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STUDY OF THE STATE OF INNOVATION PROCESSES IN THE SOCIAL SECTOR OF CHINA

ДОСЛІДЖЕННЯ СТАНУ ІННОВАЦІЙНИХ ПРОЦЕСІВ У СОЦІАЛЬНОМУ СЕКТОРІ КИТАЮ

The article is devoted to the study of the state of innovation processes in the social sector of China. A comparison of the score of the key indicators of the Global Innovation Index-2022 between China and Ukraine is carried out. A comparative analysis of the rating positions of China and Ukraine by the "Infrastructure" indicator in the context of sub-indicators is carried out. A matrix for increasing the level of inclusion of China's social infrastructure by the main structural elements has been developed. According to the results of the study of the state of innovation processes in the social sector of China, the solution of the problem of energy efficiency remains relevant for China, as for most countries with high rates of industrialization and urbanization, China faces the problem of greater pollution and an increase in the burden on the viability of ecosystems, which indicates the need to pay more attention to the range of requirements for sustainable development, giving priority to such important issues like air and water quality, biodiversity and climate change.

Keywords: *innovative processes, social sector, infrastructure, industrialization.*

Стаття присвячена дослідженню стану інноваційних процесів у соціальному секторі Китаю. Проведена порівняння бальної оцінки ключових індикаторів Global Innovation Index-2022 між Китаєм та Україною. Здійснено порівняльний аналіз рейтингових позицій Китаю та України за індикатором «Infrastructure» в розрізі субіндикаторів. Розроблена матриця підвищення рівня інклюзії соціальної інфраструктури Китаю за основними структурними елементами. За результатами дослідження стану інноваційних процесів у соціальному секторі Китаю показало, що для Китаю актуальним залишається вирішення проблеми енергоефективності, як і для більшості країн, що мають високі темпи індустріалізації та урбанізації. Китай зіштовхується з проблемою більшого забруднення та збільшення навантаження на життєздатність екосистем, що вказує на необхідність приділення більшої уваги спектру вимог до сталого розвитку з приділенням першочергової уваги таким важливим питанням, як якість повітря і води, біорізноманіття та зміна клімату.

Ключові слова: *інноваційні процеси, соціальний сектор, інфраструктура, індустріалізація.*

Relevance of the research topic. The analysis of the state of innovation processes in China's social sector should also begin with a study of the country's position in the Global Innovation Index. China, which ranked 34th in 2012, joined the ranks of the leaders in innovation in 2016 and since then, consistently strengthening its position, has been one step away from the top ten, in 11th place in 2022 [1]. Among the income-rich economies, Above average, China ranks 8th overall in the Innovation Outcomes Sub-Index, and its performance rate is comparable to that of high-income economies such as the Netherlands and Germany, but at a lower level of contribution to innovation. As can be seen in Figure 1. China in its group of countries (upper-middle-income countries) has indicator values that are much higher than the average values for the group for all indicators.

According to such indicators as "Creative outputs" and "Infrastructure", China's positions are as close as possible to those of the TOP-10 countries. In addition, China's large-scale presence in the 100 largest scientific and technological clusters – geographical areas around the world with the highest density of inventors and scientific authors – is indicative. In 2022, China equaled the United States in the number of best science and technology clusters, this indicator reached the level of 21 clusters.

It is interesting to compare the score of the indicators that form the Global Innovation Index between China and Ukraine. Despite the fact that these countries are in different groups, Ukraine's lag behind is not critical according to some indicators (Figure 2).

For example, according to the indicators "Institutions", "Human capital and research"

