. The largest amounts of financing in the field of household waste management were observed in Kharkiv region (over UAH 378 million) and in Kyiv (over UAH 292 million). In general, the statistics of financing the field of household waste management in 2020 are given in table. 2.

The largest accounts payable in the field of household waste management were recorded in Donetsk region and Kyiv. The main factor hindering the introduction of modern methods and technologies in this area is insufficient funding, which is carried out in general at the expense of consumers of services and costs from local budgets for the elimination of unauthorized landfills. [7]

Table 2. – Financing of household waste management in 2020

Indicator	Value / amount	Units of measurement
The average tariff for household waste management in the country	130	UAH./м³
– including for burial	42	UAH./м³
Average tariff for household waste management for the population	111,7	UAH./м³
– including for burial	37,8	UAH./м³
The volume of sales of services for the removal of household waste	5,2	billion UAH.
The volume of paid services for the removal of household waste	4,9	billion UAH.
The amount of benefits to the population in the provision of services for the removal of household waste according to the calculations of enterprises	55,3	Million UAH
The amount of reimbursement of benefits	52,7	Million UAH
Accounts payable in the field of household waste management	563	Million UAH
including wages	44	Million UAH
Receivables	1,79	billion UAH.
including debt: - people - budget organizations	 1,6 0,035	 billion UAH. billion UAH.

Source: [7]

C**onclusions.** At the legislative level, the executive bodies of village, settlement and city councils have the right to address the issues of collection, transportation, utilization and disposal of household waste, setting tariffs for the service of household waste management, organization of separate collection of useful components of this waste. In order to create a proper system and build infrastructure for efficient waste management, it is important to unite local communities. In addition, it is critical to apply a systematic approach to the organization of the execution chain of all stages of recycling by forming the interaction of all infrastructure elements

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THE EVENTUAL MODEL OF THE ALGORITHM FOR DESIGNING THE LOGISTICS SYSTEM OF A PRODUCTION ENTERPRISE

Oleksandr Sumets. "The eventual model of the algorithm for designing the logistics system of a production enterprise." *The logistics system is one of the most important subsystems of the production enterprise. This system is responsible for the timeliness and efficiency of logistics activities at the enterprise. Creating the logistics system for the company is based on solving a set of problems, where the development of an algorithm for its design is key one.*

The article proposes an eventual model of the algorithm for designing the logistics system of a production enterprise. The design algorithm was developed taking into account the activities of oil and fat industry enterprises. Structurally, the algorithm consists of three phases - the formation of an information array for the design of the logistics system, the design of the logistics system, the installation of the logistics system project at the enterprise. The optimal number of stages was substantiated for each design phase. According to the design stages, a list of works that must be performed in the process of project development and installation was described. Information on the time spent on each job at the stages of design and installation of the logistics system was provided. It is indicated that the development and installation of a logistics system at a manufacturing plant can take three to four months. The obtained research results are important for the top management of enterprises. They will allow to be guided in productivity of process of designing and installation of logistic systems. In the future, this will provide an opportunity to correctly draw up a logistics plan and adjust the development strategy of the enterprise.

The material presented in the article is useful for researchers in terms of further consideration of improving existing or developing new algorithms and techniques for designing logistics systems of industrial enterprises.

Keywords: eventual model, logistics system, design algorithm, design phase, design stage, enterprise.

Олександр Сумець. «Евентуальна модель алгоритму проєктування логістичної системи виробничого підприємства». *Логістична система являє собою одну із найбільш важливих підсистем виробничого підприємства. Ця система відповідає за своєчасність і ефективність здійснення на підприємстві логістичної діяльності. Створення логістичної системи для підприємства базується на вирішенні комплексу завдань, де розроблення алгоритму її проєктування є ключовим.*

У статті запропонована евентуальна модель алгоритму проєктування логістичної системи виробничого підприємства. Алгоритм проєктування розроблено з огляду на діяльність підприємств *олієжирової галузі. Структурно алгоритм складається із трьох фаз - формування інформаційного масиву для проєктування логістичної системи, проєктування логістичної системи, інсталяція проєкту логістичної системи на підприємстві. Для кожної фази проєктування обґрунтована оптимальна кількість етапів. За етапами проєктування описано перелік робіт, які обов'язково виконуються у процесі розробки і інсталяції проєкту. Наведена інформація щодо витрати часу на виконання кожної роботи за етапами проєктування і інсталяції логістичної системи. Вказано, що розробка і інсталяція логістичної системи на виробничому підприємстві може тривати три-чотири місяці. Одержані результати дослідження є важливими для топ-менеджменту підприємств. Вони дозволять орієнтуватися в продуктивності процесу проєктування й інсталяції логістичних систем. У подальшому це надасть можливість коректно скласти логістичний план і скоригувати стратегію розвитку підприємства.*

Наведений у статті матеріал є корисним для дослідників в аспекті подальшого розгляду питання удосконалення наявних або розроблення нових алгоритмів і методик проєктування логістичних систем виробничих підприємств.

Ключові слова: евентуальна модель, логістична система, алгоритм проєктування, фаза проєктування, етап проєктування, підприємство.

Александр Сумец. «Эвентуальная модель алгоритма проектирования логистической системы производственного предприятия». *Логистическая система представляет собой одну из наиболее важных подсистем производственного предприятия. Эта система отвечает за своевременность и эффективность осуществления на предприятии логистической деятельности. Создание логистической системы на предприятии базируется на решении комплекса задач, где разработка алгоритма ее проектирования является ключевой.*

В статье представлена эвентуальная модель алгоритма проектирования логистической системы производственного предприятия. Алгоритм проектирования разработан с учетом деятельности предприятий масложировой отрасли. Структурно алгоритм состоит из трех фаз – формирование информационного массива для проектирования логистической системы, проектирование логистической системы, инсталляция проекта логистической системы на предприятии. Для каждой фазы проектирования обосновано оптимальное количество этапов. По этапам проектирования описан перечень работ, которые обязательно выполняются в процессе разработки и инсталляции проекта. Представлена информация о затратах времени на выполнение каждой работы по этапам проектирования и инсталляции логистической системы. Указано, что период разработки и инсталляции логистической системы на производственном предприятии может занять три-четыре месяца. Полученные результаты исследования важны для топ-менеджмента предприятий. Они позволят ориентироваться в производительности процесса проектирования и установки логистических систем. В дальнейшем это позволит корректно составить логистический план и скорректировать стратегию развития предприятия.

Приведенный в статье материал полезен исследователям в аспекте дальнейшего рассмотрения вопроса усовершенствования существующих или разработанных новых алгоритмов и методик проектирования логистических систем производственных предприятий.

Ключевые слова: эвентуальная модель, логистическая система, алгоритм проектировання, фаза проектирования, этап проектирования, предприятие.

