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Empirical analysis of enterprises information technology evaluation system-evidence from China

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ABSTRACT

In order to conduct information technology evaluation in China's enterprises, EFA and CFA are used in this paper. By IT evaluation system analysis, prediction test and pilot test, single dimension scaling test, reliability test and validity test, the SEM can effectively reveal factors and mechanism in information technology evaluation system in Chinese Enterprises. For illustration, the collected copies are 300 enterprises, in which 210 copies are valid. The effective return rate is 70%, which meets the requirements that sample recovery rate is not less than 20%.The empirical results show that IT investment is lack of rationality, customer relationship management capacity and production IT in the process of enterprise IT construction, and IT system application process do not pay attention to IT training work. The correlation coefficient of IT infrastructure factor and the remaining three factor is too low, and correlation coefficient personnel IT quality factor and the remaining three factor is too low. The empirical research has revealed there is a big value creation expandable space for China's enterprises, which should cause the attention of relevant governments.

KEYWORDS

Information technology;
Evaluation system;
EFA(exploratory factor analysis);
CFA (confirmatory factor analysis).

INTRODUCTION

With the development of information technology (IT), a great deal of changes happens in China. IT teaching has access to avoiding formalism[1]. IT promotion is an important strategic decision for China's modernization. In 1997 the Ninth Five-Year Plan for State IT and the Long-range Objective of the Year 2010 was formulated, which listed the Internet as part of the state information infrastructure, and set the goal of pushing forward national economic IT by vigorous development of the Internet industry. In 2002 the Specialized Plan for IT in the Tenth Five-Year Plan for National Economic and Social Development was promulgated, which defined China's priorities in this regard, including promotion of e-government, vigorous development of software industry, strengthening of development and utilization of information resources, and acceleration of the development of e-commerce[2].

Enterprise IT studies in China began in 1998. Zhang Genbao(1999) argued that enterprise IT construction included five aspects: the widely computer applications in the business, enterprise information network construction, building the enterprise information resources library,

the construction of information personnel team, strengthening the foundation work of enterprise information technology. The Great Wall of Beijing Enterprise Institute for Strategic Studies (2000) presented the four evaluation factors concerning enterprise IT: the breadth and depth of IT application, information resources (including internal and external resources) development and utilization, informational human resource development, IT planning, organization and control. Liang Bin (2000) put forward the enterprise IT evaluation index system for the first time in China, indicating that enterprise IT should be embodied in the following five aspects: production process IT, flow process IT, management IT, organization structure IT, factor of production IT. Tang Zhirong (2002) argued that five one-class index of enterprise IT level evaluation were IT input and facility level, production process automation, management IT, marketing IT level, as well as the quality of personnel. Peking University Network Economy Research Center Enterprise Information Technology Group (2002) held that eight one-class index of enterprise IT evaluation system including investment in IT fixed assets, basic resources IT, enterprise electronic commerce development, IT-related investment, standardization degree, website and network construction, database size, and IT technology investment. The State Ministry of Information Industry Information Technology Evaluation Center (2002) proposed that enterprise IT evaluation index of six one-class were strategic position, infrastructure construction, application situation, human resources, security and efficiency index. Chen Xiaohong (2003) argued that enterprise IT includes three elements: basic elements, the external environment support, as well as the level of innovation. Zhang Yonggang (2005) argued that enterprise IT development index included four elements such as IT organization, IT infrastructure, information resources and IT system[3]. Wang Ying (2006) argued that four one-class indicators of the enterprise IT evaluation system include technical progress, governance optimization, option value and social contribution[4]. Zuo Meiyun (2006) obtained a five stage IT maturity model.

Therefore, when IT evaluation system is established, we should foster strengths and circumvent weaknesses, closely combine IT actual situation in China, to establish a comprehensive, scientific evaluation system to reflect the actual operation level of IT construction in China's enterprises.

ANALYSIS ON CHINA'S ENTERPRISE IT EVALUATION SYSTEM

Generally speaking, these four factors are enterprise IT infrastructure construction (1), IT systems applications (2), staff IT quality (3), as well as IT strategic management (4).

