TRANSPORT&LOGISTIC SYSTEMS IN THE SMART CITY CONCEPT

Topicality. The impact of a number of factors on climate change can be defined as twofold. Firstly, by reducing the number of pollutants responsible for global warming, and secondly, by increasing the resilience of systems (economic, environmental, social) to the vulnerability of these factors. A huge number of scientific and professional developments,
strategic documents, programmes and implementation plans are devoted to these issues. Nevertheless, a tangible effect of mitigating the impact of negative environmental factors, of which transport and logistics systems (TLS) play a leading role, including TLS of urban areas, can only be achieved through an integrated approach, combining the cooperation of various stakeholders with different public interests and goals.

**Aim and tasks.** The purpose of the study is to establish priorities and directions for the formation of new types of transport and logistics systems in the concept of a smart city

**Materials and Methods.** To carry out the research, the method of processing documented data from primary sources was used – scientific publications, expert opinions, documents of municipal authorities on this issue.

**Research results.** The peculiarity of the concept of sustainable development lies in the contradiction of its defining postulates to traditional economic mechanisms of unlimited economic growth, maximum state regulation, and profit-making by any means, without coordinating their strategies with the needs of the environment that these urban agglomerations use. It is worth noting that the vast majority of scholars and decision-makers on urban development strategies adhere to the concept of a "smart" city in terms of its intellectual provision with technologies, use algorithms, advanced digital infrastructure, etc. The economic sustainability of the transport system should aim to plan transport projects, resource consumption, etc. in a way that promotes economic growth in the long term, as the increase in the number of smart cities, as a resource-intensive and time-consuming process, is one of the mechanisms for accelerating the modernisation of the national economy as a whole. The concept of expanding the area of smart cities contributes to the expansion of domestic consumption in the region, modernisation of industry, and coordination of economic and social activities between regions.

**Conclusion.** Taking as a basis the principles of sustainable development of transport and logistics systems of cities on the basis of the introduction of green logistics can reduce numerous environmental problems that have become a consequence of industrial modernization and globalization, and ensure the reduction of external environmental effects by balancing environmental, social and economic goals by transport and logistics enterprises.

**Keywords:** greening of transport systems, logistics processes, environmental protection, sustainable development, smart cities.

Problem statement and its connection with important scientific and practical tasks. The greening of urban transport and logistics systems has been developing intensively around the world in recent years (Burkynskyi et al., 2020); (Potapenko, 2013). This development implies the availability and use of certain capabilities: - Sensor technologies (surveillance cameras, radio frequency and laser sensing, visualisation technologies and means of their interaction) - control systems using advanced sensing technologies to promote autonomy: - availability of computers with enhanced computing capabilities for processing large amounts of data, advanced analytics for big data, which involves real-time decision-making; - communication technologies, including mobile network technologies with widespread use of devices that allow for more flexible personal travel routes.

An important contribution to the fight against climate change is being made by cities that are reorienting themselves to using environmental protection measures as part of the concept of sustainable growth to counteract the ever-increasing population and the burden of fossil energy sources. The possibility of further development in this direction is determined by the coordination of various layers of the urban community - science, industry, transport, decision-makers at all levels, and citizens. The collaboration of all participants should facilitate and support the construction of an inclusive, safe, resilient and sustainable city, which is a new challenge for society in the coming years, as it involves the high-density coexistence of a large number of people in a limited space, with certain new opportunities and tensions.

Citizens, industry, policy makers and society must work together to create a human-centred ecosystem in which physical and cyberspace systems are interconnected to enable social, economic, political and environmental change.

In 2015, 17 Sustainable Development Goals (SDGs) were developed by the United Nations Member States to build a better and more sustainable future for all, where all targets are set in a global context, with profound implications for the population, the increasing pace of technological and societal change, work and travel styles, and the development of urban agglomerations that form "high impact" areas (Kiran Fernandes, 2022); (Luisa Sturiale et al., 2023).

