

Using AHP-Entropy Approach to Investigate the Key Factors on FinTech Service



Can Xu*

School of Economics and Management, Hubei Polytechnic University, Huangshi, China
25064316@qq.com

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Abstract. With the continuous transformation of modern production and lifestyle, financial consumer's demands on financial products and services in terms of timeliness, convenience, individualization, intelligence and customization are increasing. Smart finance means that on the basis of information technology such as cloud computing, it can make funds more convenient, faster, wider, more efficient and safer, and realize the scientific management system of financial business, management, security and other financial activities and the intelligent improvement of management ability. Cloud computing is a new infrastructure management method, which can combine a large number of highly virtualized resource management, form a huge resource pool and provide services uniformly. Smart finance based on cloud computing technology has brought a new change to the financial industry, making traditional financial services step into a higher stage in the internet era. Smart finance innovation under cloud computing is premised on cloud computing of basis resources, management system, business system and service security. Through interview method and literature analysis, this paper presents an index system of smart finance innovation based on cloud computing, which includes four first-level indicators and sixteen second-level indexes. Based on the AHP-Entropy method, this paper gives the weight of each index, which can provide reference for relevant researchers. The research objects of this paper are mainly enterprises. In fact, smart finance can be applied to enterprises or individuals. For different enterprises and individuals, with the more comprehensive and timely collection and analysis of customer-related data, we can provide a full process, systematic and personalized intelligent financial services based on cloud computing.

Keywords: smart finance, finance innovation, cloud computing, AHP-Entropy algorithm

1 Introduction

In recent years, great progress has been made in the development of information technology. Cloud computing, Internet of Things and in-depth learning and other artificial intelligence technologies are becoming more and more mature, which makes human society move from electronic, information, networking and digitalization to a higher stage of intelligent era [1]. With the continuous transformation of modern production and lifestyle, financial consumer's demands on financial products and services in terms of timeliness, convenience, individualization, intelligence and customization are increasing. Financial consumption experience has become one of the important concerns of financial customers in choosing financial products and services [2]. Intelligent services are often favored by financial consumers. In addition, with the acceleration of financial product innovation and diversification of business types, financial consumers urgently need to support financial activities such as financing, investment, insurance and payment through intelligent services. Financial industry has always been the frontier of the exploration and application of new information technology. With the deep integration of new information technology, especially intelligent information technology, and modern financial industry, smart finance emerged as the times require [3]. Smart finance means that on the basis of information technology such as cloud computing, it can make funds more convenient, faster, wider, more efficient and safer, and

* Corresponding Author

realize the scientific management system of financial business, management, security and other financial activities and the intelligent improvement of management ability [4]. Smart finance is the general term of all financial products, financial services and other financial activities that apply advanced information technology to enable financial institutions, financial users or regulators to carry out financial management, financial services, financial decision-making and financial supervision quickly, flexibly, correctly and intelligently [5]. Intelligent supervision supported by information technology such as big data, data mining and artificial intelligence can not only improve the efficiency of supervision, but also reduce the cost of compliance.

Cloud computing is a new computing model based on Internet. It can provide software and hardware resources, data and applications as services to users through the Internet [6]. Cloud computing is also a new infrastructure management method, which can combine a large number of highly virtualized resource management, form a huge resource pool and provide services uniformly. Cloud, in fact, is a metaphor for the Internet. Providing information processing services to customers is the core of cloud computing model. At present, cloud computing services mainly include infrastructure services (IaaS), platform services (PaaS) and software services (SaaS), hardware services (Haas), data services (DaaS) and application services (AaaS) [7]. Financial cloud computing is to make use of the principle of cloud computing model, interconnect the data centers of financial institutions and related institutions, form cloud networks, or use cloud computing service networks to disperse financial products, information and services into cloud networks to improve the ability of financial institutions to quickly discover and solve problems, enhance overall work efficiency and improve processes [8]. Cloud computing can build a smart financial system. But how do we judge the intelligence of a cloud-based smart financial system? This is a gap in the field of smart finance [9]. This paper will analyze and decompose the index system of intelligent finance under cloud computing, and elaborate on the innovation degree of intelligent finance under cloud computing.

