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Empirical Study on Alignment of Cloud Computing in Enterprises

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Abstract—**As the cloud computing is being adopted by users, the alignment of cloud computing is receiving increasing attention from researchers. On the basis of related theories about organizational fit of Information Technology (IT), this paper constructed a theoretical model to analyze factors affecting the cloud computing alignment in companies. In this model, task-technology fit and technology-organization compatibility are considered as two key factors for the alignment between cloud computing and enterprise business. Further the alignment is evaluated from two aspects: the depth of alignment and the breadth of alignment. Analyzing data collected via questionnaires with Statistical Product and Service Solutions (SPSS) and Partial Least Squares (PLS), this paper shows that the technology-organization compatibility has significant positive effects on both depth and breadth of cloud computing alignment. On the other hand, the task-technology fit has significant positive effects on breadth of cloud computing alignment, and it has no significant effects on depth of cloud computing alignment.**

Keywords-Cloud Computing; Alignment; Enterprise User

I. INTRODUCTION

As the most revolutionary IT innovation model, cloud computing has been adopted and used by enterprise users as well as individual users[1]. However, using cloud computing does not necessarily mean that it will increase value to the enterprise. Strategic IT alignment remains a key component to the successful application of information technology in the company[2]. IT alignment, a post-adoption process, refers to the continuous and dynamic alignment between IT and business process after the spread and use of this technology in a company[3]. The effective use of IT and the consequential improvement on organization efficiency cannot be realized without the alignment between IT and business. However, there are many cases of information system (IS) failure in companies; "black holes of IT investment" and "IT efficiency paradox" are also widespread in organizations[4]. Many scholars believe that one of the reasons lies in the "assimilation gap" between the adoption and alignment of information system: that is, the information system does not strategically align with business[5].

One of the objectives for companies adopting cloud service is to align cloud service with business[6]. In our preliminary investigation, we found that cloud computing had been adopted but not successfully deployed in some companies. Without strategic alignment between technology and business, cloud computing may be unable to help reduce costs and enhance efficiency; it may even to some degree increase costs and complicate business processes. There is no comprehensive study on the factors contributing to the alignment between cloud computing and business processes. What factors may affect the alignment of cloud computing after the adoption of this technology? It is a research question worth exploring.

In order to answer this question, this paper presented a theoretical model to analyze how task-technology fit and technology-organization compatibility affect the alignment of cloud computing. Based on the theory of organizational fit of IT, this model takes organizational fit of cloud computing into consideration, focusing on leading factors including task-technology fit and technology-organization compatibility. The dependent variables of this model are the depth of alignment and the breadth of alignment, which are two dimensions of cloud computing alignment. Then, we developed a set of hypotheses to examine the effects of task-technology fit and technology-organization compatibility have on cloud computing alignment, which we tested empirically with survey data collected from questionnaires. The purpose of this study is not only to extend the existing theories about cloud computing alignment, but also to provide enterprise users and cloud computing service providers with useful information on this subject.

II. THEORETICAL MODEL AND HYPOTHESES

The alignment between business and cloud computing refers to the degree to which cloud computing is incorporated into business activities at all organizational levels[7]. Upon adopting cloud computing, organizations should incorporate this technology into their business activities to make it generate real value. The process of alignment in its essence is the process of reallocating business resources and cloud computing resources. According to related theories about organizational fit of IT, the success of alignment mainly depends on the fit between the technology and the company.

Contingency theory states that there is no best way to organize or manage a company; it proposes that the organizational structure and managerial model should fit the company's situation. The concept of fit originates in organization theory, and is mostly used in organizational strategies. As IT and IS are being widely used, many scholars are extending this concept to the alignment of information systems in companies[8].

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Organizational fit of IT mainly focuses on two types of fit: task-technology fit and technology-organization compatibility. Therefore, we investigated how these two factors would affect the depth of cloud computing alignment and breadth of cloud computing alignment[9].

A. Depth of Cloud Computing Alignment

Depth of alignment refers to the degree to which cloud computing is aligned with business activities. The alignment between business activities and cloud computing is a process in which these two independent units are integrated into one inseparable system. It begins when cloud computing is adopted by the enterprise. Cloud computing at first (e.g., cloud storage service) are relatively simple, and are usually independent of specific business processes. Then they will be applied to some simple business processes, and after that more complicated tasks. During this process, users have a better understanding on cloud computing, and the cloud computing application also become more complicated. Therefore it reflects the alignment between cloud computing and business activities.