Enterprise IT infrastructure construction elements consists of four components including IT investment rationality, enterprise network performance, database stability, hard ware and software maintenance ability. First of all, IT has a rapid development in the software and hardware, and enterprise IT infrastructure must be adapted to the environmental rapid changes. IT inputs must be maintained in a moderate range, in order to obtain the biggest economic benefits. The enterprise resource always has its scarcity, excessive IT input will cause the waste of resources, and low investment will not have the advantages of scale effect. Therefore, rational planning of IT investment in the enterprise total cost expenditure ratio is an experienced and skillful work, each enterprise must establish scientific and reasonable IT investment plan according to own realities. Secondly, enterprise IT network is based on the computer systems, communication equipment and other means, and an organic synthesis composes all sorts of IT organization and IT officer for the node. Enterprise IT network construction should comply with the demand principle, namely the purpose is to solve the realistic problem of enterprise IT management. IT system maintenance work mainly includes the data entry and update, the daily operation and maintenance, operation log records, the analysis of the operation results, system security, system maintenance document management, system software configuration, IT processing, IT services, IT network operation and maintenance.

Application of IT system consists of four secondary indexes: IT decision efficiency, CRM ability, application ability of electronic commerce and development of auxiliary function.

Personnel IT quality elements include four first class indexes: compound talents ratio, IT professionals development capabilities, full IT ability, IT business train-

ing.

IT strategy management elements include four secondary indexes: IT system strategic planning, BRP construction, organizational learning and knowledge management. Enterprise IT system should be set up through a continuous exploration and development process, this process can be divided into four stages: system strategic planning, system analysis, system design and system implementation[5]. The construction of IT system should combine closely with business process reengineering. The success or failure of management IT system development in 30 years shows that, who combine closely with management business and improve the unreasonable business process, which succeed, otherwise will suffer setbacks and failure[6]. According to the foreign enterprise IT operation experience, IT system construction of the strongest correlation management thought and means is the management of organizational learning and knowledge. The process of organizational learning is learning organization construction process, is an endless activities of enterprises, and enterprise IT construction has a natural fit. The theory of learning organization is the first proposed in the book named by "the fifth disciplines -the art and practice of learning organization" presented by American Massachusetts Institute of Technology Professor Peter in 1990. Peter held that organizational learning was the five discipline overall, the five disciplines was self transcendence, improving mental model, building shared vision, team learning and systems thinking.

Based on the above analysis, enterprise IT technology measurement system is shown in TABLE 1.

TABLE 1 : The enterprise IT measure system

Element name	Secondary index name	Index value
Infrastructure construction	IT investment rationality X_1	The scientific IT investment aim at maintaining normal operation of information systems accounted for the total cost.
	Enterprise network performance X_2	Robustness, practicability, security and scalability of enterprise IT network.
	Database size X_3	Improving the design of database, capacity, storage, standard and other performance.
	Hardware and software maintenance ability X_4	IT system daily operation monitoring, modification, upgrade, maintenance ability evaluation.
Information system application	IT decision efficiency X_5	The successful rate of enterprise decision about implementing economic system evaluation, utility analysis, economic trend prediction etc via information systems.
	CRM ability X_6	IT application in customer information management and data mining to improve the market efficiency of decision making ability.
	Application of electronic commerce X_7	Online commercial transaction capabilities via communication means network.
Personnel information quality	Production information X_8	The change of production mode and the realization of technical innovation based on IT.
	The proportion of compound talents X_9	The ratio between computer technology and the specific business process personnel and the total staffs.
	IT Development capacity X_{10}	IT professionals in the system implementation, software development, hardware maintenance ability.
	Full information X_{11}	Enterprise overall staff's quality of overall IT and application ability of IT system.
IT strategic management	IT training X_{12}	The application and extension ability concerning enterprises' basic IT knowledge.
	Information system planning X_{13}	The design, implementation, operation and maintenance concerning IT systems.
	BPR construction X_{14}	The improvement, update and integration of traditional business processes via IT.
	Organizational learning X_{15}	The processes of enterprises learning organization construction under the guidance of the system theory.
	Knowledge management X_{16}	Management behavior such as intellectual capital collection, extraction, storage, transformation and integration.

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MODEL VALIDATIONS

Prediction test and pilot test

Seven respondents are respectively and independently completed questionnaire, and put forward the modification opinion.

