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INCREASING THE ECONOMIC DEVELOPMENT OF THE EU COUNTRIES THROUGH THE IMPLEMENTATION OF THE "SMART CITY" CONCEPT

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Abstract. The implementation of the Smart City concept in the European Union is the largest research program developed and supported by the European Commission. The aim of the article is to study the implementation of the "Smart City" concept as a direction for enhancing the economic development of the European Union countries. The methodological basis of the study is formed by general scientific and special methods of economic theory, in particular, statistical and information reports of EC, the United Nations and world indicators of Smart Cities. The following measures have been identified to support the development of the Smart CIty concept: involvement of citizen science and civilian advisory councils; data protection through various European and international cybersecurity support programs; constant updating and creation of legislation based on environmental protection, transparency, security and fairness of online interaction; application of a cross-sectoral approach and disaggregated data; updating strategies for talent development, education and openness in trade, investment and exchange of experience; support for environmental and digital policy in the development of citywide or national Smart City strategies. The study reveals the reasons that hinder the implementation of the Smart City development concept in Europe: citizens' lack of confidence to use digital tools to participate online; the impact of climate change and excessive environmental pressure, based on increased electricity and water consumption; and the growth of mining. The study of the relationship between the concepts of Industry 4.0 and Smart City has shown positive results of implementing the best practices of the EU countries in the innovation structures of the EU countries. To enhance the economic development of the EU countries through the implementation of the Smart City concept, it is proposed to implement a set of measures aimed at stimulating innovation, supporting small and medium-sized businesses, developing a green economy and improving energy efficiency. The practical significance of the results lies in the use of the recommendations provided, which will contribute to the economic development of the EU countries through the implementation of the "Smart City" concept and will have a positive impact on the environment, increase energy efficiency, improve the quality of life of the population and ensure the sustainable development of urban infrastructure in the EU countries.

Keywords: Smart City, economic development, European Union, Industry 4.0.
JEL Classification: O1, O2, O3, I31.

INTRODUCTION

The Smart City concept has a significant impact on the development of the economies of the European Union and the world, as it includes the use of modern technologies to improve the travel experience and efficient management of the tourism industry. The Smart Cities and Communities Initiative is one of the largest research programs developed and supported by the European Commission under the Horizon 2020 program. Eighteen Smart Cities and Communities projects have been funded under these programs over the years and have brought together 120 cities that continue to work on piloting 550+ solutions. The Smart City support programs rely on €345 million in funding from the Horizon 2020 program, which has attracted more than €1 billion in investments to develop areas with near-zero or positive energy consumption. The initiative brings together cities that are developing pilot projects in large areas, learning from the examples of leading cities and implementing bold replication plans. The projects aim to create 100 climate-neutral and smart cities by 2030. The support of the European Commission grants has led to impressive results: the program has resulted in up to 53% energy savings, up to 88% reduction in CO2 emissions, more than 17,500 smart meters installed, over 1 million m2 of space renovated, more than 5,270 electric vehicles introduced, nearly 500 electric charging stations installed, and more than 260,000 citizens engaged in this transformation (European Union, 2024).

Taking into account global and national trends in the economic development of the EU countries, which arise in the context of environmental changes, under the influence of various factors (European Commission, 2025), it is necessary to develop innovative solutions and test new ways of working and living, exploring in more detail the impact of the implementation of the Smart City concept. The quality of urban life and the attractiveness of cities as environments for learning, innovation, business and job creation are now vital parameters for success in the global competition for talent, growth and investment. Therefore, the implementation of the Smart City concept will facilitate the reconstruction of buildings, sustainable mobility solutions, and the introduction of information and communication technologies. It is worth noting that an important direction of development of the EU economic countries is not only GDP growth, strengthening of the euro against the US dollar, and job creation (Gudz, et al., 2023); (But, 2024a), financial support (Momot & Muraev, 2021), introducing digitalization to reduce energy consumption (Byelikova, et al., 2023); (Ryabev, et al., 2022), management of fuel costs and their reduction, improvement of environmental safety for society (Shelemetyeva & Trokhimets, 2022). At the same time, it should be noted that the issues related to the economic development of the EU countries and the factors influencing it continue to search for ways to solve and improve them in the context of constant political, economic, sociological and environmental changes, which determines the relevance of the chosen topic.

