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Evaluation on the New Infrastructure Drive in the Digital Economy Era Based on the Internet of Things

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Abstract: Implementing innovation-led growth strategies and digital businesses is critical. Ways to develop the digital economy include: vigorously developing the digital industry; promoting digital inclusion and strengthening the digital development of the government; accelerating the digital transformation of traditional industries; strengthening the structure of digital business service providers; strengthening the elements of ecological and digital integration of economic development. On this basis, the development of the digital economy was discussed in depth, hoping to play a certain reference role in the development of the country's digital economy. In the construction of new infrastructure, in order to make full use of the functions of the digital economy and promote the construction of new infrastructure, this paper used various algorithms to study the topic of how to make full use of new infrastructure drivers in the Internet of Things. The research results showed that the new infrastructure-driven research in the digital economy era under the Internet of Things constructed in this paper has improved economic development by 13.97%.

1. Introduction

As an important part of modern new information infrastructure, the Internet of Things is an important direction and driving force for a new round of industrial transformation, supporting the digital transformation and development of society and economy, and ultimately building a digital twin society with comprehensive perception and ubiquitous connectivity. However, the current research on the new infrastructure drivers in the era of the Internet of Things and the digital economy is very scarce, and cannot effectively provide strong data support for their related fields. Therefore, in the context of the digital economy, it is very meaningful and necessary to carry out new infrastructure construction.

In the context of the digital economy, many scholars are exploring how to develop these industries in the digital economy. Natanael Y proposed that capital operation is an important way for the rapid development of enterprises, while the traditional capital operation is "financial capital", and the control right is the key factor of capital operation [1]. Tien J M analyzed the current situation of digital economy development and digital transformation of telecom companies, and summarized the needs and transformation paths of digital economy development such as China

Mobile, China Unicom, and China Telecom [2]. According to the construction status and background of the national dual-carbon park, Jing Linbo elaborated on the construction goals, construction and operation plan of the industrial Internet-based dual-carbon park. The promotion approach of "Double Carbon Park" was discussed from the aspects of research, industry, technology, application and transaction [3]. Garrido-Hidalgo C proposed that with the continuous development of big data and Internet of Things technology, data has become a commodity, and a data mining industry has emerged, which collects and analyzes user data. The original data reflecting various fields of production and life were collected into the cloud database, and then handed over to the technicians of the network company for mining and analysis to generate products containing "surplus data" for market sales and service provision [4]. Grigorescu A emphatically introduced the application of "digital" monitoring and Internet of Things technology in grain quality and safety monitoring. The application of the "digital" monitoring system in the country was expounded from the aspects of grain harvest quality monitoring, construction of high-quality grain and oil raw material bases, source control of polluted grains, and food quality tracking [5]. Through in-depth analysis of the integration and development of various technologies in the digital economy era, and through in-depth research on technologies such as big data, the Internet of Things, and artificial intelligence, Dneprovskaya N V has contributed to the promotion of the application and development of digital technologies in all walks of life in China [6]. Soeparna I discussed the advent of the era of tourism big data, the integration of cloud computing, Internet of Things, blockchain, augmented reality and other technologies, and applied it to China-ASEAN international tourism, labor and other industries, promoting the digital transformation of tourism in the China-ASEAN region [7]. The image of the city is hotly discussed in life, but also attracts attention in academia.

