Mechanism and Simulation of Cloud Computing Federation Value-added Knowledge Capital

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Abstract

Cloud computing federation is an important trend in the development of cloud computing, and its important characteristic is knowledge capital intensive. We proposed a general process model of organizational value-added knowledge capital based on the situation and characteristics, in order to develop cloud computing federation well. It can improve the efficiency of value-added knowledge capital, and clear and definite the relationship among the Influencing factors of knowledge capital output. We give a quantitative and qualitative research about the mechanism of value-added knowledge capital of cloud computing federation through using the knowledge potential theory. Construct the value-added knowledge capital output model, based on a Cobb-Douglas function. The simulation using MATLAB software in order to show the relationship between the related factors of federation knowledge capital output and put forward the suggestion on development of cloud computing Federation. It provides a theoretical basis for improving the cloud computing federation value-added knowledge capital efficiency.

Key words: CLOUD COMPUTING FEDERATION, KNOWLEDGE CAPITAL, KNOWLEDGE CAPITAL POTENTIAL, VALUE-ADDED KNOWLEDGE CAPITAL.

1. Introduction

Recently, with the further research on the technology of cloud computing and its application gradually mature, the way organizations provide information and service is a revolutionary change. It has become the value of the information technology industry a new growth point but also gave birth to a new form of organization -- cloud computing [1]. In cloud computing, knowledge capital reflects powerful function and advantage which is different from traditional material capital. It is the key and value of alliance enterprises inexhaustible motive force of the alliance enterprise to obtain the competitive advantages created. Therefore, the research on the mechanism of cloud computing federation value-added knowledge capital and the main influence factors is of great theoretical and practical significance.

Currently, there has been made some relevant outcomes on the mechanism of cloud computing federation value-added knowledge capital and the main influence factors. Annie Brooking, Karl Erik Sveiby, Lief Edvinsson et al.

divided the structure of intellectual capital from different perspective and analyzed the nature of value of intellectual capital. The knowledge capital has dynamic characteristic, it can be added through appropriate ways [2]. Ramona Dzinkowski, Michael J. English, William H.Baker Jr. et al. had studied how knowledge capital value-added. They believed that the knowledge transfer will bring value-added knowledge, and directly affects the efficiency of knowledge capital appreciation [3,4]. Teece proposed the "knowledge market" theory, he suggested that the knowledge value creation come from the within enterprise and the external non substantive transfer and technology bundling activity [5]. Based on industrial cluster and alliance, Yang Bin, Wang Anmin, Yang Yubing et al. studied the knowledge capital value model of different subject, knowledge transfer mode and path, the realization of the value and the governance mechanism and so on, by using the value chain, complex network and game theory [6,7,8]. However, from the research results, the means of the analysis of value-added knowledge capital mechanism is the single means and described insufficient thoroughly, mainly based on qualitative analysis. While, research on mechanism of knowledge capital value alliance of cloud computing is scarce, which is a new organization form of value-added.

In this paper, we will give a quantitative research about the value-added knowledge capital of cloud computing federation through using the knowledge potential theory. Based on the analysis of the mechanism of value-added capital and the motivation of formation of federation, we introduce a Cobb-Douglas function to construct the value-added knowledge capital model. The simulation using MATLAB software in order to show the importance of factors affecting and intrinsic relationship. It provides a theoretical basis for improving the cloud computing federation value-added knowledge capital efficiency.