LITERATURE REVIEW

The term “Smart City” is now a common concept that almost everyone has encountered. It should be noted that the theory and practice of Smart City originated in developed countries, where urban infrastructure was better developed (Huang, et al., 2021). Many global experts offer modern approaches to this topic. Studies of digital inequality and the dangers of Smart City are presented in the works of such scholars as (Thompson, 2020), (Adamuscin, et al., 2016), (Cocchia, 2014), (Bárta, 2016), (Galuh & Purnama, 2024); (Neumannova, 2022) et al.

Cities of the world deserve more attention, taking into account their historical and geographical context. Study of the peculiarities of the use of information technologies and electronic media devices (Shpak, et al., 2023) point to ensuring the creation of a convenient, efficient and sustainable urban environment through smart transportation, smart management, smart environment, smart services, and smart people. An analysis of scientific research has identified the shortcomings of existing approaches (But, et al., 2023) which indicate that the classical division of

settlements into municipalities, settlements, cities, and statutory towns has long been outdated and can only be used for administrative purposes. Modern smart solutions make people's lives easier, and the development of Smart Cities is based on the introduction of information and communication technology applications. The author (But, 2024b) points out that rapid changes in living conditions cause constant migration movements of people and also affect the economic development of EU countries. And examples of the introduction of 4.0 technologies (Shpak et al., 2023); (But, 2024c) play a crucial role in the implementation of innovative solutions and testify to the increased competitiveness of the European economy. The use of best practices for post-socialist cities in Western European countries in the process of redeveloping districts into "smart districts" has become widespread (Neumannova, 2022). This topic is the subject of his own research, which is the basis for continuing scientific research in a certain direction (Mamotenko, et al., 2022); (But, et al., 2023); (Mamotenko & Shelemetieva, 2023); (But, 2024a), (But, 2024b); (But, 2024c); (But, et al., 2025).

PAPER OBJECTIVE

The aim of the study is to investigate the implementation of the Smart City concept as a direction for enhancing the economic development of the European Union countries by identifying programs to support the development of the Smart City concept, finding out the reasons hindering the development of the Smart City concept in Europe, studying the relationship between the concepts of Industry 4.0 and Smart City, and analyzing the results of implementing the best practices of the EU countries into the innovation structures of the EU countries.

METHODOLOGY

The study used general scientific and special methods, in particular, analysis and synthesis (to analyze the dynamics of Smart City indicators of 27 EU countries); cluster analysis (to group EU countries by the intensity of Smart City development); graphical analysis (to visualize the results obtained from the reports of Smart City indicators in Europe and the world); abstract and logical (to interpret the results obtained and formulate conclusions and recommendations).

The methodological basis was formed by data from the following sources: World Smart Cities Outlook; Smart City Observatory; The State of European Smart Cities; European Union; European Commission, The United Nations (IMD, 2025a); (IMD, 2025b); (UN-Habitat, 2024); (Europe 2020, 2025a); (OECD, 2019); (Smart City tech, 2025). These and other documents offer solutions and funding to achieve climate neutrality in Smart Cities in the European Union and around the world.

RESULTS AND DISCUSSION

Digital infrastructure and Smart City services are important infrastructure facilities for the development of the economy of the European Union. Municipal governments are developing special programs to support local entrepreneurial efforts aimed at solving urban problems through social and digital innovations. To do this, municipal governments work together to develop collaborative partnerships that promote the co-creation of scalable and adaptable urban innovations. In particular, they need to collaborate with private providers and research institutes to utilize alternative business models for digital infrastructure and services. To do this, we will explore how the Smart City concept is being implemented through the participation of universities, local and private initiatives in planning and developing the Smart City concept in countries around the world, including Europe.

When studying the strategic and operational planning of Smart City projects (UN-Habitat, 2024), it becomes clear that planning is based on processes open to all local stakeholders involved

in the development of Smart Cities. The global survey confirmed that this is already a widespread practice around the world. According to the World Smart Cities Outlook 2024 report (UN-Habitat, 2024), out of 128 municipalities that have developed a Smart City plan, only 14% did not involve any external stakeholders in the development of their strategy.