The set goals and tasks for their implementation are prioritised in many strategic documents of the international community - "Transforming our world: The 2030 Agenda for Sustainable Development". The 2030 Agenda sets out 17 Sustainable Development Goals (SDGs) and 169 targets to be achieved over the next 15 years. Goal 11, "Sustainable Cities and Communities," is directly related to urban systems and aims to "make cities and human settlements inclusive, safe, resilient and sustainable” (United Nations. Transforming our World, 2015).

The population orientated of proactive planning
of transport and logistics systems should be a priority in the development of urban agglomerations based on sustainability, where this approach is recognised as central and should be an integrating centre of economic, social and cultural life.

Despite the popularity of the idea of organising transport and logistics systems on the basis of sustainability, which is implied by the very idea of a smart city, there is still no generally accepted definition of a smart city. The purpose of this article is not to form a conceptual and categorical basis for the definition of a smart city and the components that ensure its status. However, the research idea will be based on the concept of a smart city as a human-centred ecosystem where physical and cyberspace systems are interconnected to achieve social, economic, political and environmental change, where smart city services (e.g., interaction between citizens and service systems) are the result, not the main offer of a smart city (Luisa Sturiale et al., 2023).

Analysis of recent publications on the problem. Many scientific papers have been devoted to the problems of orientation towards green growth in all sectors of the national economy. By choosing a "green" course for their economies, the European and global community has formed the leading scientific opinion in this area. Let's identify the most important of them: J. Levine, J. Grengs, L. Merlin (Levine et al., 2019), H. Vajjarapu, A. Verma, H. Allirani (Vajjarapu et al., 2020); A. Scuderi, L. Sturiale (Scuderi, A., Sturiale, L., 2019); V. Torrisi, M. Ignaccolo, G. Inturri (Torrisi et al., 2018); N. Afrin, N. Yodo (Afrin & Yodo, 2020); L.A.P. Gonçalves, P.J.C. Ribeiro (Gonçalves & Ribeiro, 2020); C. Wan, Z. Yang, D. Zhang, X. Yan, S. Fan (Wan et al., 2018); P. Apparicio, J. Gelb, M. Carrier, M.-E. Mathieu; S. Kingham (Apparicio et al., 2018); N.B. Aleta, C.M. Alonso, R.M.A. Ruiz (Aleta et al., 2017); M. Asghari, S.M.J. Mirzapour (Asghari et al., 2021); A. Lagorio, R. Pinto, R. Golini (Lagorio et al., 2017); R.A. Mello Bandeira, G.V. Goes, D.N. Schmitz Gonçalves, M. Almedia D’Agosto, C. M. D. Oliveira (Mello Bandeira et al., 2019). As the analysis of research results shows, there is a certain lack of scientific views on the participation of "green" transport in the formation of smart cities, especially with a quantitative determination of the benefits of such transport systems in the formation of a sustainable urban environment.

Unfortunately, the problems of environmental protection in the transport of Ukrainian cities in terms of the environmental and economic justification of the functioning of urban transport and logistics systems have received very little attention from domestic scholars, although it is advisable to develop this topic in order to transition to qualitatively new living conditions for Ukrainians in the post-war period. Among the works closest to this topic are the following Yu.F. Gutarevych (Gutarevych, 2002), D.V. Zerkalov, A.G. Govorun, A.O. Korpach; T.M. Mughanovoa (Mughanovoa, 2017); K.V. Gnedina (Gnedina, 2013); I.E. Linnik (Linnik, 2014) and others. Nevertheless, there is a need for a thorough study of the city's transport and logistics systems, based on the needs of forming the eco-space of cities, where the transport and logistics system of freight transportation is most responsible.

Allocation of previously unsolved parts of the general problem. Since urban agglomerations are nowadays the centre of economic and social activity, where transport operations are extremely important in meeting the needs of the population and the national economy, a large number of scientists and specialists are researching issues related to the problems of creating a comfortable environment to improve the quality of life in these cities, focusing on the sustainability of transport and logistics systems, where transport services facilitate the movement of people, provide social and cultural interaction in a way that involves the use of eco-friendly technologies.

