# Study on the Information Measurement System under the Background of Embedded Infosphere


## ABSTRACT

The “Embedded Infosphere” is composed of the “Internet of Things,” “Big Data,” the “Cloud”, and “Artificial Intelligence,” and represents all the new ubiquitous, smart, connected technologies and applications working as an integrated system. The EI has introduced a new stage (or Age) in the discourse on information policy, which goes beyond media, communications and the Internet, and is not currently being sufficiently addressed. In this emerging environment networking and intelligence are embedded into an increasing number of everyday things which constantly monitor and measure our lives. (Taylor, 2016)

This paper presents a proposed evaluation index system for China of informatization under the background of Embedded Infosphere. It measures and analyzes the informatization level of China, reasonably predicts China's future informatization level index., finds ways and means to improve the level of national informatization, provides a theoretical basis for improving China’s construction of informatization, and puts forward constructive policy suggestions are of great significance to developing informatization.



**KEY WORDS:** Informatization; Embedded Infosphere; Emerging Information Technology; Indicator System

# EXECUTIVE SUMMARY


Emerging information technologies such as Big Data, AI, IoT, Mobility and the Cloud are developing rapidly, blending with traditional industries and technologies, thus influencing and changing people's lives. A new age is beginning.

Obviously, the level of informatization has already become an important indicator for weighing national competitiveness. With the application and popularization of emerging information technologies, traditional information technology is being replaced by more efficient and advanced information technology. Correspondingly, the evaluation index system for measuring the level of informatization should also keep pace with the times. It should include indicators such as Big Data, AI, IoT, Mobility, and the Cloud. Only in this way, based on the embedded infosphere, it can better measure the current national informatization, thus evaluating the comprehensive competitiveness of a country.

This paper presents a proposed evaluation index system for China of informatization under the background of Embedded Infosphere. In this paper, the data are standardized by the minimum-maximum normalization method, the weight coefficient of each index is assigned by the variation coefficient method, and calculate China's information level index and growth rate for 2014-2016. On this basis, the degree of each third-level indicator influencing on the informatization level index is calculated and analyzed, and the informatization level index and growth rate of China in 2017 are predicted by the gray system model.

According to the analysis results, China's informatization level index has increased year by year, and the growth rate has decreased slightly. The “per capita mobile Internet access traffic” index has the largest growth rate. Meanwhile, Mobility, Big Data, AI, the Cloud, and IoT have contributed the most to improving the informatization level index of China. From the impact of every third-level indicator on the total index, we can see that the promotion of emerging technology and education is more beneficial for improving national informatization level. Based on this analysis, this paper puts forward policy suggestions on the development of talent education, infrastructure improvement, the promotion of emerging information technology and popularization of its application to improve China’s informatization.

# 1. Introduction

## 1.1 Research Background

With the development of information technology, the information infrastructure has experienced the gradual replacement of fixed telephones by mobile phones, and the mobile Internet has gradually replaced the traditional Internet. Now, with the universal application of emerging information technologies such as Big Data, AI, IoT, Mobility and the Cloud, a new age is beginning.

At the same time, the research on information measurement needs to be constantly updated. We have entered the era of Big Data, AI, Internet of Things, Mobility and the Cloud, and the information evaluation index system should be included in more indicators that can reflect new trends of new development. Only in this way, based on the embedded infosphere, the information evaluation system can better reflect the current situation of information development of countries and give some quantitative, scientific and comprehensive policy proposal to better promote economic growth and social development.

## 1.2 Significance of Research

**1. Understand the research status of information evaluation system**

By summarizing the theoretical system of informatization evaluation at home and abroad, it is conducive to a comprehensive understanding of the inadequacies and merits of the existing informationization evaluation system. It will play a huge reference significance in the process of building a new information evaluation system, which is helpful to promote economic development and social progress of China.

**2. Establish a reasonable evaluation index system based on the embedded infosphere**

With the continuous development of communication technology and Internet technology, the traditional information evaluation system can't meet the requirements of accurate information development evaluation. Therefore, the information evaluation system needs to be continuously improved to adapt to the new background especially in the embedded infosphere, thus providing more scientific and reasonable policy recommendations for the informationization development. The new indicator evaluation system provides us with a more scientific basis for improving national informationization development.

**3. Analyze the status quo of national informationization**

The newly constructed index system that reflects the emerging technology such as Big Data, IoT, AI, Mobility and the Cloud can greatly assist us in measuring and analyzing the latest informatization development level. Analysis of the evaluation results will enable us to have a clearer understanding of the current state of national information development, so as to better achieve the goals of social progress and economic development.

# 2. Review of Researches

## 2.1 The Concept of Embedded Infosphere

The "Embedded Infosphere" is composed of the "Internet of Things," "Big Data," the "Cloud", and "Artificial Intelligence," and represents all the new ubiquitous, smart, connected technologies and applications working as an integrated system. The EI has introduced a new stage (or Age) in the discourse on information policy, which goes beyond media, communications and the Internet, and is not currently being sufficiently addressed. In this emerging environment networking and intelligence are embedded into an increasing number of everyday things which constantly monitor and measure our lives [1].

Big Data, also known as massive data, refers to the massive, high growth rate and diversified information assets that require new processing models to have greater decision-making, insight and process optimization capabilities [2]. This is the biggest difference between Big Data and traditional data, because of the rapid development of the Internet [3]. The advantage of Big Data technology is that the sample it uses is the overall data itself. The data used is formal and comprehensive, so the results will be more accurate to reflect the real situation.

Artificial intelligence, usually refers to the application of modern communication and information technology, computer network technology, industry technology, intelligent control technology. AI has penetrated into every aspect of our social life [4]. For example, intelligent communities, intelligent hospitals, smart homes. Artificial Intelligent Systems usually have five basic characteristics: state awareness, real-time analysis, self-determination, precise execution, and learning improvement. It has the ability to continuously improve itself and improve learning, for example, intelligent robots with deep learning ability, knowledge sharing through the network, and self-renewal. It has powerful computing capabilities, so it can analyze and process Big Data, continuously apply, accumulate and create knowledge. Now, AI is widely used in many fields such as transportation, environmental protection, government work, safe home, personal health and military.