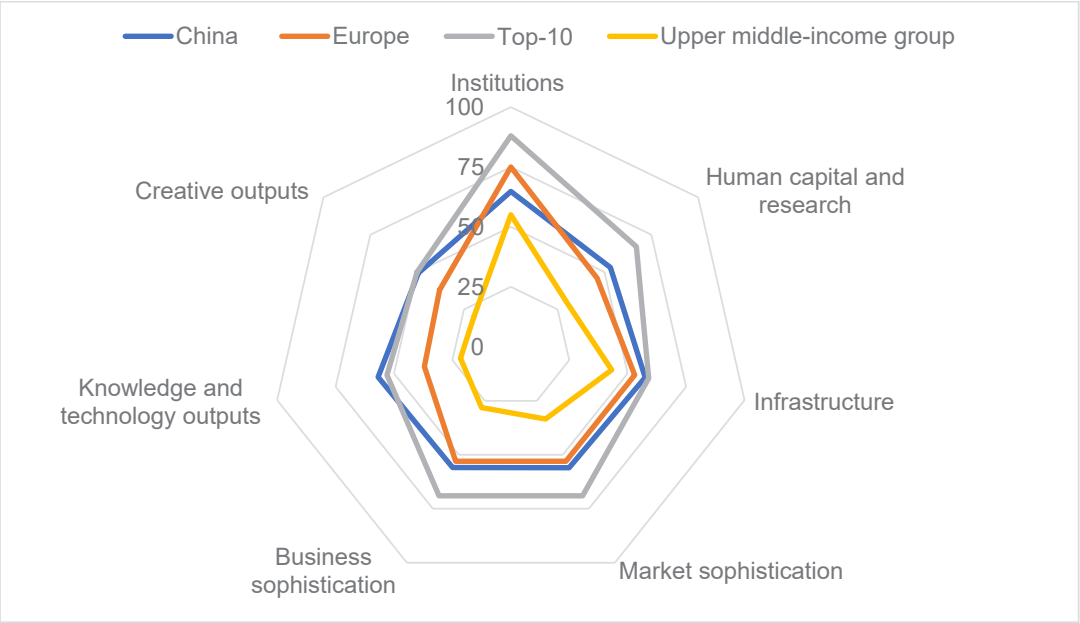

Figure 1. Radar of China's position in the Global Innovation Index-2022 ranking by main indicators

Source: based on [8]

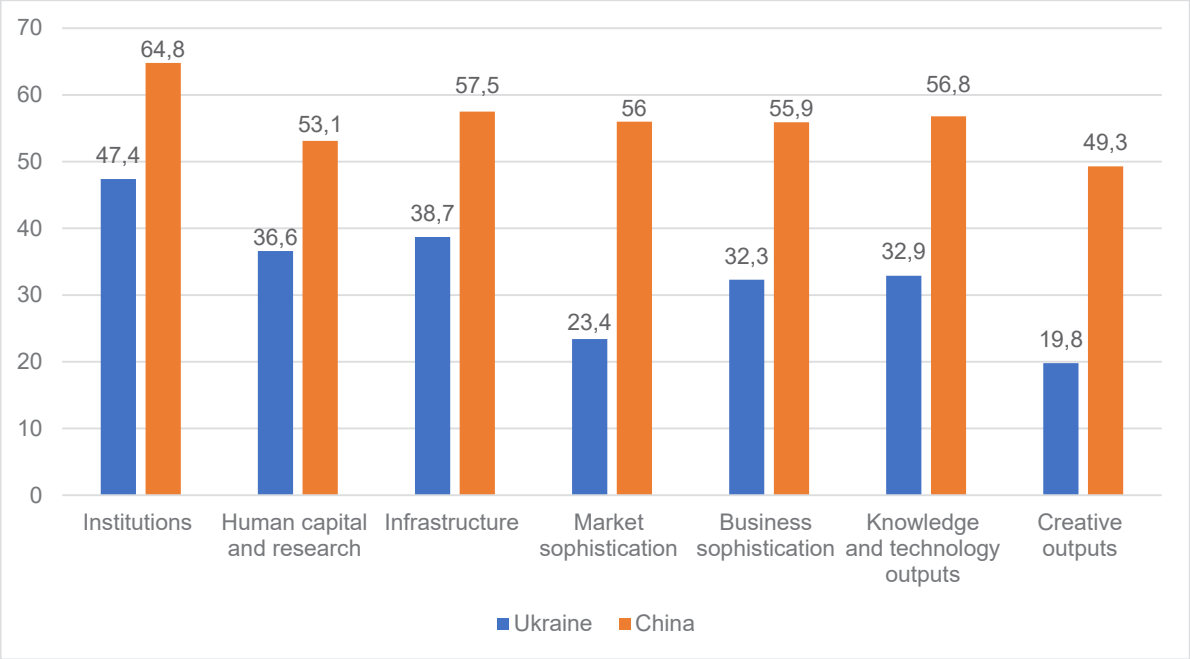

Figure 2. Comparison of the score of key indicators of the Global Innovation Index-2022 between China and Ukraine

Source: built from [2]

and "Infrastructure", the gap between China and Ukraine is the smallest. As part of our research, we will focus on a more in-depth comparative analysis of the "Infrastructure" indicator (Table 1).

