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THE IMPACT OF DIGITAL TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE ON MANAGEMENT OF SOCIO-ECONOMIC PROCESSES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

O impacto das tecnologias digitais e da inteligência artificial na gestão dos processos socioeconômicos no contexto do desenvolvimento sustentável

Alla Shlapak[1], Artur Zhavoronok[2], Natalia Vdovenko[3], Oleksiy Bilousov[4], Dmytro Horban[5], Denys Krylov[6]
[1]Borys Grinchenko Kyiv Metropolitan University, [2]Yuriy Fedkovych Chernivtsi National University, [3]National University of Life and Environmental Sciences of Ukraine, [4]Institute of International Economics and Information Technologies of Higher Education Institution "International University of Business and Law", [5]Academy of Labour, Social Relations and Tourism, [6]Zaporizhzhia National University
E-mail: av.shlapak@kubg.edu.ua, a.zhavoronok@chnu.edu.ua, nata0409@gmail.com, allanmih@gmail.com, gorban.d.a@gmail.com, krylov.denys2021@gmail.com

ABSTRACT

The modern world is experiencing transition to the digital economy, where digital technologies and artificial intelligence play the key role in transformation of socio-economic processes. These technologies allow states optimizing resource management, automating production and administrative processes, increasing efficiency of urban governance, and ensuring inclusive sustainable development. In the article, the impact of digital technologies and artificial intelligence on formation of modern development strategies, in particular in the aspect of sustainable urban and economic governance is analyzed. IMD rating indicators investigated Smart City Index for Ukraine's neighboring countries - Hungary, Romania, Poland and Slovakia. Their successes in implementing digital solutions and policies on artificial intelligence were assessed. For example, Hungary is actively developing national artificial intelligence laboratories, implementing automated administrative processes and developing a data market platform. Poland promotes development of artificial intelligence through research initiatives and investments in video games that integrate artificial intelligence elements. Romania is implementing the national development strategy of artificial intelligence aimed at optimizing public administration and supporting research. Slovakia, in turn, focuses on digital transformation and developing infrastructure for innovations in artificial intelligence. The study pays particular attention to the international Hiroshima initiative. AI Process, which is considered as the mechanism to ensure transparency and responsible use of artificial intelligence worldwide. Based on the analysis of implemented initiatives in neighboring countries, recommendations are provided for Ukraine to improve its digital strategy and implement artificial intelligence in key sectors of the economy, urban governance, and public sector to ensure sustainable development. In particular, development of the comprehensive digitalization policy, development of the national artificial intelligence infrastructure, and integration into international initiatives to ensure competitiveness and sustainable development of Ukraine are proposed.

Keywords: Digital Technologies, Artificial Intelligence, FinTech, Management, Sustainable Development, Socio-economic processes, National Economy, IMD Smart City Index, Hiroshima AI Process

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O IMPACTO DAS TECNOLOGIAS DIGITAIS E DA INTELIGÊNCIA ARTIFICIAL NA GESTÃO DOS PROCESSOS SOCIOECONÔMICOS NO CONTEXTO DO DESENVOLVIMENTO SUSTENTÁVEL

The impact of digital technologies and artificial intelligence on the management of socioeconomic processes in the context of sustainable development

Alla Shlapak[1], Artur Zhavoronok[2], Natalia Vdovenko[3], Oleksiy Bilousov[4], Dmytro Horban[5], Denys Krylov[6]
[1]Borys Grinchenko Kyiv Metropolitan University, [2]Yuriy Fedkovych Chernivtsi National University, [3]National University of Life and Environmental Sciences of Ukraine, [4]Institute of International Economics and Information Technologies of Higher Education Institution "International University of Business and Law", [5]Academy of Labour, Social Relations and Tourism, [6]Zaporizhzhia National University
E-mail: av.shlapak@kubg.edu.ua, a.zhavoronok@chnu.edu.ua, nata0409@gmail.com, allanmih@gmail.com, gorban.d.a@gmail.com, krylov.denys2021@gmail.com