As shown in Figure 1, the involvement of universities is by far the highest in Europe. Only 19% of the 177 cities with a Smart City concept have developed strategic planning by municipal authorities, without any outside involvement.

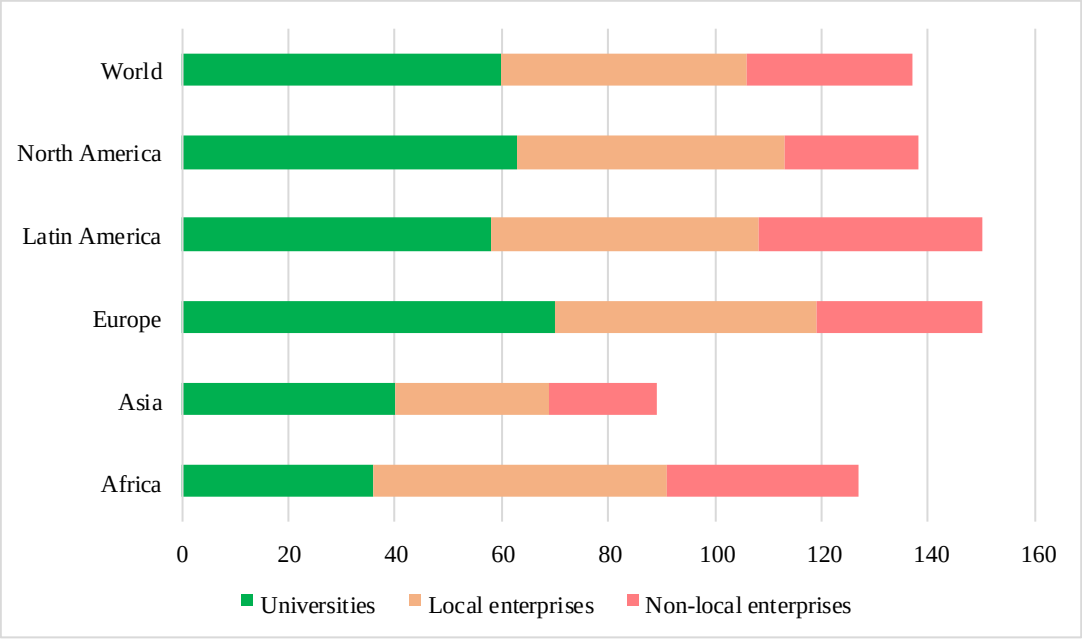

Fig. 1. Participation of various stakeholders in the development of the Smart City Development Concept

Source: (UN-Habitat, 2024)

In cities in Africa and Asia, the lowest level of planning for the Smart City concept is observed in universities (23% of residents and 14% of civil society organizations). Other patterns emerged in the development of strategies for local initiatives to create the Smart City concept. Cities in Africa, North and Latin America demonstrated the highest level of involvement of local enterprises (83% and 100% respectively), while the global average is 52% (and Europe lags behind other continents: only 40% of local enterprises were among the participants in the Smart City Strategy project) (UN-Habitat, 2024). The participation of private enterprises was more moderate (37% on average). This is because participatory planning relies on a wide range of tools and mechanisms, similar to those used by municipal governments to facilitate the involvement of local stakeholders in the collaborative ecosystem.

According to a UN DESA e-Governance study, the reason for low participation in Smart City planning is the lack of confidence of citizens to use digital tools to participate online**.** Budgeting also affects the effectiveness of Smart City planning. At the same time, the role of participants from different segments of the population is significant, including the participation of the disabled and representatives of ethnic minorities. For example, the United States, a leader in Smart City planning, emphasizes that it is important to inform city residents at the beginning and then show citizens how their feedback was used at the end. This will improve the formation of local strategies, their implementation and review.

To overcome the limitations of existing participatory planning approaches, municipalities around the world are experimenting with new methods of ensuring participation. The involvement of citizen science and citizen advisory councils is considered to be more attractive to their citizens**.**

This should take into account not only residents, but also groups such as migrants and the homeless who are part of the city.

