Evaluating End-User Computing Capability in Total Perspective

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Abstract

This study presents a methodology that efficiently evaluates and interprets the end-user computing capability in a total perspective in a computing environment. The evaluation system has an evaluation tool, evaluation method and process, and an interpretation system. The validity and reliability of the developed tool construct was verified by factor and reliability analysis with the application of SPSS software. The application and utilization of the developed system was confirmed by applying it to evaluating the computing competency of 316 workers in an enterprise and presenting its evaluation results. This will contribute to developing a methodology for totally evaluating and interpreting the end-user computing capability and improving their computing capability in industrial fields.

Keywords:

End-User Computing, Evaluation Domains and Items, Complex Indicators, Evaluation System

Introduction

With the progress of Internet and information technology (IT), enterprises have implemented their computing systems to increase their business performance and to improve the enterprise뷭 competitiveness in these environments. The efficient application of the computing system will contribute to raising organizational business performances and to improving the enterprise뷭competitiveness.
As the end-users assume greater responsibility for computing systems, it has become increasingly important to develop measures appropriate for their computing capability. But the studies on the evaluation of their computing capability have not actively executed, and these studies focus on specific software skills, professional skills, and operational skills and so on [1]. And, for end-users effectively execute their business in a computing environment and increase their business performance, they have to be qualified with not fragmentary computing skills but total computing capability.
Therefore, this study is to present a methodology that can totally examine and interpret the end-user computing capability in a computing environment.

Previous studies

End-User Computing Competency

End-user computing (EUC) refers to direct interaction with application software by managerial, professional, and operating level personnel in user departments [2]. And, EUC is defined as the adoption and use of information technology by personnel outside the information systems department to develop software applications in support of organizational tasks [3]. And, the term 뱷ompetency? was first introduced by David McClellend, a social psychology scholar [4], in the early 1970s and has since been variously defined by many researchers. Generally speaking, competency is the total set of knowledge, skills, and attitudes which function as the action characteristics of an organizational member who can do his task outstandingly in an organizational environment [5][6][7].
Hence, the end-user computing competency (EUCC), the end-user total computing capability, can be defined as the total set of computing knowledge, technology, skills and attitudes which function as action characteristics of an organizational member who can do his or her tasks outstandingly and efficiently in a computing environment.
By analyzing the major components of competency obtained from the literature, we can extract five major components: Motives, Traits, Self-concepts, Knowledge, and Cognitive & Behavioral Skills [8]. These are used as the evaluation components of the developing tool as shown in Figure 1.

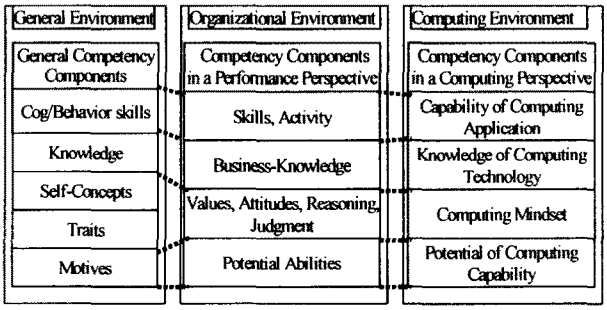

Figure 1 - Extraction Process of Components of Computing Competency

Evaluation Model

The previous literature on computing competency measurement or evaluation generally has been centered on computing and technology skills, and research into the

development of a measurement or evaluation model that could efficiently measure an end-user computing competency was barely considered in previous computing competency studies. Munro et al (1997) presented the measurement model with the three components such as computer self-efficacy, demographics, and usage in terms of EUC competence [9]. McCoy (2001) indicated the measurement model of computer competency with the five components such as hardware, software, programming, integration, and general knowledge [10]. Torkzadeh & Lee (2003) researched the measurement model of end-user computing skills with the four components such as technical ability, business knowledge, educational background, and computing experience [1] and so on. The previous studies into computing competency measurement have used fragmentary perspectives based on the knowledge and skills of an end-user computing competency.

Therefore, this study first develops an evaluation tool that can totally measure the end-user computing capability in a computing environment.