RESUMO

O mundo moderno está passando por uma transição para uma economia digital, onde as tecnologias digitais e a inteligência artificial desempenham um papel fundamental na transformação dos processos socioeconômicos. Essas tecnologias permitem que os estados otimizem a gestão de recursos, automatizem processos de produção e administrativos, aumentem a eficiência da governança urbana e garantam um desenvolvimento sustentável inclusivo. O artigo analisa o impacto das tecnologias digitais e da inteligência artificial na formação de estratégias de desenvolvimento modernas, em particular no aspecto da governança urbana e econômica sustentável.
Os indicadores de classificação do IMD investigaram o Smart City Index para os países vizinhos da Ucrânia - Hungria, Romênia, Polônia e Eslováquia. Seus sucessos na implementação de soluções digitais e políticas sobre inteligência artificial foram avaliados. Por exemplo, a Hungria está desenvolvendo ativamente laboratórios nacionais de inteligência artificial, implementando processos administrativos automatizados e desenvolvendo uma plataforma de mercado de dados. A Polônia promove o desenvolvimento da inteligência artificial por meio de iniciativas de pesquisa e investimentos em videogames que integram elementos de inteligência artificial. A Romênia está implementando uma estratégia nacional de desenvolvimento de inteligência artificial com o objetivo de otimizar a administração pública e apoiar a pesquisa. A Eslováquia, por sua vez, foca na transformação digital e no desenvolvimento de infraestrutura para inovações no campo da inteligência artificial. O estudo dá atenção especial à iniciativa internacional de Hiroshima. AI Process, que é considerada um mecanismo para garantir transparência e uso responsável da inteligência artificial em todo o mundo. Com base na análise de iniciativas implementadas em países vizinhos, são fornecidas recomendações para a Ucrânia melhorar sua estratégia digital e implementar inteligência artificial em setores-chave da economia, governança urbana e setor público para garantir o desenvolvimento sustentável. Em particular, são propostos o desenvolvimento de uma política abrangente de digitalização, o desenvolvimento de uma infraestrutura nacional de inteligência artificial e a integração em iniciativas internacionais para garantir a competitividade e o desenvolvimento sustentável da Ucrânia.

Palavras-chave: Tecnologias Digitais, Inteligência Artificial, FinTech, Gestão, Desenvolvimento Sustentável, Processos socioeconômicos, Economia Nacional, Índice de Cidades Inteligentes do IMD, Processo de IA de Hiroshima

INTRODUCTION

Digital technologies and artificial intelligence (AI) have become key factors that change socio-economic processes in the modern world. They open up new opportunities for increasing management efficiency, economic development, improving the quality of life and ensuring sustainable development. In the context of globalization and rapid technological change, these innovations can significantly affect various aspects of social and economic activity. They make it possible to automate production, optimize administrative systems, promote development of new industries and ensure more sustainable and equitable development. For example, the UN initiative AI for Good demonstrates how AI can be used to achieve public good, in particular in sustainable development.

However, using digital technologies and AI also requires careful approach, as their improper implementation can lead to social inequalities, ethical dilemmas and negative environmental consequences. Important task remains development of regulatory mechanisms that will ensure the use of digital technologies and AI in the interests of sustainable development, while minimizing potential risks to society.

1 LITERATURE REVIEW

Researchers are studying various aspects of the impact of digital technologies and AI on implementation of the Sustainable Development Goals, their interconnection and interdependence.

Recent studies by Di Vaio et al. (2020), Tulchynska and al. (202 1) focused mainly on the Sustainable Development Goals and sustainable business models, as well as the study by Khakurel et al. (2018) delve deeper into technological aspects of AI and its relationship to the framework of Sustainable Development Goals.

Rappitch (2015) analyzed the impact of digital technologies, AI, and sustainable development on various markets (energy, food, healthcare, housing, mobility, and finance) and emphasized that, provided that new technologies are implemented in responsible and sustainable manner, positive effects outweigh negative ones.

Goswami (2014) examines both positive and negative impacts of new technologies on environmental, economic and social well-being. He argues that while the digital sector offers significant opportunities for creating the green economy, collaboration between government and business is key to achieving this goal.

Jones et al. al. (2017) examined various ways in which the digital industry can contribute to achievement of the Sustainable Development Goals. The study highlighted contribution of IT companies to sustainable development and also examined main challenges they face.

Pipes and al. (2017) partially equates AI with all digital technologies, noting the impact of AI on 8 Sustainable Development Goals, in particular, mobile phones and digital technologies increase access to banking services in developing countries. However, if the device or application can easily perform the same functions without using AI, it makes no sense to claim that AI is the cause of benefits obtained from these technologies. Only in cases where AI is a major factor contributing to certain phenomenon can it be considered the driver or the obstacle to achieving Sustainable Development Goals.

Artificial intelligence is often associated with Big Tech, which usually refers to four or five largest technology companies (Herrman (2019); Dubyna et al. (20 24); Verbivska et al. (20 24)). These four companies include the GAFA (Google, Amazon, Facebook and Apple), and those who talk about top five add Microsoft to the list (Foer (2017)). They are key players in new global technology systems, competing with new companies, including Alibaba and Tencent from China.

Furthermore, AI is closely related to data collection and access. Zuboff (2019) and Parubets et al. (2023) emphasize that AI is directly related to access to and accumulation of data –valuable aspect that should be taken into account when considering relationship between AI and sustainable development.

2 METHODOLOGY

To identify the impact of digital technologies and artificial intelligence on socio-economic processes in the context of sustainable development, following research methods were used, namely: analysis of literature and regulatory acts to study scientific works, legislative documents and strategies on digitalization and AI; comparative analysis to compare the impact of digital technologies in different countries on socio-economic processes; the

systems approach to consider digital technologies as part of the comprehensive sustainable development management system; statistical analysis to process and interpret quantitative data on the digitalization level, GDP, productivity, etc.