In terms of data protection and data management, the percentage of municipalities in Europe is the highest for which it is easy to ensure data protection in Smart Cities (40%), while Africa has the lowest rate (14%). It is important to understand how information reaches the citizens of municipalities. To do this, it is necessary to increase the transparency and explainability of artificial intelligence systems and algorithms. This will make these technologies more accountable.

An increasing number of efforts in the field of cybersecurity, human rights and ethical considerations are being carried out by international organizations. The Eurocities Digital Forum Lab project covers seven European cities (Amsterdam, Barcelona, Brussels, Eindhoven, Mannheim, Rotterdam, Sofia, and Amsterdam). The initiative of the Association Espanola de la EconomiaDigital has been launched in the Netherlands. In particular, the EU and intergovernmental organizations such as the United Nations Education Organization have adopted comprehensive legislation and guidelines to regulate digital markets and digital services. As of 2022, the ITU also took into account existing laws: 85 countries have "Child Protection on the Internet", 105 have specific regulations on cybercrime, and 52 regulate online gambling. People-centered legislation is crucial in the context of the Smart City concept, as it also plays a key role in strengthening participatory democracy and protecting the environment, transparency, security and fairness of online interactions.

Only 5 percent of digital technology portals meet inclusive technology standards, according to research by UN DESA e-Governance. This points to the need for a cross-sectoral approach and disaggregated data to assess the potential impact of digital technologies on different user groups.

It should be noted that the development of the Smart City concept is influenced by climate change. The burden on the environment is being put on the basis of increased consumption of electricity and water, as well as increased mining. Thus, Europe is the leader among other regions where Smart City strategies are most likely to attach great importance to the environmental goals that Smart Cities are striving for (Fig. 2).

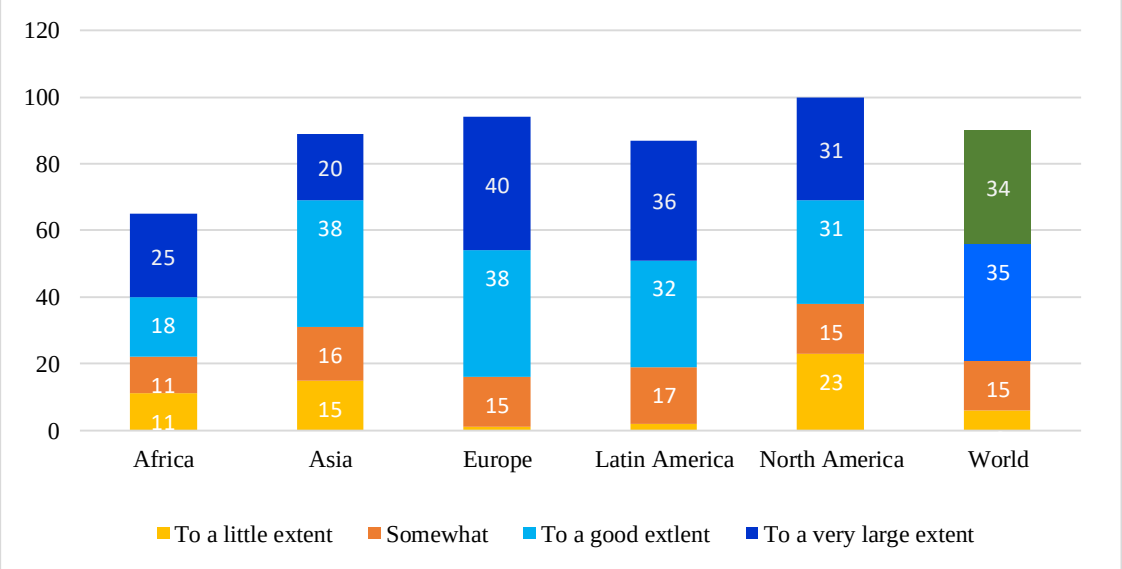

Fig. 2. The extent to which municipalities include environmental goals in their Smart City initiatives

Source: (UN-Habitat, 2024)

An example of sustainable development of urban megacities is China, where environmental and digital policy are key political priorities. In its citywide or national Smart City strategies, China pays attention to solutions that will affect various climate issues and energy use.