The Internet of Things is the Internet that connects objects to achieve intelligent identification, location, tracking, monitoring and management [5]. The core and foundation of the IoT is still the Internet. It is an extended network based on the Internet, but its characteristics are more distinct than the Internet. Compared with the traditional Internet, the wide application of various sensing technologies makes the data obtained by IoT more real-time. At the same time, IoT not only provides the connection of sensors, but also has intelligent processing to implement intelligent control of objects. It combines sensors and intelligent processing, and utilizes various intelligent technologies such as the Cloud and pattern recognition to expand its application fields. It can analyze and process meaningful data from the massive information obtained by sensors to adapt to different needs of different users and discover new application areas and application models.

Mobility combines mobile communication and the Internet. It is an emerging service that uses mobile wireless terminals to acquire services, including terminals, software and applications. Compared with the traditional Internet, Mobility has many characteristics such as the mobility for terminals, the timeliness for data information, the convenience and orientation for applications. These properties greatly facilitate our life and make the mobile Internet completely infiltrated all aspects of our life.

The Cloud provides available, convenient, on-demand network access to a configurable pool of computing resources which include networks, servers, storage and applications. In this pool, resources can be quickly provisioned with little administrative work or little interaction with service providers. The Cloud has many advantages such as ultra-large scale, virtualization, high reliability, low price, versatility, and on-demand services, but at the same time, it has a problem of trust and security to solve. By using object classification, clouds are divided into public clouds, private clouds, and hybrid clouds.

These five emerging technologies are interconnected. The Cloud requires Big Data as a the foundation, and they combine to open up a broader space for the development of AI, Mobility and IoT require the Cloud as a support. The in-depth development of Big Data in turn improves the development of Mobility and IoT, making software and hardware more intelligent.

## 2.2 Research on Informatization Evaluation Index System

### 2.2.1 Traditional Information Evaluation Index System

The first study of the theory and method on information industry evaluation is the American scholar Mark Lupu [6]. In 1962, he published "American Knowledge Production and Distribution", designed a set of indicators system and method for measuring information industry, and created a new era of informationization measurement. In 1977, American scholar Borat [7] proposed an information economy method based on Mark Lupu in his published research report "Information Economy" to examine the proportion of the information economy in the GNP of the gross national product. In 1965, Japanese economists [8] first proposed the information index method. This index system selects the four most representative factors in social information activities and decomposes them into 11 small variables.

The “Information Economy Office Index evaluation system” issued by the Australian Information Economy Office consists of 23 factors, including the popularization of information infrastructure and related equipment, ICT access costs, digital divide, and e-government development and e-commerce development level. This evaluation system is intuitive and operability, and new era indicators (e-government and e-commerce) have been added to the system.

The “Networking Preparation Index evaluation system” [9] issued by the Harvard University International Development Center and the World Economic Forum is composed of 4 elements, including 2 first-level indicators, 9 second-level indicators, 10 third-level indicators and 60 forth-level indicators. This evaluation system comprehensively evaluated and compared the development of information and communication technology in 75 countries and regions around the world.

Since 1996, International Data Corporation has used the “Information Society Index evaluation system” including 4 first-level indicators and 23 second-level indicators.to conduct a comprehensive assessment of the information society's participation capabilities in 55 countries or regions around the world. The first-level indicators include computer infrastructure, communications infrastructure, network infrastructure, and social infrastructure.

In China, it was not until the end of the 20th century when China started intensive studies on the measurement of ICT levels. In 2001, The Ministry of Information Industry proposed the

National Informatization Quotient (NIQ) [10]. The National Bureau of Statistics designed their informatization Development Index (IDI) in 2005 [11], the predecessor of the 2013 version of informatization Development Index(II) (infrastructure, industrial technology, consumer applications, knowledge support and development effect) with optimized structure and refined statistical monitoring methods. The China Internet Network Information Center identified five Grade-1 indicators, namely, network infrastructure readiness, industrial and technical innovation, ICT application benefit, cyber security and ICT sustainability.

#### 2.2.2 Research of Informatization Evaluation System on Emerging Technologies

With the rapid development of emerging technologies such as big data, intelligence, Internet of Things, mobile Internet, cloud computing, etc., it is obvious that the above traditional information evaluation systems can no longer meet the need, so researcesh on measuring emerging technologies become the new hotspot.

(1) Informational evaluation system for Big Data [12]

In the “2017 China Big Data Industry Development Evaluation Report”, the assessment targets are divided into regions, industries, and enterprises. The regions development assessment includes evaluation of the big data industry, big data applications, and development environment. The industries development assessment focuses on the basic environment of key industries, data collection, big data applications, and application benefits. The enterprises development assessment assesses the basic image, R&D innovation, and market expansion of major big data companies.

(2) Informational evaluation system for AI [13]

Zhou Xuanru and other scholars, through the national strategy of artificial intelligence and the main tasks, enumerate the application of AI in various industries, including chemistry, physics, bioinformatics, geology, drug design, construction, etc. The application of the method emphasizes the great promotion of AI to scientific research, including supercomputing, scientific data, wireless network, IoT and bioinformatics. Later, from the angles of the government, research institutes, and enterprises, the authors elaborate on the exploration of scientific informationization based on AI in the world, especially in China, and propose feasible suggestions for the construction of AI in China.

(3) Informational evaluation system for IoT [14]

Xue Jie of Hangzhou University of Science and Technology points out that the statistical index system of China's Internet of Things industry should mainly consist of the total scale of IoT industry, the industrial structure of IoT, the economic benefits of IoT, the popularity and application of IoT, the research and development capabilities of IoT, and the talents of IoT. On this basis, it has subdivided 18 secondary indicators including the added value of t IoT industry, total output, fixed asset investment and number of enterprises.