The IMD Smart City Index 2024 is also being analyzed – the fifth edition of the annual ranking that evaluates 142 cities around the world on their ability to integrate technology to improve lives of residents. The ranking is based on residents' feedback on cities' infrastructure and technology solutions, covering aspects of health, safety, mobility, opportunity and governance.

This index analyzes how effectively cities use technology to improve the quality of life of residents and sustainable development. The assessment is based on two key aspects:

The structural aspect is quality of the existing infrastructure.

Technological aspect – the level of use of digital technologies to improve living conditions of citizens.

Technological aspect of IMD Smart City The Index is created based on the survey of residents of different cities who evaluate technological solutions and use of digital innovations in the following areas:

- Health and safety.
- Mobility.
- Resource management.
- Opportunities (work and study).
- Activity.

Cities of Ukraine's neighboring countries that are included in the IMD were selected for the analysis. Smart City Index . This made it possible to assess development level of digital technologies in the countries closest to Ukraine and identify opportunities for improving Ukrainian cities.

Among countries bordering Ukraine, according to the IMD rating Smart City Index includes:

1) Poland – Warsaw, Krakow.
2) Slovakia – Bratislava.
3) Hungary – Budapest.
4) Romania – Bucharest.

We will also compare Index indicators of these cities with those of Zurich, the city that ranks first in the overall IMD ranking. Smart City Index 2024. The city demonstrates high integration level of technology into various aspects of urban life, ensuring high quality of life, efficient resource management, and sustainable development.

Using artificial intelligence for sustainable development of countries is assessed based on Hiroshima AI Process (HAIP). This is the international initiative launched by the G7 countries during the Hiroshima Summit in 2023. The main goal is to develop global guidelines for responsible use of artificial intelligence, in particular generative AI, which is rapidly developing and has significant impact on various areas of society.

3 RESULTS

The Sustainable Development Goals (SDGs), adopted by the United Nations in 2015 (Transforming Our World: The 2030 Agenda for Sustainable Development) , are the global roadmap for creating a more just, environmentally sustainable, and economically prosperous world. They aim to eradicate poverty, ensure quality education, health, economic growth, combat climate change, and many other important aspects of societal development.

Adoption of the SDGs is necessary for several reasons:

1. Global challenges – the world faces problems, including environmental crisis, social inequality, economic instability. The SDGs offer shared vision and strategy for overcoming these challenges.
2. Economic development – sustainable development contributes to formation of economies based on innovation, green technologies, and efficient use of resources, which ensures long-term growth.
3. Social justice – The SDGs aim to reduce inequality, access to quality education, healthcare, and opportunities for all segments of the population.
4. Environmental responsibility – implementing the SDGs helps minimize human impact on the environment, promotes development of renewable energy sources, and reduces greenhouse gas emissions.

5. Technological innovations – digital technologies and artificial intelligence can help achieve the SDGs, including through process automation, improved resource management, and development of "smart" cities.

Using digital technologies in broader sense, including mobile phones, online banking and other digital services, has been actively used since inception of the Sustainable Development Goals (SDGs). They have contributed to improving access to financial, educational and health services, increasing efficiency of resource management and developing inclusive economies.

Artificial intelligence, on the other hand, has more profound and transformative impact on achieving the SDGs. With its ability to analyze large amounts of data, predict trends, and automate complex processes, AI can significantly improve efficiency of decisions in healthcare, environmental monitoring, urban management, and industry. However, its application also comes with ethical challenges, privacy concerns, and risks of unequal access to advanced technologies.

Artificial intelligence is the key element in development of digital technologies for sustainable development. Its implementation allows for more efficient use of resources, reducing environmental burdens and improving the quality of life of citizens. Ukraine should consider AI as the tool for digital transformation of public space, in particular within smart cities.

Potential role of digital technologies and artificial intelligence in achieving each of the Sustainable Development Goals and the expected impact of their implementation are summarized in Table 1, which shows that digital technologies and artificial intelligence have significant impact on at least 12 SDGs

Table 1 - The role of digital technologies and artificial intelligence in achieving the Sustainable Development Goals

SDGs	The role of digital technologies and artificial intelligence in achieving the SDGs	Level of influence
Goal 1. Eradicate poverty	Digital financial services, mobile payments, data analytics for social applications	High
Goal 2. End hunger and achieve food security	Using AI to predict yields, manage food supply chains	High
Goal 3. Ensuring healthy lifestyle and well-being	Telemedicine, AI-based diagnostics, personalized medicine	High
Goal 4. Ensuring inclusive and equitable quality education	Online learning, adaptive educational systems, digital textbooks	High
Goal 5. Ensuring gender equality, empowering women and girls	Digital platforms for education and entrepreneurship, tools to combat discrimination	Average
Goal 6. Ensuring sustainable water resources management	Sensors for water quality monitoring, drought forecasting	Average
Goal 7. Ensure access to modern energy sources	Smart grids, AI-based energy consumption optimization	High
Goal 8. Promote sustainable economic growth	Process automation, development of the digital economy, new jobs in IT	High
Goal 9. Create sustainable infrastructure, promote innovation	Infrastructure digitalization, Internet of Things (IoT), artificial intelligence in construction	High
Goal 10. Reduce inequality within and between countries	Access to digital services for vulnerable populations	Average
Goal 11. Ensure open, safe, and environmentally sustainable cities	Smart cities, AI-based transportation systems, environmental monitoring	High
Goal 12. Ensuring transition to sustainable	Supply chain optimization, digital control of emissions and waste	High