2 Smart Finance Features Based on Cloud Computing

Cloud computing is a method based on distributed computing and virtualization technology. Cloud computing technology provides a variety of information services and sharing infrastructure through self-maintenance and management of massive virtual computing resources [10]. Cloud computing is also a way to access resources. Under the cloud computing mode, to ensure Internet connectivity, environmental security and complete facilities, we can get the desired resources without space and time constraints. At the same time, it can ensure the normal operation of applications in the cloud environment, and there are no restrictions on access to resources. At the same time, users pay on demand for cloud computing services [11]. This feature of cloud computing, on the one hand, reduces the use threshold, on the other hand, greatly saves costs. An important feature of cloud computing technology is the ability to share resources. It integrates different types of resources to form a pool of shared resources, and then uses virtualization technology to place all resources on the same shared platform for all types of users to share. Cloud is a huge resource to buy on demand. The use of the cloud can also be as convenient as any kind of daily necessities we use [12]. A large number of IT resources in the network will be managed and planned in a unified way, providing users with general hardware and software resources and information, and can be automatically managed, deployed and configured, combined configuration, dynamic start-up and recovery of resources according to user needs.

Based on cloud computing technology, smart finance represents the development direction of the future financial services industry. It provides accurate and high-quality financial services to customers through real and reliable data analysis [13]. It is essentially different from traditional finance. Its characteristics are mainly transparency, convenience, flexibility, instantaneity, efficiency and security. Smart finance is the most essential characteristic of smart finance [14]. Smart finance upgrades financial products, services and supervision from many channels, such as approaching user's thinking mode, actively understanding and perceiving users' needs, optimizing user's service experience, improving decision-making efficiency and preventing financial operation risks, making full use of advanced information technology to create considerate financial services. At the same time, it is gradually reducing and replacing the manual intervention in financial activities. Efficient smart finance can achieve rapid response, fast processing and quick result feedback in business processing, capital flow, transaction decision-making, risk prevention and control, and meet the real-time or quasi-real-time processing

requirements of users [15]. Convenient intelligent financial services are simple, flexible and convenient in terms of accessibility, understandability and operability. Consumers use smart financial products and services with lower time, space and intellectual costs. Smart finance provides precise personalized and customized services in understanding and perceiving customer needs, customer marketing and service scheme customization. Green smart finance is the product of highly integration and innovation of advanced information technology and modern financial business [16]. It has more advantages in reducing the consumption of human, material and other energy resources in financial activities.

Financial industry is one of the most widely and deeply applied industries of information technology. According to R.L. Nolan's six-stage model of informatization development, China's financial informatization is in the integration stage and is moving towards data management. From integration stage to data management stage is a turning point of financial informatization. Before the financial data centralization, computer and network communication technology were mainly used to realize the electronic automation of financial business and the interconnection of data. After the completion of financial data centralization, it will enter the stage of data management. In this stage, it is necessary to further use information technology to mine data, obtain hidden information in data, and find useful knowledge from information, so as to better decision-making and support business innovation [17]. This stage is characterized by the high integration of information technology and financial business. From the integration stage to the data management stage, the application of computer technology has changed to the integration of information technology and business, which will usher in a new round of rapid development. The development of China's financial informationization is in a critical transition period from financial electronic networking to financial informationization intellect ualization.

3 Research Methodology

3.1 Experimental Design and Environment

Based on interviews with experts and typical users, this study designed questionnaires. Maturity scale was used to design questionnaires according to public idioms. Based on the concept of smart finance and the research results of scholars at home and abroad, the questionnaire designs four concepts: basic resources cloud, management system cloud, business system cloud and cloud computing security [18].

The design of smart financial index system under the background of cloud computing, must follow the principles of comprehensiveness, dynamics, operability and hierarchy. Comprehensive principle. As an organic whole, the index system should be able to comprehensively reflect and measure the main operating characteristics and operating conditions of the intelligent financial system under the background of cloud computing, so as to make the index system constitute a hierarchical whole. Therefore, the index system should reflect all aspects that affect the sustainable development of smart finance, and reflect the main characteristics and status of the evaluated system from different angles [19]. Dynamic principle. Any criterion and index have certain timeliness and changing trend. The index system should be estimated as a trend when necessary. It can reflect the current situation and future trend of sustainable development comprehensively, so as to facilitate prediction and decision-making, and not be measured according to the temporary static value. Principle of operability. The more indicators, the better. We should consider the quantification of indicators, the difficulty and reliability of acquisition, the easy analysis of data needed, and try to select representative comprehensive indicators. Indicators should be reasonable, practical and feasible, easy to obtain, simple to calculate, easy to understand, operable and able to check. The principle of hierarchy. The sustainable development of smart finance is a complex system, which can be divided into several sub-systems. Therefore, the index system should be divided into corresponding levels according to the needs of measurement purposes and the different functions of indicators, and have a clear corresponding relationship. The indicators should be integrated upwards and specific downwards.

