DEVELOPMENT OF SMART CITIES: COUNTRY ANALYSIS

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Abstract

The article explores the possibilities of developing smart cities in countries with different levels of socio-economic development. This is done on the basis of the clustering of the countries of the Organization for Economic Cooperation and Development and its key partners, where all countries are divided into 4 key clusters that unite countries with similar characteristics and rates of development. It was determined that the largest number of smart cities is developing in countries with the highest level of socio-economic development, but the countries of the fourth cluster, which includes Asian countries with high growth rates of GDP and basic macroeconomic indicators, demonstrate the highest growth rates. In accordance with this, the leading countries in terms of the growth rate of smart cities have been determined, including the USA and China. China's strategy for the development of a digital society is analyzed, the key mechanisms and tools of digitization and technologization of economic development and urban planning are determined.

Keywords: smart city, intellectualization, digitalization, clusterization, digitalization.
JEL Codes: O57, O35, O14, O18.

Introduction

The construction of a modern society, a society of a new type, is accompanied by the processes of technologization, urbanization, digitalization, globalization and the expansion of the limits of the use of artificial intelligence, which from a technological breakthrough turned into a tool for the formation of communication networks. One of the key modern trends is urbanization, according to forecasts by 2050, about two-thirds of the population will live in cities or agglomerations. Management of cities of this type will require new approaches based on digital solutions, management of all aspects of social life and provision of the ecosystem. Smart cities are becoming the main paradigm of urban development, economic growth and the formation of a competitive economy. It is worth understanding that a smart city, combining local resources, innovative institutions, institutes, broadband networks, becomes the quintessence of urban development in conditions of sustainable development and widespread greening. Digital technologies are becoming a tool for solving urban problems and managing the city's ecosystem, business structures, etc. However, the rapid pace of development and the scale of urban transformation provide both significant opportunities and challenges that stand in the way of the smooth smartization of cities.

The development of smart technologies and smart cities to some extent is a consequence of the socio-economic development of countries or regions.

The level of technological development, the formation of a smart ecosystem, a high standard of living of the population, a high level of environmentalization are the necessary prerequisites that determine the possibility of building a start-up economy and a smart city.

Theoretical background. The study of the formation of the smart economy and the development of smart cities is the basis of a significant number of scientific works. Thus, the key issues of the formation of a new type of society and its formation are explored in the works of D. Bell (Bell, 1973), М.Кастельса (Кастельс М., 2006), F. Makhlup (Makhlup, 1966), D. Lukyanenko (Lukyanenko, 2008) and others. The analysis of individual factors in the formation of a new type of economy is studied in the works of M. Heylin (Heylin, 2006), D. Kellner (Kellner, 2002), D. Held, A. McGrew (Held, 1999) and others. Research into the use of smart city technologies became the object of research by Marciniak K. (Marciniak K., 2013), Greenfield A. (Greenfield A., 2013), Soldatov S. (Soldatov S., 2015), Novotny R., Kuchta R., Kadlec J. (Novotny R. and others, 2014). However, the question of the dependence of the development of smart cities on the level of socio-economic development of the country remains open, which is a very relevant issue in the study of smart technologies.

The purpose of this article is a definition of the features of the formation of smart cities in countries with different levels of socio-economic development.