Analyzing the results of the presented Table 3. The following conclusions can be drawn:

– compared to 2020, according to the overall "Infrastructure" indicator, both China and Ukraine have risen in the ranking by 11 and 12 positions, respectively;

– the most successful sub-indicator for both *Ukraine and China was the "Information and communication technologies" indicator*

Table 1

Comparative Analysis of the Rating Positions of China and Ukraine by the Infrastructure Indicator in the Context of Sub-Indicators

	Ukraine	China	Ukraine	China	Ukraine	China	Ukraine	China
	2020	2020	2021	2021	2022	2022	ranks changing 2022/2020	ranks changing 2022/2020
Infrastructure	**94**	**36**	**94**	**24**	**82**	**25**	**+12**	**+11**
Information and communication technologies (ICTs)	82	45	69	34	63	20	+19	+25
ICT access	65	71	69	71	66	61	-1	+10
ICT use	89	53	91	52	62	39	+27	+14
Government's online service	93	34	72	12	72	12	+21	+22
E-participation	74	29	46	9	46	9	+28	+20
General infrastructure	95	6	124	5	111	13	-16	-7
Electricity output, GWh/mn pop.	58	45	58	40	60	35	-2	+10
Logistics performance	65	26	65	26	65	25	0	+1
Gross capital formation, % GDP	102	6	125	4	125	3	-3	+3
Ecological sustainability	99	54	106	59	86	54	+13	0
GDP/unit of energy use	117	94	120	97	116	104	+1	-10
Environmental performance	57	98	57	98	43	115	+14	-17
ISO 14001 environmental certificates/bn PPP$ GDP	68	19	82	17	78	15	-10	+4

(+19 positions for Ukraine and +25 positions for China). It should be noted that in China, information and communication technologies have become more and more accessible. At the same time, Ukraine's accessibility to information and communication technologies has decreased. Both countries have made significant progress in the implementation of government online services and electronic participation. This means that in the analyzed countries there has been an increase in the promotion of civic engagement and accessible governance with the help of information and communication technologies. Such growth indicates the rapid expansion of e-participation as a tool for engaging and strengthening cooperation between governments and citizens and improving access to information and public services, which states the implementation by states of policies aimed at expanding equal opportunities in access to information and communication technologies for both individuals and society as a whole;

– both Ukraine and China have some problems with the "General *infrastructure*" *sub-indicator* (-16 positions for Ukraine, and -7 positions for China). For Ukraine, the downgrade of the rating for this subindicator was mainly due to a decrease in the efficiency of electricity production for the population (the shelling of energy infrastructure by the russian federation had a negative impact on this indicator). In addition, there has been a decrease in gross capital formation in Ukraine. Downgrading According to these indicators, Ukraine is the result of destructive external factors. Only in terms of logistics efficiency, Ukraine managed to maintain its position at the level of 2020. For China, the most progressive *indicator for the "General infrastructure"* subindicator was the indicator of efficiency of electricity production per capita, while no progress was made for the efficiency of logistics and the indicator of gross capital formation;

– in comparison with the "Ecological sustainability" *sub-indicator*, Ukraine in the dynamics of its development for the period from 2020 to 2022. ahead of China (+13 positions in the ranking for Ukraine). It should be noted, of course, that in fact, in 2022, China's position is higher, but unlike Ukraine, no progress has been made on this sub-index. Negative shifts in rating positions in terms of GDP per unit of energy consumption. Ratio of Gross Domestic Product (GDP) to Use energy indicates energy efficiency. To obtain comparable and consistent estimates of real GDP by country in relation to physical contribution to GDP, i.e. units of energy consumption, GDP is converted into international dollars in 2017 using purchasing power parity rates. Differences in this ratio over time and by country reflect structural changes in the economy, changes in sectoral energy efficiency, and differences in fuel balances. For China, the growth in energy

consumption is closely related to the growth in modern industrial sectors, motorized transport, and urban areas, but energy use also reflects climatic, geographical, and economic factors (such as relative energy prices) [20, 21]. Therefore, for China, the solution to the problem of energy efficiency remains relevant. In addition, China has even more significant negative indicators in the rating positions for Environmental performance. This indicator characterizes climate change, environmental hygiene and the viability of ecosystems. As for most countries with high rates of industrialization and urbanization, China faces the problem of greater pollution and increased pressure on ecosystem viability, which indicates the need to pay more attention to the spectrum of sustainable development requirements, with priority given to important issues such as air and water quality, biodiversity and climate change;