Relevance of the problem. Ukraine's economy is currently experiencing many shocks, which affects the activities of domestic enterprises, firms and companies. This has created a situation where organizations are constantly in a position to find ways to maintain a stable position in the market. Therefore, as practice shows, in recent years the top management of enterprises, firms and companies began to pay much attention to the creation and further development of logistics systems (LS). Scientists and practitioners are unanimous in the opinion that to achieve the productive work of enterprises requires a comprehensive project of improvements, which must organically combine the latest technologies and logistics development strategy. For the successful implementation of the logistics development strategy, a necessary condition is the creation of logistics systems in enterprises, which will be isolated and will have their own specific purpose and objectives.

Creating a logistics system for a functioning enterprise is based on solving a set of relevant tasks. The primary, or key, task in this aspect is to develop an algorithm for designing a logistics system.

Analysis of recent research. Analysis of publications of research results of domestic and foreign scientists [1-10], which highlights the recommendations for the formation of the logistics system in enterprises and firms, provided an opportunity to identify unresolved issues of the general problem, namely:

1) at this time there is no description of the content of the LS design process;

2) the design phase of the LS is not clearly defined and described;

3) stages in each phase of LS design are not defined in quantitative and qualitative terms;

4) in the detailed description of works on designing of LS there are elements of generality and disregard of some important works, for example, maintenance of economic safety of LS, creation of system of registration, the analysis, control of logistic expenses within logistic system, substantiation of expediency of creation of LS at the enterprise, etc.

In addition, unfortunately, not all authors indicate in their publications for which enterprise the algorithm can be applied - for one that is functioning, or for a new one, ie for one that is just being organized. However, these developments of scientists and practitioners are very useful and should be the basis for further research on this issue.

All the above indicates that the problem of creating a methodological apparatus for designing a logistics system at this point in time has not yet been resolved and it needs further study [12]. In solving this problem, from the author's point of view, the primary task for researchers is to work out an eventual model of the algorithm for designing and implementing a logistics system in the enterprise, taking into account its economic system, which has already been formed [11].

Formulation of the research purpose: construction of an eventual model of the algorithm for designing the logistics system of a production enterprise.

The main material and results of the research. Previous studies of publications on this issue have made it possible to conclude that an eventual model of the algorithm for designing the logistics system of a production enterprise is based on the classical approach to project development. Namely, it is formalized in accordance with the following procedures:

1) determination of design phases;

2) description of design stages for each phase;

3) determination of works that will be performed within each stage on a mandatory basis;

4) the choice of contractors and logistics to ensure the design process.

The clarity of the presentation of an eventual model requires detailing of each procedure.

Analysis of approaches to the design and implementation of logistics systems in industrial enterprises, published in [1-10], provided an opportunity to systematize all proposals and choose an algorithm that consists of three phases:

- phase 1: formation of an information array for the design of a logistics system;

- phase 2: design of the logistics system;
- phase 3: installation of the logistics system project.

These phases combine a certain number of stages that specify the direction and content of project work (Fig. 1).

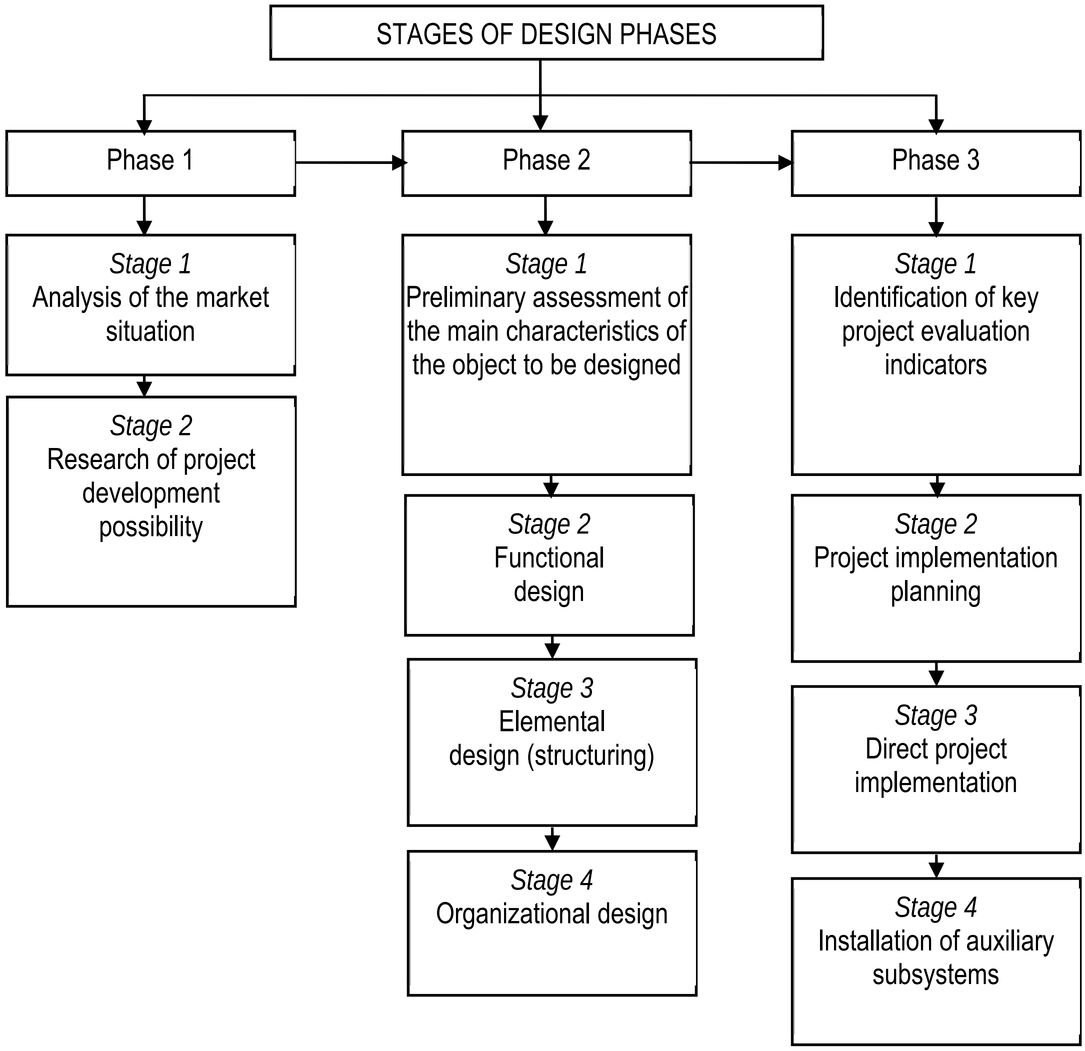

Figure 1. The main stages of the project development and implementation phases
Source: developed by the author.