Another of the Smart City databases is the Smart City Observatory 2024 index, which is updated annually and has been collected in 142 cities around the world since 2019. This report is balanced on the economic and technological aspects of smart cities. Table 1 shows the Smart City Index ranking in EU countries in 2024.

Table 1.

*Smart City Index of EU countries in 2024**

	Countries and cities	HDI city	Ranking 2024	Medium 21-23-24
1	Austria (Vienna)	0,942	23	24
2	Belgium (Brussels)	0,953	40	40
3	Bulgaria (Sofia)	0,856	113	109
4	Croatia (Zagreb)	0,916	102	104
5	Cyprus (Nicosia)	0,896	118	118
6	Czech Republic (Prague)	0,960	15	13
7	Denmark (Copenhagen)	0,967	6	5
8	Estonia (Tallinn)	0,932	24	27
9	Finland (Helsink)	0,960	9	9
10	France (Paris)	0,949	49	48
11	Germany (Hamburg)	0,972	14	11
12	Greece (Athens)	0,909	120	114
13	Hungary (Budapest)	0,922	89	85
14	Ireland (Dublin)	0,950	69	59
15	Italy (Bologna)	0,924	78	59
16	Latvia (Riga)	0,929	59	71
17	Lithuania (Vilnius)	0,913	47	56
18	Luxembourg (Luxembourg)	0,930	27	36
19	Netherlands (The Hague)	0,941	42	40
20	Poland (Warsaw)	0,926	38	41
21	Portugal (Lisbon)	0,900	108	96
22	Romania (Bucharest)	0,926	100	97
23	Slovakia (Bratislava)	0,944	56	53
24	Slovenia (Ljubljana)	0,953	32	40
25	Spain (Bilbao)	0,932	29	26
26	Sweden (Stockholm)	0,972	11	11

** Malty data is not available*
Source: (IMD, 2025a); (IMD, 2025b).

As can be seen from Table 1, some EU countries have lowered their positions in this ranking, while others have maintained or improved their ranking. These changes are caused by different levels of economic development, as well as changes in economic policy and the environment. In particular, one of the global events is the Russian invasion of Ukraine. Therefore, Europe has radically accelerated its transition to clean and fair energy: reducing dependence on foreign fuels, increasing energy efficiency and the rate of building renovation, increasing investment in renewable

energy sources, decisively fighting energy poverty and broadly improving energy affordability, empowering consumers and protecting them.

To make the cities of tomorrow smart, green, digital and human-centered, we need to pay attention to strategies for talent development, education and openness in trade, investment and exchange of experience (But, et al., 2025). In this context, combining inclusion and digitalization remains a challenge for all types of cities.

Many cities in Europe and the EU are examples of Smart Cities that demonstrate the improvement of the quality of life and sustainable development in countries through smart technologies. The top five Smart Cities in Europe include London (UK), Amsterdam (Netherlands), Berlin (Germany), Paris (France), and Lisbon (Portugal).

With its advanced technology infrastructure and green infrastructure, London has the largest number of electric vehicle charging stations and green certified buildings. London is also home to the largest number of Internet of Things (IoT) companies.

Amsterdam is actively improving urban mobility, energy management and sustainable development. Smart City is known for innovative projects such as smart lighting and waste management systems.

Berlin is one of the leading Smart Cities in the EU thanks to its innovative solutions in transportation, energy, and data management. The city actively uses IoT to improve the quality of life of its residents.

Paris is implementing Smart technologies to improve urban mobility, energy management, and sustainable development. The city is known for its smart lighting and waste management projects.

Lisbon is known for its innovative projects in transportation, energy, and data management.