– As for Ukraine, it has a negative downgrade value for ISO 14001 environmental certificates/ bn PPP$ GDP, which reflects the effectiveness of the country's environmental management system. This standard is designed primarily to reduce the impact of the activities of enterprises on the environment. In the world market, more and more organizations and enterprises are implementing the ISO 14001 system with subsequent environmental certification in order to be recognized in the market of products and services, to have access to credit for the implementation of business development measures, to gain favor from environmentally conscious consumers [23]. According to the experience of the EU countries, this practice contributes to the development of the economic component, since bringing national requirements to the level of international ones opens up opportunities for the export of products and services, increasing the scientific and technical base, attracting partnerships in the field of information technology, as well as participation in research, technical and design projects, which are aimed, among other things, at the implementation of resource-saving technologies and raising public awareness of environmental component [23]. In Ukraine, the situation is somewhat different, despite the fact that the ISO 14001 standard was adopted in 1997 [24]. It has not yet been widely used among manufacturers, which, on the one hand, is due to the lack of a conscious approach to the greening of production, and on the other hand, to a lack of understanding of the general requirements of this standard, which often requires the involvement of specialized specialists to obtain consulting services. The strategic task for Ukraine is the development of an environmental management system, as it opens up new opportunities for manufacturing enterprises, in particular for exporting products to the world market of goods and services, investing in the implementation of innovative projects, and ultimately for the economic component of the country;

– Unlike Ukraine, China has made progress in implementing an environmental management system (+4 positions in the ranking compared to 2020). Since 2016, China has been actively implementing an environmental standardization strategy with an emphasis on an innovative, coordinated, "green" development path. Together with other countries of the world, China is strengthening cooperation in the field of standardization, promoting the exchange of experience and mutual learning, and improving international standardization systems. With the great support of the Chinese government, more than 210,000 organizations have been ISO14001 certified and ISO14001 certified [25; 27].

Thus, the analysis of the positions of China and Ukraine on the "Infrastructure" indicator in the Global Innovation Index-2022 formed an idea of the progress and problem areas of innovative development of the countries' infrastructure in general and social infrastructure in particular.

At the same time, despite the fact that the Global Innovation Index is quite informative in determining the country's position on certain indicators in comparison with other countries, this index reflects global trends that are the result of internal processes, which actualizes the need to study the innovative development of social infrastructure not only at the macro level, but also at the level of internal processes of the country. In this context, attention should be paid to the trends and dynamics of formation real GDP in China, the main driver of growth in 2022 was investment (Figure 3), which was facilitated by public sector spending on infrastructure [3]. Half of the infrastructure investment was directed to transport and public facilities. An increase in the level of utilization of industrial capacities keeps investment in business at a high level, but investment in real estate has stopped due to defaults of construction companies and a drop in sales. An analysis of China's investment structure (Figure 4) showed that it is necessary to spend more on "soft" (education, healthcare, social protection) and "hard" investments (environmental facilities, renewable energy sources, urban transport systems, etc.). Social protection should increase, but government revenues are low, which requires reform of the pension system, health care system and public revenue system.

First of all, this need arises due to the fact that the Chinese have a high life expectancy compared to the level of income in the country,

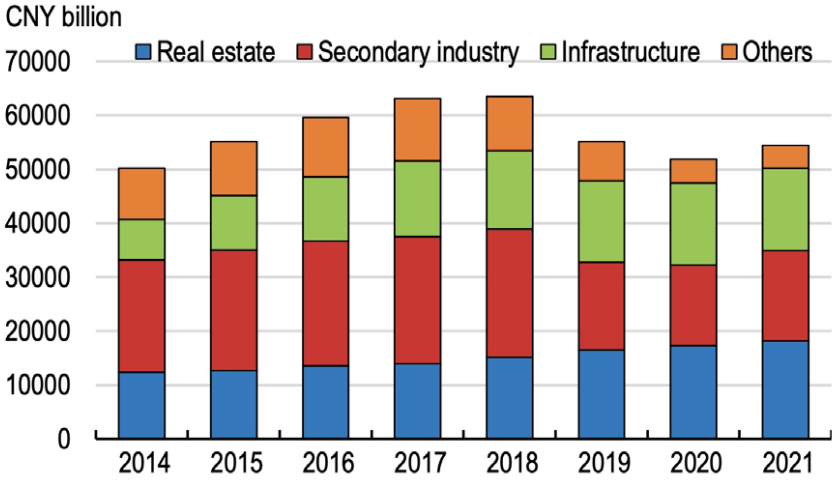

Figure 3. The share of infrastructure and real estate investment has increased, while industry's shrank

Source: [28]