In order to further implement these phases in practice, there is a need for a detailed description of an eventual model of the algorithm for designing and implementing a logistics system for a truly functioning production enterprise. For this purpose, within the framework of this study, a tabular form of information presentation was used (Table 1).

The implementation of the algorithm in practice involves its description in formulaic, verbal, graphical, tabular and algorithmic ways. From the point of view of the author, in this case the decision on formalization of algorithm in the form of the multiblock scheme is made (fig. 2). A thorough analysis of the proposed algorithm indicates that it has all the necessary properties, namely: finiteness, mass, discreteness, elementariness, determinism, efficiency and certainty. This makes it possible to state that the eventual model of the algorithm is quite suitable for practical implementation.

Table 1 - The main work of the process of design and implementation of the logistics system at the production enterprise

Phase	Number and name of the stage	Name of the main works	Work code
1	2	3	4
Phase 1	Stage 1. Analysis of the market situation	1. Analysis of suppliers and consumers, establishing the possibility of increasing their number	Ph1.S1.W1
		2. Competitors analysis	Ph1.S1.W2
		3. Formulation of the purpose of creation of LS, formulation of the basic tasks LS	Ph1.S1.W3
		4. Analysis of outsourcing opportunities (external)	Ph1.S1.W4
	Stage 2. Research of the possibility of the LS creating	1. Analysis of the overall strategy of the enterprise	Ph1.S2.W1
		2. Analysis of the resource potential of the enterprise	Ph1.S2.W2
		3. Assessment of the existing logistics infrastructure of the enterprise	Ph1.S2.W3
		4. Determining the level of logistics costs for the company and justification of expediency of creating the LS	Ph1.S2.W4
		5. Pre-selection of the type and kind of logistics system	Ph1.S2.W5
		6. Determining the main limitation (determinants) on the functioning of the LS	Ph1.S2.W6
Phase 2	Stage 1. Preliminary assessment of the main characteristics of the designed LS	1. Forecasting the development of the LS	Ph2.S1.W1
		2. Determining the potential market boundary of the LS and transport network of customer service	Ph2.S1.W2
		3. Determining the cost of the project and installation of the LS at the enterprise	Ph2.S1.W3
		4. Estimation of the expected effect of the LS	Ph2.S1.W4
		5. Evaluation of the feasibility of designing the LS	Ph2.S1.W5
	Stage 2. Functional design of the LS	1. Allocation of a strategic set of logistics functions that are necessary to maintain the competitiveness of the enterprise	Ph2.S2.W1
		2. Establishment (definition) of logistics functions that can be outsourced and which will be performed directly at the enterprise	Ph2.S2.W2
	Stage 3. Elemental design (structuring) of the LS	1. Establishing the optimal structure of the LS of the enterprise: the choice of subsystems of the LS in accordance with the logistics purpose	Ph2.S3.W1
		2. Formation of economic goals and objectives for each subsystem of the LS	Ph2.S3.W2
		3. Determining the adequacy of the technical and technological base of each subsystem of the LS	Ph2.S3.W3
		4. Establish the required level of interconnection between subsystems and links of the LS	Ph2.S3.W4
		5. Information linking of the LS subsystems	Ph2.S3.W5
		6. Formation of the system of registration, accounting, analysis and control of logistics costs of the enterprise LS	Ph2.S3.W6

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The end of the table 1

1	2	3	4
	Stage 4. Organizational design of the LS	1. Systematization of conditions, factors and parameters that determine the organizational management structure (OMS) of the enterprise LS	Ph2.S4.W1
		2. Choice of OMS type of the enterprise LS	Ph2.S4.W2
		3. Formation of conditions for the OMS of the enterprise LS	Ph2.S4.W3
		4. The choice of the OMS design model of the logistics system	Ph2.S4.W4
		5. The choice of indicators for assessing the quality of OMS of the enterprise LS	Ph2.S4.W5
		6. Formation of a system of indicators for assessing the effectiveness of OMS of the LS	Ph2.S4.W6
		7. Estimation of OMS efficiency of the enterprise LS	Ph2.S4.W7
		8. Assessment of the synergistic effect of the OMS implementation of the functioning enterprise LS	Ph2.S4.W8
		9. Working out of measures to ensure the economic security of the enterprise LS	Ph2.S4.W9
Phase 3	Stage 1. Identification of key indicators for the evaluation of the LS project	1. Determining the sensitivity of the LS	Ph3.S1.W1
		2. Determining the degree of usefulness of the LS	Ph3.S1.W2
		3. Determining the reliability of the LS	Ph3.S1.W3
		4. Evaluation of project effectiveness	Ph3.S1.W4
		5. Assessment of the economic security level of the enterprise LS	Ph3.S1.W5
	Stage 2. Planning the implementation of the LS project	1. Budgeting of the LS project	Ph3.S2.W1
		2. Drawing up a plan for the implementation of the LS project	Ph3.S2.W2
		3. Scheduling the implementation of the LS project	Ph3.S2.W3
	Stage 3. Direct implementation of the LS project	1. Launch of the LS project	Ph3.S3.W1
	Stage 4. Installation of auxiliary subsystems of the enterprise LS	1. Installation of logistics information system (LIS)	Ph3.S4.W1
		2. Installation of a system of registration, accounting, analysis and control of logistics costs	Ph3.S4.W2
		3. Installation of the economic security system of functioning of the enterprise LS	Ph3.S4.W3

Source: compiled by the author.

