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Critical IS professional activities and skills/knowledge: A perspective of IS managers

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Abstract

This study utilized the activity competency model to investigate the perceived importance of critical professional activities and skills/knowledge required by three levels of information system (IS) managers. Our findings indicated that the perceived importance of critical IS professional activities were significantly different among the management levels, but not significantly different for various industry types. Carrying a critical IS activity out involves the use of a number of different skills and/or knowledge. A portfolio of the professional activities and the needed skills/knowledge at each management level are identified. The results of this study have implications for IS professional development and training. They can also serve as a guideline for recruiting the right IS managers and developing IS curriculums.

Keywords: Activity competency model; IS professional activity; Skills and knowledge

1. Introduction

Today, information and communication technology (ICT) progression makes data resources and information systems (IS) critical corporate resources. IS managers typically exhibit management roles requiring effective communication with other functional areas and organizations, managing information resources, influencing organizational strategy

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and responsibility for the information technology (IT) planning to cope with the firm's competitive environment (Longenecker & Fink, 2001). To meet a firm's information needs, IS managers must know exactly what they should be doing in their positions and have the requisite skills and knowledge to operate and manage their IS resources effectively.

Information technology applications in the business environment have changed and continue to change dramatically (Lee, Koh, Yen, & Tang, 2002). This forces IS educators, instructional technologists and practitioners to reevaluate and acquire compulsory knowledge, skills, abilities on a regular basis (Couger et al., 1995; King, 2002; Lee, Trauth, & Farwell, 1995; Tennyson, 2001). Some analyses of progressive human resource management (HRM) practices suggested that these practices enhance organizational productivity and profitability by improving the knowledge, skill, and motivation of employees (Jackson, Schuler, & Rivero, 1989; Neal & Griffin, 1999). Hence, obtaining and retaining IS managers with the critical professional activities and the skills and knowledge required to support the organization effectively is an important challenge.

Within the IS HRM literature, a substantial body of research has examined either on the issues of roles and functions (e.g., Brown, 1999; Grover, Jeong, Kettinger, & Lee, 1993; Karimi, Gupta, & Somers, 1996), critical activities or capabilities (e.g., Benamati & Lederer, 2001; Earl & Feeny, 1994; Feeny & Willcocks, 1998; van der Heijden, 2001) important to a CIO or an IS manager or critical skills/knowledge (e.g., Lee et al., 1995, 2002; Nelson, 1991; Oser, Gualtieri, Cannon-Bowers, & Salas, 1999; Todd, McKeen, & Gallupe, 1995; Trauth, Farwell, & Lee, 1993) to an IS manager. However, prior researches do not holistically answer what the critical IS professional activities are for each level of management and the proficiency needed in each professional activity in which skills/knowledge areas. Integrating both factors could provide an even stronger model than either factor standing alone. To address the above challenges, professional development must be provided to IS managers. A successful professional development program is based on clear professional development requirements with systematic training on design and effective program implementation (Cuevas, Fiore, Bowers, & Salas, 2004; Kester, Kirschner, van Merriënboer, & Baumer, 2001; Oser et al., 1999). Therefore, a systematic study of IS professional development requirements for IS managers is keenly needed.

The objectives of this research are, therefore, to utilize the activity competency model to systematically investigate critical IS professional activities and the associated skills/knowledge requirements based on the three management levels (i.e. supervisory, middle and top levels). The remainder of this paper is organized as follows. First, the theoretical foundations of this study are discussed and research hypotheses are developed. This is followed by a description of the methodology employed and a presentation of the findings from this study. The subsequent sections present the discussions and portfolios of IS critical professional activities and skills/knowledge by IS managers' management levels. The last section concludes with the findings, implications, limitations and future research directions.

2. Theoretical background

2.1. The activity competency model

One way to characterize an IS manager's professional work is in terms the roles an IS manager plays; another is based on the functions that a manager performs. Wu, Chen, and Lin (2004) proposed the activity competency model (ACM), derived from *job characteris-*

Fig. 1. Activity competency model (Wu et al., 2004).

tics theory (JCT, Hackman & Oldham, 1980), to investigate IS manager's managerial activities and skills as shown in Fig. 1. The ACM provided a sound base to further break down the roles and/or functions into specific professional activities that a manager might perform in the course of structuring an organization's information resources.