(4) Informational evaluation system for the Cloud [15]

Liu Xue, Shen Wei, and Wang Zhuzhu of the Central Electrochemical Education Center, regarding the region (including cities, districts, and counties) as the evaluation object, and the education cloud application situation as the evaluation content, construct the Education Cloud Regional Development Evaluation Indicator System. It consists of 4 first-level indicators, including cloud application infrastructure capabilities, cloud application tools or software, teaching methods and cloud application coverage. It is intended to evaluate the development of educational clouds in pilot areas and provide an important reference for the development of regional education clouds in other regions.

Through the review of researches, we can see that the traditional information evaluation system is no longer comprehensive and contemporary. The research objects of existing researches linked to the emerging technologies are mostly targeted at specific industries or enterprises. Therefore, on the basis of above researched, this paper puts up with an evaluation index system, the indicators of which are related to Big Data, Artificial Intelligence, Internet of Things, Mobility, the Cloud. It is intended to establish an information-based evaluation index system that is more in line with China's current informatization development and can provide more scientific and reasonable guidance for China's information development.

# 3. Informatization Evaluation Index System in China

## 3.1 Construction of Informatization Evaluation Index System

### 3.1.1 Selection of Indicators

The selection of the first-level indicators is based on the following considerations:

Information resources mainly include information infrastructure and technology applications. They are the hardware foundation for implementing informationization and the prerequisite for information transmission.

Emerging technologies mainly include industry development and technology applications about Big Data, IoT, AI, the Cloud, Mobility. Incorporating indicators related to emerging technologies, we can make better use of this informatization evaluation index system to properly and correctly measure the current situation of China's informatization development, and provide policy recommendations that are more in line with the background of embedded infosphere.

Information industry development indicators mainly examines the input and output obtained by the information industry, as well as the related professional talents, which can indirectly reflect the contribution of the information industry to China's social development and economic growth. The information industry has been in a state of rapid development in recent years, and it is likely to become one of the main driving forces for China's economic growth in the future. Therefore, the inclusion of indicators for measuring the development of the information industry is conducive to the expansion in the future.

Social environment indicators are mainly to examine the innovation, science, education and residents' consumption. These aspects indirectly affect the innovation ability of the information.

The index system（ILI） adopted in this paper is composed of 4 first-level indicators, 8 second-level indicators and 20 third-level indicators.

### 3.1.2 Data Sources and standardized treatment

Data of this paper mainly comes from the China Statistical Yearbook by National Statistical Bureau, China industrial information network, Internet statistics reports, statistics from CAICT and industry research reports.

In the multi-index system, it is necessary to standardize the data. The paper adopts the Maximum Value Standardization Method to normalize data.

### 3.1.3 Weight Determination of Indexes

This paper adopts the Variation Coefficient Method (Objective Weighting Method) for weight assignment. The base idea is that if an indicator has a large degree of variation in the observed value of all indicators, the indicator should be given a greater weight. The final weights of indexes are shown in Table 3-1.

Table 3-1 Composition and weights of ILI

| First-Level indexes | Weight | Second-Level indexes | Third-Level indexes | Weight |
|---|---|---|---|---|
| Information Resources | 0.2147 | Infrastructure | Fixed telephone penetration rate | 0.0245 |
| | | | Mobile phone penetration rate | 0.0021 |
| | | | Internet penetration rate | 0.0130 |
| | | | Cable length per square kilometer | 0.0479 |
| | | Internet Resources | Number of domain names per 100 people | 0.0841 |
| | | | Number of sites per thousand | 0.0430 |
| Emerging Technologies | 0.6301 | Technological Development | Big data market size | 0.0854 |
| | | | Artificial intelligence market scale | 0.0822 |
| | | | Internet of Things market size | 0.0602 |
| | | | Cloud computing market size | 0.0721 |
| | | Technical Use | Number of patent applications related to artificial intelligence per 1000 people | 0.0526 |
| | | | Per capita mobile internet access traffic | 0.1771 |
| | | | Mobile Internet users | 0.0264 |
| | | | Enterprise cloud service industry financing round | 0.0742 |
| Industrial Development | 0..1107 | Input and Output | Per capita information transmission, software and information services fixed asset investment | 0.0210 |
| | | | Information transmission, software and information services production value as a percentage of total output value | 0.0509 |
| | | Talents | Proportion of employment in information transmission, software and information services to total employment. | 0.0127 |
| | | | Average salary of employed persons in information transmission, software and information services | 0.0260 |

| | | | | |
|---|---|---|---|---|
| Social Environment | 0.0445 | Educational Investment | Per capita public finance education funding | 0.0205 |
| | | Consumption Level | Per capita disposable income | 0.0240 |

## 3.2 Calculation of LIL

The Linear Weighting Method is adopted to calculate the indexes in this paper. According to the calculation, the results of ILI and growth rate of China from 2014 to 2016 are shown in Table 3-2.

Table 3-2 ILI and growth rate of China (2014-2016)

| | ILI | Growth rate |
|---|---|---|
| 2014 | 0.5623 | |
| 2015 | 0.7606 | 35.26% |
| 2016 | 0.9737 | 28.01% |

# 4. Application of Information Index System

In this chapter, the paper first analyzes the situation of China's informatization development in general, and then analyzes the impact of each indicator on the ILI, at last based on the calculated ILI and its growth rate, make a reasonable estimate of the future informatization development in China.

## 4.1 Analysis on the development of informatization

The level of informatization development in China has been greatly improved in 2014-2016. From 2014 to 2016, the national informatization level index increased from 0.5623 to 0.9737, with a total growth rate of 73.16% and an average annual growth rate of 36.58%. From 2014 to 2016, the growth of China's informatization development level index is shown in Figure 4-1.

