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Competence maps for the information service industry

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The primary aim of this paper is to construct competence maps for the information service industry. Starting with a review of the literature related to the information service industry and the competence in this industry, this study defined a pool of competence items and developed a questionnaire for field survey. Based on the data collected from the information service companies in Taiwan, a series of factor analyses with item filtration was carried out. This resulted in a six-factor solution including Cognition, Management I (organizing, leading, and controlling), Management II (planning), Technology Infrastructure, Application Systems, and Clerical Processing as the competence sets. Then the factor-based scales were created to represent the derived competence sets, the pairwise correlations between these scales were calculated, and the competence maps were constructed accordingly. The results obtained may be helpful to the internal (e.g., training/education, deployment, or substitution) and the external (e.g., recruitment) developments of human resource in information service companies.

Keywords: competence map; information service industry

Introduction

Modern information technology (IT) has been widely proven to have great potential for supporting business process reengineering and organizational redesign (Harkness, Segars and Kettinger 1996; Grover and Teng 1998; Broadbent, Weill and St. Clair 1999; Wu 2003). Consequently, extensively employing IT becomes one of the prevalent strategies enterprises adopt to create competitive advantages. Information service (IS) companies are those companies that provide a broad range of IT-related services including data processing, networking, training/education, and on-line databases (Shee and Tzeng 2002), all of which are in demand by enterprises. While the increasing demand for IS is good for the industry, at the same time it intensifies the competition within.

Due to the rapid development of IT, the IS industry is characterized as being highly volatile, and the cutting-edge IT-related knowledge and know-how have become the core of competitiveness (Shee and Wu 2008). For the IS companies, maintaining or even increasing organizational capability is essential, and consequently skilled and knowledgeable employees are in high demand. Ever since the term ‘competence’ began being discussed extensively, it has usually been visualized as the collective knowledge and skills of the employees and stakeholders in an enterprise (Prahalad and

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Hamel 1990; Nordhaug 1993; Hamel 1994). The ongoing changes taking place in the IS industry has called for IS companies to periodically review and expand their competence sets (CSs) (Shee 2006). One issue of great interest to IS companies is the full disclosure of their CSs necessary to maintain daily operations and create competitive advantages.

The purpose of this study is twofold. First, through factor analyses with item filtration, we explore the underlying dimensions of competence items, called 'CSs' in this paper, which are required in the IS industry. Next, based on the results of factor analyses, competence maps from two different viewpoints: full-traversal and partial-traversal, are constructed to demonstrate the inter-CS relationships. The full-traversal view draws on the path diagram in which the derived CSs are linked in a particular sequence, while the partial-traversal view analyzes each dyadic linkage appearing in the paths derived from the full-traversal view. It is hoped that the results obtained can be used as a reference for IS personnel when striving for CS expansion and for establishing policies of human resource development and deployment, such as training/education, recruitment, and substitution.

Background

This section includes two parts: the first part provides the definition and current status of the IS industry in Taiwan; the second part reviews the frequently cited competence items for the IS industry in the literature.

The IS industry

According to Maglitta (1990) and Shee, Tang and Tzeng (2003), the idea of 'information service' was developed in the 1980s when consideration was being given to providing a broad range of information on a user-friendly and full-text basis. At that time, the IS companies simply played a role of information suppliers (Shee et al. 2003). The exponential growth and advancements of IT products, coupled with the continuous drop in their price, encouraged enterprises to aggressively deploy IT applications to support their operations, or even employ them as strategic weapons to gain the edge over their competitors (Porter and Millar 1985). In fact, IT has changed the nature of competition and this is consolidated by widely used Internet applications and their inherent technologies. The Internet introduced the e-era and a new business paradigm, resulting in an upsurge in the demand for a new generation of IS (Shee and Tzeng 2002; Shee et al. 2003). Today, the so-called IS involves traditional services, such as the provision of baseline hardware and software, the analysis, design, and implementation of custom-made systems, the management of IT equipment, etc; and contemporary services resulting from the global expansion of the Internet, such as networking, system security, website construction, and webpage design (Tallarico 1998; Tang, Shee and Tang 1999; Shee et al. 2003).

In Taiwan, the government defined the IS industry as 'an industry that includes companies possessing data processing equipment, engaged in custom-designed programs, making information system analyses, processing for reporting data, providing network services, developing software packages, and offering consulting services' (Shee and Wu 2008). The *Institute for Information Industry (III)*, a non-governmental organization, defined the IS industry as 'an industry which specializes in information system or software value-added services,' and which can be divided into the following segments: software package; turn-key systems; system integration; project services; network services; and processing services (Tung et al. 2001). Since *III*'s definition is well known and widely accepted in Taiwan, we will employ *III*'s definition in this study.