The research process is shown in the following figure.

3.2 Dataset Collections and Data Pre-processing

Sixteen indicators with the highest number of votes by experts and business representatives were selected from thirty indicators. The results are shown in the following table:

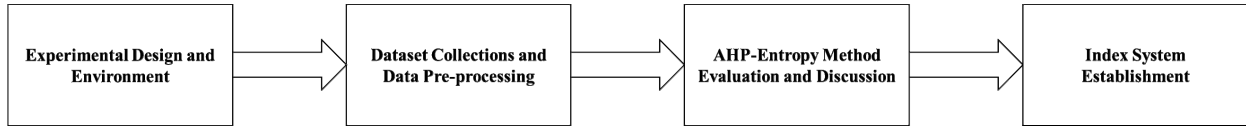


Fig. 1. Diagram of research process

Table 1. Sixteen indicators with the highest number of votes

Index name	Votes	Index name	Votes
Sales management	197	Computing resource	165
Data security	197	Network resource	156
Administrative management	192	Privacy protection	154
Production management	180	Development management	146
Meeting management	174	Financial management	145
Human resource management	172	Storage resource	144
Protection resource	170	Purchasing management	141
Platform operation	167	Legal risk	136

3.3 AHP-Entropy Method Evaluation and Discussion

We determinate the index weight of smart finance innovation indexes by the means of AHP-Entropy Method. The concrete steps are shown in Fig. 5.