During the period of 2014-2016, the growth rate of China's informatization level index declined: from 2014 to 2015, the growth rate of informatization is 35.26%; from 2015 to 2016, the growth rate of informatization is 28.01%.

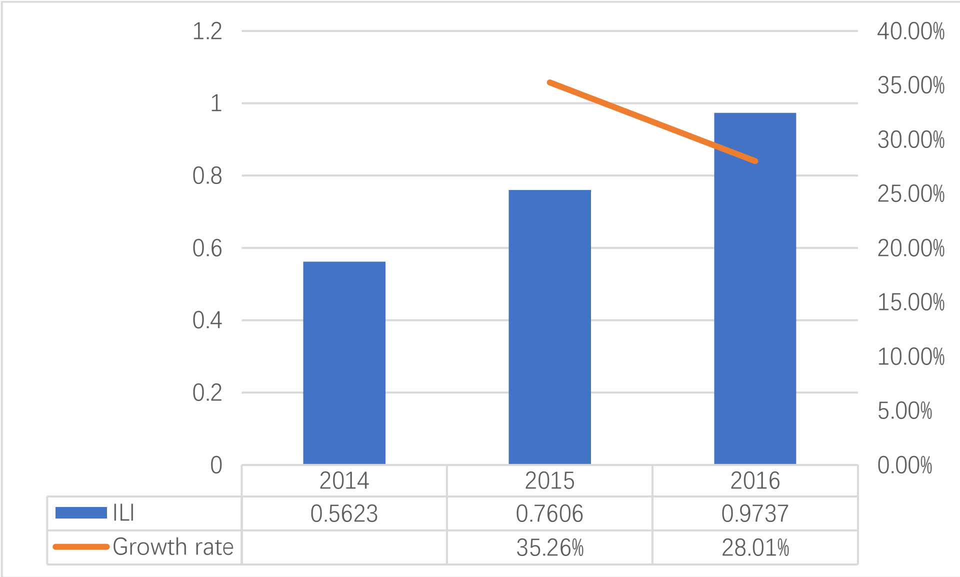


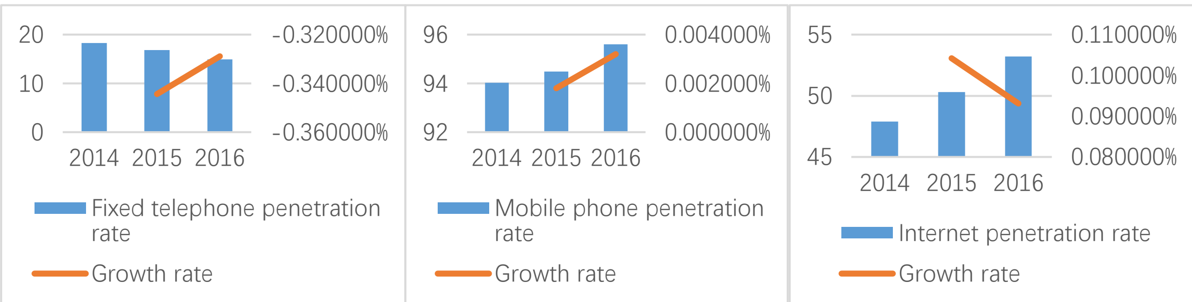

Figure 4-1 China's ILI and growth rate in 2014-2016

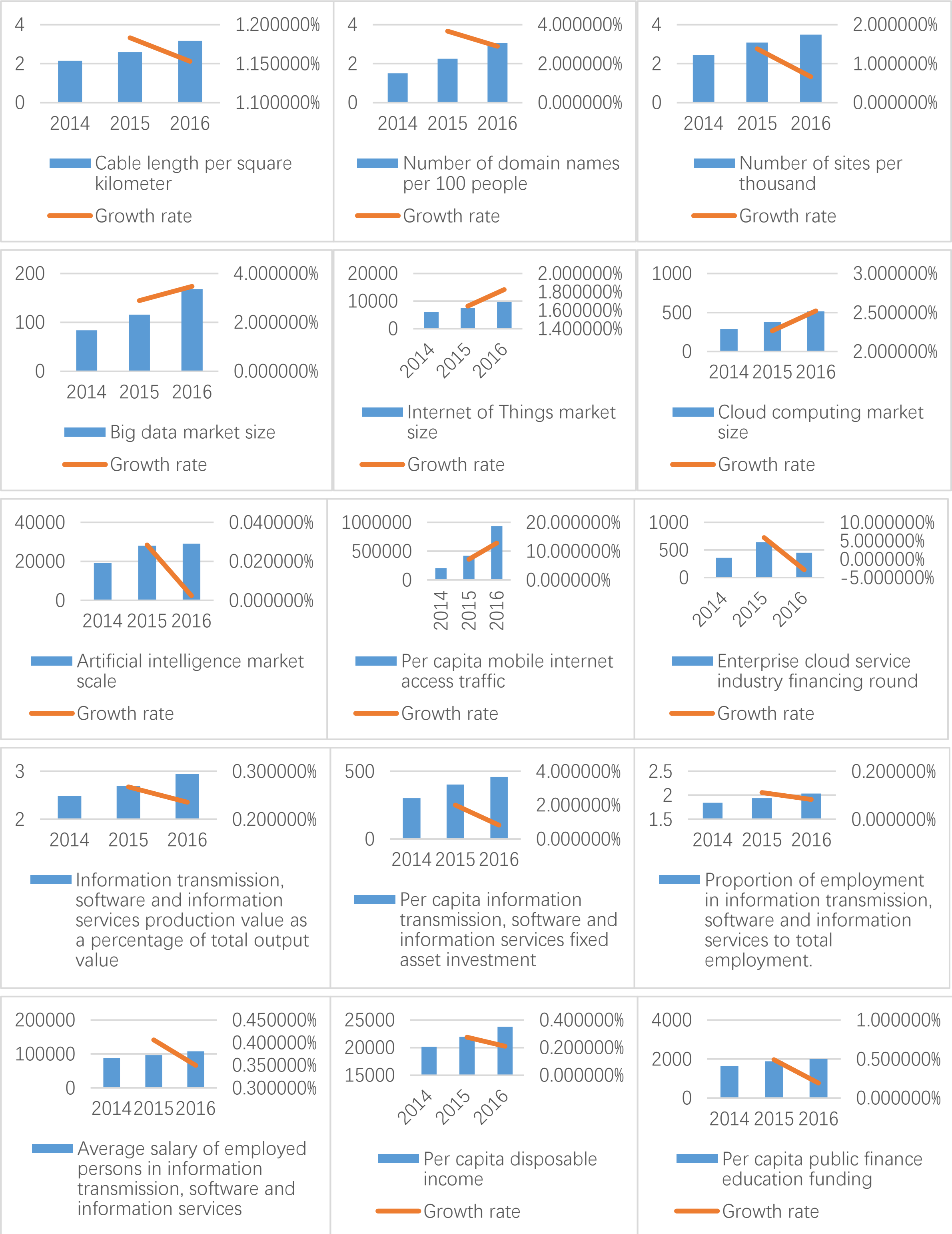
## 4.2 Analysis of Factors Affecting China's Informatization Level Index