Competence in the IS industry

Different industries have different ideas regarding the competence required for fulfilling a task, as do different companies within a particular industry. The diverse nature of required competence for the IS industry is of interest to both academics and practitioners alike, for carrying out a comprehensive exploration and for seeking a classification scheme. In the past, many researchers have adopted a resource-based perspective to view IT competence as the capability to assemble, mobilize, and utilize IT-related resources. For example, Ross, Beath and Goodhue (1996) indicated that IT capabilities are derived from the sound management of three IT assets: technology; human; and relationship. As for the IT-related resources or assets, the human aspect is always the focus. For example, Broadbent and Weill (1997), by classifying the IT infrastructure into two layers; IT components and shared IT services, advocated that the human IT infrastructure, that is, the people with knowledge, skills, and experiences, is the key to 'binding the IT components into shared IT services'.

Bharadwaj (2000) was of the opinion that human IT resources consisted of two types: technical IT skills; and managerial IT skills. Lee, Trauth and Farwell (1995), through a joint academia/industry investigation, found that an effective human IT infrastructure must include IS professionals with knowledge and skills in technology, business operations, management, and interpersonal skills to effectively carry out organizational integration and process reengineering. Byrd and Turner (2000) suggested that the analyses of human IT infrastructure should focus on the following dimensions: technology management; business knowledge; management knowledge; and technical knowledge. Chen, Hwang and Yen (1999), in their research into IT personnel in Taiwan, employed a three-dimensional perspective: IT-related business; professional IT knowledge and skills; and technical capabilities, to measure competence.

Previous works, including the conceptual and the empirical ones, carried out some preliminary exploration of IT competence. They adopted either a top-down approach, beginning with the strategic logic to analyze how to manage organizational IT assets well so as to support and facilitate this logic, or a bottom-up approach, defining several categories of skills or knowledge necessary to fulfill the requirements of IT-related jobs (Shee 2006). In summary, IT competence in extant literature is visualized as the IT staff's understandings of technology and business. The understandings of technology can be further subdivided into two subcategories: managerial and technical; and the business ones as firm-specific operations and general management processes.

Research methodology

A questionnaire survey was conducted for this study. A total of 63 competence items derived from an extensive review of literature, in tandem with four demographic questions, preliminarily constituted the questionnaire. These competence items were first assessed by six experts in academia; afterwards, this draft questionnaire was tested by 10 IS practitioners. Based on their feedback 19 items were eliminated because they were deemed conceptually redundant or inappropriate to the research context, and the phrasing of a few of the remaining items was adjusted to suit. The final list of competence items used in the questionnaire and the references to the source literature are shown later.

This study aims to investigate the CSs of the IS industry in Taiwan. The companies investigated were the 928 members of the *Information Service Industry Association of R.O.C. (CISA)*, the largest representative body of IS companies in Taiwan. Each member company received the questionnaire via regular mail. Among those responses obtained

Table 1. Demographic information of respondents.

Profile of respondents	*Frequency*	*%*	*Profile of respondents*	*Frequency*	*%*
History of company			Workforce size		
Within 1 year	5	3.0	Less than 20	50	29.8
1 year – 3 years	20	11.9	20 – 100	70	41.7
3 years – 5 years	29	17.3	100 – 200	28	16.7
5 years – 10 years	36	21.4	200 – 500	11	6.5
Over 10 years	78	46.4	500 – 1000	5	3.0
			Over 1000	4	2.4
Annual turnover (NT$)			Business model		
Less than 5 million	17	10.1	Software package	95	56.5
5 million – 10 million	22	13.1	Turn-key systems	45	26.8
10 million – 30 million	27	16.1	System integration	116	69.0
30 million – 50 million	18	10.7	Professional services	117	69.6
50 million – 100 million	26	15.5	Network services	63	37.5
Over 100 million	58	34.5	Processing services	20	11.9

For the business model, the investigated companies were allowed to choose more than one when answering this question.

168 were valid (a valid response rate of 18.1%). The demographic information of the responding companies is given in Table 1.

Analyses and results

This section presents the analyses and the results. We first describe the factor analyses which were used to derive the CSs, and then explore the important CSs by business models. In order to construct the competence maps, factor-based scales were created and the correlations between them were calculated. SPSS for Windows version 12.0 was used to analyze the data.