After the prediction test, a pilot test is conducted. The object includes 26 students of senior MBA training class of Xi'an Jiao Tong University School of management department of information management. Students carefully fill out questionnaires, and enclose corresponding improvement opinions behind the questionnaire. It was found that each Cronbach's α value distribution is between 0.7607 and 0.9268. As long as Cronbach's α value is more than 0.7, its reliability can be accepted. Therefore, questionnaire can be determined with sufficient reliability. After prediction test and pilot test, the paper still retains 16 items, in order to test the IT-related four elements.

Data collection

The paper uses convenient sampling method in the relevant studies, and extracts 300 enterprises as samples in a random from a consulting company database. Samples distribute in Beijing, Tianjin, Shanghai, Chongqing, Henan, Anhui, Zhejiang, Sue, Shaanxi, Mongolian, Guangxi Zhuang Autonomous Region of 13 provinces and autonomous regions through electronic questionnaire, mailed questionnaires, telephone interviews, interviews and other forms. Respondents are the CEO, CIO, CKO and other senior person. This survey takes back 210 valid samples, the effective return rate is 70%, which meets the requirements that sample recovery rate is not less than 20%.

Single dimension scaling test

The purpose of single dimension scaling test is used to test the question of high quality single dimension feature. The common method of single dimension scale test is exploratory factor analysis(EFA). Before EFA is conducted, KMO measure and Bartlett ball testing are used respectively for the four elements. The KMO value heals bigger, and the common factor is more. So it is more suitable for factor analysis. Kaise (1974) pointed out if the KMO value was less than 0.5, it was not suitable for factor analysis. At the same time, Bartlett test is to estimate whether the sample is suitable for factor analysis. The research results show that KMO value is between 0.826 and 0.866, and the correlation coefficient matrix is in the presence of large significant correlation (α=.000). So the samples are consistent with the factor analysis condition.

EFA will obtain each measurement item and factor loadings among factors. The factor load is higher, and the measurement association between items and factor is stronger. The factor extraction method is Principal Component Analysis method, rotation method is the Varimax method, intercept point is 0.5, that is to say any factor load of less than 0.5 or more than 0.5 should be deleted.

So the results of factor analysis are given in TABLE 2(rotation of 7 iterations).

Reliability test

Reliability analysis is to verify every observation index's reliability. Reliability refers to the level of consistency about the different measurement using the same tools for measuring, in order to reflect the repeated measurement results approximation under the same conditions. Reliability is generally available through the inspection. The common method of reliability test is to use α coefficient created by L.J. Cronbach, and α values are between 0 and 1. Generally, if α value is greater than 0.5, it is acceptable. However in some exploratory studyα value is between 0.5-0.6, it can be accepted (Li Huaizu, 2004). If a certain aspect or factor reliability value is very low, it shows that the interviewees views on these issues are quite inconsistent. The Item-to-Total correlation coefficient attached to each factor should be greater than 0.4.

From the table, the original structure of the questionnaire is more effective, and each index in the corresponding factor load is greater than the threshold value 0.5. Factor Cronbach's α minimum value is 0.7726, and the sample reliability is well.

Validity test

The purpose of validity test is to measure whether the characteristics are truly real measurement. Validity test includes content validity test, structure validity check and rule effectiveness test.

Firstly, content validity is also named surface valid-

TABLE 2 : Exploratory analysis factor loading

Two level index	Factor 1	Factor 2	Factor 3	Factor 4
IT investment rationality	.873	.187	.581	4.23E-3
Enterprise network performance	.753	8.60E-02	.543	.276
Database size	.836	.183	.178	.354
Hardware and software maintenance ability	.812	.325	5.23E-3	.432
Informatization decision efficiency	2.192E-02	.835	.329	.516
CRM ability	.212	.799	.169	.187
The level of e-commerce application	.412	.810	.258	.196
Production information	2.975E-03	.711	.205	2.12E-2
The proportion of compound talents	.478	.555	.832	.421
IT staff development ability	.187	.509	.701	.176
Full information ability	.312	.198	.767	.182
IT business training	.423	2.121E-3	.803	.346
Information system strategic planning	.503	.376	.267	.789
BPR construction	.121	.351	.120	.819
Organizational learning	.527	.212	.115	.891
Knowledge management	.313	.120	4.23E-3	.712
Cronbach's α	.8812	.7121	.8712	.7190
The cumulative variance	21.371	40.978	58.645	80.102

ity, which refers to the scale in logic and can clearly reflect the research needed to be measured by the conceptual content via the subjective judgment. In the item selection phase, there are the problems and results existing in the process of enterprise IT construction in China, which reflects IT construction status of China's enterprise status. After the completion of the first draft questionnaire, the author discusses in-depth on the questionnaire of the content and structure with several experts, scholars, business executives in the field of information system of Lenovo Group, China Southern Power Grid Company, Xi'an Electronic and Science University, eliminating the duplicates, adding the missing items, and repeating adjustment on the questionnaire structure. Therefore, it can ensure the content validity of the questionnaire.