Zurich (Switzerland) uses a LoRaWAN network to collect data throughout the city. This data is used to solve urban problems such as air quality, water management, and parking. (Smart City tech, 2025). Turin (Italy) has developed the City Teller app, which combines literature and technology to attract tourists. This helps to create a high-tech and knowledge-based economy. Barcelona (Spain) has introduced a local social currency, REC, which allows for transactions between individuals, institutions, and businesses. This helps to support the local economy and implement smart solutions such as lighting, garbage cans, and parking lot management. Copenhagen (Denmark) uses data to develop innovative solutions in its Solutions Lab. This allows solving the environmental problems of a growing urban population through collaboration between companies and knowledge providers. All these and other smart technologies are being actively implemented in the lives of their residents and improve their quality of life.

Industry 4.0 and Smart City development are closely related, as both concepts are aimed at using advanced technologies to improve the quality of life and increase the efficiency of management. Table 2 shows the objectives and results of the main Industry 4.1 projects of EU regional development for the period from 2018 to 2023.

These projects exceed a budget of EUR 2 million, are distributed across 7-10 project countries, and are aimed at improving the innovation structure of the participating countries and relevant national and regional policies in Industry 4.0 (Industry 4 Ukraine, 2025).

The results of the implementation of the best practices of EU countries in the development of Industry 4.0 are: creation of regional 4.0 hubs; innovation vouchers in the field of Industry 4.0 as a promotion tool; promotion of national Industry 4.0 programs; Digital Innovation Hubs (DIH); regional program for the development of Industry 4.0 in Lithuania; Center for Mechatronics and Engineering in Mechanical Engineering (M&M) in Belgium; implementation of the MFCA methodology in the food industry, France.

Table 2

Key Industry 4.0 projects in 2018-2023 in EU regional development

Project name	Objectives	Results
SMARTY practices - smart SMEs in the transition to Industry 4.0	addresses the excessive fragmentation of Industry 4.0 and aims to establish a unified knowledge base of best practices in regional development approaches.	60+ events to study the policies of different regions, 26 identified best practices, 4 guidelines with policy recommendations, 8 studies and action plans to transfer best practices to the regions, and tools for improving policies.
InnoHEI project - improving research infrastructure: from fragmented to integrated and sustainable cooperation with business	the 7 EU countries' project aims to improve the culture of entrepreneurship and creativity in the EU regions.	7 interregional workshops, research and visits to enterprises and universities, and more than 40 internal meetings of project participants.
PASSPARTOOL - key tools for assessing and improving the soft style of innovation development	brings together 7 EU countries that prefer to stimulate informal, soft and open innovation processes with a focus on non-R&D-driven and social innovations.	exchanges between countries, thematic workshops and trainings, identification of policy tools and practices that improve the development and implementation of action plans, and many promotional materials.
INNO Industry - improving innovation development policies by engaging clusters in Industry 4.0	increase the share of clusters involved in Industry 4.0 projects by improving relevant regional and national policies.	conducting research in 10 EU countries, identifying 30 best practices in clustering and Industry 4.0, creating a model of clusters 4.0 and action plans aimed at improving policies and instruments.
DIGITAL REGIONS - creation of regional policies adapted to Industry 4.0 in their digital transformation	increase the number of SMEs that have implemented Industry 4.0 solutions to 15% of the total number of enterprises. Key strategy: improving innovation policies.	measures to improve regional policies aimed at better engaging SMEs and increasing their knowledge and skills in I4.0 are proposed.

Source: compiled by the authors from the source: (Industry 4 Ukraine, 2025)

These aspects demonstrate how Industry 4.0 contributes to the development of Smart City, improving the quality of life of residents and ensuring the sustainable development of urban infrastructure and the economy of the European Union.

CONCLUSIONS

Thus, the Smart City concept has a significant impact on the economic development of the European Union. Among the reasons hindering the development of the Smart City Concept are the following: lack of self-confidence of citizens to use digital tools to participate in the Internet; the impact of climate change and excessive environmental burden, based on increased electricity and water consumption; growth in mineral extraction.

It is substantiated that the economic development of the EU countries is positively influenced by the development of the “Smart City” concept. The measures supporting the development of the “Smart City” concept include: involvement of citizen science and civilian advisory councils; data protection through various European and international cybersecurity support programs; Continuously updating and creating legislation based on environmental protection, transparency,

security and fairness of online interactions; strengthening democracy; applying a cross-sectoral approach and disaggregated data; updating strategies for talent development, education and openness in trade, investment and exchange of experience; support for environmental and digital policy in the development of citywide or national Smart City strategies.