Factor analyses

For solution parsimony, item filtration was added to this process. We first removed the competence items with a relatively smaller mean or larger standard deviation because they were considered less important or were highly dispersed in respondents' perceptions, respectively. The remaining items were then put into exploratory factor analysis in which another filtration mechanism proposed by Shee and Tzeng (2002), as shown in Box 1 as a form of Pascal-like pseudo code, was set. Based on this mechanism, a series of principal component factor analyses were carried out to acquire the final factor solution. A similar approach had been adopted by Lederer and Sethi (1991) and King and Teo (1996).

This process stabilized in the fifth-round analysis, resulting in a six-factor solution (total variance explained = 78.34%; case-to-variable ratio = 7.6:1). The reliability test also showed that all factors have a value of Cronbach's alpha greater than 0.7, indicating a considerable level of internal consistency of the derived factors (Hair, Anderson, Tatham and Black 1998). The results of the final-round analysis are shown in Table 2.

The first factor is named *Cognition (CO)*. It contains competence items related to a person's 'mental process involved in knowing, learning, and understanding things' (Collins Cobuild English Dictionary 1999).[1] A person's ability in active learning and independent thinking can significantly contribute to problem discovery and resolution in a more creative or innovative way. Factors 2 and 3 are called *Management I (MA1)* and

Box 1. The procedure for factor analyses.

```
VAR
   M: INTEGER;
   Continue: BOOLEAN;
BEGIN
   Continue := true;
REPEAT
      Start factor analysis with M items;
      IF (there is any item with loadings of less than 0.5 on all factors) OR
      (there is any item with loadings of greater than 0.5 on two or more factors)
         THEN
            BEGIN
               Remove those items;
               Continue := true;
               M := M - the number of removed items;
            END.
         ELSE
            Continue := false;
   UNTIL NOT Continue;
 END.
```

Source: Shee and Tzeng (2002).

Management II (MA2), respectively, since they represent the fundamental activities referred to as the management processes performed in an organization (Fayol 1916). *MA1* focuses on the leading role of managers who set organizational goals and determine what tasks are to be done in order to achieve the goals. This means that managers are required to have a good understanding of their business processes and be capable of, if necessary, building an ad hoc working team and then leading it to fulfill a particular task. *MA2* reflects the vision to establish organizational IT strategies as the guideline for designing information infrastructure and managing IT projects. This factor also implies a proactive attitude towards aligning the IT strategies with the corporate-wide strategies because such an alignment has always been visualized as a critical antecedent to organizational success (Luftman, Lewis and Oldach 1993; Grant 2003; Long, Nah and Zhu 2003).

Factor 4, *Technology Infrastructure (TI)*, refers to the abilities and experiences to deploy, operate, and maintain the components of technology infrastructure, including the hardware, software, database, and network on which business applications are running. This also includes configuring these components in a particular arrangement to meet an organization's requirements. Factor 5, *Application Systems (AS)*, emphasizes the domain knowledge underlying those business application systems. It is widely recognized that the extent to which an application system support a particular business process greatly relies on the extent to which the domain knowledge is modeled and built into this system. However, one of the toughest tasks system engineers will face is how to elicit the domain knowledge underlying a particular process and then transform it into a form of system abstraction. The system engineers' familiarity with a particular process, which is important to the discovery of domain knowledge, will thus be the key to excellent system analysis and design.

Finally, *Clerical Processing (CP)* signifies the tasks traditionally performed by the so-called data workers or clerical workers (e.g., bookkeepers, secretaries, and so on). Compared with those knowledge workers in the IS industry, the skills demanded by data workers are mainly related to the paperwork, which can be supported by the office

Table 2. Results of the final-round factor analysis.

Factors (abbrev./acronym; Cronbach's α; eigenvalue; accumulated variance explained %) Competence items	*Factor loadings*
Cognition (CO; 0.92; 3.938; 17.90%)	
Discovering problems	0.842
Analytical thinking	0.838
Independent thinking and learning	0.830
Creativity and innovativeness	0.823
Solving problems on one's own	0.807
Management I: Organizing, leading, and controlling (MA1; 0.90; 3.713; 34.78%)	
Arranging teams and assigning tasks	0.863
Setting goals	0.860
Designing task steps and details	0.835
Leadership and guidance	0.637
Understanding the business processes	0.576
Management II: IT Planning (MA2; 0.90; 3.045; 48.62%)	
Formulating organizational IT strategies	0.852
Planning and managing information infrastructure	0.794
Formulating corporate-wide strategies	0.758
Managing information system projects	0.714
Technology Infrastructure (TI; 0.85; 2.412; 59.58%)	
Programming	0.877
Database management	0.872
Operating system	0.753
Application Systems (AS; 0.83; 2.380; 70.40%)	
Customer relationship management	0.889
Knowledge management	0.845
Enterprise resource planning	0.712
Clerical Processing (CP; 0.78; 1.746; 78.34%)	
Manipulating Internet tools (such as browser, email, and so forth)	0.891
Manipulating office automation software (such as MS Word, Excel, and so forth)	0.841