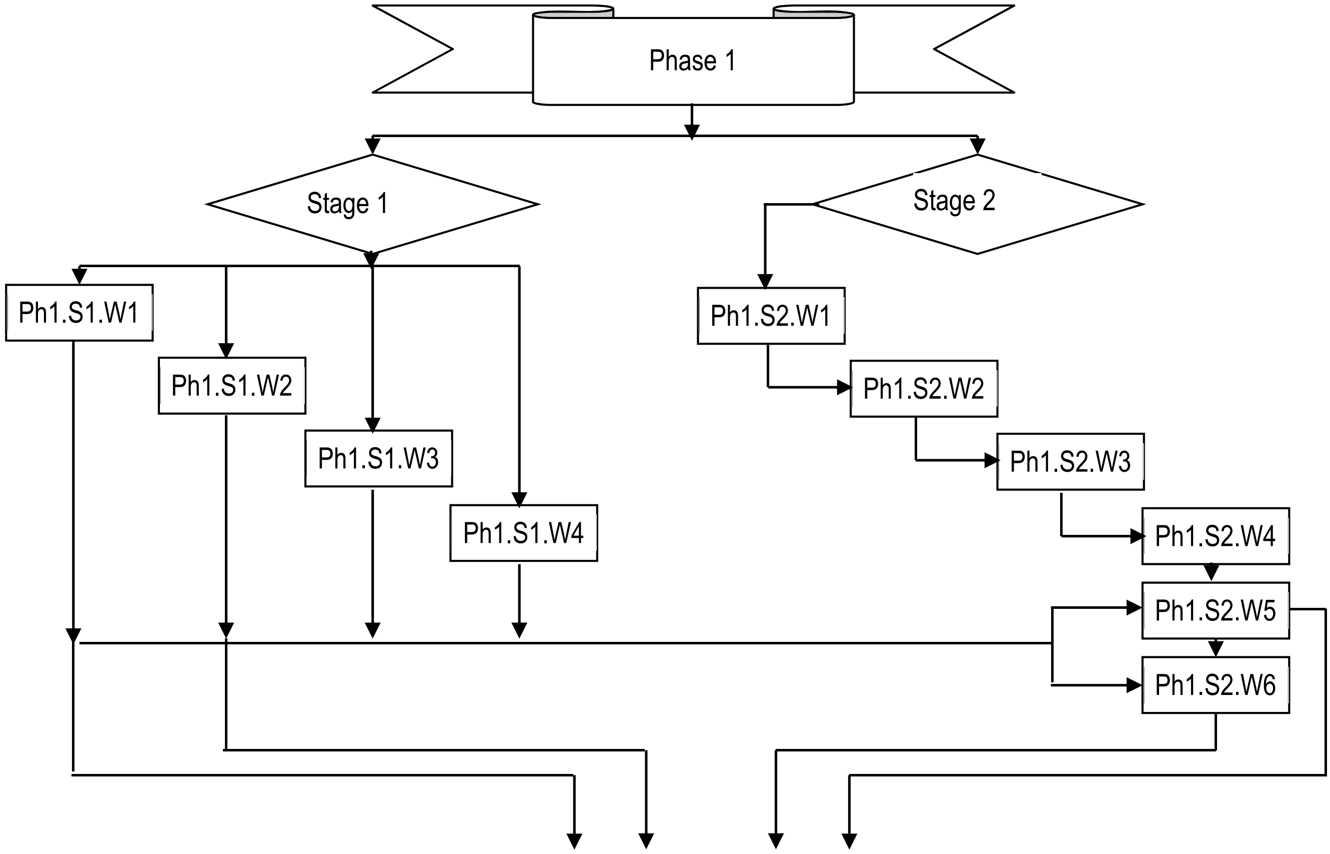

Figure 2 - Algorithm for designing the LS of a production enterprise (sheet 1)

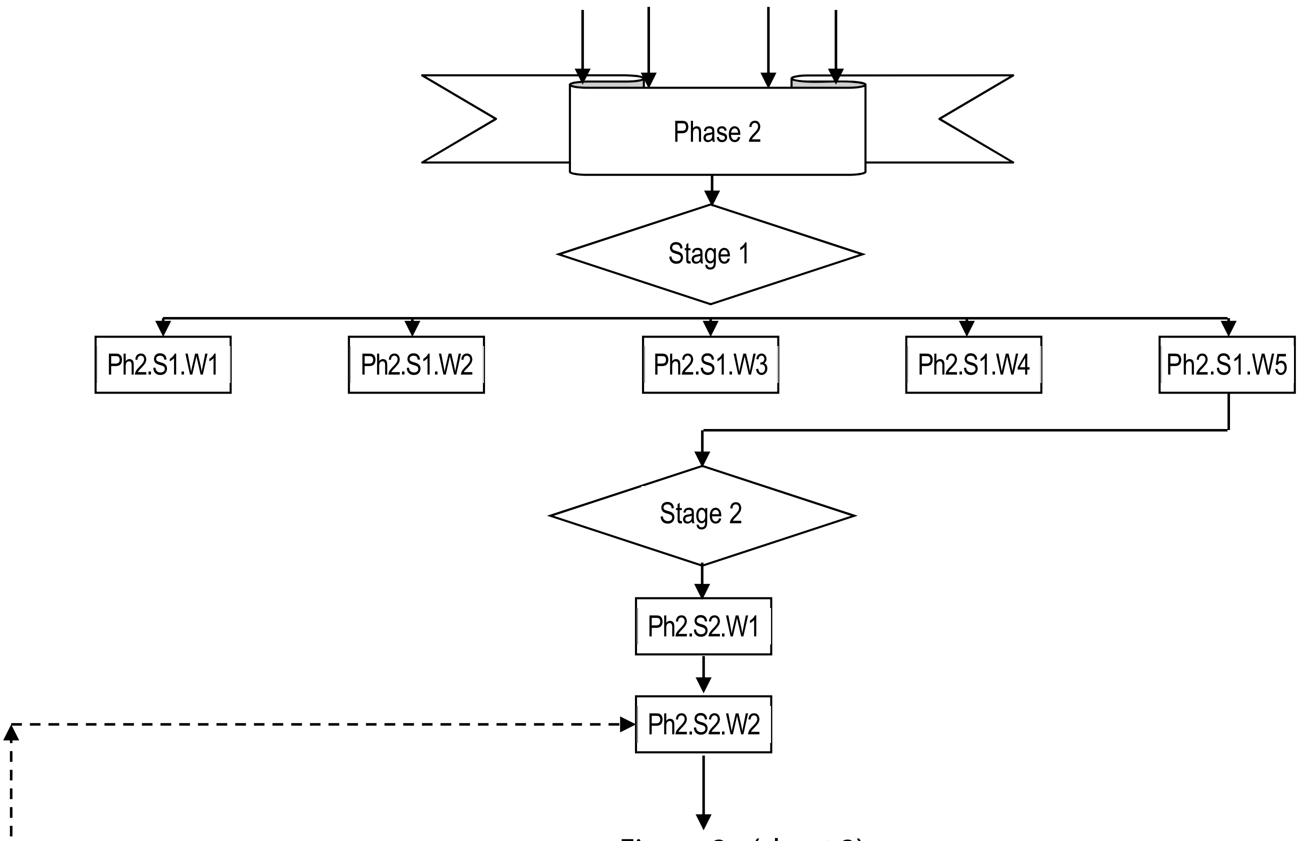

Figure 2 - (sheet 2)