### 4.2.1 Analysis of third-level indicators affecting on China's ILI

In order to conduct more in-depth research on the main factors affecting China's informatization level index, it is necessary to further analyze the impact of each third-level indicator on the informatization evaluation index system. In order to analyze more intuitively, each third-level indicator's trend graph of year-to-year growth rate versus time has been drawn, as shown in Figure 4-2.

It can be clearly seen from the figure that the growth rate of each third-level indicator has a large difference. Further sorting can be used to rank the growth factor of the third-level indicator from 2014 to 2016. The faster growth indicators are shown in Table 4-1.




4
2
0
1.200000%
1.150000%
1.100000%
2014 2015 2016
Cable length per square kilometer
Growth rate
4
2
0
4.000000%
2.000000%
0.000000%
2014 2015 2016
Number of domain names per 100 people
Growth rate
4
2
0
2.000000%
1.000000%
0.000000%
2014 2015 2016
Number of sites per thousand
Growth rate
200
100
0
4.000000%
2.000000%
0.000000%
2014 2015 2016
Big data market size
Growth rate
20000
10000
0
2.000000%
1.800000%
1.600000%
1.400000%
2014 2015 2016
Internet of Things market size
Growth rate
1000
500
0
3.000000%
2.500000%
2.000000%
2014 2015 2016
Cloud computing market size
Growth rate
40000
20000
0
0.040000%
0.020000%
0.000000%
2014 2015 2016
Artificial intelligence market scale
Growth rate
1000000
500000
0
20.000000%
10.000000%
0.000000%
2014 2015 2016
Per capita mobile internet access traffic
Growth rate
1000
500
0
10.000000%
5.000000%
0.000000%
-5.000000%
2014 2015 2016
Enterprise cloud service industry financing round
Growth rate
3
2
0.300000%
0.200000%
2014 2015 2016
Information transmission, software and information services production value as a percentage of total output value
500
0
4.000000%
2.000000%
0.000000%
2014 2015 2016
Per capita information transmission, software and information services fixed asset investment
2.5
2
1.5
0.200000%
0.000000%
2014 2015 2016
Proportion of employment in information transmission, software and information services to total employment.
200000
100000
0
0.450000%
0.400000%
0.350000%
0.300000%
2014 2015 2016
Average salary of employed persons in information transmission, software and information services
25000
20000
15000
0.400000%
0.200000%
0.000000%
2014 2015 2016
Per capita disposable income
Growth rate
4000
2000
0
1.000000%
0.500000%
0.000000%
2014 2015 2016
Per capita public finance education funding
Growth rate

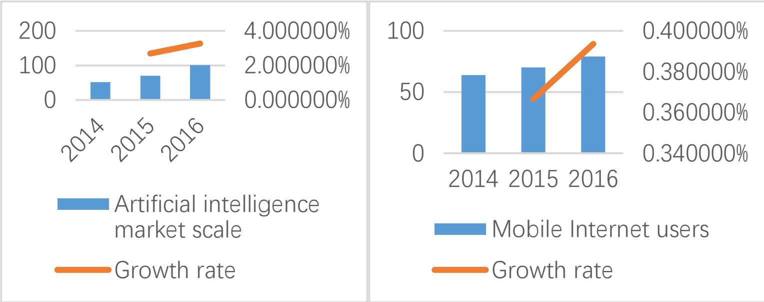



Figure 4-2 Growth rate of each third-level indicator

Table 4-1 The top indicators increase of the third-level indexes

| Ranks up | Indicators | Growth multiple |
|---|---|---|
| 1 | Per capita mobile internet access traffic | 3.4901 |
| 2 | Number of domain names per 100 people | 1.0265 |
| 3 | Big data market size | 1 |
| 4 | Artificial intelligence market scale | 0.9458 |
| 5 | Cloud computing market size | 0.7944 |
| 6 | Internet of Things market size | 0.625 |
| 7 | Per capita information transmission, software and information services fixed asset investment | 0.5225 |
| 8 | Number of patent applications related to artificial intelligence per 1000 people | 0.5119 |

Obviously, between 2014 and 2016, “per capita mobile Internet access traffic” indicator has the largest increase, reaching 3.49 times the base. It reflects that during this period, the development of China's mobile Internet industry has indeed been greatly promoted. The 2014 Mobile Internet Development Conference was held in Beijing. The “Blue Book of China Mobile Internet Development Report (2014)”, edited by the People's Network Research Institute, was published at the conference, which comprehensively introduced the development status and characteristics of mobile Internet in China. The report pointed out that 2011 to 2013 is the three years of rapid development of mobile Internet, China's mobile Internet has entered the era of the whole people. In June 2015, the Standing Committee of the National People's Congress first reviewed the "Network Security Law (Draft)", which established the basic system of China's network security, once again added policy support for mobile security and industry regulation, and further promoted the development of China's mobile Internet.