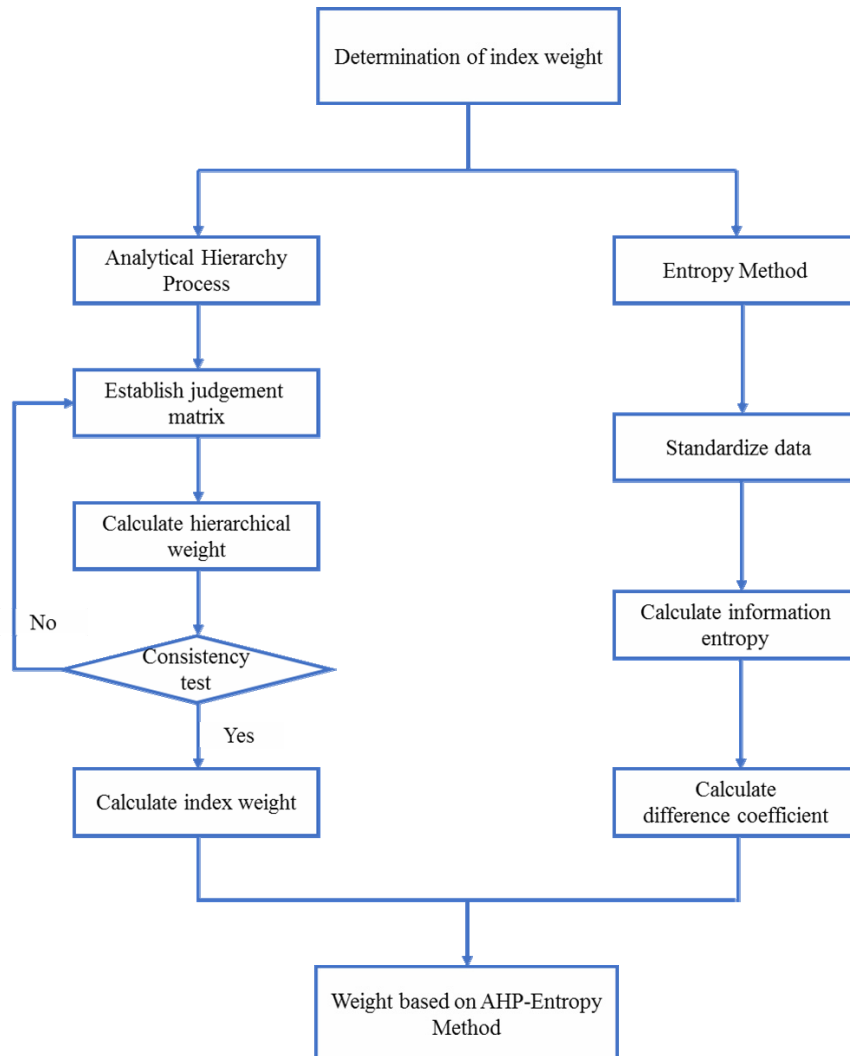


Fig. 2. Calculation steps of AHP-Entropy algorithm

Analytical Hierarchy Process (AHP) adopts the method of hierarchy and mathematics to deal with decision-making problems [20]. The elements in complex problems and their relationships are analyzed. According to the analysis results, a hierarchical structure is established, and the two comparisons among elements are made. The judgment matrix is constructed and the weight is calculated. Analytic Hierarchy Process can simplify unstructured and multi-objective complex decision-making problems and deal with decision-making problems lacking quantitative information [21]. The essence of analytic hierarchy process is actually a comprehensive evaluation algorithm, which provides a quantifiable basis for the analysis, judgment and decision-making of complex problems, and uses the model to make a comprehensive evaluation of the target system.

The first step: to judge the product of all the elements in each row.

$$M_i = \prod_{i=1}^n A_i(1, 2, 3, \dots, n) \tag{1}$$

The second step: to calculate the root of each M_i .

$$W_i = (\overline{M_i})^{\frac{1}{N}} \tag{2}$$

The third step: to normalize the vector.

$$W_i = \frac{\overline{W_i}}{\sum_{i=1}^n \overline{W_i}} \tag{3}$$

The fourth step: to calculate the final evaluation value.

$$F = \sum_{i=1}^n W_i V_i \tag{4}$$

The concept of entropy was first put forward by German physicists. Later, American mathematicians, founders of cybernetics and information theory Wiener and Shannon proposed broader information entropy, which has been widely used in engineering technology, social economy and other fields. Entropy method is an objective weighting method, which uses the information of the index itself to judge its validity and value. It can make an objective and fair comprehensive evaluation of the system.

The first step is to standardize the data. For the positive index, the equation is:

$$x'_{ij} = \frac{x_{ij} - x_{ij\min}}{x_{j\max} - x_{j\min}} \quad (j = 1, 2, \dots, n; j = 1, 2, \dots, m) \tag{5}$$

For the negative index, the equation is:

$$x'_{ij} = \frac{x_{j\max} - x_{ij}}{x_{j\max} - x_{j\min}} \quad (j = 1, 2, \dots, n; j = 1, 2, \dots, m) \tag{6}$$

Therefore, we can obtain the data standardization matrix:

$$X = \begin{pmatrix} x'_{11} & \cdots & x'_{1m} \\ \vdots & \ddots & \vdots \\ x'_{n1} & \cdots & x'_{nm} \end{pmatrix} \tag{7}$$

Then, we can normalize the data standardization matrix by the equation:

$$p_{ij} = \frac{x'_{ij}}{\sum_{i=1}^n x'_{ij}}, 0 \leq p_{ij} \leq 1 \tag{8}$$

The normalization matrix is as follow:

$$P = (p_{ij})_{nm} \quad (9)$$

The second step is to calculate information entropy of the j th index.

$$e_j = -k \sum_{i=1}^n p_{ij} \cdot \ln p_{ij} \quad (10)$$

The third step is to calculate difference coefficient of the j th index.

$$g_j = 1 - e_j (j = 1, 2, \dots, m) \quad (11)$$

3.4 Index System of Smart Finance Innovation Based on Cloud Computing

In this paper, a variety of research methods are used to construct the index system. The interview method, factor analysis method and discriminative force method are used to screen the index system. The interview method can carry out in-depth observation and questioning of the interviewees. The flexibility and easy way of conversation can fully mobilize the enthusiasm of the interviewees and help the interviewers collect opinions and suggestions of the interviewees on the research questions [22].

Based on the evaluation indicators of intelligent financial innovation in the existing theory, we hope to collect more effective information through communication with interviewees. In the interview, collect relevant people's understanding of the effectiveness of financial innovation and financial system construction; understand what business managers believe that the financial innovation system needs to be built; explore what aspects of financial innovation should be evaluated. We hope to use the interview research of grounded theory to establish the evaluation index of the effectiveness of the smart financial innovation system.