Development of Evaluation Tool

Structure of Evaluation Tool

The evaluation tool has 4 evaluation domains such as the computing mind, the knowledge of computing technology, the capability of computing application and the potential of computing capability, and each evaluation domain includes the evaluation items as shown in Figure 2.

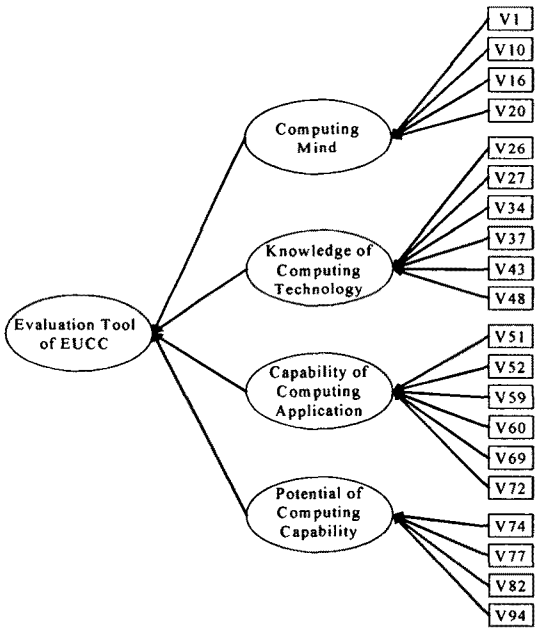

Figure 2 - Structure of Developed Evaluation Tool

These evaluation items were extracted from studies and discussions by about 30 experts in computing departments, such as postdoctoral researchers, professors and senior developers in computing research centers, and the previous literature on an end-user computing [1][8][9].

Evaluation Domain and Items

The evaluation domain of the computing mindset, Table 1, examines the sense of value and understanding of computing, and adaptability. It includes the evaluation items that can identify an end-user computing mind such as understanding of computing strategy and objectives, IT knowledge and computing industry, and ethics consciousness and etiquette related to computing. This is the direction and foundation for advances in an end-user computing competency; it is like the head of the entire body.

Table 1 - Evaluation items for computing mindset

Domain	Extracted Evaluation Items
Computing Mindset	-V1: Understanding of computing objectives and strategy -V10: Presentation of IT knowledge on an organization Homepage -V16: Understanding of national or international IT industries -V20: Ethics consciousness in a computing society

The evaluation domain of the knowledge of computing technology, Table 2, indicates the knowledge that end-users have to know to efficiently apply computing technology and computing systems to their works. It comprises the evaluation items that can measure knowledge of computing technology such as H/W & S/W related to computing, technology knowledge related to business solutions such as ERP, SCM, KMS, HRM, CRM, PDM and e-Commerce, and knowledge of operation and technology of their computing systems.

Table 2 - Evaluation items for knowledge of computing technology

Domain	Extracted Evaluation Items
Knowledge of Computing Technology	-V26: Possession of H/W knowledge related to computing -V27: Possession of S/W knowledge related to computing -V34: Possession of solution knowledge related to ERP, SCM, KMS, CRM, PDM, HRM and so on -V37: Possession of technology knowledge related to e-commerce -V43: Possession of knowledge related to S/W of O/S -V48: Possession of knowledge related to O/S computing security measures

The evaluation domain of the capability of computing application, Table 3, is the domain to measure the capability that end-users can effectively apply computing knowledge and systems to their business tasks. It includes OA ability such as Spreadsheet, Presentation, Word processing, the ability of information search and usage on Internet and Intranet, the capability to apply business solutions such as ERP, SCM, CRM, KMS, and DW, the ability to apply e-business of the form B to E, B to B, and B to C, and

DBMS and security. This domain is a very important department that can mostly influence the performance of the end-user tasks through applying their all capabilities of mind, technology, knowledge, and skills to their tasks in a computing environment.

Table 3 - Evaluation items for capability of computing application

Domain	Extracted Evaluation Items
Capability of Computing Application	-V51: Ability to search and use information on the internet -V52: Ability to use Word processing -V59: Ability to use ERP, SCM, CRM, KMS, DW and so on -V60: Ability to apply Solutions to Business (B to E, B to B, B to C) -V69: Ability to apply DBMS to Business -V72: Possession of security establishment and management capability

The evaluation domain of the potential of computing capability, Table 4, means the potential development probability of the end-user computing competency such as degree and job experience, participation of domestic & overseas education and training, and publication and lecture related to computing. This is the important domain for extension of the breadth and depth of an end-user computing capability. But it is difficult to produce computing knowledge and is a weak domain of the evaluation domains for an end-user computing competency.