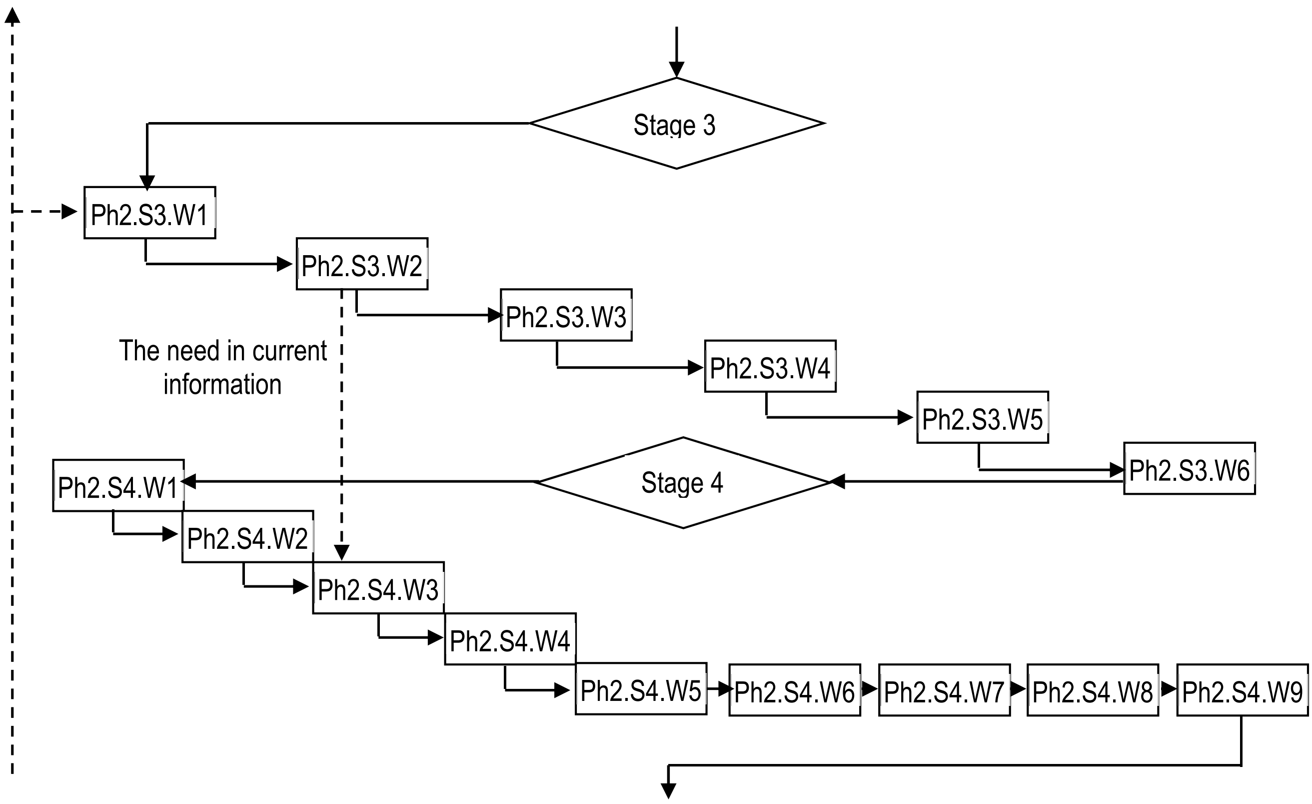

Figure 2 - (sheet 3)

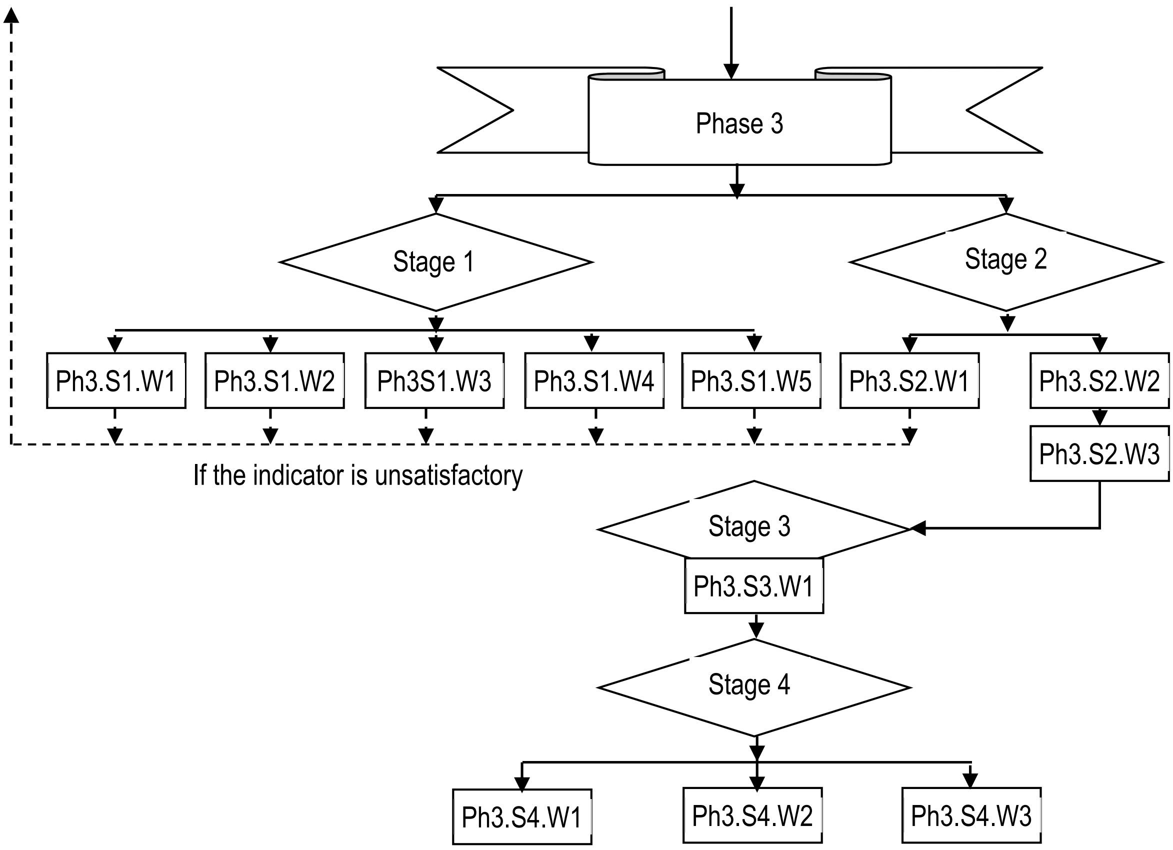

Figure 2 - (sheet 4)

Source: developed by the author.

In order to ensure the practical implementation of the proposed algorithm should provide a list and a brief description of the work to be performed within each stage of certain phases of design and implementation of the logistics system project for a functioning enterprise. A tabular form was also used in the study to describe the work planned to be performed during the design of the logistics system. The proposed table provides information of the following nature: code, title and content of the work (Table 2).