The top of the ACM is the IS manager's management level. IS managers in each level play various professional roles or functions vital to the success of the enterprise. At the next level, the IS manager must have mastered professional activities to fulfill the role or performed certain functions. Proficiency in each of the critical activities depends on a command of the more elemental competencies at the skill and knowledge level that can be thought of as the most fundamental competencies contributing to organizational success. Based on the ACM and JCT concepts, a skill in this study is defined as an ability that can be developed, not necessarily inborn, and that is manifested in performance, not merely in potential. Note that a competency at the lower level is likely to support more than one competency at a higher level. Similarly, many competencies at the lower levels are likely to support a specific competency at a higher level (Wu et al., 2004).

2.2. Research hypotheses

The ACM explains the relationships between the levels of management occupied by given IS personnel, their subsequent professional activities, and the requisite skills/knowledge. IS managers play different roles and functions in various organizational settings and at different hierarchical levels. For instance, in supervisory levels, they may act as first-line leaders of teams of programmers and analysts, computer operations, and data entry staff. In many companies, the IS department might be headed by a chief information officer (CIO) who is a senior management to oversee the strategic use of IT in the firm (Laudon & Laudon, 2002).

The hierarchical management level is an important factor that could influence an IS manager's critical professional activities through his or her work roles. Due to the different job characteristics at different hierarchical levels, the relative importance across each IS critical professional activities would vary. Synnott and Gruber (1983) suggested that the IS manager is a functional manager with line responsibility for IT product and service, whereas the CIO is "a senior executive responsible for establishing corporate information policy, standards, and management control over all corporate information resources."

In addition, Stephens, Ledbetter, Mitra, and Ford (1992) studied five successful CIOs in five divergent industries and found that IS managers in top managerial levels operate like executives rather than functional mangers, that is, CIOs spend more time interacting with those outside the IT unit or with groups participating in IT and other areas. In contrast, lower-level IS mangers tend to remain in their own professional IT territories and spend fairly more time interacting with their organization subordinates. They recognized that a CIO operates as an executive and is an active participant in strategy planning, acting as a bridge between the IT group, functional areas, and external entities and concluded that the CIO's accountabilities and his or her professional activities are, indeed, different from that of the MIS manager: The CIO is an executive rather than a common technical-function manager. Therefore, based on the ACM and the foregoing discussion, the following hypotheses are proposed:

H1: There is a significant perceptual difference among the management levels regarding the importance of professional activities.
H2: Each one of the professional activities is important to each one of the management levels.

As mentioned previously, proficiency in each of the critical activities depends on a command of the more elemental competencies at the skill and knowledge level that can be thought of as the most fundamental competencies contributing to organizational success. For instance, Sandwich (1993) proposed that managers acquired conceptual/creative skills, leadership skills, interpersonal skills, administrative skills, and technical skills applied to the work situation to achieve effective results. Rifkin, Fineman, and Ruhnke (1999) proposed a hierarchical frame work for a technical manager competency model and pointed out that the technical manager's role will influence the work activities and the associate skills and knowledge through critical accomplishments. Kakabadse and Korac-Kakabadse (2000) adopted the IS/IT professional model, role analysis model, work discretion benchmark, and strategic positioning and partnering model to study the future role of IS/IT professionals and the need for new skills and capabilities required for the new millennium.

In essence, an IS manager's capacity to execute each of his IS critical professional activities well depends heavily on his possessing the relevant underlying competencies, or clusters of relevant knowledge and related skills used in performing the critical professional activities. Although this relationship applies to all kinds of work, the specific mixes of necessary competencies vary with the critical professional activities itself and with the setting in which it is performed. Thus, based on the ACM and the foregoing discussion, the following hypothesis is proposed:

H3: Skills and knowledge are important to each professional activity for each one of the management levels.