Results

The development of smart cities in the modern world takes place within the framework of the formation of a general concept of intellectualization of economic activity. The development of technologies, the formation of a new type of society are prerequisites for the development of smart cities and the formation of a new type of ecosystem. An actual issue is the possibility of developing smart cities in countries with different levels of socio-economic development. When determining the level of development of the country, we will take as a basis the Organization for Economic Cooperation and Development, as well as its key partners, as countries with the highest level of development in the world and can serve as a basis for determining the level of dependence between the level of development of the country and the presence and number of smart cities. The studied sample includes countries that differ markedly in terms of socio-economic and geopolitical situation. To account for these differences, all countries selected for the study are divided into 4 groups. First, a group of rapidly developing Asian countries (China, Hong Kong, Singapore, India, the Republic of Korea) was formed. The remaining countries are divided into three groups according to the value of GDP per person during 2005-2015. When dividing the countries, we relied on the results of the hierarchical agglomerative cluster analysis procedure. The procedure for combining countries into clusters is presented in the form of a dendrogram. In fig. 3.8 presents a dendrogram of the clustering of countries by the size of GDP per person using the method of complete ties, the Euclidean distance between countries is chosen as a measure of proximity (Fig. 1).
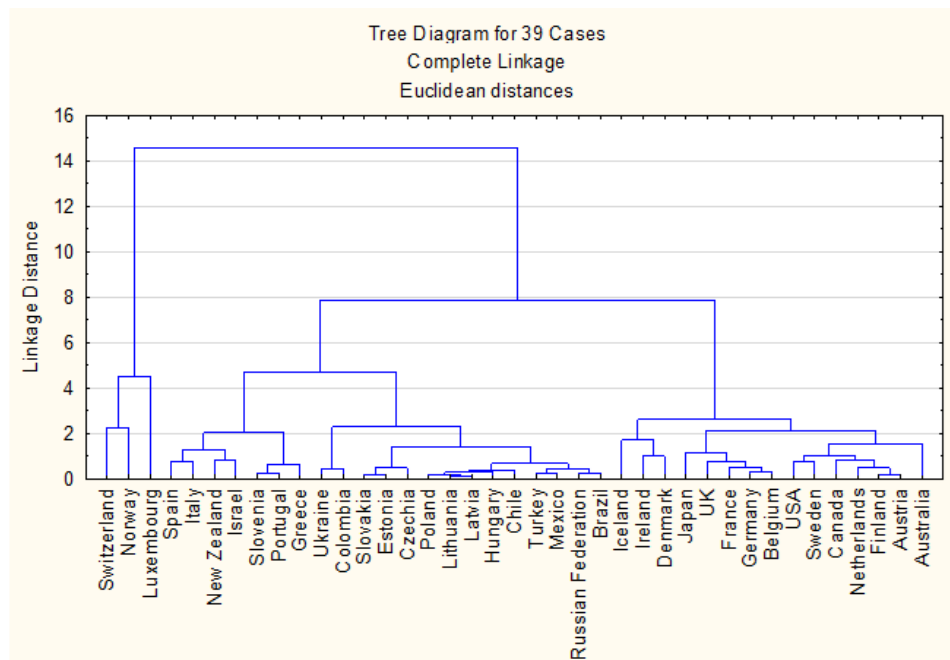
Figure 1. Dendrogram of hierarchical clustering of countries by GDP per capita
Source: built by the authors.

Based on the clustering results, we identified 3 groups of countries characterized by high (cluster 1), medium (cluster 2) and low (cluster 3) values of GDP per person. The 4th cluster included previously selected Asian countries. The composition of each cluster is given in table. 1.

Table 1. List of countries included in each cluster

Cluster 1	Cluster 3
Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Japan, Luxembourg, Netherlands, Norway, Sweden, Switzerland, Great Britain, United States of America	Brazil, Chile, Colombia, Estonia, Hungary, Latvia, Lithuania, Mexico, Poland, Russian Federation, Slovakia, Turkey, Ukraine
Cluster 2	**Cluster 4**
Czech Republic, Greece, Israel, Italy, New Zealand, Portugal, Slovenia, Spain	China, Hong Kong, India, Republic of Korea, Singapore