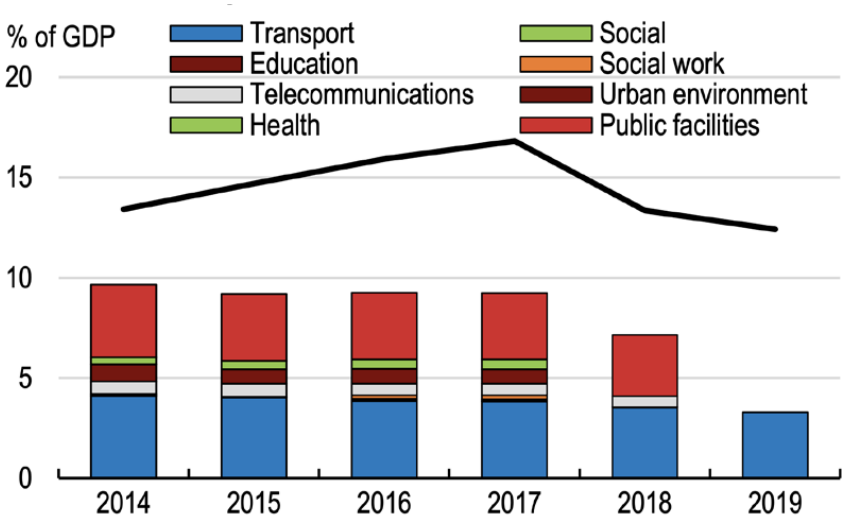

Figure 4. Infrastructure investment exceeded a quarter of the total and goes mainly to transport and public facilities

Source: [4]

but they retire early. Different pension schemes offer different benefits, while contribution rates are a high burden on low-income populations. COVID-19 has exposed weaknesses in China's healthcare system. The emergence of the health crisis was the result of insufficient funding and staffing of disease control centers, as well as insufficient development of the mechanism of the infectious disease information system. Therefore, in order to achieve inclusive and sustainable growth, it is necessary to modernize social security systems and fiscal revenues.

Common features of the health system, such as underfunding, uneven geographic distribution of resources, especially high-quality ones, a high proportion of out-of-pocket health expenditures, limited availability of intensive care units, the level of effectiveness of the emergency response system, and other factors have contributed to the outcome of the COVID-19 outbreak.

For example, according to the official data of the Chinese Statistics Service, personal expenditures of the population in the field of health care continue to grow despite the increase in social spending in the field of health care (Figure 5). In 2021, personal expenditures of the population exceeded the level of public spending. Of course, 2021 showed the country's better preparedness to deal with the consequences of the pandemic. These features will also determine the system's ability to make growth more inclusive and sustainable. The health insurance coverage rate is high, over 95%, but the reimbursement rate is relatively low, especially outside the place of