Table 2 - Description of the work content on the design and implementation of the LS project at the enterprise

Work code	The title of the work	The content of the work
1	2	3
Ph1.S1.W1	Analysis of suppliers and consumers, establishing the possibility of increasing their number	The market share for suppliers and consumers is determined; analysis of the potential of suppliers and consumers is performed; opportunities for their growth are forecasted; the degree of their loyalty to the enterprise and readiness for long-term cooperation is established
Ph1.S1.W2	Competitors analysis	The market share for competitors is determined; their strengths and weaknesses are assessed and potential opportunities in the use of logistics are identified; the implemented logistics technologies are analyzed; logistics partners and intermediaries are determined; competitors' logistics indicators are analyzed, if it possible
Ph1.S1.W3	Formulation of the purpose of creation of LS, formulation of the basic tasks LS	The economic system of the enterprise is analyzed; describes the logistics concept for the enterprise, on the basis of which the logistical purpose of creating a logistics system is formed, the main tasks for the logistics system are formulated
Ph1.S1.W4	Analysis of outsourcing opportunities	The logistic activities (LA) realized at the enterprise are allocated; the analysis of expediency of performance of LA directly at the enterprise is carried out; selection of LA which are economically expedient to carry out by forces and resources of the enterprise is carried out; LA are established, which should be performed through the use of logistics outsourcing; the market of outsourcing services is analyzed and possibilities of involvement of outsourcing for performance of previously allocated LA are established
Ph1.S2.W1	Analysis of the overall strategy of the enterprise	In terms of the overall strategy, an analysis of growth and support strategies is performed. Competitive advantages and opportunities of growth and support strategies are singled out
Ph1.S2.W2	Analysis of the resource potential of the enterprise	The resource potential of the enterprise is analyzed, first of all the financial and personnel possibilities concerning the organization and realization of certain logistic activities are analyzed
Ph1.S2.W3	Assessment of the existing logistics infrastructure of the enterprise	A detailed analysis of the main components of the enterprise infrastructure is performed. Namely, analyzes are performed: technical, technological, organizational and economic, in order to use them to perform certain logistics activities

Continuation of the table 2

1	2	3
Ph1.S2.W4	Determining the level of logistics costs for the company and justification of expediency of creating the LS	In the general expenses of the enterprise logistic expenses are allocated. Their correlation with the general expenses is established on the basis of which the substantiation of expediency of creation of logistic system at the enterprise is carried out
Ph1.S2.W5	Pre-selection of the type and kind of logistics system	Based on the analysis of the level of logistics integration of the functions performed at the enterprise, the appropriate level of logistics aggregation is established. Pre-selected for the organization logistics system with direct connections or tiered or flexible
Ph1.S2.W6	Determining the main limitation (determinants) on the functioning of the LS	Price and non-price determinants of the logistics system of the enterprise are determined
Ph2.S1.W1	Forecasting the development of the LS	The forecast of performance of concrete volume of works by logistic system of the enterprise for the future periods is carried out
Ph2.S1.W2	Determining the potential market boundary of the LS and transport network of customer service	The expedient sizes (geographical territory) of the logistic range where implementation of logistic activity of the enterprise is planned are established
Ph2.S1.W3	Determining the cost of the project and installation of the LS at the enterprise	An estimate is made for forecasting the logistics system and installing it at the enterprise
Ph2.S1.W4	Estimation of the expected effect of the LS	The effect of the functioning of the logistics system at the enterprise is predicted
Ph2.S1.W5	Evaluation of the feasibility of designing the LS	According to the forecasted indicators of functioning efficiency of logistic systems expediency of its designing for the future periods is established
Ph2.S2.W1	Allocation of a strategic set of logistics functions that are necessary to maintain the competitiveness of the enterprise	Selection of logistics functions and operations is performed. These are essential to maintain the competitiveness of the enterprise in the selected market segment
Ph2.S2.W2	Establishment (definition) of logistics functions that can be outsourced and which will be performed directly at the enterprise	The logistic activities which will be carried out directly at the expense of possibilities of the enterprise, and the logistical activities which can be transferred for performance to other organizations are defined
Ph2.S3.W1	Establishing the optimal structure of the LS of the enterprise: the choice of subsystems of the LS in accordance with the logistics purpose	On the basis of the selected logistic activities which will be carried out by the enterprise the necessary list of subsystems of logistic system is proved
Ph2.S3.W2	Formation of economic goals and objectives for each subsystem of the LS	Economic goals and objectives are formulated for each subsystem of the logistics system in accordance with the logistics purpose of the enterprise
Ph2.S3.W3	Determining the adequacy of the technical and technological base of each subsystem of the LS	The technical and technological base of the enterprise is analyzed and sufficiency of means for performance of the specific logistics subsystems defined by LA is established.

Continuation of the table 2

1	2	3
Ph2.S3.W4	Establish the required level of interconnection between subsystems and links of the LS	The level of interrelation (information, financial, organizational, technological) between subsystems and links of logistic system is established
Ph2.S3.W5	Information linking of the LS subsystems	The information linking of the subsystems of the logistics system between itself and between the services of the enterprise is formed
Ph2.S3.W6	Formation of the system of registration, accounting, analysis and control of logistics costs of the enterprise LS	Responsibility centers are organized. The system of registration, accounting, analysis and control of logistics costs of the enterprise through the centers of responsibility is being worked out
Ph2.S4.W1	Systematization of conditions, factors and parameters that determine the organizational management structure (OMS) of the enterprise LS	A matrix of conditions, factors and parameters is formed. These are crucial for building the organizational structure of management of the logistics system of the enterprise
Ph2.S4.W2	Choice of OMS type of the enterprise LS	The type of OMS for the enterprise LS is substantiated
Ph2.S4.W3	Formation of conditions for the OMS of the enterprise LS	Requirements to OMS of the enterprise LS concerning reliability of its functioning are formulated
Ph2.S4.W4	The choice of the OMS design model of the logistics system	The model of designing OMS of the enterprise LS is reasoned
Ph2.S4.W5	The choice of indicators for assessing the quality of OMS of the enterprise LS	Indicators of assessment of quality of functioning of OMS of the enterprise LS are substantiated
Ph2.S4.W6	Formation of a system of indicators for assessing the effectiveness of OMS of the LS	The system of indicators of an efficiency estimation of OMS of the enterprise LS is formed
Ph2.S4.W7	Estimation of OMS efficiency of the enterprise LS	A preliminary assessment of the OMS effectiveness of the enterprise LS is performed
Ph2.S4.W8	Assessment of the synergistic effect of the OMS implementation of the functioning enterprise LS	The synergistic effect of the OMS of the LS implementation at the enterprise is determined
Ph2.S4.W9	Working out of measures to ensure the economic security of the enterprise LS	Measures are being developed to ensure the economic security of the enterprise LS, taking into account the external environment and the position of the enterprise in a particular market segment
Ph3.S1.W1	Determining the sensitivity of the LS	The sensitivity index of the logistics system is determined. It is evaluated and analyzed
Ph3.S1.W2	Determining the degree of usefulness of the LS	The numerical value of the utility indicator of the LS is determined. It is evaluated and analyzed
Ph3.S1.W3	Determining the reliability of the LS	Reliability indicators of the LS are calculated. Their evaluation and analysis is carried out
Ph3.S1.W4	Evaluation of project effectiveness	The effect of the functioning of the LS is determined.
Ph3.S1.W5	Assessment of the economic security level of the enterprise LS	The level of economic security of the enterprise LS is determined
Ph3.S2.W1	Budgeting of the LS project	The budget for the project is drawn up taking into account the level of reliability and economic security of the LS
Ph3.S2.W2	Drawing up a plan for the implementation of the LS project	A detailed plan for the implementation of the LS project is being drawn up