The studied interconnection of Industry 4.0 and Smart City concepts has shown positive results of implementing the best practices of the EU countries into the innovation structures of the participating countries, which improves the quality of life of residents and ensures sustainable development of urban infrastructure and the economy of the European Union.

Thus, summarizing the above, we can note that in order to enhance the economic development of the EU countries through the implementation of the Smart City concept, it is necessary to implement a set of measures aimed at stimulating innovation, supporting small and medium-sized businesses, developing a green economy and improving energy efficiency. Among the key measures are the following:

- support research and development, implementation of new technologies and innovative solutions in various sectors of the economy, including the creation of clusters and technology parks;
- support small and medium-sized businesses (SMEs);
- implement measures to reduce greenhouse gas emissions, increase energy efficiency and develop renewable energy sources;
- support and implement the digitalization of the economy;
- attract investments in the modernization of transport, energy and communications infrastructure;
- ensure even regional development, reduce economic imbalances and support backward regions.

The practical significance of the results lies in the use of the recommendations provided, which will contribute to the economic development of the EU countries through the implementation of the "Smart City" concept and will have a positive impact on the environment, energy efficiency, improving the quality of life of the population and ensuring the sustainable development of urban infrastructure in the EU countries.

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ПІДВИЩЕННЯ ЕКОНОМІЧНОГО РОЗВИТКУ КРАЇН ЄС НА ОСНОВІ ВПРОВАДЖЕННЯ КОНЦЕПЦІЇ «SMART CITY»

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Впровадження концепції "Smart CIty" в країнах Європейського Союзу є наймасштабнішою науково-дослідницькою програмою, розробленою і підтримуваною Європейською Комісією. Метою статті є дослідження впровадження концепції «Smart City», як напрямку підвищення економічного розвитку країн Європейського Союзу. Методологічну основу дослідження склали загальнонаукові та спеціальні методи економічної теорії, зокрема в основу яких використано статистичні та інформаційні звіти ЄК, ООН та світових показників Smart Cities. Серед заходів, підтримуючих розвиток концепції "Smart City" визначено: залучення громадянської науки та цивільних консультативних рад; захист даних за допомогою різних Європейських та міжнародних програм з підтримки в області кібербезпеки; постійне поновлення та створення законодавчих актів, які засновані на захисті навколишнього середовища, прозорості, безпека та чесність онлайн-взаємодії; застосування міжсекторального підходу і дезагрегованих даних; поновлення стратегій розвитку талантів, освіти та відкритості у сфері торгівлі, інвестицій та обміну досвідом; підтримка екологічної політики і політики в області цифрових технологій при розробці загальноміських або національних стратегій Smart City. За результатами дослідження з’ясовано причини, стримуючі впровадження концепції розвитку "Smart City" в Європі: невпевненість в собі громадян, щоб використовувати цифрові інструменти для участі в Інтернеті; вплив зміни клімату та надмірне навантаження на навколишнє середовище, на основі збільшення споживання електроенергії і води; зростання видобутку корисних копалин. Досліженння взаємозв’язку концепцій Індустрії 4.0 та Smart City вказало позитивні результати впровадження кращих практик країн ЄС у інноваційні структури країн ЄС. Для підвищення економічного розвитку країн ЄС, за рахунок впровадження концепції "Smart City", запропоновано впровадження комплексу заходів, спрямованих на стимулювання інновацій, підтримку малого та середнього бізнесу, розвитку зеленої економіки та підвищення енергоефективності. Практична значимість результатів полягає у використанні наданих рекомендацій, які сприятимуть підвищенню економічного розвитку країн ЄС, за рахунок впровадження концепції "Smart City" і позитивно впливатимуть на екологію, підвищення енергоефективності, покращення якості життя населення та забезпечення сталого розвитку міської інфраструктури країн ЄС.

Ключові слова: Smart City, економічний розвиток, Європейський Союз, Індустрія 4.0.