We interviewed 50 interviewees in the form of semi-structured interviews in March 2019. The interview questions include: What do you think smart finance is, and what aspects do you think it includes? What aspects do you think the evaluation of intelligent financial innovation should be carried out? What do you think of the overall level of financial innovation in China? If you think that the level of innovation is not good, what aspects should be improved? These questions are used to understand the connotation of intelligent finance, how to evaluate the current level of financial innovation, the direction of financial innovation system construction efforts and related suggestions.

In order to enrich and specify the content of the interview, the interviewees selected randomly and interviewed people of different positions and ages. The sample statistics of interviewees are shown as Table 2.

Table 2. Sample statistics of interviewees

Sample features	Classification	Sample number	Percentage
Gender	Male	23	57.5%
	Female	17	42.5%
Age	25 years old or below	5	12.5%
	25-35	9	22.5%
	25-45	18	45.0%
	46-55	5	12.5%
	56 years old or above	3	7.5%
Education	Below bachelor degree	5	12.5%
	bachelor degree	20	50.0%
	Master degree	11	27.5%
	Doctor degree or above	4	10.0%

For the questions in the interview “What aspects do you think the evaluation of intelligent financial innovation should be carried out”, we summarized the keywords described in the interviewees and divided the content of these keywords. This study uses the most commonly used word frequency statistics in content analysis, that is, the keywords related to the evaluation indicators of the research questions are recorded. Then calculate the frequency of these keywords, and summarize the dimensions of intelligent financial innovation evaluation and its evaluation indicators. Through the analysis of the

number of occurrences of the interview content keywords, the evaluation indicators can be clearly divided into four dimensions: cloud computing of basis resources, cloud computing of management system, ability of online service and cloud computing of service safety.

Index of cloud computing of basis resources. Cloud computing of basis resources is a method of deploying enterprise websites, data, files in local computers or servers to the cloud platform. We use cloud resources instead of physical computer room resources, and gradually apply new technologies from simple peripheral systems. Basic resources cloud includes computing resources cloud, storage resources cloud, network resources cloud, security protection cloud and so on. While guaranteeing the stability of the system, cloud computing of basic resources can save the enterprise’s early information investment and reduce the cost of IT operation and maintenance. Enterprises do not need to understand the specific details and composition of cloud computing, nor directly control the relevant infrastructure, they can host all resources and data in the cloud server, and can access related cloud services. Enterprises or ordinary users only need to customize the corresponding services or applications from cloud service providers through their own needs. Cloud servers can deploy the services and applications required by users according to their different needs. Because of the advantages of cloud computing, such as customization on demand. More and more users begin to use cloud computing services. Infrastructure layer is the entity of service hardware facilities provided by cloud computing to users. It covers the computing resources and storage resources needed in the service process. It can provide users with virtualized computing and storage resources. Without reinvesting funds, users can directly and effectively use hardware service facilities and other basic resources, and without additional investment and maintenance costs, they can obtain data and computing resources of data centers according to their own needs without time and space constraints.

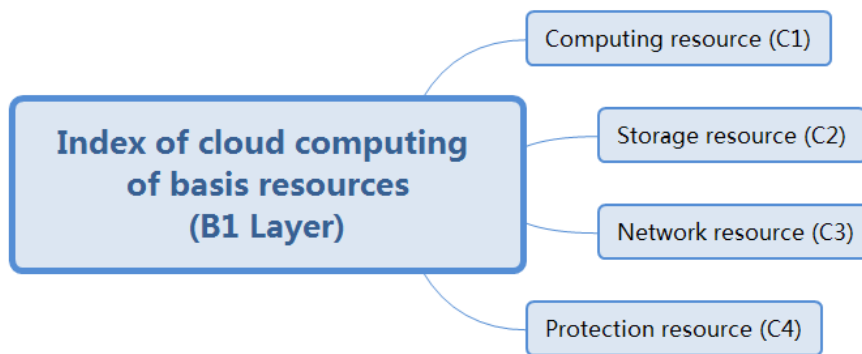


Fig. 3. Index of cloud computing of basis resources

Index of cloud computing of management system. At present, smart financial enterprises can solve insurance plan, portfolio management and other business through cloud services. Payment and settlement business refer to the services provided for unit customers and individual customers by means of bills, remittances, letters of credit, credit cards and other settlement methods for currency payment and fund settlement. At this stage, smart financial enterprises can complete such business as currency settlement and credit card processing through cloud service platform [23]. Credit business, also known as credit assets or loan business, is one of the most important assets business of financial institutions, which mainly makes profits through interest. Professional competence of personnel determines the professionalism of business development of financial enterprises. At the same time, the professional competence of financial enterprises to participate in cloud services also determines the security and stability of financial enterprises to carry out cloud services. Professional competence of personnel determines the development of business of financial enterprises. With the rapid development of Internet finance, a large number of intelligent financial institutions have been born, mainly through the cloud service platform to put credit loans to the market, and continue to make profits.