In the context of global economic integration, the development prospects of new infrastructure in the digital economy are broader, and scholars are paying more and more attention to new infrastructure. Tianshi G U believed that the digital economy is an important driving force for China's economic development in the new era, and it is particularly important to build a new system that is compatible with the new infrastructure [8]. Wang J started from the traditional trust theory model. Combined with the development characteristics of the digital economy and the new security issues arising in the development process, a new concept of digital trust was proposed, and it was summarized and analyzed [9]. Yu H proposed to further strengthen top-level design, focus on effective investment and precise implementation, connect with advanced systems, and use new development concepts to grasp and develop new infrastructure, so as to better promote the high-quality development of China's service trade in the new era [10]. Murdoch A analyzed the trend of the times and took "new infrastructure" as the driving force to promote the digital transformation, intelligent upgrade, and integration innovation of smart cities, laying a solid foundation for China's economic and social development in the new era [11]. On the basis of his predecessors, Liu Y proposed the use of new infrastructure to promote the upgrading and transformation of the country's manufacturing industry, hoping to provide a reference for economic growth and high-quality development under the influence of the current epidemic [12]. Jiang Z went from the state's vigorous support of "new infrastructure" to the irreplaceability of "new infrastructure" such as big data investigation, drone sterilization, unmanned distribution, artificial intelligence, etc. under epidemic prevention and control, as well as the concepts and tasks of "new infrastructure". All of them indicate that the "new infrastructure" is coming [13]. Birch K believed that with the acceleration of the global digitization process, the new generation of information network has become a strategic public infrastructure, and its development degree has become an important symbol to measure a country's comprehensive strength [14]. At this stage, most of the research on new infrastructure drivers in the digital economy era is to explore the impact of a

certain technical algorithm on new infrastructure drivers, and does not link the Internet of Things and new infrastructure drivers. Based on this, in the era of digital economy, this paper combined research on the new infrastructure-driven research of the Internet of Things.

In order to promote the development of new urban infrastructure and improve economic vitality, in the era of digital economy, this paper would construct new infrastructure drivers based on algorithms, put forward feasible suggestions, and conduct research on the influence of urban infrastructure constructed in the era of digital economy. At the same time, a comparative study was carried out with the influence of traditional urban infrastructure, so as to draw a feasibility conclusion.

2. New Infrastructure-driven Model in the Digital Economy Era

(1) Nonlinear filtering algorithm based on interpolation formula approximation

In order to improve the influence of rotation error on filtering accuracy during function approximation, a discrete difference filtering theory based on Stirling (Stirling's approximation) interpolation polynomial is used in this paper [15].

First, two operators are defined, the pseudo-difference operator δ and the averaging operator μ:

$$\delta f(x) = f(x+\frac{h}{3}) - f(x-\frac{h}{3}) \tag{1}$$

$$\mu f(x) = \frac{1}{3}(f(x+\frac{h}{3}) - f(x-\frac{h}{3}) \tag{2}$$

Among them, *h* is the interpolation step size

The function f(x) is expanded by second-order Stirling interpolation at $x = \bar{x}$, and the result is obtained:

$$f(x) \approx f(\bar{x}) + f'_{DD}(\bar{x})(x-\bar{x}) + \frac{f''_{DD}(\bar{x})(x-\bar{x})^2}{2} \tag{3}$$

Here, the central difference is used instead of the derivative in the Taylor series expansion, that is:

$$f'_{DD}(\bar{x}) = \frac{f(\bar{x}+h) - f(\bar{x}-h)}{2h} \tag{4}$$

$$f'_{DD}(\bar{x}) = \frac{f(\bar{x}+h) - f(\bar{x}-h) - 2f(\bar{x})}{h^2} \tag{5}$$

(2) Kalman filter

The Kalman filter is an optimal filter for a Gaussian noise linear dynamic system with minimum error as the criterion [16]. Consider the following linearly invariant system:

$$x_{k+1} = Fx_k + \Gamma w_k \tag{6}$$

$$y_k = Hx_k + \upsilon_k \tag{7}$$

$w_k \in R^n$ and $\upsilon_k \in R^m$ are input white Gaussian noise and measurement noise, respectively. *F* and *H* are the state transition matrix and measurement matrix, respectively. Formula 6 is the state formula of the system, which is used to describe the dynamic characteristics of the system. Formula

7 is the observation formula of the system. Although the state vector of the system cannot be directly observed, it can be assumed that it is produced by some excitation and a relationship can be established between the observed vector and the state vector.

The Kalman filter first needs to establish the following assumptions. The system is linear and known; the interference is Gaussian white noise; the optimal criterion is the minimum mean square error.