The depth of alignment goes through three phases: mechanical alignment, organic alignment, and innovative alignment[9]. Mechanical alignment means that enterprise users simply treat cloud computing as a substitute for how they used to work, and there is no adaptation of their business processes to "fit" the new technology. Organic alignment, on the other hand, means that enterprise users can make strategic adjustments to their business processes in order to fit the new technology. Innovative alignment, as the deepest level of alignment, refers to a situation in which employees at all levels can use cloud computing to accomplish tasks, generate business processes, or provide products and services that can never be achieved without the new technology.

B. Breadth of Cloud Computing Alignment

Breadth of alignment refers to the scope of the alignment between cloud computing and business activities. After the adoption of cloud computing, they are first applied in one business unit. The business process in this unit and the new technology integrate and adapt to each other. Then the alignment expand to other business units, and finally to all units of an enterprise.

Breadth of alignment therefore also goes through three phases: single-unit alignment, cross-unit alignment, and enterprise-level alignment[9]. Single-unit alignment means cloud computing is only aligned with a certain business unit in an enterprise. Cross-unit alignment happens when unprecedented cross-unit collaboration is achieved using cloud computing, especially among core business units; the alignment of cloud computing makes it possible for different business units to share data and synthesize together. Enterprise-level alignment is the alignment between cloud computing and business units at all levels. Tasks of operators, managers, and decision makers are all supported by cloud computing, and information at all levels is also integrated and synthesized.

C. Task-Technology Fit

Task-technology fit (TTF) is the degree to which an information technology or product assists an individual in performing his or her tasks. TTF model indicates that both task characteristics and technology characteristics determine TTF, which determine user performance. According to this model, higher TTF means that there are greater chances for this technology to have positive effects on performance[8]. If a technology or a system has positive effects on user performance, the IT or IS must "fit" well with the task. The TTF theory is constructed based on the research on individual users[8], and is then applied to study organization users, especially in the information management field[10].

Requirements and business processes vary in enterprises. Some can be well-supported by existing cloud services while others cannot. Based on the TTF model, the better the functions provided by cloud service technology "fit" the requirements of a task, the higher the level of alignment will be. This leads to our first pair of hypotheses:

H1: TTF has a positive effect on depth of alignment.

H2: TTF has a positive effect on breadth of alignment.

D. Technology-organization compatibility

Technology-organization compatibility (TOC) is the degree to which a new information technology suits an organization. TOC originates from Rogers' concept of compatibility in his theory "Diffusion of Innovations" [11]. TOC encompasses two aspects: first, the compatibility of technology, such as user interface and system functions; second, the compatibility of culture, which refers to the compatibility between the technology and organizational management, such as values, beliefs, and organization culture.

Many empirical studies have found the significant positive relation between TOC and the application of IT in companies[12]. However, as a new innovation technology, cloud services may bring unknown challenges and risks to its users. Cloud computing is better aligned with business processes if it is more compatible with the company's software and hardware in data format and standards, because there will be no need to adjust data format or adapt standards to the new technology. Likewise, cloud computing is better aligned with business if its spirit of openness and freedom is more compatible with the company's strategies, beliefs, values, and culture. This leads to our second pair of hypotheses:

H3: TOC has a positive effect on depth of alignment.

H4: TOC has a positive effect on breadth of alignment.

Based on the hypotheses above, we set up the theoretical model as Fig. 1.

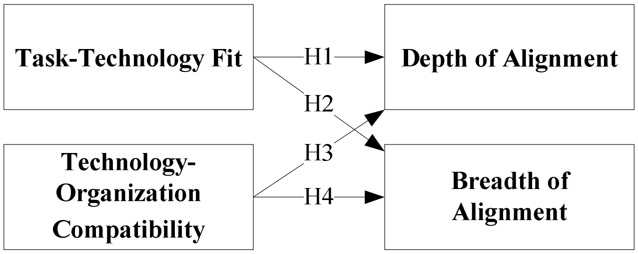

Figure 1. Model of cloud computing alignment in enterprises

III. QUESTIONNAIRE AND DATA COLLECTION

In this paper, questionnaires were made to testify the model's hypotheses. In order to ensure the validity of the questionnaires, according to the research model and research hypotheses, this study looked for scales used in previous studies and made appropriate changes to it. After the questionnaires were completed, we conducted a small scale pre-test to detect problems in the questionnaires. Problems exposed in the pre-test have been corrected before on the large scale questionnaires. Questionnaires were designed by Likert's seven-point scale, respondents choose 1 (extremely disapprove) to 7 (all for) to score the questions.