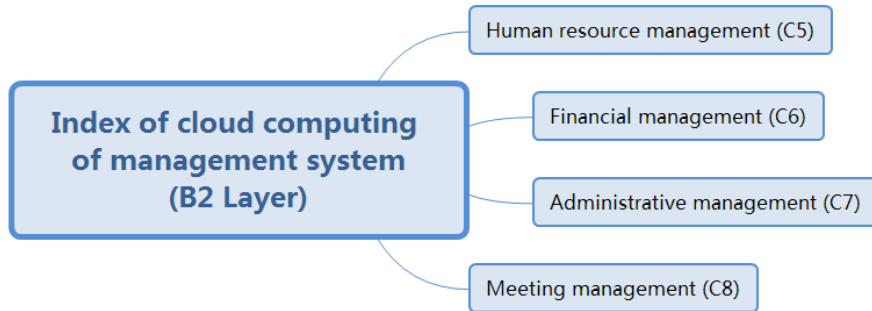


Fig. 4. Index of cloud computing of management system

Index of cloud computing of business system. Cloud computing of business system helps enterprises to achieve cross-platform, cross-business unified deployment and management of all kinds of data generated by different business. Enterprises use cloud-based large data platform to obtain data collection, analysis, mining, storage and collaborative application services. We use cloud product resources to implement enterprise complex applications such as ERP, CRM, MES and other large-scale application systems in the cloud, or use mature SaaS-based service software to replace traditional buy-out application systems. Through enterprise purchasing management, production management, sales management, supply chain management, e-commerce, customer resource management and other applications to cloud, we can enhance the level of business operations, through enterprise design and system development to enhance the efficiency of enterprise development and innovation level. Promote cost reduction, analyze product cost structure, further optimize delivery forecasting management and production and procurement planning process, improve supply chain response speed [24]. In order to further improve the collaboration of upstream and downstream resources in supply chain and improve the level of supply, financial companies upgrade the existing ERP, improve the visual management of suppliers, strengthen the tracking of raw material supply progress, and enhance the level of smart financial innovation.

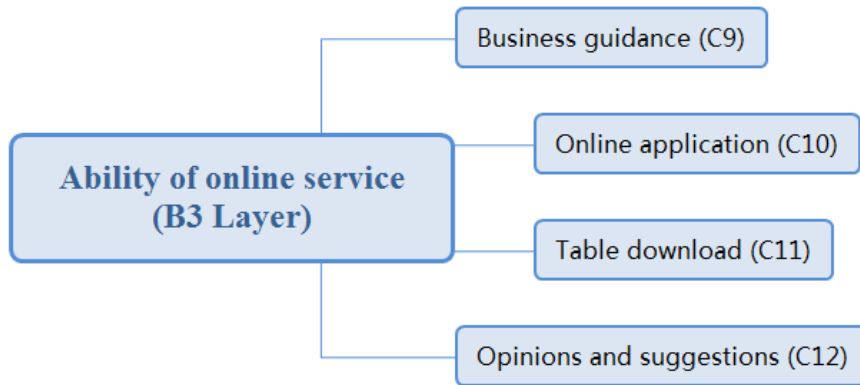


Fig. 5. Index of cloud computing of business system

Index of cloud computing of service safety. In the process of information development of financial enterprises, the traditional financial industry is faced with the problems of the number of servers, storage capacity, operation and maintenance costs, which perplex the development of information technology of financial enterprises, especially the smart financial enterprises with weak capital strength. However, virtualization technology has brought advantages such as allocation and utilization of basic hardware facilities, improvement of resource utilization and energy saving, which are gradually solving this problem. At the same time, as the country continues to increase the construction of information technology, the traditional financial industry is also constantly exploring the application of new information technologies such as distributed architecture and open source technology, and gradually moving towards the modernization of financial enterprise informatization, while virtualization technology and distributed architecture are also the core of cloud services. Intelligent financial companies customize cloud services to cloud service providers according to their business needs. When users need

to delete or discard the data, if cloud service providers cannot delete the corresponding data completely in time, they will face the risk of data leakage.