3. Research methodology

3.1. Instrument development and pilot study

A survey instrument was developed and used to collect the data used in this study. The questionnaire contained three major parts including basic data portion, the importance of

IS manager's critical IS professional activities and the relationships with needed professional skills/knowledge. The basic data portion asked IS managers to give the name of their organization and circle their current management position. The answering principles of the second portion of the survey instrument in this study is to ask IS managers to evaluate and write down the degree of perceived importance for each critical activity based on their current position. Respondents were asked to rate the importance of these activities using a five point Likert type scale, where 1 = strongly disagree; 2 = disagree to some extent; 3 = uncertain; 4 = agree to some extent; 5 = strongly agree. If the degree of importance for the activity ranked 3 or above in importance, they were asked further to choose the skills and knowledge needed to accomplish that activity effectively in the third part of the survey instrument. Each of the skill/knowledge chosen or not was coded as 1 or 0, respectively. The frequencies of each skill/knowledge related to each professional activity were then calculated and used to determine whether the skill/knowledge is important to accomplish the IS manager's professional activity.

This study used multiple-item measures to structure Mintzberg's managerial roles (Mintzberg, 1973) and other researchers' functional perspectives and adapt them for use within the IS manager's professional context. The IS research discipline has a rich literature on the subject of IS critical activities drawing on the viewpoints of IS managers' roles (Grover et al., 1993; Kakabadse & Korac-Kakabadse, 2000; Karimi et al., 1996) and functions (Feeny, Edwards, & Simpson, 1992; Markus & Benjamin, 1997; Stephens et al., 1992). For instance, Earl and Feeny (1994) identified six critical IS professional activities (i.e. obsessive and continuous focus on identifying and supporting the emerging business imperatives, interpretation of external IT success stories, establishment and maintenance of key executive relationships, and establishing and communicating the IS performance record, concentrating of the IS development effort, and achieving a shared and challenging vision of the IT role) and for successful CIOs, who add value to the organization.

Rockart, Earl, and Ross (1996) argued eight imperatives (e.g., deliver and implement new systems, build and manage infrastructure) to guide IS managers at all levels that are trying to respond to business technological changes, assume new roles, and build relationships with line mangers involving what actions to take to be successful in the new IT organization. Feeny and Willcocks (1998) proposed nine core IS capabilities (e.g., architecture planning, making technology work) for IS managers to support the recreation of high-valued-added IT applications and get the most out of the external market's ability to deliver cost-effective IT services. Based on a modified systems development life cycle framework, Lee et al. (1995) generated a list of 21 critical IS activities with IS practitioners and in-depth interviews with IS executives, to investigate the critical skills/knowledge required by IS professionals. Based on the foregoing literature review and carefully compared manuals of job description and handbooks of standard operation procedure for IS mangers that were collected from a number of enterprises in Taiwan. An initial list encompassed 33 critical IS professional activities were generated.

Similarly, the measures for professional skills/knowledge adopted in our research were from previous studies mainly. For instance, Clarke and Teague (1996) suggested six important skills such as logical thinking and problem solving abilities; communication skills, organizational skills, research skills, technical writing skills, creativity and teamworking skills, required by professional women for their computing careers. Byrne and Moore (1997) interviewed with 16 software development managers and addressed 10 non-technical skills (i.e., planning, written, presentation conducting interviews, time

management, business aspects of IT, team working, assertiveness dealing with customers and team leading skills) sought as desirable attribute by 15 of the 16 interviewees. The results of the interviews conducted by Byrne and Moore (1997), including IS technical topics such as requirement analysis, telecoms, databases, software lifecycle, windows programming, software testing and maintenance, and so on. Those IS technical skills and knowledge were found to require more emphasis in college computing courses.

In addition, we reviewed the literatures and recommended ACM curriculum documents, such as ''IS 2002 – model curriculum and guidelines for undergraduate degree programs in information systems'', ''MSIS 2000 – model curriculum and guidelines for graduate degree programs in information systems'', and ''final report of the joint ACM/IEEE-CS task force on computing curricula 2001 for computer science'' to find critical job skills/knowledge related to IS managers. Based on this intensive review, 14 professional skills/knowledge were identified and used as the measurement scales.