At the same time, we can see from the table 4-1 that 6 of the biggest growth indicators in

2014-2016 are related to the emerging technology such as Big Data, AI, IoT, the Cloud and Mobility. The growth rate of these indicators in 2015-2016 is slightly larger than 2014-2015. It reflects the booming of emerging technologies. In 2015, the Chinese premier proposed the “Internet Plus” action plan in the government work report to promote the integration of mobile Internet, the Cloud, Big Data, and IoT with modern manufacturing, and lead Internet companies to expand the International Market.

In addition to the above six indicators related to emerging technologies, there are also a large increase in the number of “domain names per 100 people” and “the per capita information transmission, software and information services, and the fixed assets investment of the whole society”. It reflects that China's information infrastructure is well constructed, and China's informatization is entering a relatively stable development stage.

The contribution rate of the third-level indicators from 2014 to 2016 on the growth of ILI is shown in Table 4-2. According to the ranking of the contribution rate, the third-level indicators that have the greatest and least impact on the growth of ILI are shown in Table 4-3.

Table 4-2 Contribution rate of each third-level indicator to total index growth

| Third-Level indexes | 14-15 | 15-16 | 14-16 |
|---|---|---|---|
| Fixed telephone penetration rate | -0.3444% | -0.3289% | -0.7893% |
| Mobile phone penetration rate | 0.0018% | 0.0032% | 0.0061% |
| Internet penetration rate | 0.1042% | 0.0931% | 0.2302% |
| Cable length per square kilometer | 1.1832% | 1.1530% | 2.7428% |
| Number of domain names per 100 people | 3.6660% | 2.8909% | 7.5764% |
| Number of sites per thousand | 1.3817% | 0.6648% | 2.2809% |
| Big data market size | 2.8920% | 3.4743% | 7.5915% |
| Artificial intelligence market scale | 2.6894% | 3.2672% | 7.1088% |
| Internet of Things market size | 1.6460% | 1.8253% | 4.1150% |
| Cloud computing market size | 2.2650% | 2.5210% | 5.6751% |
| Number of patent applications related to artificial intelligence per 1000 people | 2.8422% | 0.2383% | 3.1646% |
| Per capita mobile internet access traffic | 7.1533% | 12.8089% | 24.4791% |

| | | | |
|---|---|---|---|
| Mobile Internet users | 0.3666% | 0.3936% | 0.8990% |
| Enterprise cloud service industry financing round | 5.8641% | -2.8750% | 1.9753% |
| Per capita information transmission, software and information services fixed asset investment | 0.2673% | 0.2353% | 0.5855% |
| Information transmission, software and information services production value as a percentage of total output value | 2.0012% | 0.8152% | 3.1039% |
| Proportion of employment in information transmission, software and information services to total employment. | 0.1110% | 0.0821% | 0.2220% |
| Average salary of employed persons in information transmission, software and information services | 0.4061% | 0.3496% | 0.8790% |
| Per capita public finance education funding | 0.28% | 0.21% | 0.56% |
| Per capita disposable income | 0.49% | 0.19% | 0.75% |

Table 4-3 Third-level indicators that have the greatest and least impact on the growth of ILI

| Ranks up | The most influential indicator | The least influential indicator |
|---|---|---|
| 1 | Per capita mobile internet access traffic | Fixed telephone penetration rate |
| 2 | Big data market size | Mobile phone penetration rate |
| 3 | Number of domain names per 100 people | Proportion of employment in information transmission, software and information services to total employment. |
| 4 | Artificial intelligence market scale | Internet penetration rate |
| 5 | Cloud computing market size | Per capita public finance education funding |
| 6 | Internet of Things market size | Per capita information transmission, software and information services fixed asset investment |

On the whole, the popularization and application of the Internet, Big Data, AI, IoT, the Cloud, Mobility and other related technologies have the greatest impact on China's information development, especially the development of mobile Internet contributed the most.

From the perspective of information infrastructure, traditional information technology contributes little to the informationization development in China at present. In 2014-2016, “the penetration rate of fixed telephones” in China continues to decline, “the penetration rate of mobile phones” is close to saturation, there is no room for growth. The growth rate of “Internet penetration rate” is relatively flat, which comprehensively explains that traditional information technologies are gradually replaced in China.

### 4.2.2 Analysis of first-level indicators affecting on China’s ILI

Based on Table 4-2, a total of 20 indicators are divided into large impact (rank 1-6), medium impact (rank 7-13) and less impact (rank 14-20). As shown in Table 4-4, the number of third-level indicators included in the classification of first-level indicators is counted.

From the perspective of the first-level indicators, the development of emerging technologies contributes most to the ILI in China. Information resources also has some impact on the ILI. Relatively, information industry development and the social environment have little impact on the ILI.

Table 4-4 Impact degree under first-level indexes

| | Information Resources | Emerging Technologies | Industrial Development | Social Environment |
|---|---|---|---|---|
| Great impact | 1 | 5 | 0 | 0 |
| Medium impact | 2 | 3 | 2 | 0 |
| Small impact | 3 | 0 | 2 | 2 |

## 4.3 Future Forecast of China's Informatization Development

Since the existing data is three-year data, belonging to small sample data, and the object to be predicted is completely unknown, the grey system theory is chosen as the main method for predicting the future development trend of informationization.

Based on this, data from 2014 to 2016 is used to predict the ILI of 2017 by the gray system model.

(1) Calculating the accumulated sequence$\mathrm{X}^{(1)}$ once from the original data sequence $X^{(0)}$, as shown in Table 4-5.