The end of the table 2

1	2	3
Ph3.S2.W3	Scheduling the implementation of the LS project	The schedule of implementation of the LS project according to the established terms is made
Ph3.S3.W1	Launch of the LS project	Putting into operation of the LS project
Ph3.S4.W1	Installation of logistics information system (LIS)	Installation of LIS and its adjustment to the organizational structure of enterprise management
Ph3.S4.W2	Installation of a system of registration, accounting, analysis and control of logistics costs	Establishment of the system of registration, accounting, analysis and control of logistics costs and its adjustment to the general system of accounting of expenses of the enterprise
Ph3.S4.W3	Installation of the economic security system of functioning of the enterprise LS	Implementation of measures to organize the economic security of the enterprise LS in the general system of the enterprise

Source: compiled by the author.

Substantiation of decisions related to the use of the described algorithm for designing a logistics system, as well as the selection of the most efficient types of work at each stage can be performed with varying degrees of depth and detail. The latter is determined not only by the source information possessed by the designer and its reliability, but also by the knowledge of the project team (consultants, specialists of the enterprise) with the tools of the work and the availability of sources of project funding.

When developing projects, an important issue is the time spent on the planned work. Also, in order to focus on the time budget for the development of a logistics system project in the course of the study on the example of oil and fat industry enterprises were set (forecast) time that can be spent on the work at each stage. The results of this study are given in table. 3.

From the table 3 it follows that the process of designing and installing a logistics system can be carried out in an average of 143 days. Therefore, if a decision is made on the organization of the logistics system in the oil and fat industry, the top management should focus on a period of 3-4 months. This time can be reduced if some design work is done in parallel. However, this is decided purely in a particular case.

Presented in table 3 deadlines for the execution of works related to the design and installation of the logistics system are approximate. Their values may vary depending on the scale of production, enterprise structure, availability of information system and qualified specialists in the field of logistics. However, the value of such information is that thanks to it, the top management of the enterprise will focus on the productivity of the process of designing and installing a logistics system. In the future, this will provide an opportunity to correctly draw up a logistics plan and adjust the development strategy of the enterprise as a whole.

Conclusions. The author's approach to realization of development process of the logistic system project of the industrial enterprise and its practical realization is published in the article. This approach is formalized in the form of an eventual model of the algorithm for designing of the enterprise logistics system. According to the algorithm, the phases and stages of designing a logistics system are described; the types of work that must be performed within each stage are detailed.

The proposed algorithm for designing and implementing a logistics system of a manufacturing enterprise does not claim to be exhaustive of this scientific problem, although it may be a contribution to the formation and development of the methodological apparatus for designing logistics systems. In addition, the material presented in the article is useful for researchers in terms of further research to improve existing or developed new algorithms and techniques for designing logistics systems of industrial enterprises.

Table 3 - Estimated values of time for work related to the design and installation of the enterprise LS

Phase	Number and name of the stage	Work code	Time, days*
Phase 1	Stage 1. Analysis of the market situation	Ph1.S1.W1	4
		Ph1.S1.W2	6
		Ph1.S1.W3	1
		Ph1.S1.W4	3
	Stage 2. Research of the possibility of the LS creating	Ph1.S2.W1	3
		Ph1.S2.W2	5
		Ph1.S2.W3	3
		Ph1.S2.W4	6
		Ph1.S2.W5	2
		Ph1.S2.W6	3
Phase 2	Stage 1 Preliminary assessment of the main characteristics of the designed LS	Ph2.S1.W1	2
		Ph2.S1.W2	2
		Ph2.S1.W3	4
		Ph2.S1.W4	1
		Ph2.S1.W5	1
	Stage 2. Functional design of the LS	Ph2.S2.W1	2
		Ph2.S2.W2	3
	Stage 3. Elemental design (structuring) of the LS	Ph2.S3.W1	4
		Ph2.S3.W2	1
		Ph2.S3.W3	5
		Ph2.S3.W4	3
		Ph2.S3.W5	7
		Ph2.S3.W6	6
	Stage 4. Organizational design of the LS	Ph2.S4.W1	5
		Ph2.S4.W2	2
		Ph2.S4.W3	3
		Ph2.S4.W4	2
		Ph2.S4.W5	2
		Ph2.S4.W6	1
		Ph2.S4.W7	1
		Ph2.S4.W8	1
		Ph2.S4.W9	3
Phase 3	Stage 1. Identification of key indicators for the evaluation of the LS project	Ph3.S1.W1	3
		Ph3.S1.W2	
		Ph3.S1.W3	
		Ph3.S1.W4	
		Ph3.S1.W5	1
	Stage 2. Planning the implementation of the LS project	Ph3.S2.W1	5
		Ph3.S2.W2	3
		Ph3.S2.W3	2
	Stage 3. Direct implementation of the LS project	Ph3.S3.W1	14
	Stage 4. Installation of auxiliary subsystems of the enterprise LS	Ph3.S4.W1	7
		Ph3.S4.W2	4
		Ph3.S4.W3	4

*Note. *) Average value.*
Source: compiled by the author.

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EVENTS AND SCIENTIFIC CONFERENCES

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THE SCIENTIFIC CONFERENCE'S RESULTS: LOGISTIC VIEW "Mathematical modeling, optimization and information technology"

The economic consequences of the global COVID-19 pandemic have come as a shock to global and national economies, and its effects will be felt for a long time for different spheres. Quarantine restrictions have been added to traditional uncertainties such as changes in consumer demand and market conditions, reciprocal trade restrictions and climate change, which together increase logistics risks and complicate the management of the global supply chain, reduce it resilience and change its configuration.