The development of cities based on the use of smart approaches involves the reorientation of the entire transport and logistics system, along with manufacturing industries, to the principles of eco-orientation, as transport is a leading factor in the economic growth of cities, regions, and the national economy. At the same time, it is the most vulnerable factor in optimising energy use, population mobility, and ensuring the sustainability of production, service, mining, and other systems. The study of the problems of smart cities development always involves the need to take into account the configuration and principles of functioning of their transport and logistics systems. However, this area of research is mostly focused on the problems of cities as eco-environments, which are formed on the basis of the exponential use of digital technologies in all areas of city functioning without paying due attention to environmental protection measures in transport in terms of its use by citizens for their own needs and in support of economic, social and other activities of the city. The lack of analysis and scientific substantiation of approaches to the development of transport and logistics systems in smart cities slows down the processes of "green"
growth of these systems, the implementation of the Sustainable Development Goals, and also hinders the formation of the smart city concept in Ukraine.

Formulation of research objectives (problem statement). Based on the above, the article aims at considering the conceptual aspects of the development of transport and logistics systems of smart cities based on the principles of "green" growth. The main focus of the study is on the peculiarities of the functioning of transport and logistics systems based on green growth, which are located in cities whose basic principles of operation can be defined as smart.

The main problem of the study is to determine the main directions of organising a transport and logistics system in a smart city and to identify obstacles on this way. This task should be investigated by conducting content analysis, forming theoretically sound approaches and answering the following questions:

- what is a smart city – theoretical and applied approach;
- what configuration of transport and logistics systems is appropriate;
- the importance of public transport in the development of smart cities and the potential for its use.

Materials and Methods. The purpose of the study required a basic review of professional literature and scientific articles with a theoretical basis on the formation of smart cities and the contribution of the transport component to its development. To ensure this part of the study, the method of processing documented data from primary sources - scientific publications, professional opinions, and documents of municipal authorities on this issue – was used.

An outline of the main results and their justification. According to the UN, cities generate more than 80% of the economic benefits that contribute to the quality of life of the population. At the same time, and thanks to these processes, they produce more than 70% of greenhouse gas emissions. The exponential increase in urbanisation, with more than 50% of the world's population already living in urban areas, creates sustainable problems of organising living space for so many people concentrated in small areas alongside production, social and extractive infrastructure (United Nations, 2015).

Road transport generates 18% of global emissions, 60% of which are from private vehicles and half of which are from urban transport. The very interpretation of the concept of a "smart" city has evolved from being understood as an "intelligent" city, with the acquisition and dissemination of digital infrastructure and a number of technologies for providing timely and efficient services (with the most comprehensive use of artificial intelligence in all spheres of life), to a "green" city, as a concept of transition to qualitatively new tools and mechanisms for the existence of urban agglomeration residents, in accordance with the requirements set out by the sustainable development goals for the near future.

In general, when drawing up plans for the development of a smart city, the issues of forming transport and logistics systems that would meet the needs and principles of functioning of such cities are extremely complex, which involves taking into account the needs of the population, including technical, technological, economic and environmental characteristics of means of transport and cargo, and routing their movement in the most environmentally and economically feasible way. Any changes are costly and time-consuming, and their management must meet the needs of the parties involved. A smart sustainable city is, first and foremost, an innovative city that uses information and communication technologies and other means to improve the quality of life, efficiency of urban activities, and competitiveness, ensuring that the needs of today's and future generations are met in economic, social, environmental, and cultural terms.

The list of issues of transport and logistics systems research should include – passenger traffic flows (public, private); – freight transport, which ensures the functioning of all sectors (production, service, processing) of the city, whose problems are still complex and diverse and are related to economic, financial, environmental and social issues.

The peculiarity of the concept of sustainable development lies in the contradiction of its defining postulates to traditional economic mechanisms of unlimited economic growth, maximum state regulation, and profit-making by any means, without coordinating their strategies with the needs of the environment that these urban agglomerations use. It is worth noting that the vast majority of scholars and decision-makers on urban development strategies adhere to the concept of a "smart" city in terms of its intellectual provision with technologies, use algorithms, advanced digital infrastructure, etc. However, the perception of a smart city as a green city, with all the inherent features of a city with an environmental system-forming framework, remains beyond the reach of researchers, professionals, and government officials.