Secondly, construct validity represents the degree about measurement tools proving the theory hypothesis, namely degree of the measurement obtains empirical data consistent to the measurement concept theory, including effective validity and difference validity.

Convergent validity means that when an ideal concept is measured, if it is highly correlated with the same structure of different measurement tools, the measuring tool has a convergent validity. The study uses confirmatory factor analysis(CFA) to measure the scale of convergent validity.

CFA is a kind of special form of structural equation model (SEM). Containing a wide range of mathematical model, SEM is a statistical method to analyze the relationships between variables based on the covariance matrix of the variables, which is related to latent variable complex relationships. When SEM is used to verify whether a factor model be suit with data, it is called confirmatory factor analysis.

The paper uses SPSS11.5 and LISREL8.7 to conduct CFA (fixed variance). The factor load parameter list is given in TABLE 3.

TABLE 3 : Confirmatory analysis of factor loading

Factor name	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Factor loading	.06	.43	.63	.38	.43	.08	.33	.13
SE	.07	.07	.07	.08	.08	.06	.07	.08
t	1.01	6.0	9.0	4.9	5.1	1.31	4.7	1.51
Factor name	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}
Factor loading	.65	.46	.39	.16	.46	.11	4.0	3.2
SE	.07	.09	.13	.09	.11	.07	.08	.08
t	9.6	5.01	3.0	1.37	4.00	1.62	5.0	4.0

Note: the model is made two amendments, and the gray part is the factor that is deleted owing to low load value (X1, X6, X8, X12, X14).

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The factor covariance matrix san be seen in TABLE 4 (revised).

TABLE 4 : Factor covariance matrix

	ξ_1	ξ_2	ξ_3	ξ_4
ξ_1	1.0			
ξ_2	0.31	1.0		
ξ_3	0.28	0.27	1.0	
ξ_4	0.36	0.32	0.11	1.0

At the same time that the model fitting and index list is given in TABLE 5(revised).

Therefore, the model fitting well, it has good convergent validity, without the need of continued correction[7].

Thirdly, according to the correlation coefficient matrix, the rule of the effectiveness is high.

TABLE 5 : The model fitting and index list

Fit indices	Df	CHI-Square	RMSEA	NNFI	CFI
Index value	159	302	0.031	0.933	0.934
The optimal value tendency	one	The smaller is the better	<0.08	>0.9	>0.9

CONCLUSIONS

Based on the above factors validation process, the following conclusions about the present situation of China's enterprise IT construction can be drawn.

Firstly, Chinese enterprise IT ability system has a certain operational performance. The obtained measurement system can provide the effective strategy reference system for China's enterprises to strengthen IT construction, and improve IT utilization efficiency, thereby enhancing the core competition ability of enterprises.

Secondly, according to the factor of load list, index X1, X6, X8, X12 and X14 pass the EFA(exploratory factor analysis) rather than CFA (confirmatory factor analysis). Combined with China's enterprise IT construction, IT investment is lack of rationality, customer relationship management capacity and production IT in the process of enterprise IT construction, and IT system application process do not pay attention to IT training work. In addition, enterprise IT doesn't blend with business process reengineering.

Thirdly, IT application can enhance enterprises' competitiveness through effectively supporting the corporate strategy, and IT-related support corporate strategy level determines the degree to improve business performance via IT capabilities[9]. Based on the factor correlation coefficient matrix, correlation coefficient of IT infrastructure factor and the remaining three factor is too low, and correlation coefficient personnel IT quality factor and the remaining three factor is too low. In the process of enterprise IT construction, IT infrastructure does not fully play its platform functional support role. Therefore, at least according to the current IT construction and the application level, there is a big value creation expandable space for China's enterprises, which should cause the attention of relevant governments.

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