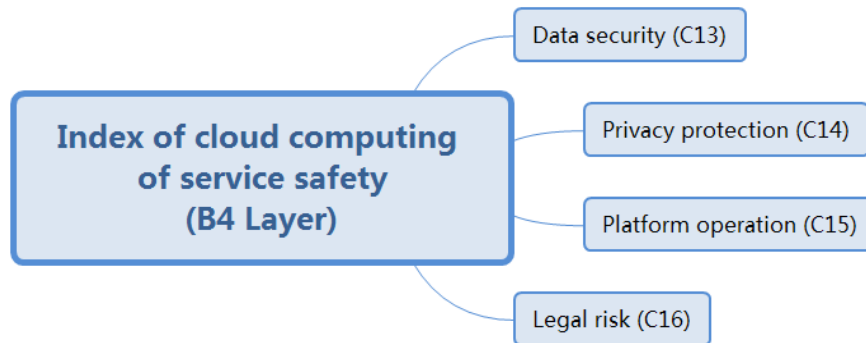


Fig. 6. Index of cloud computing of service safety

4 Experimental Results and Performance Evaluation

4.1 AHP-Entropy Method Evaluation

The emergence of AHP entropy method not only enriches and perfects the methodology system of index weight setting, but also provides reference and reference for the update of corporate financial innovation research methods [25]. The current methods of financial innovation assessment are seriously inadequate, and there are subjective randomness. It is easy to cause the results of the assessment to be quite different from the actual situation. It is urgent to introduce a more scientific and reasonable innovation evaluation method.

We have made weight determinations on the above-mentioned intelligent financial innovation indicator system by AHP-entropy method. The result is showed in the following table.

Table 3. Determination of evaluation index weight according to AHP-Entropy algorithm

Index name	weight
Computing resource	0.1031
Storage resource	0.0554
Network resource	0.0708
Protection resource	0.0885
Human resource management	0.0639
Financial management	0.0348
Administrative management	0.0214
Meeting management	0.0303
Development management	0.1145
Purchasing management	0.0638
Production management	0.0731
Sales management	0.0437
Data security	0.0611
Privacy protection	0.0767
Platform operation	0.0351
Legal risk	0.0638

4.2 Discussion

The intelligent financial innovation evaluation framework based on AHP entropy method, from the construction of the index system to the evaluation of the innovation system, adopts a combination of subjective and objective methods, which changes the status quo of subjective evaluation of financial innovation evaluation and makes innovation. The results of the assessment are more objective, accurate and reliable [27].

5 Conclusions

According to the concept and features of smart finance based on cloud computing, a set of index system of smart finance innovation is designed. This paper analyses the theoretical basis, previous literature and basic methods of the construction of smart finance innovation based on cloud computing. The objective layer of the index system of smart finance innovation based on cloud computing is divided into four rule layers. Each rule layer is decomposed into four scheme layers, and all the scheme layers are explained and illustrated. The weights of the sixteen second-level indexes are the key to the index system of smart finance innovation, which are calculated based on AHP-Entropy algorithm. The research objects of this paper are mainly enterprises. In fact, smart finance can be applied to enterprises or individuals. For different enterprises and individuals, with the more comprehensive and timely collection and analysis of customer-related data, we can provide a full process, systematic and personalized intelligent financial services based on cloud computing.

5.1 Research Limitations

This paper establishes the index system of smart finance innovation based on cloud computing, but there are certain limitations. First, the application of AHP entropy method must rely on the integrity and accuracy of financial data but due to the low degree of financial data sharing of some enterprises, some key identification indicators are missing, which will have certain impact on the financial innovation evaluation results. Second, the index system is dominated by subjective evaluation indicators, lacking support from objective indicators. Third, because China's experience in smart financial practice is still insufficient, relevant theories and applications are lacking, so there will inevitably be a theoretical basis. Finally, the design of the interview method is not mature enough to affect the overall accuracy of the development and use of indicators.

5.2 Future Works

Based on the above limitations of this paper, we believe that the follow-up study can start from the following two aspects: on the one hand, introduce more objective data to support the corporate financial innovation evaluation system; on the other hand, collect and explore more examples of corporate financial innovation models under cloud computing, to learn from successful experiences.

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