In this survey, it was required that subjects' companies had adopted or using cloud computing. Questionnaires were distributed and recycled by using electronic methods, which lasted for 25 days. At the beginning of the questionnaire, we gave definition of cloud computing and current well-known cloud computing products. After rejecting invalid questionnaires, this research received 81 valid questionnaires.

Sample characteristics are shown in Table 1. Industry category here is based on the standard industry classification published by the National Bureau of People's Republic of China, which can be seen by the following table. Our samples are mainly concentrated in manufacturing and the information transmission, computer service and software industry, and many of them are medium-scale private enterprises.

IV. DATA ANALYSIS AND RESULTS

In analyzing the collected data, we employed SEM, SPSS and PLS. We used SPSS to conduct samples' reliability and validity analysis and then we used PLS to examine the SEM to see the strength and direction of the relationships among the variables.

A. Reliability and Validity Analysis

Reliability refers to the consistency and stability of measurement results, the higher questionnaire's reliability is, and the more reliable results are. Cronbach's alpha coefficient analysis is a method of testing reliability, it is generally believed that alpha score exceeded 0.7 indicating strong internal reliability[13]. In this study, all the variables' alpha score exceeded 0.7, thus showing this scale has a dependable reliability. Another important index of measuring reliability is composite reliability (CR), and CR exceeded 0.7 indicating strong internal reliability[13]. Table 2 shows that the CR scores of each variable exceeded 0.8, confirming that our scale had high reliability.

Validity is a metric to measure effectiveness. We used the average variance extraction (AVE) to measure the convergent validity of the scale and AVE exceeded 0.5 indicating good convergent validity[14]. From table 3, the AVE value for each variable exceeded 0.6, indicating our scale had good convergent validity.

Then, we measured the discriminate validity by comparing the square root of AVE of each factor and the correlation coefficient between the factor and other factors. Discriminate validity can be proved good when variables' square root values of AVEs are more than the correlation coefficient between two variables[15]. Table 4 shows that the discriminate validity is good in the model.

TABLE I. CHARACTERISTICS OF THE SAMPLE

Items	Types	Sample	
		Frequency	Percentage (%)
Industry categories	Agriculture, forestry, animal husbandry and fishery	2	2.5%
	The mining industry	2	2.5%
	Manufacturing	14	17.3%
	Electricity, gas and water production and supply	4	4.9%
	The construction industry	3	3.7%
	Transportation, storage and postal service	5	6.2%
	Information transmission, computer service and software industry	30	37.0%
	The financial sector	12	14.7%
	Wholesale and retail trade	2	2.5%
	Accommodation and catering	3	3.7%
	The real estate industry	2	2.5%
	Other	2	2.5%
Enterprise nature	State-owned and State-holding enterprises	11	13.6%
	Collective enterprises	21	25.9%
	Private enterprise	38	46.9%
	Foreign-owned or joint venture	11	13.6%
Enterprise scale	Less than 200 people	22	27.2%
	200-2000 people	45	55.6%
	More than 2000 people	14	17.2%
Enterprise assets	Less than 20 million Yuan	14	17.2%
	20 million-200 million Yuan	50	61.7%
	More than 200 million Yuan	17	21.1%

TABLE II. RELIABILITY RESULTS

	TTF	TOC	DOA	BOA
Cronbach's alpha	0.732	0.836	0.811	0.810
Composite reliab.	0.863	0.904	0.875	0.897

TABLE III. CONVENGENT VALIDITY

	TTF	TOC	DOA	BOA
Avg. var. extrac.	0.677	0.740	0.723	0.610

TABLE IV. CORRELATIONS BETWEEN VARIABLES

	TTF	TOC	DOA	BOA
TTF	**0.823**			
TOC	0.550	**0.860**		
DOA	0.603	0.578	**0.851**	
BOA	0.620	0.134	0.616	**0.781**

B. Analysis of the Structure Equation Model

A structural equation modeling (SEM) was adopted in our research. We used PLS to conduct SEM analysis, whose results are mainly measured by the value of standardized path coefficients, which can predict the strength of relationships between constructs. In addition, when p value is lower than 0.05, we consider the relationship between constructs are significant.

According to the result of SEM analysis, hypotheses 2,3 and 4 were supported, but hypothesis 1 was not supported. Table 5 shows specific testing results.