Table 4-5 Accumulated sequence$\mathrm{X}^{(1)}$ once from the original data sequence $X^{(0)}$

| | 2014 | 2015 | 2016 |
|---|---|---|---|
| $x^0(i)$ | 0.5623171 | 0.760614 | 0.973694 |
| $x^1(i)$ | 0.562317 | 1.322931 | 2.296625 |

(2) Establish matrix B, y;

$$B = \begin{bmatrix} -\frac{1}{2}(x^1(1)+x^1(2)) & 1 \\ -\frac{1}{2}(x^1(2)+x^1(3)) & 1 \end{bmatrix} = \begin{bmatrix} -0.942624 & 1 \\ -1.809778 & 1 \end{bmatrix} \quad \text{Equation (4-1)}$$

$$y = [x^0(2) \quad x^0(3)]^T = \begin{bmatrix} 0.760614 \\ 0.973694 \end{bmatrix} \quad \text{Equation (4-2)}$$

(3) Inverse matrix $(B^T B)^{-1}$;

$$(B^T B)^{-1} = \begin{bmatrix} 2.6599 & 3.6606 \\ 3.6606 & 5.5377 \end{bmatrix} \quad \text{Equation (4-3)}$$

(4) According to $\widehat{U} = (B^T B)^{-1} B^T y$, obtain the estimated values $\widehat{a}$ and $\hat{u}$;

$$\widehat{U} = \begin{bmatrix} \hat{a} \\ \hat{u} \end{bmatrix} = (B^T B)^{-1} B^T y = \begin{bmatrix} -0.2456 \\ 0.5289 \end{bmatrix} \quad \text{Equation (4-4)}$$

$$\widehat{a} = -0.2456 \quad \hat{u} = 0.5289 \quad \text{Equation (4-5)}$$

(5) According to the time response equation, calculate the fitted value $\hat{x}^{(1)}(i)$,

$$\hat{x}^{(1)}(K+1) = \left[x^1(1) - \frac{\hat{u}}{\hat{a}}\right] e^{-\hat{a}k} + \frac{\hat{u}}{\hat{a}} = 2.715819e^{0.2456k} - 2.153502 \quad \text{Equation (4-6)}$$

(6) Restore according to the post-reduction operation to obtain $\hat{x}^{(0)}(i)$（i=2,3,…,n）;

$$\hat{x}^{(0)}(2) = 0.756052 \qquad \hat{x}^{(0)}(3) = 0.966528 \quad \text{Equation (4-7)}$$

Specific results are shown in Table 4-6.

Table4-6 Model calculation results and actual values

| | Model calculation values | Actual values | Residual | Relative error |
|---|---|---|---|---|
| | $\hat{x}^{(0)}(i)$ | $x^{(0)}(i)$ | E(i) | e(i) |
| i=2 | 0.756052 | 0.760614 | 0.004562 | 0.005998 |
| i=3 | 0.966528 | 0.973694 | 0.007167 | 0.007360 |

(7) Accuracy testing and forecasting

According to $0.6745S_1 = 0.008951$ and $|E(i) - \overline{E}| < 0.008951$, small error probability is calculated:

$$P = P\{|E(i) - \overline{E}| < 0.6745S_1\} = 1 > 0.95 \quad \text{Equation (4-8)}$$

Because of $P \geq 0.95$ $\quad C \leq 0.35$, the prediction accuracy is well. The extrapolation prediction can be performed using the obtained prediction equation.

Let K = 3, get:

$$\hat{x}^{(1)}(4) = 2.715819e^{0.2456*3} - 2.153502 = 3.520494 \quad \text{Equation (4-9)}$$

$$x^{(0)}(4) = 1.235597 \qquad \text{Equation (4-10)}$$

(8) Get the result

Through the calculation of the gray system model, we get the ILI of 2017 is about 1.235597. Compared with 2016, the growth rate is about 26.90%. Although it is slightly smaller than the average growth rate of 31.63% in 2014-2016, the informatization of China has maintained a stable development.

# 5. Policy and Suggestion

According to the analysis of the calculation results in the previous chapter, in 2014-2016, China's informatization development has maintained an upward trend, but there is still a large room for development in some aspects. At the same time, according to the calculation results of 2017 China's informationization development level index, the index of China's informatization development level in 2017 is about 1.235597, which is about 26.90% higher than that of 2016 and slightly smaller than the average growth rate of 31.63% in recent years. To better promote the pace of China's informatization development in the future, propose the following policy recommendations.

## 5.1 Adjust the focus of information infrastructure construction

Information infrastructure is very important as the basis for all information transmission, exchange and sharing. In order to fully realize the overall benefits of informationization, the information infrastructure construction must be continuously improved.

By analyzing the calculation results, we can see that the traditional communication technology level of information on the current development of China's contribution is very small and has no adequate space for development. For example, mobile phone penetration rate has increased by only 1% in three years from 2014 to 2016. However, the Internet-related technical application indicators still have a greater thrust on the development of information technology. Therefore, in the process of building information infrastructure in the future, we can adjust the focus on the construction of Internet infrastructure to maintain the current upward trend of informatization development.

At present, there are problems in the construction of information infrastructure in China that are difficult to share information resources. The information construction in various fields or industries or regions has achieved results. However, due to geographical differences or institutional differences, the situation of information islands has not been greatly alleviated, and even become a major obstacle to the development of information technology in China. For example, although the “three networks integration” targeting telecommunication networks, radio and television networks, and the Internet has achieved great results at the operational level through pilot and pilot experience promotion, the operating systems of the broadcasting and television departments and the telecommunications sector have a large Differences, triple play is still unable to move forward in terms of regulation and network construction. Therefore, we need to establish a comprehensive application platform for social information resources that integrates information intelligent retrieval and decision analysis at present, and use it to strengthen the analysis, sharing and exploitation of relevant data, so as to better accomplish the goal of information sharing in China and develop information technology.

## 5.2 Strengthen support for emerging information technologies and industries

With the continuous updating of information technology, people's attention to emerging information technology has been increasing in the Embedded Infosphere. At the same time, the development of emerging technology-related industries has gradually become one of the main driving forces for promoting social progress and economic growth.