Table 4 - Evaluation items for potential of computing capability

Domain	Extracted Evaluation Items
Potential of Computing Capability	-V74: Possession of an M.A. or PhD. degree from a computing departments -V77: Number of working years in a computing department -V82: Completion of education and training related to computing -V94: Achievements publishing papers and articles related to computing in journals

By studying the end-user computing competency, we developed a feasible evaluation tool that comprises Figure 2 and Table 1, 2, 3, and 4.

Verification and Discussion

Many researchers have studied methods of verifying the validity of model constructs. Kerlinger (1978) presented two methods of construct validation: (1) the correlations between the total scores and item scores, and (2) factor analysis [11]. Mirani & King (1994) [12] and Etezadi-Amoli & Far-hoodmand (1996) [13] used factor analysis to verify the validity of the measurement instrument construct. Palvia (1996) [14] and Torkzadeh & Lee (2003) [1] used correlation analysis to verify the validity of the measurement instrument construct. This study also uses factor analysis and reliability analysis to verify the validity and reliability of the evaluation tool construct. The evaluation questionnaire used a five-point Likert-type scale; where, 1: not at all; 2: a little; 3: moderate; 4: good; 5: very good.

Sample Characteristics

A sample of 152 usable responses was obtained from a variety of industries and business departments, and from management levels with considerable experience. The industries represented in the sample were manufacturing and processing (4.9%), construction (1.2%), finance, banking and insurance (2.4%), transportation, communication and services (24.4%), and information consulting and system implementation services (67.1%).
The respondent had on average of 11.5 years of experience (S.D. =1.075) in their field, their average age was 35.5 years old (S.D.=6.611), and their sex, male (81.7%) and female (18.3%). The respondents identified themselves as top manager (3.7%), middle manager (62.2%), and worker (34.1%). The respondent had on average of 11.5 years of experience (S.D. =1.075) in their field, their average age was 35.5 years old (S.D. =6.611), and their sex, male (81.7%) and female (18.3%). Most respondents (66.6%) were at a higher level than middle manager and had more than 10 years of experience (76.4%).

Analysis Results and Discussion

Table 8 shows the results of factor loadings, corrected item-total correlation and coefficients alpha for 20 evaluation items extracted from factor analysis and reliability analysis on first 97 evaluation items. Based on the analysis results, the factor loading and Cronbach뭘alpha values of the extracted items in each evaluation domain were generally analyzed as factor loading > 0.662 and Cronbach뭘alpha > 0.738. The correlation for each of the 20 items was positive and significant ($P \leq 0.01$).

Table 5 - Factor loadings, corrected item-total correlation and coefficients alpha of 20-evaluation items

Variable	Factor Loading				Corrected Item-Total Correlation	Coefficients Alpha
	Factor 1	Factor 2	Factor 3	Factor 4		
V1	0.705				0.496	
V10	0.752				0.548	0.796
V16	0.851				0.530	
V20	0.823				0.682	
V26		0.716			0.702	
V27		0.783			0.753	
V34		0.684			0.605	0.876
V37		0.738			0.566	
V43		0.742			0.774	
V48		0.833			0.627	
V51			0.807		0.648	
V52			0.751		0.702	
V59			0.706		0.583	0.738
V60			0.820		0.584	
V69			0.662		0.612	
V72			0.728		0.484	
V74				0.769	0.685	
V77				0.873	0.732	0.845
V82				0.822	0.707	
V94				0.899	0..806	

* Significant $P \leq 0.01$

The validity and reliability of the extracted evaluation items was corroborated by two kinds of analysis. After conducting the factor analysis, the number of evaluation items in each domain was reduced as follows; computing mindset: from 25 items to 4 items; knowledge of computing technology: from 25 items to 6 items; capability of computing application: from 23 items to 6 items; potential of computing capability: from 24 items to 4 items. In other words, the 97 evaluation items were reduced to 20 items, and 77 items were deleted.
In this way, the evaluation items in each evaluation domain comprise those items with superior validity and reliability, and were presented as shown in Table 1, 2, 3, and 4.