2. The motivation of formation of federation and the mechanism of value-added capital

2.1. The motivation of formation of federation

The further research on the technology of cloud computing and its application gradually mature, integration the cloud computing commercials services chain resources of different subjects, according to its own characteristics and reduce the cost, meet the needs of the market requirement of cloud computing. It is the inevitable choice of the alternative development of cloud computing, and cloud computing development alliance is the optimal way to solve resource integration problem. The cloud computing is guided by the demand of the market, as the basis for cooperation with the cloud computing industry value chain alliance, specifically refers to the value chain to enterprises, research institutes, industry associations and between users, in order to realize the whole value chain value maximization, and constantly improve the strength and level of competitiveness and the members of their own, by contract the ways of complementary advantages, benefit sharing, risk sharing loose network of tissue. Specifically, the cloud computing federation formation motivation can be summarized as the following aspects: 1) the cloud computing technology of large-scale, general-purpose, flexible extensibility features, objectively determine any single enterprise considering the costs and benefits are non-optimal choice, it only can maximize the technical characteristics of cloud computing, and can realize the benefit maximization; 2) Cloud computing technology has the characteristics of rapid development, technology changes quickly, many factors of uncertainty, enormous technology research and development risk. The establishment of enterprise alliance can effectively reduce or share the development risk, the main play alliance technology advantage, improve the success rate of development, grasp the market opportunity; 3) Cloud computing as a new field, human capital scarcity, alliance can effectively integrate human capital, improve value-added human capital efficiency, mutual parties. 4) The development of cloud computing follows a series of technical standards and service specification. Based on the alliance's influence, it can take the lead on putting out or participate in the formulation of the relevant technical standards and service standards, which is conducive to the coalition partners to gain core competence, to maintain a sustained competitive advantage. 5) The establishment of cloud computing federation can collect user demand information more effectively. Through further communication between the coalition partners, we can comprehensive understanding of the actual needs of users, mining the common demand, formation the basis of product development. The advantages of cloud computing technology and the cloud computing federation promote the formation and development of the alliance of cloud computing.

2.2. The mechanism of value-added capital

2.2.1. The general process of organizational value-added knowledge capital

The concept of the knowledge capital is emerges and gradually popular which follows the emergence and development of knowledge economy. Understanding the relationship between 'knowledge' and 'knowledge capital' is first and foremost of discussion the value of knowledge capital. Knowledge becomes "knowledge goods" will be stripped from the other factors of production, which can be freely exchanged in the production elements market. "Knowledge" becomes a "knowledge capital", when the knowledge commodity become value means. In some degree, the knowledge capital value-added equivalent to the knowledge "quality increase" itself, namely knowledge innovation.

Therefore, in essence, the process of federation knowledge value-added capital is a process of the knowledge capital transferring and sharing between knowledge federation partners. It is impact on the efficiency of value-added knowledge capital, which is not only realized the value of knowledge resources, but also an important means to win the competitive advantage of the alliance partners.

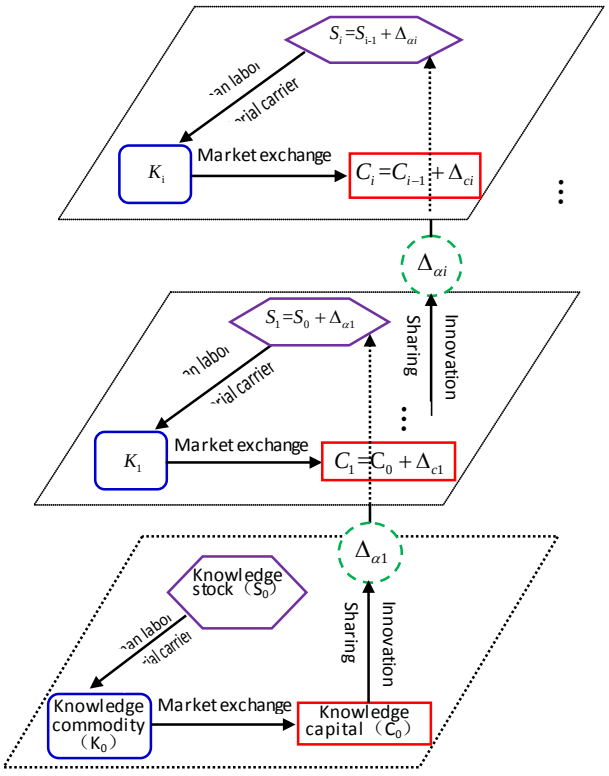

Figure 1. The spiral model of general process of organizational value-added knowledge capital