Once the initial lists were generated, an iterative process involving personal interviews with industrial and academic experts was conducted to refine the instrument. The interviews were recorded to improve the quality of data collection. From this, the researchers were able to gauge the clarity of the tasks presented, assess whether the instrument was capturing the phenomenon desired by the researchers, and verify that important activity and skill aspects were not omitted. This process was continued until no further modifications to the questionnaire were necessary. Feedback from this pilot study served as the basis for correcting, refining, and enhancing the experimental scales. For instance, scales were eliminated if they represented the same aspects with only slightly different wording or modified if the semantics were ambiguous. Finally, we identified 20 critical IS professional activities and 14 professional skills/knowledge as a basis of the preliminarily lists for our instrument design as summarized in Tables 1 and 2, respectively.

3.2. Sampling

Data for this study were collected across various management levels using a questionnaire survey administered in Taiwan. Enterprises from the Top-2000 in manufacturing and service ranked by Taiwan's Bureau of business were included. Only those firms with a formal MIS department were qualified for selection. Using a random sampling procedure and referred from the NASIC 2002 SIC code from the US Census Bureau, 150 companies from the Top-2000 firms in Taiwan were randomly selected, constituting a representative sample in this study. Each company received an initial phone call explaining the purpose of this research project and inquiring about the firm's willingness to participate in this study. A contact person was identified at each company, asked to provide the number of managers in the MIS department, and to distribute the self-administered questionnaires to MIS managers. Participation in this study was voluntary and people were assured that their individual responses would be treated as confidential. A follow-up phone call was used to increase the response rate.

3.3. Characteristics of the sample

One hundred and eleven companies agreed to participate in this study. The samples were then classified into two industry types: manufacturing and service in accord with the NASIC 2002 SIC code from the US Census Bureau. We sent out 310 questionnaires

Table 1
Critical activities of IS managers

Code	Critical activity	Description
Pa1	Establish IS documentation standard	Establish the standard for content and formats to be observed by contractors, technicians, programmers, system analysts, and various applications specialists in the preparation of user manuals for information systems, such as systems documentation, user documentation (e.g., reference manuals, operating procedures, on-line documentation). The requirements of this standard shall apply to systems developed or made to government or industry specifications (SRSAT, 1994).
Pa2	Establish IS operation standard	Develop the IS operation standard for minimizing costs, maintain quality support, and simplify systems integration efforts in order to speed the delivery process and ensure that the standards do not handcuff business units with unique IT requirements (Ross et al., 1996).
Pa3	Reskill IS personnel	Conduct knowledge/skills needs assessments, determine requisite areas of significant deficiencies and appropriate education/training programs for IS professionals; keep track of subordinate training and special skills as they relate to job assignments to facilitate their personal growth and development (Nelson, 1991).
Pa4	Train and educate end users	Develop end-user capabilities and involve them in IS activities by providing end users classroom training as well as on-the-job training that allow them to think openly about problem solving and customer expectations (Rondeau et al., 2002).
Pa5	Manage IS crisis	Be responsible for corrective action when the organization faces unexpected IS crises. This may include formulating plan and executing these plans through coordinated responses (NCOITRD, 1994).
Pa6	Support existing portfolio of applications	Extend or maintain the legacy systems' functionality by using standard information system development methodologies and application architecture (Reddy & Reddy, 2002).
Pa7	Manage/plan systems development/ implementation	Help plan systems development methodology (SDM) implementation, provide necessary people and resources to complete it, understand the new SDM, manage the change to the new SDM, insure that personnel are properly trained and use measure of success to track the progress of SDM implementation; to make sure that personnel adhere to the practices of the new SDM by making sure that they understand (Roberts et al., 1999).
Pa8	Analyze business problems and IS solutions	Deeply understand the business units within which they work and effectively apply IS/IT in seeking solutions to business problems (Trauth et al., 1993).
Pa9	Manage/plan corporate IS strategies, strategic applications, technology architecture	Create the coherent blueprint for a technical platform and manage the IS/IT sourcing strategy that meets the interests of the current and future business needs involving analysis of the external market for IS/IT services, selection of a sourcing strategy to meet business needs and technology issue, and leading the tendering, contracting, and service management processes (Feeny & Willcocks, 1998).
Pa10	Manage/plan feasibility/ approval process for new systems and technology	Assess the severity of recent problems due to IT change; identify coping mechanisms that might have avoided or reduced the problems; anticipate future problems due to IT change and implement coping mechanisms that will avoid or reduce future problems (Benamati & Lederer, 2001).