TABLE V. HYPOTHESE TESTING RESULTS

Hypothesis	Content	Result
H1	TTF has a positive effect on depth of alignment	Unsupported
H2	TTF has a positive effect on breadth of alignment	Supported
H3	TOC has a positive effect on depth of alignment	Supported
H4	TOC has a positive effect on breadth of alignment	Supported

The detail data analysis results are as follows:

1) The effects of TTF have on depth of alignment

Results from the above tables shows that TTF does not have a significant effect on cloud computing alignment depth (β= 0.092 , t-value=0.610 , P>0.05). Therefore, H1 is not supported.

2) The effects of TTF have on breadth of alignment

Results from the above tables shows that TTF has a significant effect on cloud computing alignment breadth (β=0.486 , t-value=3.439 , P<0.001). Therefore, H2 is strongly supported.

3) The effects of TOC have on depth of alignment

Results from the above tables shows that TOC has a significant effect on cloud computing alignment depth (β=0.783 , t-value=4.472 , P<0.001). Therefore, H3 is strongly supported.

4) The effects of TOC have on breadth of alignment

Results from the above tables shows that TOC has a significant effect on cloud computing alignment breadth (β=0.376 , t-value=2.379 , P<0.05). Therefore, H4 is supported.

And Fig.2 shows the SEM analysis results:

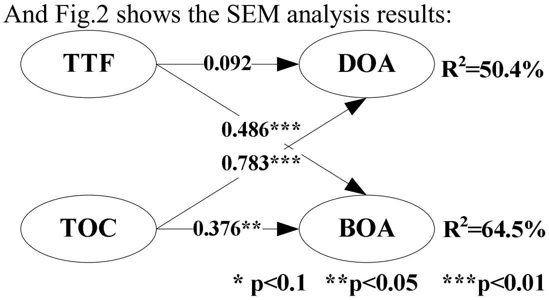

Figure 2. SEM analysis results

V. DISCUSSIONS

Based on the above data analysis results, specific discussions are as follows:

A. Factors affecting the depth of alignment

From our analysis above, we found that TOC had a significant positive effect on the alignment depth of cloud computing. Our findings indicated that the depth of alignment depends on the compatibility between cloud computing technology and the company. Cloud computing can be more deeply aligned with business if its spirit is more compatible with the company's strategies, beliefs, values, and culture. Likewise, cloud computing can be more deeply aligned with business processes if its software interface and data interface are more compatible with the company's current software and hardware. Enterprises therefore can produce new products, services, or processes using this technology.

However, the results from our empirical study did not support our hypothesis about TTF's effects on depth of alignment. One possible explanation might be that TTF alone cannot achieve a very deep alignment. The depth of alignment has three levels: mechanical alignment, organic alignment, and the highest of all -- innovative alignment, under which new products and services can be provided using the new technology. Therefore, the depth of alignment relies more on factors like the compatibility of philosophy behind cloud computing and corporate strategies; it also requires leaders and employees not only be skillful in dealing with new technology, but also be experienced in business contents, processes, and organizational management. In this case, the effects of TTF has on the depth of alignment are not so significant.

B. *Factors affecting the breadth of alignment*

The above results indicated that both TTF and TOC had positive effects on the alignment breath of cloud computing.

Breadth of alignment can be achieved when the functions provided by cloud computing "fit" the requirements of a task well. If business processes within a business unit, across different units, or throughout the enterprise can be well supported by cloud computing, a broad alignment between business and technology is attained.

On the other hand, cloud computing can be more broadly aligned with if its software and hardware interface are more compatible with the company's software and hardware. Likewise, cloud computing can be more broadly aligned with business if its philosophy is more compatible with the company's strategies and values.

VI. CONCLUSIONS

Through empirical studies, this paper found that both task-technology fit (TTF) and technology-organization compatibility (TOC) had positive effects on alignment breadth between cloud computing and business; TOC had a positive effect on the depth of alignment. This paper had its significance in theory and practice. Theoretically, this paper extended and revised the alignment theory of cloud computing. Practically, for enterprise users who have adopted cloud computing, this paper stated the key factors affecting the alignment of this technology; for cloud computing service providers, this paper could provide useful information to improve their after-sale services, which would enhance the alignment of cloud computing in enterprises, or even certain industries.

This paper also had its limits. Although we based our scales on previous studies and conducted reliability and validity analysis on our samples to ensure the accuracy and validity of our results, subjective biases from users may still have some effects on our measurements of variables. In future researches, companies' perceptions can be better represented if we have several respondents from the same company to complete the questionnaires, or if objective variables are introduced to the model.

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