That is to say, w(t) and v(t) are uncorrelated zero-mean white noise, satisfying:

$$E\{w_k w_j'\} = Q\delta_{ki} \tag{8}$$

$$E\{\upsilon_k \upsilon_j'\} = R\delta_{kj} \tag{9}$$

$$E\{w_k \upsilon_j'\} = 1 \tag{10}$$

(3) Information filtering

Information filtering is a processing method in which the propagation error variance matrix of the traditional Kalman filter is converted into an information matrix by the matrix inversion formula, and then the process is repeated to transmit and update the data [17]. Using data filtering avoids searching for high-dimensional inverse matrices and transforming high-dimensional covariance matrices into low-dimensional inverse matrices when the sensor noise for each sensor is irrelevant. The observed noise for each sensor is the state and diversity indicators in data filtering, respectively:

$$\hat{y}_{i|j} = P_{i|j}^{-1}\hat{x}_{i|j} \tag{11}$$

$$Y_{i|j} = P_{i|j}^{-1} \tag{12}$$

The observation formula is:

$$z_k = H_k x_k + \upsilon_k \tag{13}$$

The information obtained from this observation can be described as:

$$ik = H_k^T x_k + z_k \tag{14}$$

$$I_k = H_k^T R_k^{-1} H_k \tag{15}$$

3. Driving Factors of the New Infrastructure of the Digital Economy under the Internet of Things

(1) Analysis of Internet of Things elements

IoT is to exchange information through sensors according to an agreed protocol, intelligently identify and realize monitoring and management, and perform positioning and tracking [18]. The Internet of Things is a "tangible Internet", and its connotation includes two levels. First, the Internet is the expansion and expansion of the Internet, and its core and foundation are still the Internet; second, in the Internet of Things, it is not only people, but also things, and the Internet of Things is the interaction and communication between people and things. With the development and application of the Internet of Things, it would promote the development of production, life and social governance in the direction of intelligence, refinement and networking, and greatly improve the level of social governance and public services, as well as large-scale production. The emergence

of new technologies, new products, new applications, new models, the upgrading of traditional industries and the transformation of economic development methods would promote and become the growth point of future economic development, as shown in Figure 1.

It can be obtained from Figure 1 that the structure is divided into three layers: the perception layer, the network layer, and the application layer.

Perception layer: its main function is to collect and understand various physical quantities, signs, sounds, videos and other physical quantities, including sensors, RFID (radio frequency identification), two-dimensional codes and other technologies.

Network layer: it is mainly used to realize wider and faster networking, and transmit data information reliably and securely. At present, the communication network that can be used for the Internet of Things is mainly the Internet; wireless communication networks include satellite communication networks and cable television networks.

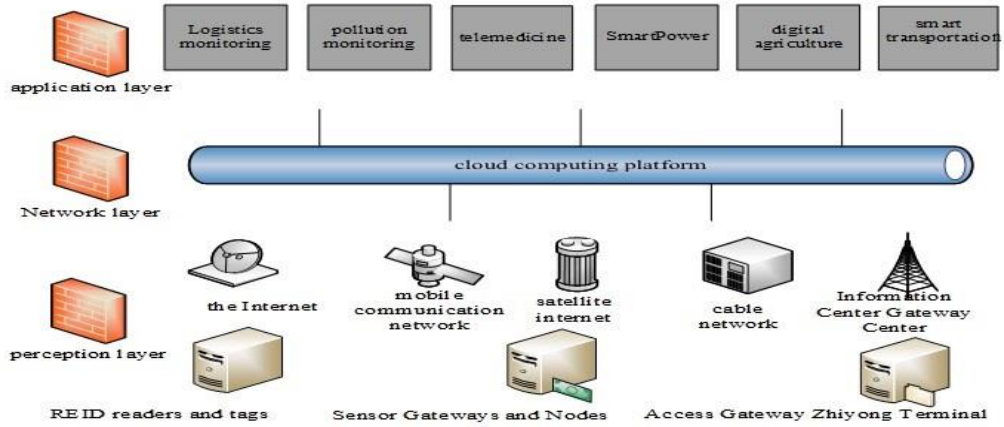

Figure 1: Analysis of the Internet of Things elements

Application layer: application support includes platform layer and application service layer. Information support in applications and systems is used to support sharing and interaction. The application service layer covers smart transmission, smart home logistics, smart medical care, smart digital environmental protection, digital agriculture, digital deep forest and other fields.