Instability, complexity and uncertainty in the management of logistics systems and global supply chains raise the issue of finding new approaches to optimizing both individual logistics business processes and complex transport and logistics systems and networks of trade. One of the effective optimization tools is to use big data on the current state of objects and mathematical modeling, because they can be used to describe and optimize any business processes that depend on many variables. This is especially true in the field of logistics, as any logistics company currently operates a variety of information and communication technologies, including TMS (transport management systems), WMS (warehouse management systems), YMS (territorial management systems), CRM (customer relationship management system), ERP (enterprise resource management systems), etc. Thus, the combination of existing information infrastructure, databases and mathematical models can be a new source of improving the efficiency of supply chain management and logistics systems in general.

In this regard, we would like to draw the attention of the logistics business community to the results of the 7th International Scientific Conference "**Mathematical Modeling, Optimization and Information Technology**", which took place from 15th to 19th of November, 2021 in online format. The event was part of the project CPEA-LT-2016/10003, funded by the Norwegian Agency for International Cooperation and Quality Improvement in Higher Education (DIKU). The conference was organized by the participants of the project: Transports, Informatics and Communications Academy of the Republic of Moldova, V.M. Glushkov Institute of Cybernetics of National Academy of Sciences of Ukraine, Moldova State University, Taras Shevchenko National University of Kyiv (Ukraine), Norwegian University of Science and Technology (Trondheim, Norway), Batumi Shota Rustaveli State University (Georgia), Ivan Javashi Tbilisi State University (Georgia), International Institute for Applied Systems Analysis (IIASA, Austria), Applied Systems Analysis National Academy of Sciences of Ukraine.

The conference was attended by researchers and scholars from academic institutes and universities of Ukraine (52), Moldova (13), Georgia (8), Austria (2), Norway (1), Azerbaijan (2) and other countries.

The purpose of this scientific event is connected to the project CPEA-LT-2016/10003 objectives and was to create a discussion around the theoretical and empirical problems of modeling complex systems, solving various optimization issues and active development of modern information technology; establishing scientific communications between young researchers specializing in systems analysis, risk management and modeling. The leitmotif of the conference was the use of innovative technologies in science, education and industry.

During the five busy days, were held 5 plenary sessions and 12 sectional meetings in the following areas:

– Modeling of transport systems and logistics,

– Optimization methods, stochastic processes and optimal management,

– Economic and mathematical models and methods

– Information technologies and software systems

– Innovative technologies and risk management in the industry, transport and services in the face of modern challenges

80 reports were heard, representing scientific schools of Moldova (13), Ukraine (52), Russia (2), Georgia (8), Azerbaijan (2), Austria (2), Norway (1).

Based on the results of the meetings and discussions, we would like to draw special attention to the possibilities of using the work of leading scientists to solve practical logistics problems.

1. 1. In the Stetsyuk P.I., Nurieva U.G., Nurieva F.U. report was presented a new model of integer linear programming for the travelling salesman problem, which combines the constraints of two classical problems in order to avoid breaks in the Hamiltonian cycle. The presented model can have wide practical application for the decision of extremely actual logistical problem of "last mile". It is well known that optimizing the final link of goods delivery directly to the consumer is quite difficult, because you need to take into account many factors: the exact place and time of delivery, traffic, special conditions of a particular order and others. The proposed mathematical model and the method of its solution allow to take into account many delivery conditions and choose the best route.

2. Interesting approaches to solving complex transport problems were presented in the report of Kozin I.V., Zemlyansky A.A. on the topic "Hybrid metaheuristics in the search for optimal routes". The authors proved that almost all problems related to the building of optimal routes on the graph can be formulated as optimization problems on a fragmentary structure. Such tasks include options for travelling salesman, road inspection, village postman and more. To find suboptimal solutions on a fragmentary structure (set of subsets of a finite set), scientists used hybrid algorithms representing combinations of known metaheuristics (in particular, the simulated annealing method, the evolutionary algorithm, the mixed jump frogs' algorithm) and a fragmentary algorithm.

3. Two- and multi-stage transport problems attract the attention of scientists. In particular, the report of P.I. Stetsyuk and V. Stovba proposed two modifications of the classic two-stage transport problem, provided that the number of intermediate points is given and their capacity is limited at the bottom and top. The first modification can be used in the distribution and delivery of grown products for sale or processing at the own facilities of agricultural enterprises. The second modification is relevant for finding a rational location of a given number of warehouses, taking into account the specific location of suppliers and recipients of technical resources. It can be used to determine the appropriate locations in the unified energy system of Ukraine of electricity storage and their energy consumption. D.I.

Solomon presented various modifications of multi-stage transport tasks that are widely used in various areas of the agro-industrial sector.

4. Another urgent problem in logistics is the packaging processes' optimization. In this context, the report of T. Romanova from the Institute for Mechanical Engineering Problems of the National Academy of Sciences of Ukraine on the topic "The sparse packing and its application" is of interest. This problem is motivated by the thermal energy method applied for cleaning complex shaped parts (objects) obtained by additive technologies (3D printing) from particles of non-sintered powder. The sparse packing is aimed at place the objects as distant as possible, freely sliding and rotating on the horizontal shelves of the cylindrical container subject to balancing conditions. A corresponding nonlinear programming model is derived, using the phi-function technique.

5. Inventory management is a traditional problem in logistics. Despite the large number of existing formulations of these problems and methods of solving them, the Institute of Cybernetics has developed a new method, which was presented in the report of M.S. Dunaevsky "Optimal inventory management in the condition of uncertainty". The author proposed to compare two inventory management strategies - maximization of demand fulfillment and maximization of profitability. The optimal level of inventory, determined on the basis of deficit and excess costs, is a great profitable alternative for a small company that does not require a high speed of demand or simply conducts its trading business over the Internet and does not need to be widespread.

More detailed information about the work of the conference MMOIT-2021 is presented on V.M. Glushkov Institute of Cybernetics of National Academy of Sciences of Ukraine website in "Events" section, which contains the program and materials of the conference http://new.incyb.kiev.ua/podrzdeleniya/viddilennya-matematichnoi-kibernetiki-ta-sistemnogo-analizu/viddil-metodiv-negladkoyi-optimizaciyi/konferenciya-mmoti-2021?show=1

During the numerous discussions, the conference participants paid considerable attention to the possibilities of using the presented scientific developments in real sectors of the economy, in particular, transport, logistics and energy. That is why it was decided to hold a separate scientific-practical conference "Modeling of transport systems and logistics", which will be held in March, 2022. We invite everyone to join this event and present the results of their research to a wide range of scientists and practitioners.

Chairman of the conference organizing committee,
Doctor of Technical Sciences, **D.I. Solomon**,
Co-Chairman of the conference organizing committee,
Doctor of Physical and Mathematical Sciences, **P.I. Stetsiuk**,
Member of the conference program committee,
Doctor of Economics, **M.Yu. Hryhorak**

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