consumption and production models		
Goal 13. Take action to combat climate change	Big data-based climate change analysis, CO_2 emissions management	High
Goal 14. Conservation and sustainable use of oceans, seas and marine resources	Satellite monitoring of oceans, fishing control	Average
Goal 15. Protection and restoration of terrestrial ecosystems	Remote sensing, satellite image analysis to track deforestation	Average
Goal 16. Peace, justice and strong institutions	Digital governance, open data, fighting disinformation	High
Goal 17. Global partnership for sustainable development	Digital collaboration, access to global knowledge and innovation	High

Source: compiled by the authors based on Transforming Our World: The 2030 Agenda for Sustainable Development (https://sdgs.un.org/2030agenda)

Digital technologies and artificial intelligence have the potential to transform economic, social and environmental processes. The impact of digital solutions on various spheres of life contributes to increased efficiency, transparency and inclusiveness, making them the powerful tool for solving global challenges.

First, digital technologies contribute to poverty reduction (SDG 1) through development of financial technologies, mobile payments and remote access to banking services, which allows the poor to integrate into the economy. In the area of food security (SDG 2), artificial intelligence is used to monitor soil conditions, predict yields and optimize agricultural production, which allows reducing food losses and increasing resource efficiency.

AI and digital technologies are also having significant impact on health systems (SDG 3), enabling telemedicine, personalized diagnostics, and epidemic prediction. Similarly, in education (SDG 4), digital platforms, adaptive learning technologies, and online courses are enabling access to quality education regardless of where one lives. This is particularly important for ensuring equal opportunities for women and girls (SDG 5), as digital platforms enable gender-equal access to knowledge and careers.

Natural resource management also benefits significantly from digitalization. In the area of water and sanitation (SDG 6), sensors are used to monitor water quality, reducing the risk of pollution. Similarly, digital technologies are facilitating transition to renewable energy sources (SDG 7), through optimization of electricity consumption and implementation of "smart" energy grids.

Sustainable economic development (SDG 8) depends to large extent on automation, digital transformation of enterprises and creation of new forms of employment, which reduce costs and increase productivity. Innovation and infrastructure development (SDG 9) are also receiving significant boost from digital solutions that contribute to emergence of "smart" cities (SDG 11) with modern transport and environmental infrastructure.

Digital technologies also contribute to the fight against climate change (SDG 13) through big data analytics to predict environmental changes, manage CO_2 emissions and monitor air pollution. In ocean conservation (SDG 14) and terrestrial ecosystems (SDG 15), remote sensing technologies allow monitoring of deforestation, poaching and water pollution levels.

The role of digital technologies in strengthening peace, justice and institutions (SDG 16) is also significant, as they provide access to open data, promote government transparency and prevent corruption. In addition, development of global partnerships (SDG 17) is based on technology sharing, digital collaboration platforms and diffusion of innovation.

The level of "smartness" of cities around the world based on implementation of digital technologies and AI is assessed by the Institute for Management Development (IMD) in collaboration with the Singapore University of Technology and Design (SUTD). Results of this study feed into formation of the IMD Smart City Index, the global ranking.

Unlike other rankings, the Smart City Index focuses not only on implementation of technologies, but also on the extent to which these solutions actually improve lives of citizens. The rating is used by municipalities and

governments to assess the level of digital transformation of cities, as well as to determine directions of further development of infrastructure, management of socio-economic processes in sustainable development.

Accordingly, we will focus on the study of the technological aspect of the IMD Smart City Index to analyze the ranking of world cities in terms of implementation of digital innovations, their impact on socio-economic processes and possibile application for sustainable development of Ukrainian cities. The rating includes cities from different parts of the world that seek to implement innovative solutions to improve comfort, safety and quality of life of their residents. In 2024, the index included 142 cities. It is worth noting that the “smart city” concept is also gaining popularity in Ukraine. Some Ukrainian cities, such as Kharkiv, are already implementing Smart City elements and are gradually moving towards the status of a smart city (Smart City Ukraine), however, military operations in Ukraine have suspended these processes, so as of the end of 2024, not a single Ukrainian city was included in this rating.

Table 2 contains data on the impact of digital technologies on health and safety of residents in different cities in the IMD Smart City Index 2024. The leader in all indicators is Zurich, which ranks 1st in the overall index ranking. Warsaw, Bratislava, Krakow, Budapest and Bucharest show average and lower results, which correlates with their positions in the overall ranking.