The general process of organizational value-added knowledge capital is shown in Fig.1. Supposed that the knowledge stock of an organizational at some time is s_0. Through human labor, enable it have the attributes and conditions of knowledge commodity, by using the use of certain matter. Formed the knowledge commodity k_0, which can be exchanged according to the market rules. The organization has the corresponding knowledge capital C_0, which can be realized knowledge innovation and acquired new knowledge $\Delta_{\alpha 1}$, through knowledge acquisition, knowledge communication, knowledge application and knowledge acceptance and knowledge assimilation of knowledge transfer and sharing links. Then, the stock of knowledge enterprises is S_1 ($S_1=S_0+\Delta_{\alpha 1}$) and the knowledge commodity K_1 ($K_1 \succ K_0$). When K_1 converted to knowledge capita, it will increase Δ_{c1} and the organization for the knowledge capital is increase to C_1 ($C_1=C_0+\Delta_{c1}$). Completed a knowledge capital appreciation process, temporarily reaching steady state. At some time, the stock of knowledge enterprises is S_i ($S_i=S_{i-1}+\Delta_{\alpha i}, i=1,2,\cdots,n$), meanwhile, the knowledge commodity is K_i ($i=1,2,\cdots,n$), the knowledge capital is C_i ($C_i=C_{i-1}+\Delta_{ci}$, $i=1,2,\cdots,n$). The above process of continuous cycle back and forth, trend spiral, realizing the growing intellectual capital value, which is the process of organizational knowledge capital [9]. The federation is Consists of some federation partners, so the federation value-added knowledge capital is also applicable to the process.

2.2.2. Analysis of value-added knowledge capital of cloud computing federation based on knowledge potential theory

Knowledge potential theory is borrowed from the definition of the body potential energy physics $E=\frac{1}{2}gh^2$, which is "the object in a position and a certain potential energy". The body of knowledge mainly affected by the inner Knowledge Depth in some knowledge area (i.e., KD which is the relative position of the single knowledge chain knowledge)and the KW (i.e., Knowledge Width that is the diversity degree of the body of knowledge) of the knowledge of subject knowledge. From a particular area of expertise, different organizations have different of quality and quantity of knowledge. While, the knowledge potential can represent task knowledge structure and the stock of knowledge team. Therefore, the knowledge potential can be defined

by the two dimensional spatial constituted of KD and KW. The knowledge potential of the knowledge body i in area j is:

$$KP_{it} = G(KW_{it}, KD_{it}) = \frac{1}{2} M_{it} \left[f(KW_{it}, KD_{it}) \right]^2 \quad (1)$$

where KP_{it} is the knowledge body i in t time and M_{it} is the knowledge stock i in t time. f is the function of KW and KD, which represent the difference between the different knowledge body [10]. In a moment, different knowledge body have different knowledge potential, for different knowledge body, which is the power of the behavior of different knowledge transferring and sharing and diffusion. At present, from the potential perspective, the researches on the diffusion of [11], process of the knowledge creation [12], knowledge sharing [13], strategic alliance stability [14] etc. obtained some results. But the research about organization or union value of intellectual capital mechanism by using the knowledge potential theory research is still rare. Knowledge potential theory can well explain the mechanism of value-added knowledge capital of cloud. 1) the knowledge potential difference between the cloud computing federation partners is the motivation of the sharing of knowledge transfer within the federation, according to value-added knowledge capital spiral model. The knowledge transfer and sharing is the premise to achieve value-added federation knowledge capital; 2) cloud computing federation partners have similar knowledge Width, namely the federation partners are all belonging to the IT industry. Moreover, the federation partners have complementary knowledge depth, which provides an objective basis for knowledge sharing and innovation, and a guarantee knowledge capital value-added continues.