According to the calculation results, from 2014 to 2016, 6 of the top 8 indicators with the largest growth rate of indicators were related to the emerging technology industry . Among them, the growth rate of mobile Internet access flow indicators is the most significant, reaching about 3.5 times. The indicators related to emerging technologies has become the largest contribution to the level of information technology development in China, with a total of 55%. These indicate that at this stage, China's industry and technology related to emerging technologies are in a period of rapid development. At the same time, per capita information transmission, software and information services, the whole society's fixed asset investment is a part that contributes less to the development level of China's informatization, indicating the concern of emerging technology-related industries and technologies in China's current informationization development process. The degree is still insufficient. Therefore, it is necessary to have corresponding financial support to enable emerging technologies to better play the role of promoting China's informationization process.

Specific measures that can be taken include: increasing support for emerging information technologies and promoting traditional enterprise reforms; actively leveraging fiscal and taxation financial policies, and improving support policies for new information technologies or related industries to ensure the development of emerging information technology has been fully supported; supporting qualified information service companies to raise funds in domestic and overseas capital markets, thereby improving the support policy for venture services in the information service industry. In this process, China's informatization development process can obtain ways and opportunities that are in line with the development of international informatization, which can significantly advance China's informationization process; implement the state's software and integrated circuit industry on the basis of existing relevant policies.

## 5.3 Focus on talent training and increase investment in education

The cultivation of informatization talents is the key to the construction of national informatization, and it has a decisive influence on the development speed and quality of other elements of informatization construction. The investment in science and education innovation ability determines the future potential of the information industry.

In terms of human resources in the information industry, the growth rate of the proportion of employees in the information service industry in China declined from 2014 to 2016, while the growth rate of wages for employed personnel showed an upward trend. In general, the supply of information services in China is insufficient. Therefore, the cultivation of human resources in the information service industry may become a major obstacle to the development of information technology in China in the future, and needs to be strengthened. In terms of science and education input, the growth rate of per capita public finance education funds has shown a downward trend in 2014-2016, and this indicator is one of the indicators that contribute the least to China's informatization development level. Therefore, in order to improve the future development level of China's information technology, we need to invest more in the cultivation of science and education innovation capabilities.

Paying attention to the cultivation of professional talents requires the whole society to attach importance to acquiring knowledge in science and technology and education. Only when the awareness of the whole nation is raised, the number of service audiences in the information service industry can be expanded, and the informationization process can be better promoted. Ultimately, we can expand the base of professional talents. At the same time, a new round of information technology update has caused a new round of industrial transformation. The concept of "Internet +" has been applied step by step in various traditional industries. China's demand for composite information professionals has increased significantly. Based on this situation, We must pay attention to the focus on the cultivation of high-quality composite information-based talents.

In terms of investment in science and education innovation, in addition to establishing a technological innovation system for enterprises and strengthening their independent innovation capabilities, they can also focus on selecting products and projects with high technical relevance and industry-driven nature to conduct special research to promote introduction, digestion and absorption. The process of innovation strives to break through core technologies and promote independent innovation in key areas of information technology. At the same time, higher education institutions should also focus on the innovative ability of students.

# References


[1] Taylor. The Next Stage of U.S. Communications Policy: The Emerging Embedded Infosphere (2017) [R]. Telecommunications Policy, 2017,41(10):1039-1055.

[2] Wang Min, Liao Mingyang. Application of Big Data Analysis in Mobile Communication Network Optimization[J]. Communications, 2017, 46(2): 123-123.

[3] Huang Jinghua. Research on the Service Mode of Higher Vocational College Libraries in the Age of Big Data[J]. Library and Information Guide, 2015(17):73-74.

[4] SI Jinghua, LI Mingyan. Research on Innovation Environment Construction under the New Technology of Digital Campus Network[J]. China Educational Technique & Equipment, 2011(26): 52-54.

[5] Mao Yanqin, Shen Subin. Information Model and Capability Analysis of Internet of Things[J]. Journal of Software,2014,25(08):1685-1695.

[6] Ye Shasha, Zhang Xu. Innovation and Limitation of Mark Lupu's Information Economy Theory[J]. SCIENCE CHINA Information, 2007(1):267-269.

[7] Wang Xihe. Comparative Analysis of Four Methods of Social Information Measurement[J]. Library Science Research, 2008(3): 12-14.

[8] Yuan Jun. Research on Japanese Informatization Index Model[J]. Journal of Information, 2006, 25(4): 112-113.

[9] Zhang Wenjuan. Research on Measurement Methods of Social Informationization in China and Foreign Countries[J]. Information Science, 2009(6): 953-956.

[10] International Comparative Research Group of Informatization Level of National Institute of Statistics. International Telecommunication Union's Informationization Opportunity Index (ICT-OI) International Comparison - "International Comparative Research on Informatization Level" Series III [J ]. China Information Industry, 2010 (5): 58-62.

[11] International Comparative Research Group of Informatization Level of National Institute of Statistics. International Telecommunication Union Informationization Development Index (IDIITU) International Comparison - "International Comparative Study of Informatization Level" Series Report II [J]. China Statistics, 2010 (2): 54-55.

[12] Zhao Peiyun, Zheng Shurong. From the "National Informatization Index Composition Scheme" to See the Improvement of Social Information Measurement Index System[J]. E-Government, 2005(21).

[13] Zhou Xuanzhen, Zhao Liya, Zhao Di et al. The Promotion of Artificial Intelligence to Informatization of Scientific Research[J]. Science and Technology Information Technology & Application, 2016, 7(6).

[14] Xue Jie. Research on the Basic Framework of the Statistical Index System of China's Internet of Things Industry[J]. Science and Technology Management Research, 2015, 35(23): 50-53. Liu Xue, Shen Wei, Wang

[15] Zhuzhu. Research on Evaluation Index System of Education Cloud Regional Development[J]. China Electro-chemical Education, 2018(3).