Table 2 - Comparative analysis of health and safety indicators in the IMD Smart City Index 2024

Indicator	Zurich (1st place)	Warsaw (38th place)	Bratislava (56th place)	Krakow (76th place)	Budapest (89th place)	Bucharest (100th place)
Online reporting of city maintenance issues ensures quick resolution	60.6	49.2	45.8	50.2	38.2	47.3
Free public Wi-Fi has improved access to public services	54.8	57.9	57.7	53.6	52.1	52.8
CCTV cameras helped residents feel safer	51.2	51.4	54.3	57.7	53.8	50.6
Website or app allows residents to effectively monitor air pollution	45.4	61.7	43.6	69.0	43.4	51.7
Online doctor appointment booking improved access	63.4	66.8	61.3	63.1	47.9	61.0

Source: compiled by the authors based on the Smart City Index (https://imd.widen.net/content/uurdpo9mt3/pdf/20240412-SmartCityIndex-2024-Full-Report_4.pdf)

The highest value of the indicator "Online reporting of technical maintenance issues" is in Zurich (60.6%), which indicates the effective system for monitoring city problems. In Warsaw (49.2%), Krakow (50.2%) and Bucharest (47.3%) indicators are close, while Budapest (38.2%) lags significantly behind. This indicates the need to improve digital platforms for prompt response to technical problems in the city.

The best results for the Free Public Wi-Fi indicator are in Warsaw (57.9%) and Bratislava (57.7%), indicating wide availability of digital services in these cities. In Zurich (54.8%), Krakow (53.6%), Budapest (52.1%) and Bucharest (52.8%), Wi-Fi also plays an important role, but there is room for improvement.

Residents in Krakow (57.7%) and Bratislava (54.3%) experience the highest levels of comfort and security with video surveillance. Other cities have similar figures, indicating active use of cameras to maintain order.

Krakow has the highest level of digital air quality monitoring (69.0%), due to the city's high pollution levels and the need for constant monitoring. Bratislava (43.6%) and Budapest (43.4%) lag significantly behind.

The best results for the "Online doctor appointment" indicator are in Warsaw (66.8%) and Zurich (63.4%), indicating effective digital services in the healthcare sector. Krakow (63.1%), Bratislava (61.3%) and Bucharest (61.0%) also have positive results, while Budapest (47.9%) needs to improve its online medicine system.

To improve its position in the global ranking of smart cities in health and safety, Ukraine needs to implement the following measures:

1. Expand the use of digital platforms for monitoring urban problems, which will ensure rapid response to technical malfunctions (as in Zurich).

2. Develop free Wi-Fi in public places, especially in small towns, to improve citizens' access to electronic services.
3. Strengthen video surveillance systems to increase security in cities.
4. Implement environmental monitoring with access to air quality data through mobile applications.
5. Massively implement e-medicine and online doctor appointments, which will significantly improve accessibility of medical services for the population.

Table 3 contains data on the impact of digital technologies on mobility in different cities in the IMD Smart City Index 2024. The selected cities have average or lower scores compared to Zurich, indicating problems in transport infrastructure and the use of digital solutions to improve mobility.

The most widely used apps to reduce congestion are in Warsaw (47.0%) and Zurich (43.6%), indicating effective use of smart transport systems. Budapest (39.6%), Bratislava (39.9%) and Krakow (40.9%) have significantly lower rates, indicating the need to develop digital solutions to combat congestion.

Table 3 - Comparative analysis of mobility indicators in the IMD Smart City Index 2024

Indicator	Zurich (1st place)	Warsaw (38th place)	Bratislava (56th place)	Krakow (76th place)	Budapest (89th place)	Bucharest (100th place)
Online access to job listings simplifies job search	79.8	74.9	68.4	73.6	72.0	67.3
Teaching IT skills in schools	63.9	56.3	53.5	53.6	54.1	45.9
Online services for starting a business	57.1	60.8	44.0	57.8	51.9	43.9
Internet speed and reliability	82.0	69.8	67.8	70.2	66.8	76.1

Source: compiled by the authors based on the Smart City Index (https://imd.widen.net/content/uurdpo9mt3/pdf/20240412-SmartCityIndex-2024-Full-Report_4.pdf)

Parking apps are also most widely used in Warsaw (50.5%), indicating effective integration of digital technologies into the parking system. Krakow (48.6%) also has a high rate, while Zurich (44.5%) and Bratislava (44.1%) have worse situation.

In terms of “Bicycle rental as a way to reduce congestion,” Warsaw (57.6%) and Zurich (55.6%) are the leaders, indicating popularity of cycling in these cities. Bratislava (51.1%), Krakow (51.8%) and Budapest (49.5%) also show good results, while Bucharest (47.2%) lags behind.

Zurich has the highest score for "Online planning and ticketing for public transport" (79.3%), confirming the ease of using digital services for public transport. Bratislava (67.7%) and Bucharest (59.7%) have the lowest scores, indicating the need to improve the e-ticketing system.