The eliminated items are: operating and maintaining computer hardware and peripherals, planning and managing information systems, planning and managing network, multimedia technology, object-orientated technology, information security, information system development methodology, transaction processing system, management information system, decision support system, e-commerce system, supply chain management system, intra-organizational business process analysis, inter-organizational business process analysis, monitoring task progress and performance, teamworking, interpersonal communication, foreign language, information system development, information system cost/benefit analysis, understanding the internal and external business environments, and cross-field integration; Competence items are collected from Nelson (1991), Kanungo and Misra (1992), Weill (1993), Davenport and Linder (1994), Duncan (1995), Lee et al. (1995), Boar (1996), Broadbent, Weill, O'Brien and Neo (1996), Chen et al. (1999), Bharadwaj (2000), Bassellier, Reich and Benbasat (2001), and Tiwana (2001).

automation, workflow, or document management system (Laudon and Laudon 2002; Robbins and DeCenzo 2004).

Although such results are largely consistent with those of previous studies, their own distinctiveness is evident in the following points. First, the importance of cognitive ability, which accounts for the largest amount of variance, is discovered. A similar perspective can be found in Ross et al. (1996), where a problem-solving orientation was deemed a key dimension of valuable human IT assets. Second, our work divides the competence items related to the general management processes into two categories: *MA1* and *MA2*, thus providing an insight into the managerial competence. Third, our findings indicate that the fundamental skills possessed by data workers (*CP*) are emphasized in Taiwan's IS industry. Regarding the IT-related CSs, it should be noted that although both *TI* and *AS* contain three competence items, the present study suggests a broader perspective, calling for incorporating as many aspects as possible into our findings. Hence, the notions involving *TI* are expanded to those competence items related to the constituents of IT infrastructure, such as computer networks and other peripherals. The same is true for the notions involving *AS* to a wider range of business application systems, such as transaction processing, managerial control, and strategic planning systems (Anthony 1965; Gorry and Morton 1971).

Important CSs by business models

IS companies with different business models might emphasize different CSs. An analysis was therefore conducted to delve into the important CSs for each business model. As shown in Table 3, *CO* is universally regarded as the most important CS, with *MA1* in second place. For the third spot, the processing services picks *AS*, the turn-key systems prefers *TI*, both the software package and the network services choose *CP*, and *TI* and *CP* share this spot under the models of system integration and professional services.

Construction of the factor-based scales

In order to examine the cases in terms of dimensions rather than items, it is necessary to construct factor scales to represent the derived factors. According to Kim and Mueller (1978), approaches that can be taken for this endeavor include: (1) regression; (2) least squares criterion; (3) Bartlett's criterion; (4) Anderson-Rubin's criterion; and (5) simple summation of variables with a high factor loading. They add that (1) the first three are proposed to deal with a possible non-fit induced by sampling variability between the scales and the underlying factors; (2) the fourth, which is the modification of Bartlett's criterion, is most suitable when the situation where created scales are orthogonal is stressed; and (3) the last approach is used when one believes that the factor model exactly fits the data from the population and when the variation of factor loadings can be ignored. This study chose the approach of simple summation partly because it is the simplest in operation, and partly because we adopted a complete sampling strategy according to the member lists published by a well-known IS companies' association in Taiwan, which diminishes the sampling variability. At the same time, the orthogonality of the created scales is not insisted upon in this study, thus eliminating the need for a more complex procedure like Anderson-Rubin's criterion.

The approach of simple summation utilizes 'some of the information obtained from factor analysis' (Kim and Mueller 1978, p. 70). In fact, this approach creates a scale by summing all the variables with a higher loading and ignoring the remaining variables with a lower loading. Consequently, the output 'should not be visualized as a factor scale but merely a factor-based one' (Kim and Mueller 1978, p. 70). In this study, we chose a threshold value of 0.5 to differentiate between the higher and the lower loadings. As for the weights assigned to the variables in a factor-based scale, the choice between equal and unequal weights is the last decision to be made. Since differential weighting can increase the correspondence between the scale and the observed variables (Wang and Stanley 1970; Wainer 1976), we constructed the factor-based scales on the basis of the factor loadings of each variable (unequal weights). The cases were then examined in terms of these scales to calculate the correlations between these scales, which are shown in Table 4.