Development of Evaluation System

Structure of Evaluation System

This system consists of two kinds of major components such as the evaluation tool and the interpretation system.
The evaluation tool extracts the evaluation results through examining the end-user computing competency by the evaluation tool, and the interpretation system explains the meanings of the evaluation results extracted from each evaluation domain and the complex indicators.

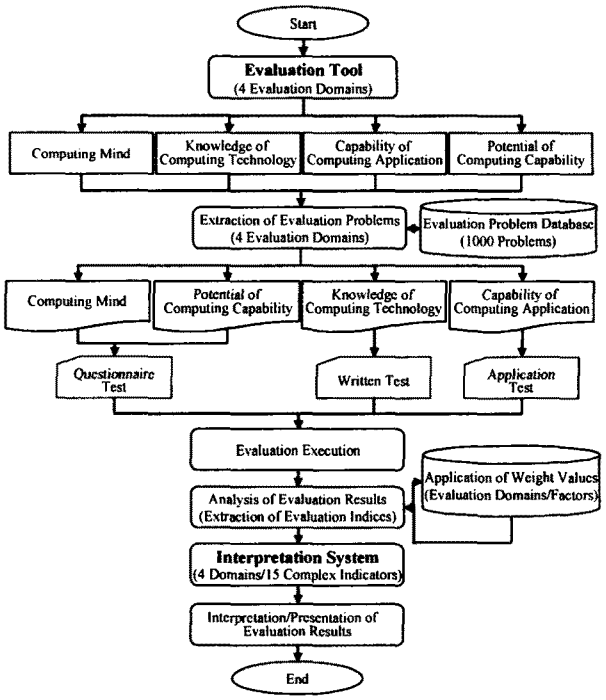

Figure 3 - Structure of Evaluation System

Evaluation Method

The weight values considered the relative importance of each evaluation domain, Table 6, were extracted from the analysis results of the questionnaire survey for about 50 experts in computing departments. We use the evaluation index to extract the calculated value of the evaluation results. The extraction method of the evaluation index (EI) first calculates the evaluation values of each evaluation domain through the analysis of the evaluation results, and figures out the evaluation indices of each evaluation domain by multiplying each weight value by each evaluation value in each domain. The total evaluation index is the sum of evaluation indices of each domain extracted by multiplying each weight value by each evaluation value in each domain of the evaluation tool.

Table 6 - Weight values of each evaluation domain evaluation tool

Evaluation Domain	Weight Value
Computing mindset	0.26
Knowledge of Computing Technology	0.25
Capability of Computing Application	0.30
Potential of Computing Capability	0.19

Interpretation System

Structure of Interpretation Systems
This has two kinds of interpretation methods as shown in Figure 4; one is to explain the evaluation results in each evaluation domain, and the other is to present its results on the complex indicators. The interpretation by the evaluation domains explains the meanings of the evaluation results on four evaluation domains. The interpretation by the complex indicators presents 5 core and 15 general complex indicators based on the evaluation results extracted by evaluation items of each complex indicator.

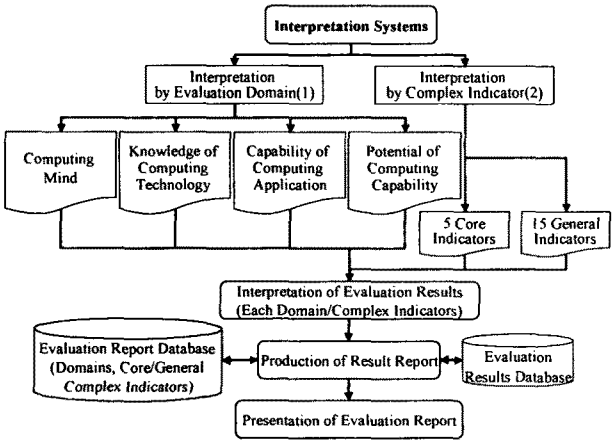

Figure 4 - Structure of Interpretation System

Complex Indicators
The complex indicators that indicate the implicative meanings of the evaluation results were identified as 15 general complex indicators. The complex indicator shows the implicative meanings and states of the end-user computing competency as presenting the significant indicators in their evaluation results. Each complex

indicator for the evaluation results is yielded by the result values based on the evaluation factors and items of it. Table 7 shows the complex indicators and the evaluation factors and items belonging to each complex indicator to generate each complex indicator of the computing competency of human resources.