Zurich has the highest score for “Traffic information via mobile devices” (61.8%), meaning that residents receive up-to-date information about traffic situation. Krakow (45.0%) and Bratislava (45.2%) have relatively low scores.

To improve mobility in Ukrainian cities and move up in the global IMD Smart City Index ranking, it is necessary to implement the following measures:

1. Develop intelligent transport systems to reduce congestion through digital applications, as done in Warsaw.
2. Implement smart parking with mobile applications that simplify the search for free spaces.
3. Expand the bicycle rental system, which will promote environmentally friendly transport.
4. Digitize public transport through online ticketing and route planning, like in Zurich.
5. Develop information platforms for tracking traffic jams in real time.

Ukraine has great potential for development of smart mobility and implementation of these solutions will contribute to improving the quality of life in cities.

Table 4 contains comparative data on available digital solutions for employment, training, starting a business, and the quality of Internet connection in the cities studied in the IMD Smart City Index 2024.

Table 4 - Comparative analysis of possibilities of using digital technologies for work and learning in the IMD

Indicator	Zurich (1st place)	Warsaw (38th place)	Bratislava (56th place)	Krakow (76th place)	Budapest (89th place)	Bucharest (100th place)
Apps that help reduce traffic jams	43.6	47.0	39.9	40.9	39.6	41.5
Parking search apps	44.5	50.5	44.1	48.6	45.4	47.7
Bicycle rental as the way to reduce congestion	55.6	57.6	51.1	51.8	49.5	47.2
Online planning and ticket sales for public transport	79.3	71.1	67.7	71.2	71.3	59.7
Traffic information via mobile devices	61.8	49.9	45.2	45.0	57.8	52.2

Source: compiled by the authors based on the Smart City Index (https://imd.widen.net/content/uurdpo9mt3/pdf/20240412-SmartCityIndex-2024-Full-Report_4.pdf)

The leader in the indicator "Online access to job listings simplifies job search" is Zurich (79.8%), indicating effective digital infrastructure for job search. Warsaw (74.9%) and Krakow (73.6%) also have high scores, indicating well-developed online services. Budapest (72.0%) and Bratislava (68.4%) lag behind, and Bucharest has the worst score (67.3%).

The highest level of the indicator "Teaching IT skills in schools" is in Zurich (63.9%), demonstrating high level of digital education. Warsaw (56.3%), Krakow (53.6%), Bratislava (53.5%) and Budapest (54.1%) are approximately at the same level. Bucharest (45.9%) lags significantly behind, indicating problems in teaching digital skills.

The best results for the indicator "Online services for starting a business" are in Warsaw (60.8%) and Krakow (57.8%), which demonstrates high level of business digitalization. Zurich (57.1%) has slightly lower indicator, but is still the leader. Bratislava (44.0%) and Bucharest (43.9%) have the lowest indicators, which indicates difficulties with registering business online.

Zurich (82.0%) has the best internet connection quality. Warsaw (69.8%), Krakow (70.2%) and Bratislava (67.8%) have average internet quality. Budapest (66.8%) has the lowest score among the cities considered.

To improve its position in the global IMD Smart City Index ranking and develop opportunities for using digital technologies in work and education, Ukraine should implement following measures:

1. Create single national online platform for job search, integrated with educational and government services.
2. Implement digital skills training programs in secondary and higher education institutions, following the example of Switzerland.
3. Simplify business opening procedures, develop e-government, and reduce bureaucracy for business registration.
4. Improve internet infrastructure and, especially, expand access to high-speed internet in the regions to reach the level of Bucharest.

Ukraine has significant potential for digital development and implementation of these changes will contribute to the growth of employment, entrepreneurship, and the quality of education.

Table 5 contains data on available online services for purchasing tickets for cultural events (shows, museums) in cities ranked in the IMD Smart City Index 2024.

Table 5 - Digitalization of cultural activities in the IMD Smart City Index 2024

Indicator	Zurich (1st place)	Warsaw (38th place)	Bratislava (56th place)	Krakow (76th place)	Budapest (89th place)	Bucharest (100th place)
Online purchase of tickets for shows and museums	82.0	78.6	74.6	79.1	79.1	77.1

Source: compiled by the authors based on the Smart City Index (https://imd.widen.net/content/uurdpo9mt3/pdf/20240412-SmartCityIndex-2024-Full-Report_4.pdf)

The analysis of indicators of digital services for purchasing tickets for cultural events (shows, museums) shows that this aspect is well developed in all cities, regardless of their position in the ranking. High indicators, which vary within 74.6% - 82.0%, indicate active implementation of online services in culture. This indicates that residents of these cities have convenient access to digital platforms for purchasing tickets, which simplifies visiting cultural events. Development of digital solutions in the cultural sphere is important component of the "smart city" concept, as it contributes to user's convenience, increasing availability of cultural services and overall development of the digital economy.