According to Table 4, all correlations are significant at the level of 0.05 except between *TI* and *CP*. Managerial CSs (*MA1* and *MA2*) correlate higher with other CSs;

Table 3. Important CSs by business models.

Ranking						
Business models	*Software package*	*Turn-key systems*	*System integration*	*Professional services*	*Network Services*	*Processing services*
1	CO (6.21, 0.71)	CO (6.03, 0.87)	CO (6.17, 0.77)	CO (6.36, 0.61)	CO (6.05, 0.69)	CO (5.91, 0.98)
2	MA1 (5.87, 0.75)	MA1 (5.65, 0.82)	MA1 (5.91, 0.87)	MA1 (5.92, 0.83)	MA1 (5.86, 0.67)	MA1 (5.83, 1.08)
3	CP (5.76, 0.88)	TI (5.50, 0.88)	CP (5.70, 0.95)	TI (5.78, 1.06)	CP (5.83, 0.93)	AS (5.78, 1.00)
4	TI (5.64, 1.13)	CP (5.49, 1.01)	TI (5.70, 0.96)	CP (5.78, 0.95)	TI (5.61, 1.09)	TI (5.55, 0.95)
5	AS (5.53, 0.86)	MA2 (5.47, 0.91)	MA2 (5.62, 0.92)	MA2 (5.66, 0.90)	MA2 (5.60, 0.92)	MA2 (5.54, 1.17)
6	MA2 (5.48, 0.89)	AS (4.96, 0.94)	AS (5.52, 0.99)	AS (5.62, 0.98)	AS (5.38, 0.96)	CP (5.48, 1.23)

The figures in each parenthesis are the mean and standard deviation.

Table 4. Correlations between the factor-based scales.

	CO	*MA1*	*MA2*	*TI*	*AS*	*CP*
CO	1					
MA1	0.437**	1				
MA2	0.460**	0.632**	1			
TI	0.349**	0.257**	0.360**	1		
AS	0.287**	0.449**	0.396**	0.250**	1	
CP	0.229**	0.334**	0.181*	−0.012	0.306**	1

*$p < 0.05$; ** $p < 0.01$.

MA1–MA2, *CO–MA2*, *MA1–AS*, and *CO–MA1* are the higher correlated pairs. It seems plausible that *MA1–MA2* is the highest correlated pair because these two CSs share the common core of managerial competence. *CO* highly correlates with *MA1* and with *MA2*, suggesting that a person's cognitive ability is a key factor in managerial works. The high correlation between *MA1* and *AS* reveals that a person's experiences in organizing, leading, and controlling the company/team can enrich her/his knowledge of business processes, which is essential to the development of application systems.

Competence maps

Based on the correlations between factor-based scales, this section explains the construction of competence maps from two different views: the full-traversal and the partial-traversal. In addition, the implications of these maps are discussed.

Competence maps: A full-traversal view

The competence maps with a full-traversal view draw on path diagrams to show the connections between CSs. The full-traversal view emphasizes the completeness of a path. This means that one takes a particular CS as the starting point and then uni-directionally links up all the other CSs one by one based on the correlations between factor-based scales to complete the path. Paths with such a view can be made by either of the following two methods: initial starting point (ISP) and staged starting point (SSP). The ISP method picks one CS as the starting point and then sorts the remaining CSs in a descending manner by their correlations with the starting CS. The path can be established by linking the starting CS with the remaining CSs in the sequence derived from the foregoing sorting. For example, with *CO* as the starting point, the path goes through the order of *MA2*, *MA1*, *TI*, *AS*, and *CP*. For other paths constructed by the ISP method, please see Figure 1.

The SSP method constructs the paths with the following rule: for the path starting from ***A***, we first look for the CS which has the highest correlation with ***A*** from the candidate list including all CSs except ***A***. Let's assume that it is ***B***, and we then remove ***B*** from the list. Next, by taking ***B*** as the starting point of the next stage, the search continues to locate a CS which correlates highest with ***B*** from the candidate list. Assuming that it is ***C***, then ***C*** is removed from the list. This process will proceed until the candidate list is exhausted to finish the path. For example, with *CO* as the starting point, the path goes through the order of *MA2*, *MA1*, *AS*, *CP*, and *TI*. For other paths made by the SSP method, please see Figure 2 for more details.