In this paper, we propose the concept of "knowledge capital potential", by using the knowledge potential theory. The knowledge capital comprehensive level, which a federation partners or the whole federation have, is expressed by Three dimensions of capital that is the knowledge capital quantity, the knowledge capital quality and the knowledge capital type as:

$$KCP_{i,t} = \frac{1}{2} C_{i,t} \left[f(CQ_{i,t}, CK_{i,t}, CA_{i,t}) \right]^2 \quad (2)$$

where $KCP_{i,t}$ is the knowledge capital potential of the ith federation partner in time t and $C_{i,t}$ is the stock of knowledge capital of the ith federation partner in time t. $CQ_{i,t}$ is the stock of knowledge capital of the ith federation partner in time t and $CK_{i,t}$ is the knowledge capital type of the ith federation partner in time t. $CA_{i,t}$ is the knowledge capital quantity of the ith federation partner in time t. f is a function that is the knowledge capital stock changes caused by the three variation of the $CQ_{i,t}$, $CK_{i,t}$ and $CA_{i,t}$. The higher knowledge capital potential of federation partner, the higher quality of knowledge capital. Similarly, the kinds of knowledge capital contains, the quantity of knowledge capital. It is indicated that the research staff has a higher capability and technical level, more type knowledge capital and knowledge capital. Obviously, the level of knowledge capital stock determined the knowledge capital potential in the federation. Moreover, the gap between knowledge capital potential is the power of flow among different coalition partners. The stock of knowledge capital of the ith knowledge body in time t is defined as:

$$C_{i,t} = (1-\delta) C_{i,t-1} + \lambda_i (K_t + S_{i,t}) \quad (3)$$

where $\delta (0 \le \delta \le 1)$ is the knowledge capital depreciation rate of the i th Federation Partners, and $C_{i,t-1}$ is the knowledge capital stock of the ith Federation Partners at time $(t-1)$. K_t is the amount of sharing new knowledge at time t. $S_{i,t}$ is the i th federation partners' creating new knowledge through their own knowledge stock during time t. λ_i is the coefficient of turning the new knowledge into knowledge capital for the ith Federation Partners.

As shown as (3), at some time, the knowledge capital stock of federation partners is related to the depreciation rate of knowledge capital, the initial knowledge capital stock, the sharing, the knowledge capital conversion speed and generate new knowledge. Knowledge capital depreciation rate the level is developed by the state-of-art of the industry. Knowledge sharing is decided by the overall strength and relevant mechanism of the whole federation. The initial knowledge capital stock consists is depending on the organization development history. While the production speed of new knowledge and the conversion rate is determined by researchers' knowledge absorptive capacity, knowledge creation capability and transforming the knowledge as the knowledge commodity hardware level. However, all the above ability is affected by the number of the technique level and the advanced degree of hardware. The increment of knowledge capital stock for the ith federation partners at some time is:

$$\Delta C_{i,t}=f(N_{i,t},T_{i,t},H_{i,t}) \quad (4)$$

where $N_{i,t}$ is the number of the ith federation partners at some time t. $T_{i,t}$ is the technical level of the ith federation partners at some time t. $H_{i,t}$ is the level of the hardware of the ith federation partners at some time t. f is a function of these variables. Since, the initial knowledge capital stock of the organization is accumulated by the knowledge capital of every period. The increment of knowledge capital in different periods are also determined by the researchers' technology level and the level of the hardware facilities and the current number researchers. It is a sum function of the variable.

Supposed that the ith federation partners at historical period n, according to Eq.(3) and (4) ,then

$$C_{i,t}=(1-\delta)C_{i,t-1}+\Delta C_{i,t}=\sum_{t=1}^{n} f(N_{i,t},T_{i,t},H_{i,t}) \quad (5)$$

We substitute Eq.(5) for Eq.(2)

$$KCP_{i,t}=\frac{1}{2}\sum_{t=1}^{n} f(N_{i,t},T_{i,t},H_{i,t})\left[f(CQ_{i,t},CK_{i,t},CA_{i,t})\right]^2 \quad (6)$$