Ukraine has all prerequisites for improving the digitalization level of the cultural sphere and can develop this sphere in the following areas:

1. Create single online platform for booking tickets to theaters, museums, cinemas and cultural events, which will be integrated with mobile applications.
2. Develop mobile applications for culture that will allow not only to buy tickets, but also to receive additional information about events, history of places, and integration with audio guides.

Table 6 compares effectiveness of using online initiatives in city government, reflects the value of each indicator in respective cities, and allows us to assess their contribution to improve efficiency of governance using modern digital technologies.

Table 6 - Comparison of online initiatives to improve city governance in the IMD Smart City Index 2024

Indicator	Zurich (1st place)	Warsaw (38th place)	Bratislava (56th place)	Krakow (76th place)	Budapest (89th place)	Bucharest (100th place)
Online access to city finances for the public to reduce corruption	48.4	44.4	37.3	42.6	33.0	28.6
Online voting to increase citizen participation	53.1	61.4	45.8	51.9	53.6	35.4
Online platforms for citizens' suggestions for improving the city	51.7	63.7	45.8	58.9	46.6	43.6
Online processing of identity documents to reduce waiting times	63.6	68.3	55.7	65.0	67.2	56.9

Source: compiled by the authors based on the Smart City Index (https://imd.widen.net/content/uurdpo9mt3/pdf/20240412-SmartCityIndex-2024-Full-Report_4.pdf)

Effectiveness of using online platforms to ensure financial transparency in Zurich is demonstrated by the highest level of the indicator "Online public access to city finances to reduce corruption" (48.4%). Bucharest (28.6%) has the lowest score, indicating the lack of proper financial control or distrust in online systems. Overall, the data indicate that online access to finances contributes to reducing corruption, but not all countries have achieved significant results.

Warsaw (61.4%) has the highest level of participation through online voting, indicating the well-developed infrastructure for electronic voting. Bucharest (35.4%) has the lowest rate, indicating a lack of reliable platforms and limited access to these services. Online voting contributes to increased citizen participation, which is important to improve democratic processes.

Warsaw also has the highest (63.7%) indicator for "Online platforms for citizens' suggestions for improving the city", which indicates active involvement of citizens in improving the urban environment through online initiatives. Bucharest has the lowest result (43.6%). Cities that actively use online platforms for suggestions have more opportunities for development and improvement of living conditions.

Zurich shows high efficiency (63.6%) in fast document processing, which is due to development of digital technologies in the public sector. Bucharest (56.9%) has an average score, which also indicates the developed, although not perfect, online document processing system.

Prospects for Ukraine:

1. Ukraine should develop online systems for financial transparency at the local level, which will help reduce corruption. It is necessary to create platforms where citizens can access financial information, projects and tenders of city authorities, programs similar to those used in Zurich.

2. Ukraine should introduce electronic voting, primarily in referendums and local elections, which will increase citizen participation in decision-making. This will make the processes democratic and ensure greater trust in the electoral system.

3. Increasing the use of online platforms for collecting ideas from citizens will allow city residents to actively participate in development of projects that improve the urban environment.

4. Further development of online services for document processing will help significantly reduce waiting times and improve citizens' interaction with authorities. It is important that online systems are reliable, convenient and accessible to all citizens, especially those who do not have constant access to the Internet.

Overall, Ukraine has great potential to improve governance using digital technologies. It is important to invest in the infrastructure, ensure access to online platforms, and create mechanisms for active citizen participation in governance processes.

To explore the role of artificial intelligence in managing socio-economic processes in the context of sustainable development, we will use the initiative launched by the G7 countries to promote development of safe, reliable and ethical artificial intelligence technologies, known as the Hiroshima AI Process (HAIP) (National AI policies & strategies).

As part of this process, the G7 countries are working to establish international standards and codes of conduct for organizations developing advanced AI systems. The key element is establishment of the reporting framework to promote transparency and accountability in development and implementation of these systems. This also helps to identify and disseminate best practices, and provides opportunities for benchmarking of AI risk mitigation efforts.

Thus, researching AI implementation projects in countries will help to understand how international AI initiatives and policies can contribute to achieving sustainable development, and will also allow us to identify the best approaches for implementing AI.

Table 7 provides information on the number and nature of AI projects in Hungary, Poland, Romania, Slovakia, and Ukraine. It demonstrates the diversity of initiatives aimed at developing AI in these countries, including scientific research, innovation, and implementation of AI in public administration and the economy.