According to Yu (1990), competence deficiency makes problem-solving a tough job, preventing people from achieving high-level performance. If people are willing to expand

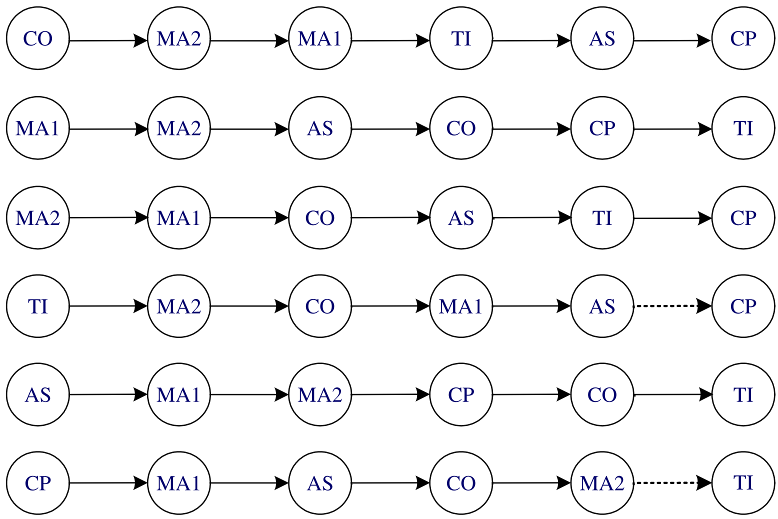

Figure 1. Competence map constructed by the ISP method: A full-traversal view.
The dotted lines in the 4th and the 6th paths stand for insignificant correlations (to the initial starting CSs), which can be ignored.

their CSs, 'a challenging problem will become a structured one' (Shee and Wu 2008). The competence maps with a full-traversal view can serve as a guideline for IS companies to establish training/education programs and for the personnel to expand their CSs. However, such maps should be interpreted with caution. The correlation coefficient is primarily used to describe the extent of the connection between entities; a pair of significantly correlated CSs signifies that there is a certain degree of 'structural, functional, or qualitative correspondence'[2] between them. However, the correlation analysis should not be confined to the face values, but rather highlights the differences among those coefficients. Since the correspondence between a highly correlated pair will be higher than that between a lower correlated one, we can therefore infer that it will be better for people to choose the CS which is correlated higher with the one they possess now as the target of CS expansion.

In Figure 1, the CSs on each path are sequenced by their correlations to the starting CS: the closer to the starting CS a particular CS is, the higher the correspondence is between them. Hence, the CS expansion suggested by this figure is a single-node perspective, meaning that further moves are all derived from the initial starting CS. For example, for a person possessing *MA1*, *MA2* is the priority pick, and *AS* is the next. Contrary to the single-node perspective, Figure 2 aims at each stage, meaning that any move in the CS expansion should be based on the present stage. For example, when starting with *MA1*, *MA2* is the target of the next stage, and *CO* is then recommended based on *MA2*, which exhibits a different structure from that in Figure 1. However, from Figure 1 and Figure 2, we find that the managerial CSs top the candidate list under all circumstances, thus demonstrating their importance. The fact that managerial CSs correlate higher with other CSs plays a pivotal role in explaining the path structure displayed in Figure 1 and Figure 2. That is also why *MA1* and *MA2* always appear in the beginning segment of the paths in both figures.

CS expansion by inter-CS correlations does not imply that people can quickly and easily learn the knowledge and skills which correlate highest (or higher) with the CSs they possess now, and it is rarely possible to traverse a particular path from the beginning to the