Table 7 ? Complex indicators and its evaluation items

General Complex Indicators	Evaluation Items
1. Computing Understanding Indicator	-Understanding of computing plan & implementation and application of business
2. Sense of Value Indicator	-Attitude, acknowledge, etiquette and law & regulation related to computing
3. IT Knowledge Indicator	-Knowledge of Information Technology
4. Computing Knowledge Indicator	-Knowledge of H/W, S/W, N/W, and DB related to computing
5. e-Business Knowledge Indicator	-Knowledge of e-Business, e-Commerce and m-Business
6. Computing System Knowledge Indicator	-Knowledge of H/W, S/W, N/W, and DB related to operating system
7. Computing Security Indicator	-Knowledge of computing security, security system and institution & regulation of computing security
8. OA Application Ability Indicator	-Ability using Word processing, Spread sheet, Presentation
9. Internet/Homepage Application Indicator	-Ability related to application of Internet and Intranet
10. Solution Application Indicator	-Ability using ERP,SCM,CRM,KMS, and HRM solutions
11. Computing System Application Indicator	-Ability applying computing systems to B2E, B2B, B2C and so on
12. Computer Management Ability Indicator	-Ability related to utility, security establishment and computer management
13. Computing Base Ability Indicator	-Degrees, certificates and job experience related to computing
14. Computing Education & Training Indicator	-Participation of oversea & domestic education and training related to computing
15. Computing Knowledge Production Indicator	-Presentation in national or international journals, publication of computing books, and lectures & education related to computing

Case study and result analysis

Sample Characteristics

This case study applied the developed evaluation tool to 316 persons working in 밁 enterprise. The business departments of respondents were identified as follows; strategy plan department (management strategy, plan management, management plan etc.): 27%, development and maintenance department (development, management, maintenance support etc.): 21%, business application department (sale, marketing, customer management, service etc.): 34% and administration support department (personnel, finance, welfare etc.): 18%. The respondents had on average 7.7 years of experience (SD = 0.597), and most respondents (86%) had college or university degrees.

Analysis and Discussion based on Evaluation Domains

The case study based on the interpretation of evaluation domains considers an overall organization and the strategy plan department (SPD). First, as shown in Figure 5, the total evaluation index of the entire organization is 61.12 as quite a high level, and the EI of strategy plan department was higher than those of the other department. This is due to the capability to effectively perform management strategy planning, establishment and execution of information programs by executing plans, and the control and performance analysis for the enterprise 밁operations.
Second, the evaluation results of SPD, Figure 6, shows that its evaluation indices are quite high in the evaluation domains of the computing mind, the knowledge of computing technology, and the capability of computing application, except for the potential of computing capability. Therefore, the end-users in SPD should make an effort to improve the department related to degree and experience, education and training, and computing knowledge production in order to effectively raise the organizational computing competency.

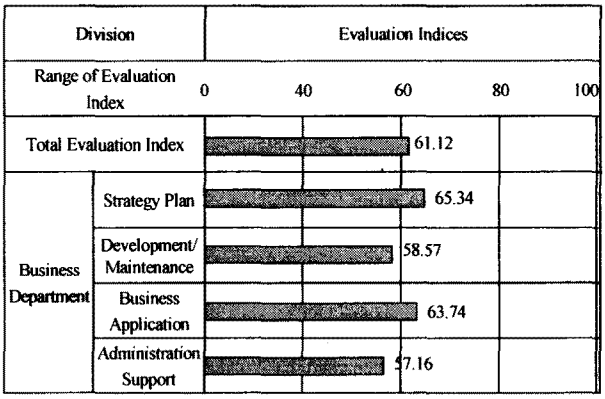

Figure 5 - Evaluation Indices of each Business Department and Overall Organization