Despite the interest in the smart city concept, as
can be seen in Fig. 1, where a sharp increase in interest has been observed especially in recent years, Fig. 2 demonstrates the complete lack of scientific research into the economic problems of building transport and logistics systems that operate in smart cities and form their environment.

**Fig. 1.** Number of papers in the field of smart city research since 1995

*Source: Asghari, Mirzapour Alehashem S.M.J., 2021*

![Fig. 1](image1.png)

**Fig. 2.** The sciences within which the problems of smart cities have been studied

*Source: Asghari, Mirzapour Alehashem S.M.J., 2021*

![Fig. 2](image2.png)

The greatest interest in the development of smart cities, primarily in terms of its transport and logistics component, is observed in engineering, computer science, and social sciences. Unfortunately, there are currently no issues related to the economics of transport and logistics systems, although the implementation of a smart city strategy in Ukraine, focused on the needs of the population, requires transport planning, including public transport (primarily electric), which should play an integrating role in urban development and in the overall sustainable development of the state. Creating a smart city development strategy is a key factor in Ukraine’s transition to sustainable development principles, as it is virtually impossible to achieve these goals without
localising them at the local level. Therefore, the system of smart cities in Ukraine should become the dominant form of organisation of living space as the centre of economic, social, and cultural life of citizens.

Such a set of capabilities, primarily technological, makes it possible to build intelligent urban transport systems, which are mostly inherent only in highly urbanised and developed countries with a high level of mobile connectivity. Although the leading technologies used in transport and logistics flows are very common in all cities around the world, modern sensor devices and their integration into the vehicle-to-vehicle and vehicle-to-infrastructure systems are limited to use only in countries with a strong research and development sector in this area, which enables them to develop smart cities with existing smart transport. At the same time, attention should be focused on the financial, service and information flows that form, initiate and support material flows, contribute to the growth of their consumer value and provide information services.

The application of such an approach in the post-war reconstruction of Ukrainian cities, the gradual development of smart cities on the basis of sustainable development, is possible and appropriate in many areas, which can only be implemented on the basis of scientifically sound approaches, appropriate investment and political will of decision-makers in this area.

Transport infrastructure is an important component of the transport system. Its importance is increasing in the area of monitoring and control, where innovative, so-called "smart" technologies are being introduced to improve its functions, primarily for traffic management, weight registration of heavy vehicles, and toll collection (Burkynskyi, 2020). These capabilities reduce travel time by optimising traffic, reducing fuel consumption and greenhouse gas emissions, and reducing driver stress by sensing and collecting information on congestion, traffic restrictions, and parking availability.

The set of transport operations and the relevant infrastructure that ensures the implementation of these operations on a sustainable basis is a challenge for authorities at all levels, from the political will to implement them to certain programmes and algorithms for implementing large urban projects and coordinating them. The reason is insufficient intellectual, technical and technological potential, lack of sufficient funding for innovative ideas, planning and forecasting of development prospects in this area (Potapenko, 2013).

In order to operate and plan the development of urban transport and technology systems on the basis of sustainability, it is essential to take into account the three aspects of this three-dimensional concept – economic, environmental and social sustainability (Kiran, Yu Xiong, 2022, Levine, Grengs, 2019).

To be environmentally sustainable, transport should not endanger public health and ecosystems. Since the main problem in transport is emissions, which are directly related to the use of fossil fuels in internal combustion engines of vehicles, measures aimed at ensuring environmental sustainability should include

1. controlling emissions by raising emission standards through: – the use of alternative fuels in internal combustion engines and – technological modernisation and renewal of internal combustion engines themselves;
2. designing vehicle engines to support electric vehicles or hybrids; and
3. promoting environmentally friendly travel by improving driving skills or using environmentally friendly modes of transport.