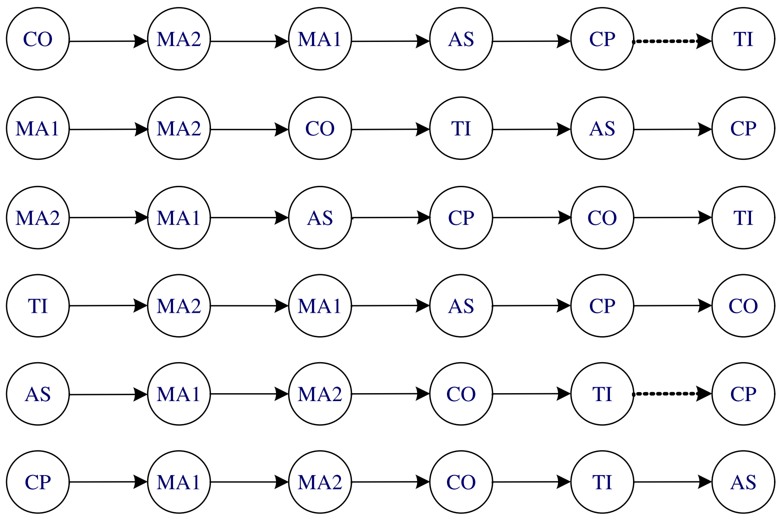

Figure 2. Competence map constructed by the SSP method: A full-traversal view.
The dotted lines in the 1st and the 5th paths stand for insignificant correlations (to the staged starting CSs), which can be ignored.

end, or in other words, to experience all stages that result in the acquisition of all CSs. The full-traversal view shows us a way to completely and uni-directionally link up the empirically derived CSs in a particular order to demonstrate their relationships. For more meaningful insights, a deeper exploration is required.

Competence maps: A partial-traversal view

The partial-traversal view, which takes all the dyadic linkages in the paths in Figure 1 and Figure 2 as the units of analysis, is proposed to provide a different angle. More specifically, competence maps with a partial-traversal view are based on those with a full-traversal view. Let's take the map made by the ISP method (see Figure 1); since the CSs situated near/at the end of a path have lower correlations with the initial starting CS, further analyses will focus on the CSs appearing in the early stages (assuming that the initial starting CS is defined as stage 0, the CS that has the highest correlation with the initial starting CS is defined as stage 1 and the rest may be deduced by analogy). In the present study, we gather the first two stages to develop the competence maps with a partial-traversal view. For the paths in Figure 1, the links between the initial starting CS and the CS of stage 1 are captured first to construct the map with a first-order partial-traversal view, and the links between the initial starting CS and the CS of stage 2 are captured next to construct the map with a second-order partial-traversal view. The results are shown in Figure 3.

Figure 3(a) and Figure 3(b) depict the directed inter-CS connection based on each CS's highest and second highest correlations to other CSs, respectively. The CS pointed by more arrows can be viewed as a 'bridge' or an 'interface' among other CSs which point at it. Such a result is useful when the IS companies need to arrange for teamwork, which is always the case in this industry. For example, Figure 3(a) demonstrates the important role of personnel with managerial competence, suggesting that any working team/group should include talents of this type. *MA1* is required when the team is composed of members with *AS* and *CP*, and *MA2* is required when the team is composed of members with *TI* and *CO*.

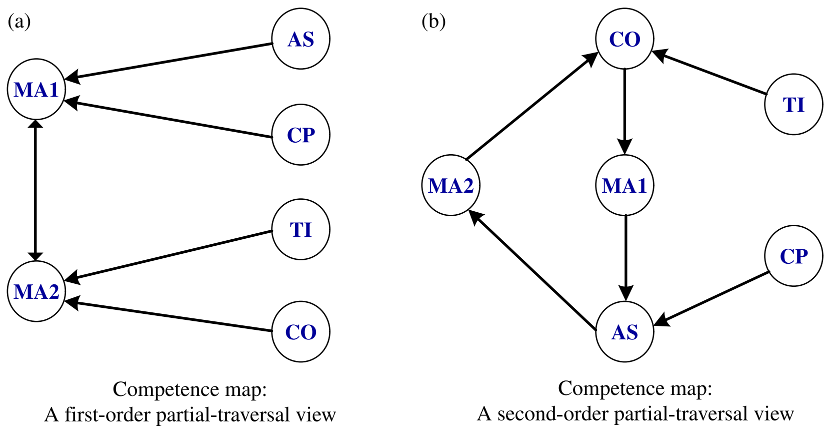

Figure 3. Competence maps constructed by the ISP method: A partial-traversal view.

If personnel with *MA1* or *MA2* are unavailable, according to Figure 3(b), personnel with *AS* or *CO* can be the candidates.