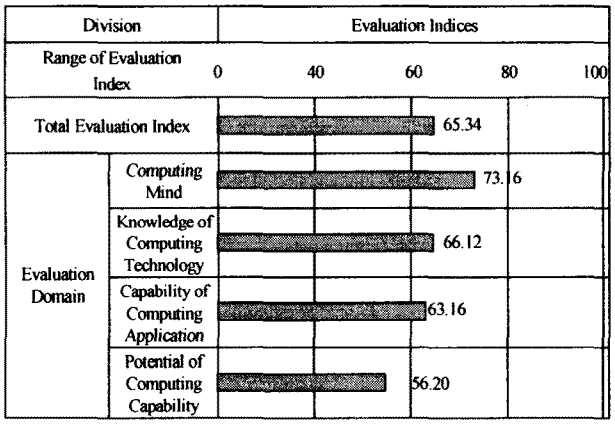

Figure 6 - Evaluation Indices of each Evaluation Domain of SPD

Analysis and Discussion based on Complex Indicators

The case study based on the interpretation of complex indicators considers an end-user in administration support department (ASD) as a sample. First, the evaluation results on 5 core complex indicators of an end-user working in ASD are as shown in Figure 7. In general, the evaluation indices of 5 core indicators are low level, and the indicator of solution application ability (ERP, SCM, CRM, KMS, HRM and so on) is a little higher than those of the other core indicators.
Second, the evaluation results on 15 general complex indicators of an end-user working in ASD are also low level in general as shown in Figure 8. The complex indicators such as computing understanding, knowledge of computing

system, OA application ability, application of computing system and computing base ability are quite a high but the others are low level.

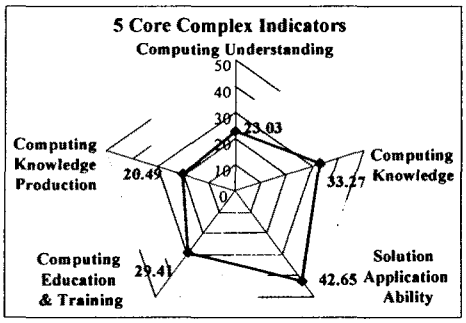

Figure 7 - Evaluation Indices of 5 Core Complexes Indicators of an End-User in ASD

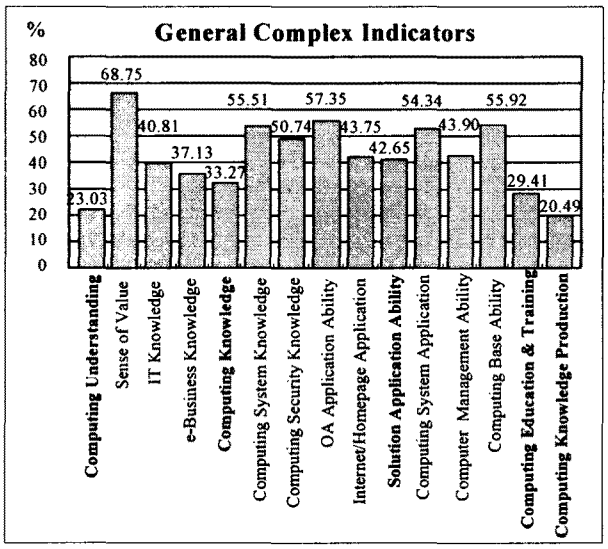

Figure 8 - Evaluation Indices of General Complex Indicators of an End-User in ASD

Therefore, the end-user has to make a sufficient effort for raising the low level indicators to efficiently improve his or her computing competency in general.

Conclusions

The expectation performance and significance of this study can be explained as follows.

First, this study developed an original evaluation system that can efficiently measure and interpret the end-user computing capability in a computing environment. Second, this presents the concrete evaluation items in each evaluation domain that can totally measure the end-user computing capability. Third, this confirmed the validity of the evaluation tool construct by factor and reliability analysis, and the practicality by a case study. Fourth, this system provides the effective interpretations by the evaluation domains and complex indicators to help the comprehensive understanding of the evaluation results.

Finally, the developed system opens up a new direction and possibilities in developing an evaluation and interpretation methodology for examining an end-user computing competency in a computing environment.

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