As shown as Eq.(6), the number of researchers, the technical level, infrastructure level, knowledge capital stock, knowledge capital quality type and the overall number of knowledge capital determine the knowledge capital potential of the partners. But, the final results of the former three variables will ultimately reflected in the knowledge capital quality, species and quantity. Therefore, the knowledge capital potential of partner can be comprehensive evaluation by using knowledge capital quality, type and overall three indexes. So, the different between the knowledge capital potential of federation partners must exist. In order to improving the competitiveness of enterprises and reducing the potential gap between the objective, the low potential enterprise will be closer to the high potential to obtain new knowledge quickly, according to the demand of the market. Meanwhile, in order to further consolidate the core competitive position, the high potential enterprise make up for their lack of a type of knowledge capital and ensure that differences exist. Under relevant protection about federation mechanisms, the high potential are also willing to exchange and sharing with low potential enterprise to complement. Therefore, as long as the difference of knowledge capital potential exist between federation partners, the transferring and sharing of knowledge capital will not stop. The stock of knowledge capital federation partners can spiral, the knowledge capital value of the whole federation will be growing.

3. Analysis of cloud computing knowledge capital value-added model and Simulation

3.1. Model

The "spiral model of organizational value-added knowledge capital process" shows that , the increment of value-added knowledge capital depends on the amount of new knowledge $K_t+S_{i,t}$. Generally, according to the properties and superior characteristics of the federation , the amount of new knowledge obtained from federation is much higher than the new knowledge output of partner itself (i.e. $K_t \succ S_{i,t}$), which is the precondition for cloud computing federation establishment. Therefore, the amount of new knowledge is mainly come from the amount of knowledge capital transferring and sharing, (i.e., K_t), which provided by federation partners. K_t is determined by the knowledge capital stock and sharing proportion coefficient. For convenience, without loss of generality, we assume that cloud computing federation is made up of 2 partners, i.e. $i=1,2$. Based on a Cobb-Douglas function, we study the value-added knowledge capital output and influencing factors and construct the value-added knowledge capital output function[15] as:

$$Y=A(\mu C_1)^{\alpha}(\upsilon C_2)^{\beta} \quad (7)$$

where Y is the amount of knowledge capital output. A is the comprehensive knowledge innovation level of cloud computing federation. C_1, C_2 are the amount of knowledge capital output of partner 1 and partner 2, respectively. $\mu,\ \upsilon(0\le\mu,\ \nu\le 1)$ are the capital share proportions of partner 1 and partner 2, respectively. $\alpha,\ \beta(0\le\alpha,\ \beta\le 1)$ are the elastic coefficients of knowledge capital output for partner 1 and partner 2, respectively.

3.2 Analysis

In a certain period, the development level of cloud computing federation is stable, so we can consider the comprehensive knowledge innovation level remains unchanged within this period. And assumed $A=0.4$. the elastic coefficients of knowledge capital output for partner 1 and partner 2 are also stable, let $\alpha=0.3$, $\beta=0.4$. According to Eq.(7), we study the influence relations among the knowledge capital output of cloud computing federation, knowledge sharing intention of partners and knowledge capital stock.

Supposed that C_1, C_2 are invariant, the simulation result about the relationship of knowledge capital output of federation(Y)and knowledge sharing intention of partners (μ, υ) is shown Figure 2.

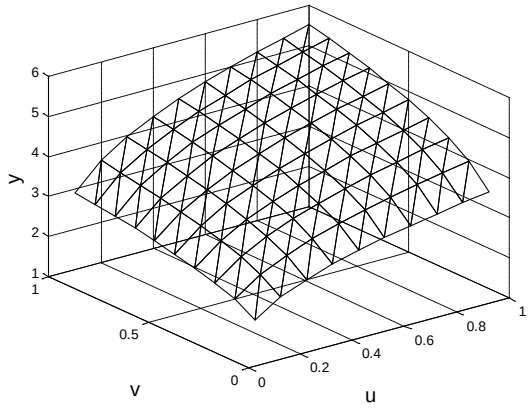

Figure 2. The relationship of knowledge capital output of federation and knowledge sharing intention of partners