The economic sustainability of the transport system should aim to plan transport projects, resource consumption, etc. in a way that promotes economic growth in the long term, as the increase in the number of smart cities, as a resource-intensive and time-consuming process, is one of the mechanisms for accelerating the modernisation of the national economy as a whole. The concept of expanding the area of smart cities contributes to the expansion of domestic consumption in the region, the modernisation of industry, and the coordination of economic and social activities between regions.

The social sustainability of urban transport should include ensuring an appropriate, equitable distribution of transport services and a reasonable cost structure among different segments of the population in order to achieve community cohesion and improve the quality of life. There is often a divide between drivers and non-drivers due to accessibility factors, between road users and nonroad users (e.g. residents) in terms of the environment, and between mobile and disabled people in terms of modes of transport.

But social equity can hardly be achieved through the development of urban transport alone. Economic growth rates, population demographics, political climate and other aspects such as the availability and spatial location of housing, employment opportunities, healthcare and education all contribute to a just society. However, as transport in general affects all sectors of society,
transport policies that are designed without considering the impact on the city's community are likely to become socially unsustainable at some point in time.

Many cities around the world have already moved to a smart growth strategy, and there are some positive examples of cities that have managed to overcome the problems of environmental, economic and social sustainability in the field of transport. It is important to formulate programmes both at the level of ideas and at the level of implementation, which will include – strategies for investing in public transport systems; – integration into land use plans to ensure a high level of public transport accessibility; – bridging the gap between intentions and actual technology implementation.

The implementation of the concept of transport and logistics support for a smart city should be based on certain key approaches:

- consideration of a unified approach and its reasonable application to information infrastructure and public transport infrastructure (e.g., transport resource management, dynamic monitoring of its environmental impact, waste classification and disposal, etc);
- work on building community unity for environmental protection and low-carbon lifestyles;
- preliminary public ideological foundations should use a transparent, fair and inclusive mechanism to stimulate these processes;
- providing equal access to all transport and logistics services, as well as to public transport;
- introducing modernisation of the entire management system of the city's transport and logistics system with increased public participation;
- support for innovation in business models of transport and logistics projects;
- ensuring transparency and the exercise of the rights of all stakeholders in the operation of the city's transport and logistics systems.

The city is also a conglomeration and accumulation of time in spatial terms as a means for us to pass on both material and spiritual civilisations from one generation to the next. Building smart cities is a never-ending project whose long-term variables include technical innovation, governance challenges, and changing demands. Building smart cities will by no means follow a single path. Likewise, there is no one-size-fits-all panacea that will cure all ills in smart city building. From the perspective of long-term sustainable development and city prosperity, "smartness" is the future, as well as the sharing and updating of knowledge across generations and the evolution of civilisation (The Commercial Press China, 2016).

Conclusions and perspectives of further research. The principles of sustainable development of urban transport and logistics systems based on the introduction of green logistics can reduce numerous environmental problems that have resulted from industrial modernisation and globalisation and ensure the reduction of external environmental effects by balancing environmental, social and economic goals by transport and logistics enterprises (Peng, Lin., 2008).

Based on the understanding of the urban transport and logistics system as a system that ensures mobile, stable, livable cities by supplying the necessary goods for the city's life, as well as minimising the negative impact on the environment, safety and energy consumption by the city's production, service sectors and population, the general concept of urban transport and logistics systems should be supported by social values and include the global competitiveness of the urban agglomeration, efficiency and a favourable environment. Taking these conditions into account will ensure increased mobility of cities, their sustainability and suitability for a quality of life.

Taking into account the factor of economic globalisation, which intensifies the international division of labour and increases the flow of goods between countries, should include the processes of forming cargo flows, their promotion, optimisation, and environmental protection measures at the level of urban agglomerations. Meeting these requirements requires additional research, which should primarily be aimed at establishing a link between the performance of local transport and logistics systems in terms of meeting domestic and international environmental requirements in the most acceptable and economically feasible way and indicators that characterise the level of economic development of the city, region and country as a whole. Such an approach will ensure the gradual systematic implementation of the concept of building transport and logistics systems of a smart city on the basis of environmentally friendly development.
REFERENCES