In general, each cluster has specific pace parameters in both the static and dynamic plane. In general, it is worth determining the average indicators for each cluster in the dynamics. The dynamics of average GDP values by clusters is presented in Fig. 2.
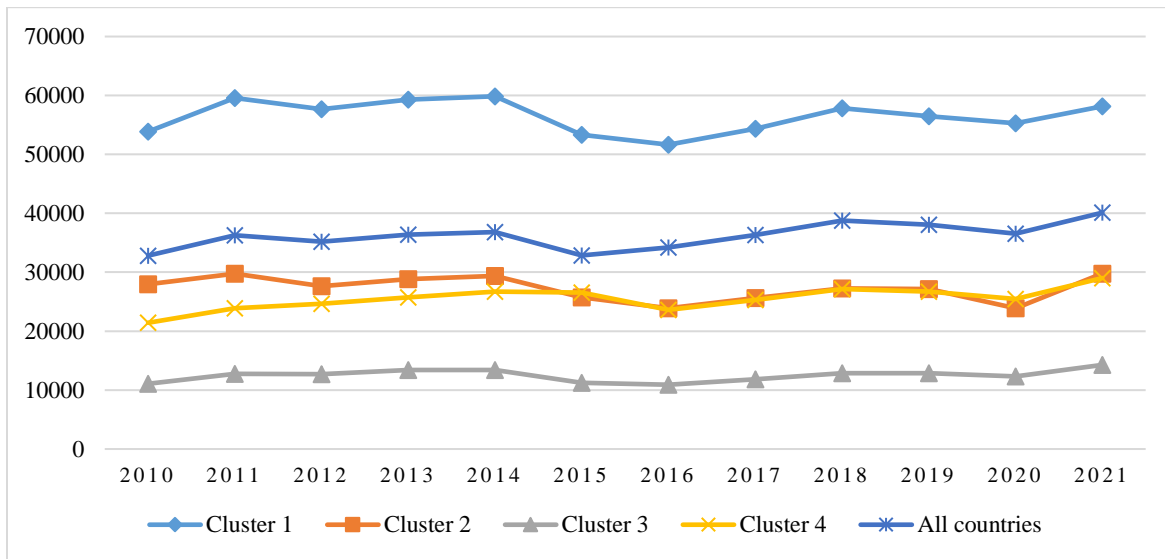
Figure 2. Average values of GDP per person by cluster, USD. USA in 2005-2021
Source: built by the authors based on (World bank…, 2022).

It should be taken into account that the level of development of the countries is a fairly significant basis for the formation of the smart city system, and the countries of the first cluster, which are represented by the most developed countries in the world, are characterized by the largest number of smart cities (Table 2).

Table 2. Number of smart cities by clusters

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
2015	53	20	19	10
2016	57	20	17	9
2017	57	21	18	9
2018	60	25	13	6
2019	69	23	15	18
2020	68	25	16	18
2021	50	11	14	17

Source: built by the authors based on (Smart cities …, 2022).

It is worth noting that the largest number of countries belong to the first cluster, but the dependence between the number of countries and the number of smart cities in the cluster is not observed. However, we can note that the growth rate of smart cities in Asian countries is significantly higher than in other clusters. If for highly developed countries the level of growth has a negative value and shows a decrease in the number of smart cities (this situation is typical for the first three clusters), then in the fourth cluster the growth is 70% in 2021, compared to 2015 (Fig. 3).
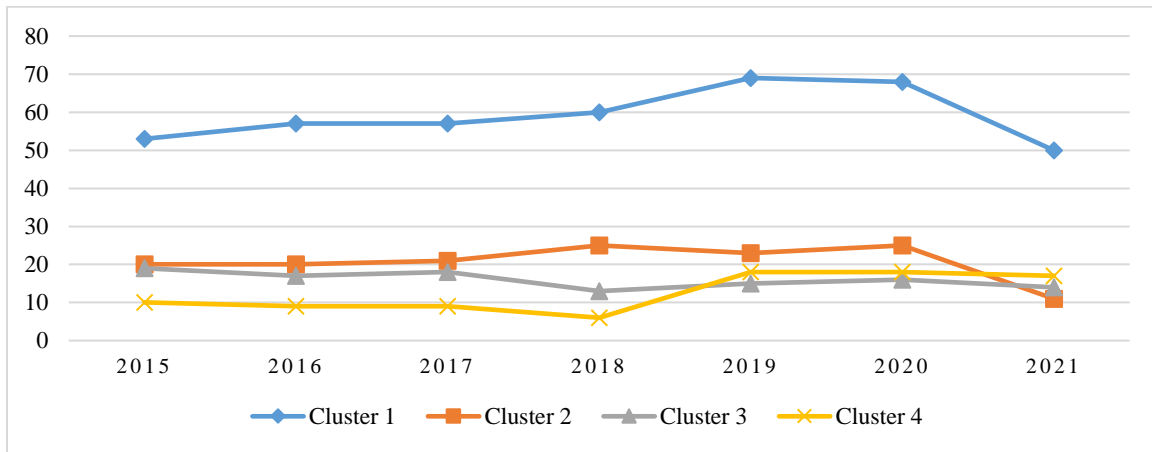
Figure 3 – Dynamics of the number of smart cities by clusters, 2015-2021.

