INNOVATIVE TECHNOLOGIES OF THE TRANSPORT SECTOR IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Abstract

The author explores innovative technologies in the transport sector and their impact on the achievement of sustainable development goals. The benefits and challenges of the introduction of electric vehicles, hybrid vehicles, intelligent transport systems and the use of alternative fuels are discussed. Electric and hybrid vehicles help to reduce greenhouse gas emissions and improve the energy efficiency of transport, which improves the quality of life of the population. Intelligent transport systems improve transport safety and efficiency by reducing congestion and optimising traffic flows. At the same time, high technology costs and insufficiently developed charging infrastructure for electric vehicles remain major challenges. The article offers recommendations for further development and implementation of these innovations to ensure a sustainable future.

Keywords: transportation infrastructure, sustainable development, innovative technologies, electric vehicles, intelligent transportation systems, alternative fuels, public transport

INNOWACYJNE TECHNOLOGIE SEKTORA TRANSPORTOWEGO W KONTEKŚCIE ZRÓWNOWAŻONEGO ROZWOJU

Streszczenie

Autor bada innowacyjne technologie w sektorze transportu i ich wpływ na osiągnięcie celów zrównoważonego rozwoju. Omówiono korzyści i wyzwania związane z wprowadzeniem pojazdów elektrycznych, pojazdów hybrydowych, inteligentnych systemów transportowych i wykorzystaniem paliw alternatywnych. Pojazdy elektryczne i hybrydowe pomagają zmniejszyć emisję gazów cieplarnianych i poprawić efektywność energetyczną transportu, co poprawia jakość życia ludności. Inteligentne systemy transportowe poprawiają bezpieczeństwo i wydajność transportu poprzez zmniejszenie zatorów i optymalizację przepływów ruchu. Jednocześnie wysokie koszty technologii i niewystarczająco rozwinięta

infrastruktura ładowania pojazdów elektrycznych pozostają głównymi wyzwaniami. Artykuł zawiera zalecenia dotyczące dalszego rozwoju i wdrażania tych innowacji w celu zapewnienia zrównoważonej przyszłości.

Słowa kluczowe: infrastruktura transportowa, zrównoważony rozwój, innowacyjne technologie, pojazdy elektryczne, inteligentne systemy transportowe, paliwa alternatywne, transport publiczny

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Introduction

The transport sector plays a key role in the development of modern society, ensuring the mobility of the population and goods, which is an integral component of economic growth. At the same time, transport is one of the main sources of emissions of greenhouse gases, pollutants and noise, which negatively affects the environment and people's health. In view of this, the introduction of innovative technologies in the transport sector is a necessary condition for securing sustainable development. In today's world, issues of sustainable development are becoming ever more urgent. According to the Intergovernmental Panel on Climate Change (IPCC), the transport sector is responsible for about 14% of global greenhouse gas emissions [IPCC].

Sustainable development involves a balance between economic growth, social welfare and environmental protection. The introduction of innovative technologies can significantly reduce the negative impact of transport on the environment. Thus, research into innovative technologies in the transport sector is an important task for achieving the goals of sustainable development and ensuring a sustainable future for next generations.

Recent years have been characterized by rapid development of innovative technologies in the transport sector. These technologies are aimed at reducing the impact of transport on the environment and increasing the efficiency of transportation. The scientific works of many researchers are devoted to the problematic issue of evaluating innovative technologies

in the transport sector and, accordingly, their impact on achieving the goals of sustainable development.

In the study [Yakymchuk et al., 2022], the authors conducted an analysis of the current state of the transport system in Ukraine, its production activity and prospects for the introduction of innovative technologies into the national transport system. The work proposes a set of measures for economic stimulation of the transport system, analyzes the state of the transport infrastructure of Ukraine and reveals the possibilities of implementing transport innovations that have been successfully applied in the countries of the European Union.

In their work [Ahn and Park, 2022)], the authors conducted a study devoted to user acceptance of the concept of sustainable transport, in response to the growing global interest in environmental issues and the importance of sustainable development. They proposed an integrated model that combines two theoretical frameworks: the theory of diffusion of innovations and the model of technology adoption. The results of the structural analysis revealed a consistent relationship between users' intention to use sustainable transport and the two main determinants of this intention – perceived usefulness and attitude.

In work [Geerlings, 1996)], the authors study the topic of technological changes in the transport sector in order to achieve long-term goals of sustainable development. They analyze how technological change can be stimulated to reduce the environmental impact of transport. The article examines the dynamics of technologies and sustainable development, emphasizing the need for additional theoretical knowledge in this context. Special attention is paid to cooperation strategies between the government and companies, as well as the role of the state in implementing new tools.

In the article (Goldman and Gorham, 2006), the authors explore the concept and implementation of sustainable transport, focusing on the efforts to define and practically apply this concept in an urban context. They see sustainable transport as a political strategy and as an ultimate policy goal, emphasizing the importance of considering the larger systems in which transport activities are embedded. The study singles out four main areas of innovation in the field of transport: new mobility, urban logistics, intelligent system management and survivability.