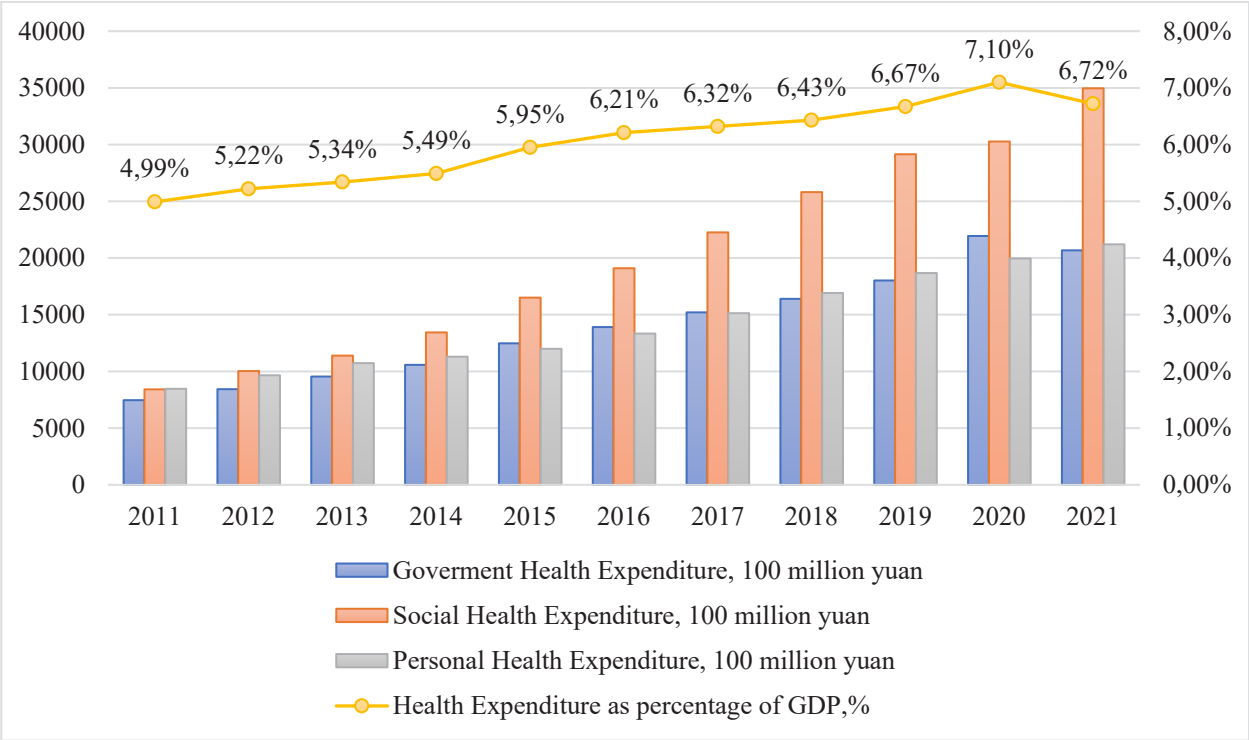

Figure 5. The structure of healthcare expenditures in the dynamics for the period 2011–2021

Source: based on information from the website of the State Statistics Service of Cathay [5]

household registration. In general, the development of the health care sector in China, as well as Ukraine, has discriminatory problems in terms of servicing the rural population. Regional discrimination also applies to China's social insurance system, which is currently highly segmented across categories of workers and regions. Unification at the provincial level of pension administration will help avoid deficits in regions with ageing populations and surpluses in regions with young populations, and the transfer of social security between regions should be seamless and free of penalties for receiving services outside the registered place of residence.

The next indicator that should be analyzed to understand the development of China's social infrastructure is the average number of people enrolled in education per 100,000 population by level of education and regionally. Analysis of statistical data has shown that over the past 10 years there has been a gradual increase in the average number of people enrolled in preschool and higher education by 100 thousand. populace. The trend of resumption of growth after a sharp decline in the period from 2012 to 2015. observed for primary and junior secondary education. But the average number of people covered by senior secondary education per 100 thousand. Compared to 2011, it decreased by almost 21%. This trend may lead in the future to an uneven filling of the labor market and a shortage of specialists in certain professions.

An analysis of the average number of enrolments per 100,000 population by region in 2021 showed that the Bejing region has the highest enrolment rate in tertiary education, while having the lowest enrolment rates in junior secondary education and upper secondary education (Table 2). Qinghai region has the lowest higher education enrolment, almost 4 times lower than Bejing region. The Guangxi region has the highest enrolment in preschool education and upper secondary education, while the Heilongjiang region has undercoverage in early childhood education. The Xinjiang region has the highest rate of enrolment in junior secondary education. Thus, in general, there is a certain unevenness of coverage among different levels of education in China.

Thus, the conducted study of the state of innovation processes in the social sector of China on the basis of the country's position in the Global Innovation Index and the analysis of statistical indicators of social infrastructure, we consider it expedient to offer a matrix of identified bottlenecks and appropriate recommendations for overcoming them (Table 3).

It should be noted that the innovative development of China's social infrastructure over the past few years is primarily due to the COVID-19 pandemic, which has caused a new wave of