(2) Analysis of elements in the digital economy era

The digital economy is a new type of economic development, and it has become an important force in promoting national economic growth [19]. The platform economy, sharing economy, and digital industry of the "14th Five-Year Plan" believe that in order to promote the deep integration of the digital economy and the real economy, the pace of industrial digitization must be accelerated. The high-quality development of the "new economy" should be guaranteed by government regulation; coordination between the government and the market is strengthened. Diversified collaboration, social organization management and multilateral collaboration provide institutional guarantee and support for the healthy development of the company's new business, as shown in Figure 2:

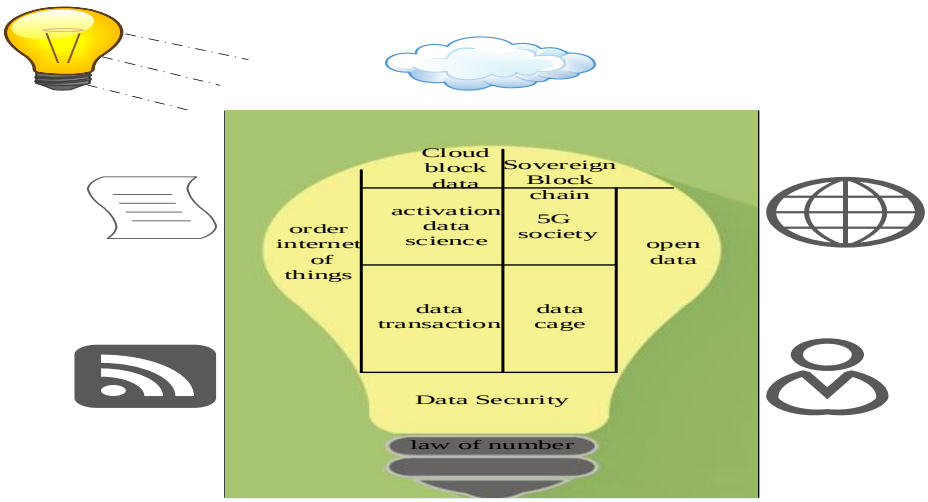

Figure 2: Factor analysis in the digital economy era

As shown in Figure 2, the digital economy, that is, the economic concept of the economy, refers to the use of massive data in the process of understanding, selection, screening, storage, and use of people to achieve optimal resource allocation and revitalization and high-quality economic development. The digital economy is a relatively broad term that can include any economic form that directly or indirectly directs resources and supports productivity development through data. Technical aspects include big data, cloud computing, Internet of Things, blockchain, artificial intelligence, and 5G (the 5th generation mobile communication technology) communications. From the application point of view, "new retail" and "new construction" are typical representatives.

The digital economy is a new economic model following new economic models such as agriculture and industry. The data source is the main body as the main carrier of the modern information network; the integration is centered on the application of information technology and digitization. With the rapid development of the digital economy, its radiation range and extensive impact on people's production methods have brought profound changes to the way of life and economics. This global factor plays a key role in the adjustment of resource structure and is applied to the global economic model and international competition model.

(3) Analysis of the driving factors of new infrastructure in the digital economy era

The construction of new infrastructure (referred to as new infrastructure) includes the key construction of 5G base stations, UHV expressways, high-speed rail subways, new energy vehicle charging, big data centers, artificial intelligence and other seven major areas; digital transformation, based on informatization, promotes new development on the basis of multi-chain industrial chain, and provides comprehensive innovation and other services to achieve the needs of intelligent and high-quality development [20].

The construction of new infrastructure would realize new development in the era of smart economy. The results of absorbing new technology innovation would endow society with intelligent digitalization, rapid transformation of old and new kinetic energy, modern economic system, infrastructure, disaster resistance and other functions, so as to establish an effective preventive and public health service mechanism and national capital construction and infrastructure. Based on 5G-Internet-cloud computing-blockchain-Internet, the basic framework of the AI big data center, the health-centered industrial network system, the new municipal infrastructure, and the development of emerging technology industries are established, as shown in Figure 3:

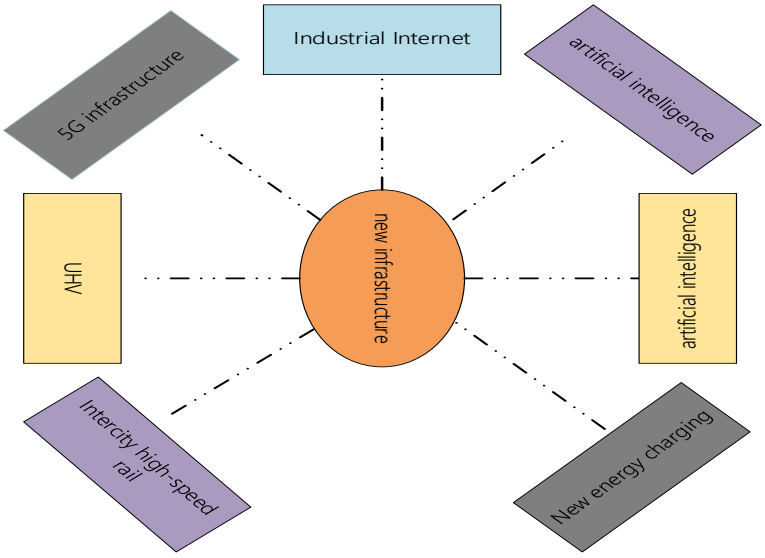

Figure 3: Analysis of the new infrastructure driving factors in the era of digital economy

As can be seen from Figure 3, the intelligent Internet is much like an Internet infrastructure composed of a large system similar to the brain. This infrastructure is an important infrastructure affecting the development of the future digital economy, and it is very much like a giant intelligent system. The cutting edge system for this intelligence is the Internet of Things. Various digital, network and intelligent IoT terminals collect various data and information such as optical fiber networks, mobile communication networks, and 4G (the 4th generation mobile communication technology), and transmit them to the data center through 5G and other network lines. After processing and exchanging the data of the resources in the resource library, it builds its own computing and services on the network, that is, cloud computing services. Processing and analyzing data with the computing power constituted by such cloud computing services would gradually improve the overall data analysis and decision-making capabilities, which is the epitome of artificial intelligence. This entire infrastructure is upgraded to a new form of infrastructure.

New infrastructure is a new type of infrastructure with a new development concept as the core. It would absorb the results of the new technology revolution, thereby changing the ecological environment of the entire country, and establishing and establishing a new economic system that can coordinate the old kinetic energy with the economy.

4. New Infrastructure-driven Experiment under the Internet of Things

(1) The new trend of wealth management development in the era of mobile Internet of Things

The IoT network is an important piece of infrastructure that is gradually transforming traditional businesses including asset management. "Internet of Things +" is particularly prominent in the government work report, using the Internet as the carrier and new technologies as the driving force to transform traditional enterprises. Figure 4 is an analysis chart of IoT user volume and IoT market size from 2017 to 2020:

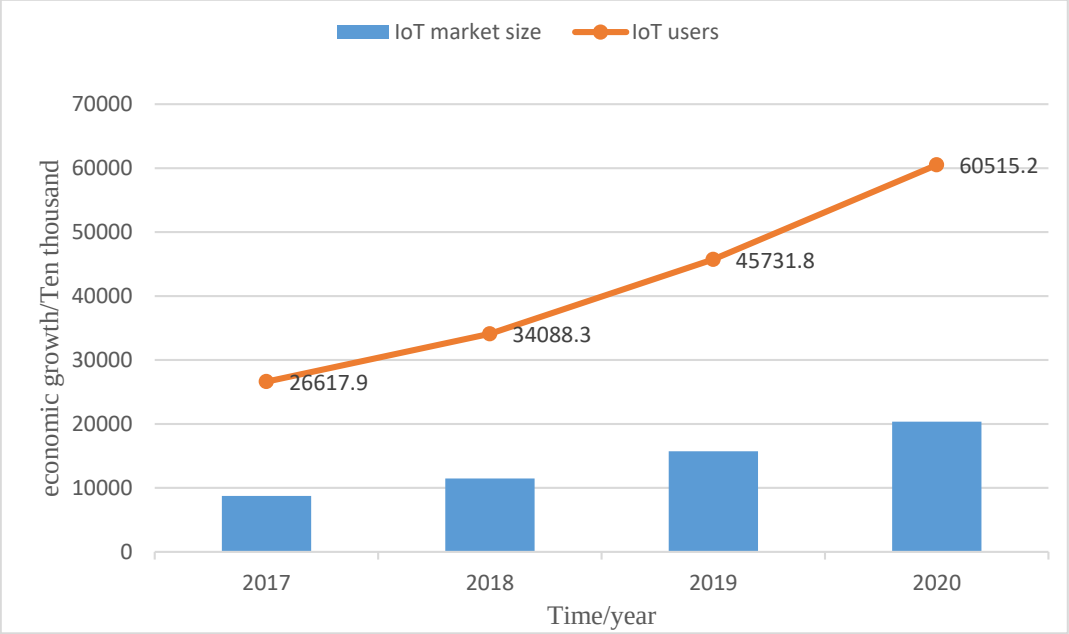

Figure 4: Continued rapid growth in the number of Internet of Things connections of China Mobile

As can be seen from Figure 4, in 2017, the growth rate of mobile users exceeded the growth rate of total users, and the growth rate of overall users in China has changed from the growth rate of PC (Personal Computer) users to the growth of mobile users. The convenience of a smartphone is that it attracts more users than a PC that cannot be carried around instantly. The market size of China Mobile's network in 2017 has reached 87,341,000 yuan, and it would maintain rapid growth in the future. It is expected that the overall mobile Internet market size would exceed 200 million by 2020; the number of IoT users has increased from 266.179 million in 2017 to 605.152 million in 2020, a year-on-year growth rate of 127%.

(2) Big data center in "new infrastructure"

China's economy has transformed from rapid development to high-quality development. A new round of technological revolution and industrial transformation has become an important factor in driving economic growth and optimizing economic structure. Under such circumstances, "new infrastructure", as a new type of infrastructure, has been repeatedly mentioned at high-level meetings across the country and the central government. According to the definition of the National Development and Reform Commission, "new infrastructure" is the infrastructure that provides digital transformation, intelligent upgrade, integrated innovation and other services for enterprises. In the computing power architecture, data centers have been listed as part of the information architecture. For data-driven enterprises, the data center is the basis for supporting the storage, computing and high-level applications of large amounts of data. Figure 5 and Figure 6 show the analysis of the scale and growth rate of China's data centers and public infrastructure racks from 2017 to 2020:

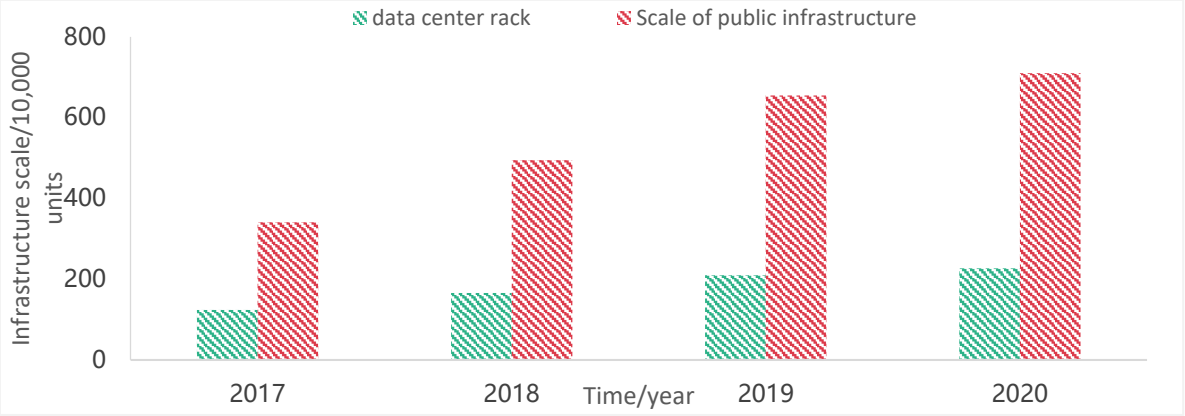

Figure 5: Framework scale of China data center from 2017-2020

As can be seen from Figure 5, data centers and public infrastructure racks have increased year by year during 2017-2020. Data center racks increased from 1.24 million in 2017 to 2.27 million in 2020, a year-on-year increase of about 83%; the number of public infrastructure racks increased from 3.41 million in 2017 to 7.1 million in 2020, a year-on-year increase of about 108%.