In the article (Kuzior and Staszek, 2021), the authors compare road transport with rail transport, presenting the issues in the context of corporate social responsibility, energy efficiency and sustainable development.

In today's world, environmental problems and the need for sustainable development are becoming increasingly urgent. Various aspects of the implementation of innovative technologies and strategies for achieving the goals of sustainable development

in the transport sector are considered in the research. This includes an analysis of the current state of the transport system, the prospects for the introduction of new technologies, as well as the role of the government and business in these processes. Special attention is paid to the study of user acceptance of sustainable transport, the integration of environmental knowledge and perceived usefulness, as well as the need for a systemic approach to the implementation of transport innovations.

The purpose of this study is to assess innovative technologies in the transport sector and their impact on achieving the goals of sustainable development.

Thematic analysis

Innovative technologies in the transport sector are crucial to reducing the negative impact of transport on the environment, increasing transport efficiency and improving road safety. We will consider the main innovative technologies used in the transport sector.

Electric and hybrid vehicles play a key role in sustainable development by reducing greenhouse gas emissions and air pollution. The introduction of these vehicles also reduces noise pollution, improving the quality of life in urban areas. In addition, the development of infrastructure for charging electric vehicles stimulates innovation and creates new jobs, contributing to economic growth (Electric Vehicles (EVs) / Sustainable Development Goals: RELS Group).

Electric vehicles have advantages such as environmental friendliness, the absence of exhaust gases and high energy efficiency, which cuts fuel costs. They also operate more quietly, reducing noise pollution in cities. However, electric vehicles face challenges, including limited range and insufficient charging infrastructure.

Intelligent Transportation Systems (ITS) integrate information and communication technologies to improve transportation management and increase the efficiency of road infrastructure. ITS includes traffic management systems, traffic monitoring, electronic platforms for fare payment and the use of Big Data to analyze and predict traffic flows (Zhao et al., 2021). They contribute to reducing traffic jams, improving road safety and reducing the negative impact of transport on the environment.

The benefits of ITS include optimizing traffic flows, improving road safety through timely information on accidents and road conditions, and reducing emissions through more efficient use of infrastructure.

ITS challenges include the high cost of implementing and maintaining systems, the need to modernize existing infrastructure, and potential data privacy and security issues. In addition,

successful implementation of ITS requires coordination between various authorities and private companies, which can be a challenging task.

Alternative fuels, such as biofuels, hydrogen, and natural gas, are progressively gaining popularity in the transportation sector (Bhan et al, 2020). Biofuels are made from renewable sources such as plants and waste, which helps reduce greenhouse gas emissions. Hydrogen is used in fuel cells to generate electricity that powers vehicles. Natural gas is less polluting than traditional fuels and can be used as a temporary solution on the way to full decarbonization of transport.

Public transport, such as electric buses and trams, is also an important component of a sustainable transport sector. Electric buses do not emit pollutants into the atmosphere and work more quietly than their diesel counterparts. The implementation of such technologies in urban transport helps reduce the level of air pollution and improve the quality of life in cities.

The economic feasibility of the introduction of innovative technologies in the transport sector includes a significant reduction of operating costs, in particular fuel and maintenance costs. Electric and hybrid cars use less or no traditional fuel, which saves money. Intelligent transport systems increase the efficiency of transportation by reducing the number of traffic jams and optimizing traffic flows, which also helps to diminish logistics costs. In addition, investments in these technologies stimulate economic growth by creating new jobs and developing new industries.

Ecological expediency involves a significant reduction of emissions of greenhouse gases and other pollutants, which has a positive effect on the environment and the health of the population. The introduction of electric cars, hybrid cars and intelligent transport systems helps to improve air quality and lessen the level of noise pollution. This, in turn, leads to lower health care costs, as fewer people suffer from air pollution-related illnesses. In general, innovative technologies in the transport sector are both economically beneficial and environmentally necessary achievements of sustainable development.

Conclusion

In order to successfully implement innovations in the transport sector, it is necessary to develop the infrastructure for charging electric vehicles, ensuring the availability of charging stations in cities and along major transport routes. It is important to encourage the use of electric and hybrid vehicles by providing tax incentives and subsidies for buyers of such vehicles. State support for the development of intelligent transport systems should include investments in modern traffic management technologies and road monitoring. In addition, it is necessary

to develop educational programs for the training of specialists in the field of innovative transport and increase public awareness of the benefits of environmentally friendly transport.

Innovative technologies in the transport sector are crucial to achieving the goals of sustainable development. The introduction of electric cars, hybrid cars and intelligent transport systems helps reduce greenhouse gas emissions, increase energy efficiency and improve the quality of life. The economic feasibility of these technologies is confirmed by a significant reduction in fuel and maintenance costs, as well as by stimulating economic growth through the creation of new jobs. The development of infrastructure for charging electric vehicles and government support are key factors for these innovations to be successfully implemented. In general, innovative technologies in the transport sector are necessary to ensure an environmentally sustainable future and improve the welfare of the society.

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