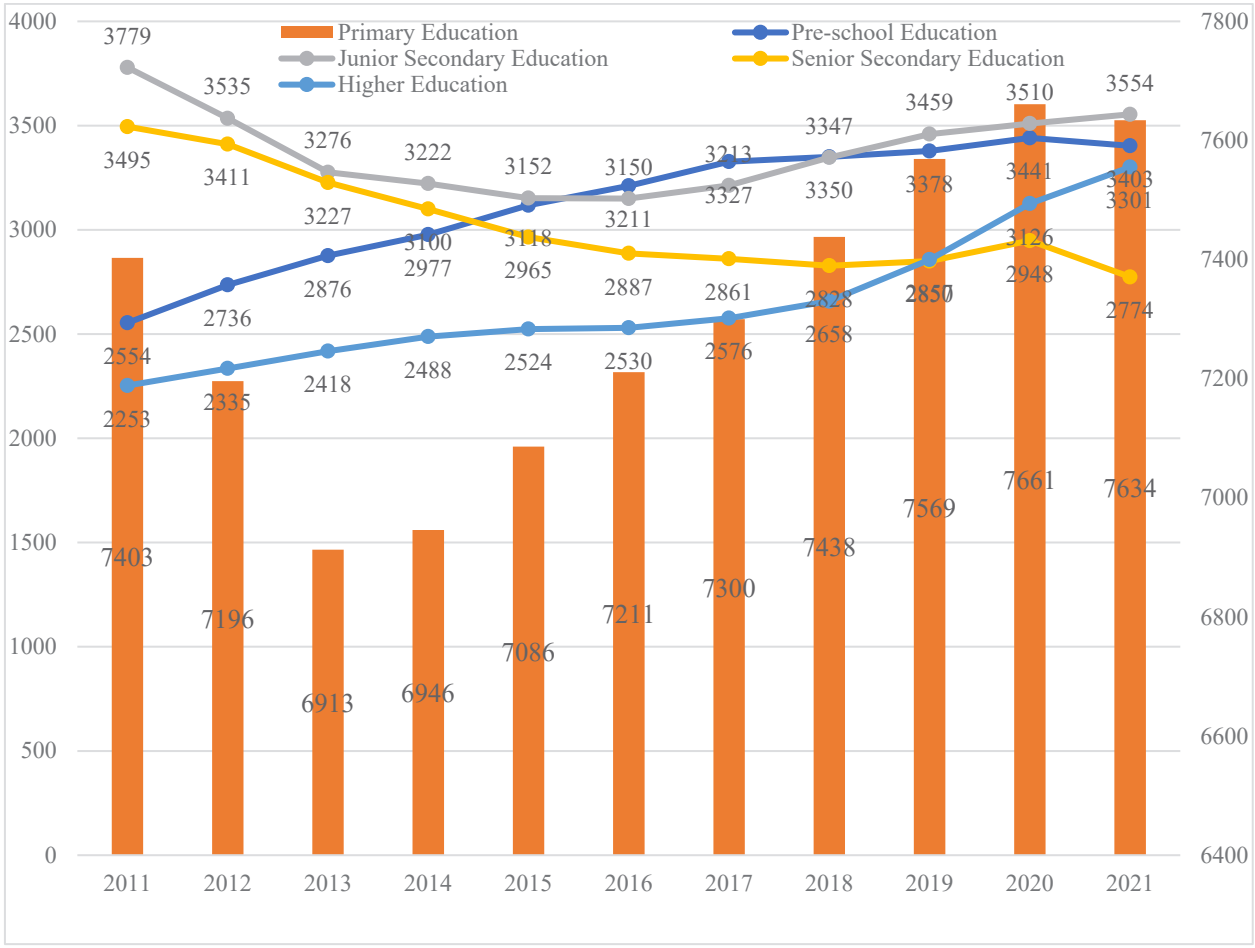

Figure 6. Average Education Enrolment per 100 000 Population by Level in the dynamics for the period 2011–2021

Source: based on information from the website of the State Statistics Service of Cathay [4]

innovation throughout the economy. Medicine is the main area where the government has pledged to invest more in research and development, but this time the innovation is more inclusive as it meets the demand of hundreds of millions of people. Another area that has undergone further innovative development in China is digital services for the public. But not all digital services have benefited from the COVID-19 outbreak. The share of the sharing economy, which accounted for 3.2% of GDP in 2019 and has developed dynamically in recent years, is likely to decline due to growing wariness about the physical sharing of homes, cars, appliances, and other facilities.

The main source of innovative development of social infrastructure in China today is considered to be concession projects. According to the World Bank of China, 130 billion dollars should be invested annually in the development of social infrastructure. USD. and the total amount of state spending on the social sphere is 200 billion USD. USD. This is 40% of the state budget revenues [30]. Such expenditures prompted the Chinese authorities in 2004 to amend the Constitution regarding the nationalization of land and allowed the use of concessions in the implementation of large-scale infrastructure development projects, mainly in the construction of roads and expressways, bridges, educational institutions, etc. This made it possible to attract private investment and start large-scale projects. Thus, according to the concession project for 300 billion. USD. 16 thous. Km. a new high-speed railway, which also contributed to an increase in employment in construction. The construction of the Shanghai-Beijing branch involved 100 thousand tons. According to the project, it is planned to build 42 high-speed branches [6].

In China, concession projects have been developed in the construction of water utilities and power plants, highways, new metro lines and light metro, the creation of high-speed bus lines connecting residential areas of cities with industrial and commercial centers. Examples of such concession projects are: the construction