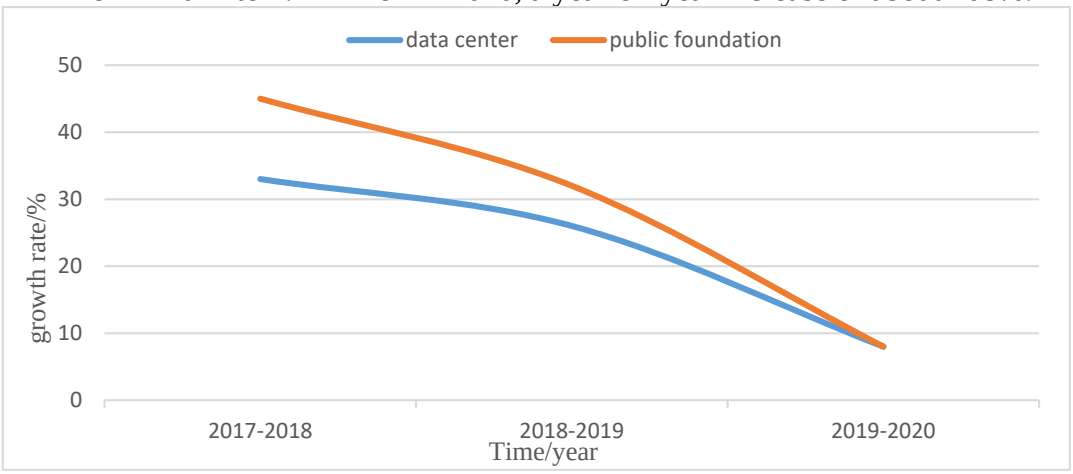

Figure 6: Growth rate of China data center and public base rack from 2017 to 2020

It can be obtained from Figure 6, and its growth rate is obtained according to the scale of China's data centers and public infrastructure racks in 2017-2020. Data center racks increased by approximately 33% in the 2017-2018 interval, approximately 26% in the 2018-2019 interval, and approximately 8% in the 2019-2020 interval. Public infrastructure racks increased by approximately 45% in the 2017-2018 interval, 32% in the 2018-2019 interval, and 8% in the 2019-2020 interval. It can be seen that with the gradual increase in the number of infrastructure construction, the growth rate of the two would gradually decrease, and both are stable at a growth rate of around 8%. In particular, the country can pay special attention to the data centers and public infrastructure racks in the new infrastructure, so as to lay the groundwork for economic development in the digital economy era.

Through a comprehensive comparative analysis of new infrastructure in various industries in the world, the comparative information on new infrastructure in energy, transportation, communication, and water conservancy is listed here, as shown in Table 1:

As can be seen from Table 1, China's total infrastructure scale is the largest in the world, but there is still a big gap with the level of developed countries. After the reform and opening up, relying on the infrastructure construction of hypermarkets, China has rapidly developed into the

world's second largest economic power and the world's largest production base. The basic point is that the construction should be moderately promoted. In terms of economic and social development, infrastructure construction is still in a leading position; otherwise, it would become an important factor restricting the country's economic and social development.

Table 1: Comprehensive comparison between China and the new infrastructure of the United States, Japan, Britain and France

	China	U.S.	Japan	U.K.	France
energy	7111.8large watt hour	4460.8large watt hour	1051.6large watt hour	333.9large watt hour	574.2large watt hour
Transportation	13.17kilometer	22.5kilometer	2.73kilometer	1.68kilometer	2.82kilometer
communication	61.2%coverage	87.3coverage	84.6coverage	94.9coverage	82coverage
water conservancy	64.9percentile	86.1percentile	94.6percentile	90.7percentile	90.9percentile

(3) Data application for business scenarios in the growth stage of new infrastructure-driven enterprises

The ultimate goal of the new infrastructure is to leverage information about the state of the business to deliver tangible benefits to the business. In response to the clear need for a story library, businesses can opt for leaner and product-based digital tools that are flexible to market changes. In particular, big data applications can be divided into general applications and industrial applications according to different conditions of interest. The general application of advertising marketing analysis of user behavior and other fields were first implemented in industries such as financial communication, healthcare, industrial and government affairs. Figure 7 shows the data of general and industrial applications of new infrastructure.