As shown as Figure 2, knowledge capital output and partners' knowledge sharing intention is positive correlation, when knowledge capital stock is invariant. With increasing of knowledge sharing intention of partners (μ, υ). The knowledge capital output of federation(Y) gradually rise. Y will reach the peak, when μ=1, υ=1. Then, knowledge innovation of federation itself has been completed and the new knowledge capital has been generated. Meanwhile, the knowledge capital potential of federation partner is nearly zero and the value-added knowledge capital alliance would temporarily stop. A new round of capital cycle needs to knowledge spillover or new alliance partners with a knowledge capital potential difference join in. Moreover, the value added process of (μ, υ) is limited.

Figure 3 is the simulation result about the relationship of knowledge capital output of federation(Y)and the amount of knowledge capital output of partners (C_1, C_2).

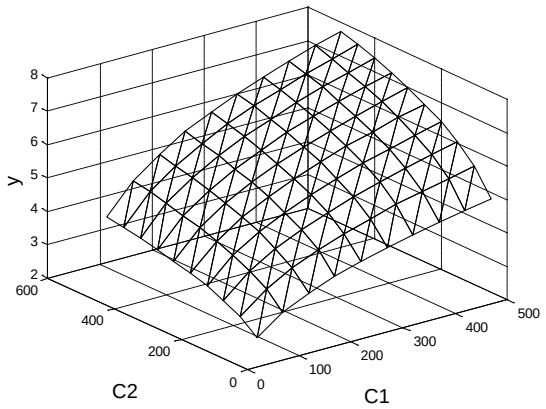

Figure 3. The relationship of knowledge capital output of federation and the amount of knowledge capital output of partners

From Figure 3, the knowledge capital output of federation and the amount of knowledge capital output of partners is positive correlation. When partners have knowledge sharing intention, C_1, C_2 will be infinite extension to space with increasing of Y. Well, Y is impacted by 'wooden pail effect'. That is, the magnitude of Y depends on the partner with lowest knowledge capital stock, when federation value-added knowledge capital comes to a steady state.

4. Conclusion

This paper proposed a general process model of organizational value-added knowledge capital. Based on the knowledge potential theory, we give a quantitative and qualitative discussion about the mechanism of value-added knowledge capital of cloud computing federation. Construct the value-added knowledge capital output model, based on a Cobb-Douglas function. We analyze the relationship between the related factors of federation knowledge capital output using MATLAB. The results is indicated that there are 4 key nodes when a cycle of value-added knowledge reaches stable temporarily. That is knowledge capital stock, the conversion rate of knowledge commodity, the conversion rate of knowledge capital and the new knowledge production output from knowledge capital caused by sharing. Intellectual capital increment speed and efficiency are directly affected by the state of these 4 key nodes. Cloud computing federation knowledge capital potential can be represented as three dimensions through knowledge capital quality, type and quantity, which corresponding to the three variables, namely the number of researchers, technical level and infrastructure level. The function of these variables can reflect the increment of knowledge capital stock. Federation value-added knowledge is determined by the comprehensive level of knowledge

innovation, knowledge capital initial stock among federation partners, willingness of sharing and output elasticity. The simulation results show that, federation knowledge capital output and partners' knowledge sharing intention and the capital stock are positive correlation, influenced by the "wooden pail effect".

Through our research, we found: First, alternative partners' initial stock of knowledge capital is the important reference factors in when select federation partner; Second, establish a collaborative concept. Because value-added knowledge capital behavior function relates to personnel quantity, technical level, the level of software and hardware facilities and so on many factors, which should be coordinated, balanced development; Third, the federation should establish an incentive mechanism, the benefit assignment mechanism, evaluation mechanism and restraint mechanism and so on, in order to ensure a high level of knowledge capital sharing willingness among partners; Forth, establish the update mechanism of federation partners, in order to protect the existing difference among knowledge capital potential. That will provide the basic motivation for value-added knowledge capital spiral uprising.

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