Table 2

Average Education Enrolment per 100 000 Population by Regions in 2021

Region	Pre-school Education	Primary Education	Junior Secondary Education	Senior Secondary Education	Higher Education
Bejing	2589	4735	1597	1024	5313
Tianjin	2278	5421	2458	1953	5153
Hebei	3310	9169	4139	3429	2926
Shanxi	2893	6671	3131	2880	3112
Inner Mongolia	2514	5861	2770	2454	2351
Liaoning	2049	4638	2335	2062	3742
Jiilin	1749	4798	2506	2423	4550
Heilongjiang	1541	3700	2632	2367	3448
Shanghai	2251	3588	2000	1139	3691
Jiangsu	2979	6909	3113	2233	3531
Zhejianng	3105	5928	2572	2162	2632
Anhui	3506	7678	3765	3138	3089
Fujian	4020	8481	3668	2583	3023
Jiangxi	3581	8758	4789	3712	4001
Shandong	3830	7435	3818	2622	3429
Henan	4018	10179	4820	3578	3424
Hubei	3108	6670	3085	2413	3914
Hunan	3542	7977	3874	3161	3487
Guangdong	3964	8547	3400	2306	2922
Guangxi	4533	10280	4580	3792	3432
Huinan	3871	8596	3876	3112	2839
Chongqing	3101	6329	3528	3129	3605
Sichuan	3127	6558	3343	2760	2925
Guizhou	4291	10273	4665	3533	2593
Yunnan	3748	8158	3886	3318	2871
Tibet	4274	9989	3964	2976	1634
Shaanxi	3473	7494	3046	2395	4279
Gansu	3879	8097	3538	2868	2999
Qinghai	3845	8730	3747	3719	1613
Ningxia	3626	8373	3980	3380	2749
Xinjiang	4305	11328	4312	2906	2526

– maximum value

– maximum value

of the LaibinB Power Plant in Guang Chi Province – foreign investors participated in the concession on a tender basis; construction of water treatment plants in Chengdu, Shenyang and Beijing. In 2005, a public expert and analytical department "China Center for Public-Private Partnerships" was established in Beijing, which is engaged in analytical research and control over concession projects in the field of public utilities [31]. In a fairly short time, when establishing mutually beneficial relations between the state, private partners and the public through the use of various forms of public-private partnership, including concessions, significant positive results were obtained in the social sphere of China.

Conclusions. Thus, a study of the state of innovation processes in the social sector of China showed that for China the solution of the problem of energy efficiency remains relevant, as for most countries with high rates of industrialization and urbanization, China faces the problem of greater pollution and an increase in the burden on the viability of ecosystems, which indicates the need to pay more attention to the range of requirements for sustainable development, with priority given to such important issues like air and water quality, biodiversity and climate change. In addition, the innovative development of social infrastructure requires an increase in the level of its inclusion, especially in the areas of education, health care and public services.

Table 3

Matrix for Increasing the Level of Inclusion of China's Social Infrastructure by Main Structural Elements

Strengthening inclusiveness	
Bottlenecks	Recommendations
Health	
1. COVID-19 has highlighted the drawbacks of low health cost reimbursement, pushing many people to the brink of poverty. 2. Disease control centers are underfunded and losing staff. 3. A system of direct reporting of infectious diseases to the central government, but it can be blocked at the local level. 4. Lack of a transparent and effective mechanism for global data exchange.	1. Distribute high-quality healthcare resources more evenly to reduce incentives to move to metropolitan areas. 2. Increase the number of qualified medical personnel in rural areas through more efficient rotation of quality personnel. 3. Ensure that local centers for disease control are adequately funded and staffed so that they can help avoid future health crises. 4. Improve the mechanism of the infectious disease reporting and information exchange system and guarantee its smooth functioning. 5. Increase transparency and data sharing with global healthcare experts and organizations
Education	
1. Uneven distribution of qualified teaching staff between regions. 2. Uneven coverage of the population at different levels of education. 3. Uneven filling of the labor market and shortage of specialists in certain professions	1. Increase the number of qualified teaching staff in rural areas through more effective rotation of quality personnel. 2. Expand the network of preschool education institutions and the coverage of children with education in rural areas. 3. Distribute high-quality education resources more evenly to reduce incentives to move to metropolitan areas.
Public Services & Public Transport	
1. People's access to public services is still largely related to their residence or place of household registration. 2. Currently, only city workers are covered by unemployment insurance. 3. China has a high life expectancy for its income level and a low retirement age 4. Lack of an adequate commuter transport network	1. Extend unemployment insurance to the entire workforce and unify administration at the national level. 2. Ensure the sustainability of the pension system by linking retirement age to life expectancy. 3. Establish commuter rail networks for better integration of rural areas near cities. 4. Widen and improve rural roads to integrate such areas into commercial networks and provide commuting to cities.
Environmental sustainability of cities and regions	
1. Pollution causes great damage to human lives 2. Constant increase in energy consumption against the background of a lack of sufficient energy efficiency 3. Increasing the burden on the viability of ecosystems	1. Accelerate China's energy transition through green investment. 2. Incentivize producers of electricity from renewable sources by allowing them to sell the electricity they generate through the grid. 3. Increase investment in wastewater treatment plants and environmental infrastructure, including urban water treatment and environmentally friendly rural sanitation facilities.

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