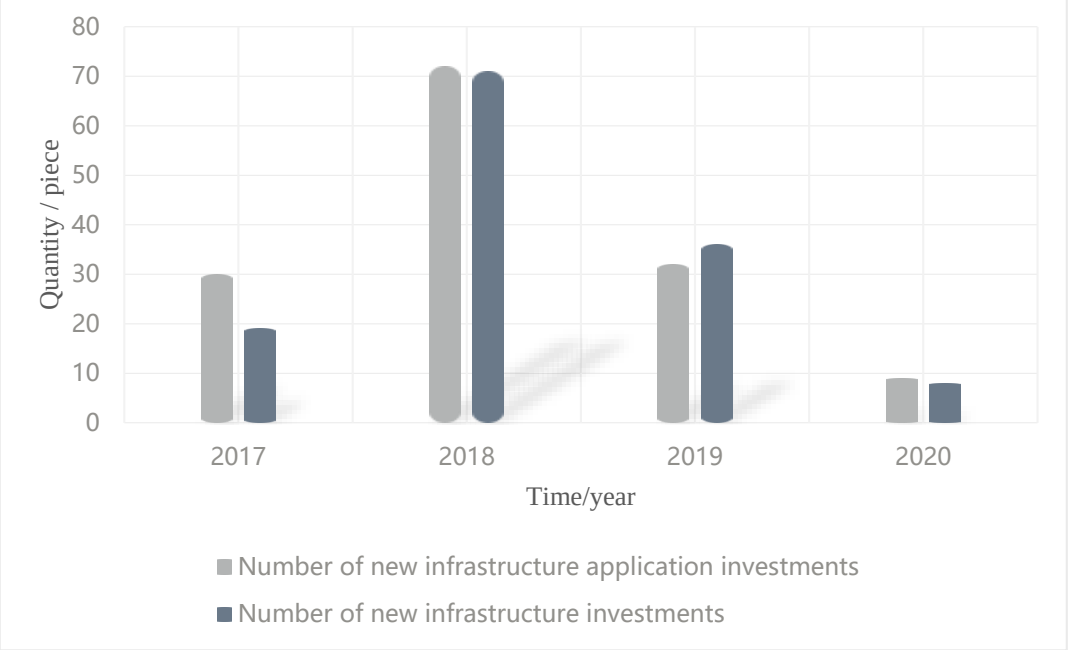

Figure 7: Investment data of big data for general use and industry applications

As can be seen from Figure 7, the overall trend of the number of general-purpose applications and the number of industry applications in 2017-2020 is an increase first and then a decrease. The number of general applications increased from 30 in 2017 to 72 in 2018, an increase of 140% year-on-year. 2018 was a watershed. Due to the impact of economic globalization, it began to show

a downward trend, from 72 to 36, a year-on-year decrease of 100%. The number of industrial applications increased from 19 in 2017 to 71 in 2018, a year-on-year increase of 270%. It can be seen that industry applications have played an important role in the growth stage of new infrastructure-driven enterprises. Therefore, the new infrastructure-driven research in the digital economy era under the Internet of Things has improved economic development by 13.97%.

5. Conclusions

In the information age, due to the wide application of data, the production activities of enterprises are dominated by data. Therefore, to vigorously develop the digital economy, it is necessary to accelerate the development. However, this would also have a certain impact on the core competence of the enterprise, thereby enhancing the strength of the enterprise. The development of the digital industry not only refers to the digital industry, but also refers to the traditional manufacturing industry. At the same time, this has also fostered digital transformation in areas such as agriculture and renewable services. Digitization is about streamlining related administrative procedures and promoting the digitization of society as a whole, in order to build a strong digital business service, digital industry and digital business demonstration park; it is necessary to make full use of the function of "mass entrepreneurship and innovation", maximize the role of the innovation platform of digital technology and introduce more talents and teams to develop the digital economy. In order to develop the digital economy rapidly, it is necessary to build a sound information security network to ensure its healthy development.

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