If we do a country analysis, then within the framework of the clusters, the largest number of smart cities is in the countries of the first cluster (countries with the highest level of socio-economic development, world leaders), however, the countries of cluster 4 (countries with the highest growth rates of welfare, Asian countries) show the greatest growth. The countries with the largest number of smart cities in 2021 combine representatives of these two clusters (Fig. 4).
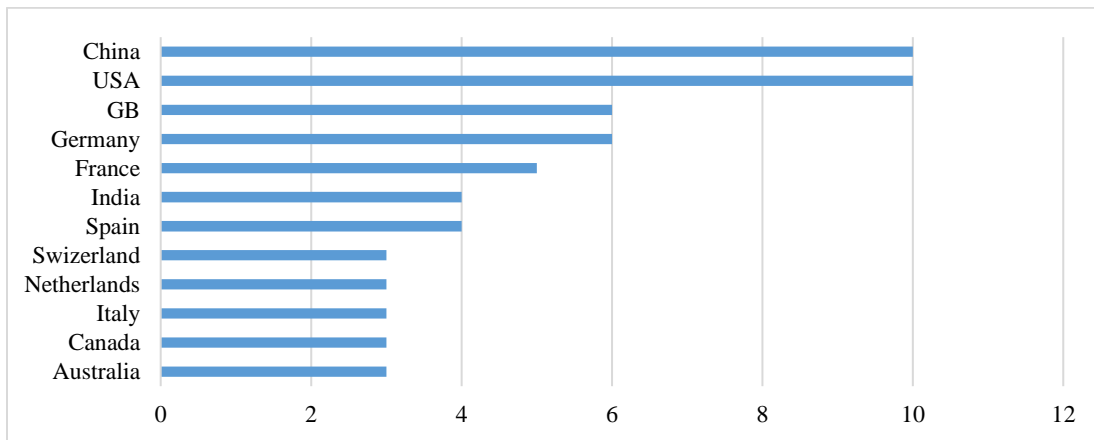

Figure 4. – TOP countries by the number of smart cities, 2021

It is worth noting that China is one of the few countries that significantly increased the number of smart cities during the period under analysis. This was the result of China's purposeful digitalization and intellectualization policy. Thus, the construction of a "digital" China is one of the priorities of the state policy, which contributes to the construction of a technological society, the formation of an industrial ecology, a digital economy, a digital society, the deepening of international cooperation in the digital sphere, the use of digitalization and technologies to fight pandemics, poverty, and provide for the population digital services, formation of stable development (Shanghai's new…, 2021). This was also a consequence of the global coronavirus pandemic in 2020, when the world economy fell into recession, and the management system needed fundamental

changes (Coronavirus…, 2021). Digitization provides opportunities for management in new conditions, in the conditions of the need for remote management and control. As a result of the development of the digital and information ecosystem, there was an increase in the competitiveness of the economy in 2020 (New infrastructure…, 2021). China's digitization and digital economy are becoming an important source of innovation in economic activity, so in 2020, the value of the main sectors of the digital economy was 7.8% of China's GDP (China's digital…, 2021), and revenues from software production in 2020 increased to 8.16 trillion. yuan, relative to 4.9 trillion. in 2016 Accordingly, during the same period, the income from the production and sale of computers, communications, semiconductors, electronic equipment, etc. increased significantly. from 10 trillion yuan in 2016 to 11 trillion in 2019. The Big Data industry grew from 0.34 trillion. yuan (2016) to more than 1 trillion. yuan (2020). Key process management and digitalization of R&D design in key manufacturing industries overall increased from 45.7% and 61.8% in 2016 to 52.1% and 73%, respectively, in 2020. Also, e-commerce transactions increased accordingly from 21.8 trillion. yuan to 37.2 trillion. yuan from 2015 to 2020, respectively. Also, during the specified period, the scale of information consumption increased from 3.4 trillion yuan to 5.8 trillion. yuan respectively (Shanghai's new…, 2020). The industries of software development, distributed operating systems, cloud services and database formation, microcircuit design, memory technologies (flash memory 3D-NAND and DRAM), artificial intelligence technologies, display production (in 2020 the power of China in the production of TFT-LCD displays occupy the first place in the world), optical communications, high-quality optoelectronic microcircuits, 25G laser chips, detector microcircuits, auxiliary electrical microcircuits, quantum information, etc. All these technologies have gained significant development and widespread use, making a breakthrough in the economic and technological development of China and forming the prerequisites for the development of technologies for providing smart cities and their functioning. In order to form a smartmist digital ecosystem, quantum information technologies and the production of supercomputers are also used, where China shows quite good results in the world ranking and provides 45% of the world market (China continues…, 2019). In addition, the unified operating system (UOS) and the operating system of the mobile smart terminal "Hongmeng OS", intelligent voice recognition, cloud computing, etc. contribute to the formation of a smart ecosystem (Huawei releases…, 2021).