Table 7 - Projects of neighboring countries and Ukraine in artificial intelligence and their impact on sustainable development

Country	Number of projects	Essence of the project
Hungary	14 projects	Projects: creation of the national AI laboratory, data market platform, and automation of administrative processes promote innovation and efficiency. The Hungarian government is also focusing on ethical aspects of using AI, adapting European guidelines to national conditions.
Poland	4 projects	Projects: GAMEINN program funds the use of AI in video games, Poland-Taiwan Scientific Co-operation promotes scientific exchange with Taiwan. The AI Development Policy in Poland, approved in 2021, defines the strategy for implementation of AI technologies in the economy, healthcare and other areas. Poland is actively adapting its legislation, in particular the Labor Code, to consider changes related to automation and implementation of AI in the workplace.
Romania	4 projects	The National Strategic Framework Plan on AI (2023-2027) aims to introduce innovative technologies into public administration to improve business efficiency. The country is also working on the National Strategy for Research, Innovation and Smart Specialization for 2021-2027 to develop AI in the economy and science. Romania is creating the National Strategy for AI, which will determine further development of technologies in the country. As part of the research program "The Impact of ICT and AI on the Evolution of Humans and Society", the Romanian Academy is conducting research and reflection groups to analyze the impact of AI on society.
Slovakia	2 projects	The Digital Transformation Action Plan sets out steps to create successful digital country with focus on sustainable, human-centric and trustworthy AI. Slovakia implements state R&D programmes and R&D infrastructure development programmes that promote development of scientific research and innovation in the AI sphere, providing support for research institutes and innovation centres.
Ukraine	1 project	The National Strategy for the Development of Artificial Intelligence is focused on using the country's existing potential in AI sphere to achieve strategic goals in various areas. The strategy provides for creation of favorable environment for development of innovations, in particular in the areas, including industry, agriculture, medicine and public administration, and provides for support for scientific and research initiatives and cooperation with international partners to integrate advanced technologies.

Source: compiled by the authors based on National AI policies & strategies (https://oecd.ai/en/dashboards/overview)

AI projects in these countries have positive impact on socio-economic processes, contributing to sustainable development. They improve efficiency of public administration, support innovation in industry, healthcare and agriculture, which leads to economic growth. AI projects also help automate processes, reducing costs and improving access to services. Implementation of ethical principles for the use of AI ensures the balance between technological progress and social responsibility, which is important aspect of sustainable development. For example, projects in Hungary, including creation of the national AI laboratory and the data market platform, contribute to increasing innovation and economic efficiency. This allows the country to create new jobs and support sustainable development through automation of administrative processes. Poland's GAMEINN program finances the use of AI in video games, supports development of the creative industry, which stimulates economic development, and also creates new opportunities for entrepreneurs.

Ukraine has one main project – the National Strategy for the Development of Artificial Intelligence [15], which is focused on using existing potential of AI to achieve strategic goals in industry, agriculture, medicine and public administration. The strategy includes creating favorable environment for development of innovations and supporting research initiatives, as well as cooperation with international partners. This indicates that Ukraine is at the initial stage of development in this area, and to achieve success in the future it is necessary to expand initiatives and increase the number of projects in the AI sphere.

DISCUSSION

According to research results (Djakona et al. (2021); Filyppova et al. (2024); Hryhorkiv et al. (2024)), digital technologies and AI are actively transforming socio-economic processes, contributing to achievement of sustainable development goals. We agree with Kochubei's statements et al. (2021), Zybareva et al. (2021) and Shaposhnykov et al. (2023) w Digital technologies and artificial intelligence (AI) are key factors in transformation of socio-economic processes, particularly in the context of sustainable development. Implementation of innovative solutions contributes to effective management of resources, optimization of production and improvement of the standard of living of the population.

Scientists Tanasiichuk et al. (2024), Popelo et al. (2024) and Marhasova et al. (2023) analyzed and determined economic impact of AI and digital technologies on functioning of the national economy (automation, productivity, digital transformation). In contrast, Kosach et al. (2022) and Fedyshyn et al. (2022) analyzed sustainable development and AI (environmental initiatives, "green" technologies, emission reduction) and concluded that digital technologies and AI are key factors in managing socio-economic processes in the context of sustainable development.

Based on the analysis of all scientific literature, among debatable issues remain the following challenges that arise and relate to: ethical issues (data privacy issues and discriminatory algorithms); imbalance in the labor market (automation can displace traditional professions); digital divide (uneven access to digital technologies between countries and social groups).

CONCLUSION

The analysis of the experience of Ukraine's neighboring countries shows that introduction of digital technologies in urban governance is the key factor for improving the quality of life of citizens, increasing efficiency of governance and sustainable development. Ukrainian cities should consider these trends and invest in development of digital infrastructure, smart transport, environmental projects and e-government. This will increase competitiveness of cities, attract investments and ensure sustainable development in the future.

Despite many benefits, implementation of digital technologies and artificial intelligence also brings certain challenges. In particular, there are risks of digital inequality between different countries and social groups, issues of data protection, cybersecurity and responsible use of AI, which are prospects for further research. Therefore, to maximize potential of digital technologies, it is necessary to create appropriate policies and regulations aimed at ensuring inclusive and sustainable development, ethical standards and security measures. It is important to ensure equal access to digital solutions, minimize negative consequences of automation and develop environmentally responsible technologies.

Overall, digital technologies and artificial intelligence are indispensable tools for achieving the SDGs. They can significantly accelerate resolution of global problems, but their implementation must be carried out responsibly, considering social, economic and environmental aspects of sustainable development.

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