For the map constructed by the SSP method (see Figure 2), subsequent analysis from a partial-traversal view should be carried out in a different way because the SSP method is based on the CS of each stage, rather than on the CS that originated the path. An adjacency analysis was therefore made, and the findings furnished us with a deeper insight. According to Figure 2, we first find that *MA1* and *MA2* are adjacent in all paths, and we also find that *CO* is adjacent to the *MA1*–*MA2* pair in four paths. In spite of the directionality, the relationship among these three CSs is redefined, as shown in Figure 4. This not only echoes the findings observed from the pairwise correlations, but also implies a causal or complementary relationship between one person's 'mental process involved in knowing, learning, and understanding things' (Collins Cobuild English Dictionary 1999)[1] and her/his knowledge and skills in performing managerial tasks. This suggests that, for example, if a person in the IS industry has a great cognitive ability, she/he better chooses the area of management as the next step of CS expansion. Or if there is a shortage of managerial talents in an IS company (or in the labor market), the company can select (or recruit) employees with an exceptional cognitive ability as substitutes, by training/educating them to be knowledgeable and skilled in management.

Other notable adjacent pairs include *AS*–*CP*, *CO*–*TI*, and *MA1*–*AS*, which all appear in four of the six paths in Figure 2. We treated the first one as negligible because compared to the other two, it has least correlation and, considering the directions which are all from *AS* to *CP*, it is impractical in real life. For the *CO*–*TI* pair, the directions are from *CO* to *TI*, pointing out a likely choice for a person with an outstanding cognitive ability in the IS industry, besides *MA1* and *MA2*, to take *TI* as her/his next step of CS expansion. The directions of the *MA1*–*AS* pair are mostly from *MA1* to *AS* (three out of four), suggesting

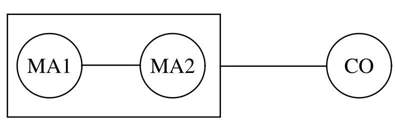

Figure 4. The relationship among *MA1*, *MA2*, and *CO*.

that the personnel involved in organizing, leading, and controlling the organization can expand their CSs into the development of business application systems because their experiences from the field enrich their knowledge about business processes, which is critical to system analysis and design.

Limitations

A comprehensive list of competence items, an extensive field survey, and a series of factor analyses with item filtration give our findings a considerable level of credibility. However, as with any study, our work is subject to certain limitations. First, while the factor analyses with item filtration did result in a parsimonious solution, some key competence items, especially those related to inter-organizational networking and cooperation, for example, analysis of inter-organizational process, supply chain management, and information security, were eliminated by such a structural, mechanical procedure. This study has indicated the importance of organizational system competence through the factor *AS*; nevertheless, the items comprising this factor seem to be more related to the intra-organizational aspect. This result might reflect a part of industrial phenomenon in Taiwan. In order to simultaneously achieve parsimony and inclusiveness, we suggest a post-analysis validation in further research to examine the final solution.

Second, constrained by the lack of information, we were unable to make a comparison between the demographics (e.g., the workforce size and the annual turnover) of all companies in our survey lists and that of the returned samples to test the non-response bias. Since our respondents were mostly medium-sized companies, we suggest that readers interpret or draw inferences from the findings of this study with caution.

Finally, the derived CSs in this study were primarily an exploratory factor solution. In order to gain higher reliability and validity, further confirmatory-based analyses are required. When considering the creation of factor scales, we encourage the applications of other methods.

Conclusions

This study has explored the CSs of the IS industry and analyzed the relationships between them. The pairwise correlations preliminarily indicate that *MA1* and *MA2* correlate higher with other CSs; *MA1*–*MA2*, *CO*–*MA2*, *MA1*–*AS*, and *CO*–*MA1* are the higher correlated pairs. These correlations further lay the groundwork for constructing the competence maps with a full-traversal view by the ISP and the SSP methods, which facilitate several findings. Afterwards, the partial-traversal view reveals the importance of personnel with managerial competence. The partial-traversal view also demonstrates a unique relationship among *MA1*, *MA2*, and *CO*. These findings can be applied to a broad range of human resource development in the IS industry, from the individual level (e.g., personal CS expansion) to the corporate level (e.g., strategic human resource planning for training/education, recruiting, and substitution).

The IS industry is highly competitive and dynamically changing. Therefore, people in this field should keep on learning as a response. Once they become skilled in a new CS area, they can face challenges more confidently (Yu 1990). IS companies should cultivate their strength through continuous organizational CS expansion. This process, which consists of competence planning, external competence acquisition, internal competence development, and competence utilization (Nordhaug 1993) largely depends on effective training/education and recruiting programs. It is recognized that quality human resource is critical to competitiveness. The results of our study are helpful to IS companies to gain and secure their competitiveness and achieve organizational success.

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Notes

1. A definition of 'cognition' from Collins Cobuild English Dictionary (1999).
2. http://dictionary.reference.com/search?q=correlation.

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