Significant volumes of digital public services are aimed at the formation of a digital government, which becomes the basis for the modernization of the national management system. In this area, China also advanced quite significantly from 65th place in 2018 to 45th place in 2020 according to the e-Government Development Index (UN E-gpvernment…, 2020). This was the result of the formation of a national integrated platform of public services, to which 31 provinces, 46 Departments of the State Council and 400 million users were connected.

Conclusions

We can note that the level of technology, digitalization and, in general, the level of socio-economic development can affect the level and quality of the formation of smart cities. The number of smart cities to some extent depends on the level of socio-economic development of the country, but the analysis indicates that recently Asian countries have become quite active in the smartization of urban development, which have prioritized the technologicalization of the economy as a whole and the formation of smart cities as a certain enclave of technology accumulation and formation a certain plan of technological clusters, an example of which can be the Chinese policy for the development of a digital country.

References

Bell D. The coming of post-industrial society: A venture of social forecasting. N.Y.: Basic Books. 1973. ISBN 0-465-01281-7

Castells M., Himanen P. Information society and the welfare state. Finnish model / Trans. from English K.: Vakler Publishing House in the form of LLC, 2006.

China continues to claim most supercomputers on Top500 list. URL: http://www.xinhuanet.com/english/2019-06/17/c_138150718.htm

China's digital economy sees continued growth. URL: http://english.www.gov.cn/archive/statistics/202103/25/content_WS605be874c6d 0719374afb663.html

Coronavirus: How the pandemic has changed the world economy. URL: https://www.bbc.com/news/business-51706225

Greenfield, A. Against the Smart city. URL: https://urbanomnibus.net/2013/10/against-thesmart-city/.

Held, D., McGrew, A., Goldblatt, D. & Perraton, J. (1999) Global transformations. Oxford. Polity Press.

Heylin, M. (2006). Globalization of science rolls on. In Science & Technology. 84(48) 26-31.

Huawei releases the innovative operating system HarmonyOS 2 What is the future of the Hongmeng ecosystem in the era of Internet of Everything? URL: https://www.breakinglatest.news/business/huawei-releases-the-innovative- 89 operating-system-harmonyos-2-what-is-the-future-of-the-hongmeng-ecosystemin-the-era-of-internet-of-everything-_equipment/

Kellner, D. (2002). Theorizing globalization. In Sociological Theory. Vol 20(3) 285-305.

Lukyanenko D.G. Global management strategies. International economic policy. 2008. No. 8-9.

Machlup F. Production and dissemination of knowledge in the USA. M.: Progress, 1966. 462 p.

Marciniak, K. (2013). Applying knowledge grid models in smart city concepts. Proceedings of the 6th Knowledge Cities World Summit, 238–244.

New infrastructure creates a new engine for the digital economy. URL: http://www.gov.cn/xinwen/2021-08/21/content_5632578.htm

Novotny R., Kuchta R., Kadlec J. Smart City Concept, Applications and Services. Journal of Telecommunications System & Management 2014, Volume 3, Issue 2. Doi:10.4172/2167-0919.1000117

Shanghai's new digital infrastructure is energizing and paying dividends. URL: http://www.gov.cn/xinwen/2021-08/20/content_5632427.htm

Smart city index. 2022. URL: https://wwwcontent.imd.org/smart-city-observatory/home/

Soldatov, S.A. (2015). «Smart sity» – gorod buduschego. Sovremennyie tehnologii avtomatizatsii, 2, 24-35.

The truth about smart cities: 'In the end, they will destroy democracy'. URL: https://www.theguardian.com/cities/2014/dec/17/truth-smart-city-destroy-democracy-urbanthinkers-buzzphrase.

UN E-Government Survey 2020. URL: https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-GovernmentSurvey-2020

World bank open data. URL: https://data.worldbank.org/indicator