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Table 1 (*continued*)

Code	Critical activity	Description
Pa11	Support information access and security	Protect organizations' information against the risks of disclosure, modification, or deletion; execute comprehensive security program and exemplify management's awareness and understanding of the need to protect information (Wright, 1994).
Pa12	Integrate existing and new business applications	Build bridges between legacy systems and new to deliver data across locations and applications; recognize opportunities to apply new ITs as they become available (Ross et al., 1996).
Pa13	Analyze software packages-evaluation and selection	Collect relevant information, talk to potential software vendors, evaluate the options available in the market, and choose the products that meet their needs (Chau, 1995; Tam & Hui, 2001).
Pa14	Implement new or changed computer-supported business processes	Envision the business processes which technology makes possible (Feeny & Willcocks, 1998). The capabilities include involvement in business strategy, occupation with IT implications on processes, new processes made possible by IT and an eye for dependencies (van der Heijden, 2001).
Pa15	Support end-user computing	Develop end users' understanding of IT's potential and provide a wide range of services such as consulting, technical/product support, user hotlines, help desks, and training to assist end users in acquiring, developing, using, and controlling their computer resources with an organization (Montazemi et al., 1996).
Pa16	Evaluate IS performance and upgrade planning	Identify IS structure including IS administration style, hardware configuration, and information/application-sharing across departments. Such assessments can facilitate selection and prioritization of appropriate measures of performance. Introduce the idea of various qualitative or quantitative measures of system performance, e.g., IS function efficiency, information quality, user satisfaction, work group's decision-making, and strategic or financial impact on organizations. The measure may also need to change, if an organization is planning to shift from one phase to the next in the IS evolution path (Heo & Han, 2003).
Pa17	Explore new technology and knowledge	Spend time scanning firm's environment for new development in IT and technology related issues that are relevant to their roles in order to understand the implications for their business; scrutinize the internal environment for opportunities to use new IT innovations; link IT management strategies to firm's business strategy (Harris et al., 2001; Karimi et al., 1996).
Pa18	Support hardware/ software installation and maintenance	Perform the equipment and/or systems installation in a timely manner and ensure that equipment and systems in assigned areas are appropriately installed and connected and are in good condition and properly maintained (CSU HRA, 1996).
Pa19	Facilitate and monitor contract progress	Ensure the success of existing contracts for IS/IT services and protect the business's contractual position, current and future (Feeny & Willcocks, 1998).
Pa20	Manage vender partnerships	Identify the potential added value of IS/IT service suppliers (Feeny & Willcocks, 1998) and recognize whether vendor relationship is purely transactional and contractual or more strategic and joint (Rockart et al., 1996).

to the IS managers at these companies and received 121 questionnaires. Six invalid responses were discarded. The remaining 115 valid responses from 73 companies were then coded for statistical analysis. The response rate was 37.1%. Table 3 lists demographics of the subjects. The data indicate that the majority of respondents had a college or higher

Table 2
Critical IS professional skills/knowledge of IS managers

Code	Skill/knowledge	Description
Pc1	Systems analysis and design	The skills/knowledge including: Understanding of the system development and modification process, evaluating and choosing a system development methodology. Effective communication and integration with users and user systems. It encourages interpersonal skill development with clients, users, team members, and others associated with development, operation and maintenance of the system. Object oriented analysis and design. Use of data modeling tools. Development and adherence to life cycle standards (Gorgone & Gray, 2000).
Pc2	System life cycle management	The skills/knowledge to manage systems development life phases: requirements analysis, system analysis and design, implementation, testing, evaluation and deployment (Kruchten, 2003).
Pc3	Database management	The concepts, principles, issues and techniques for managing corporate data resources. Techniques for managing the design and development of large database systems including logical data models, concurrent processing, data distribution, database administration, data warehousing, data cleansing, and data mining (Gorgone & Gray, 2000).
Pc4	Distributed systems	The skills/knowledge concerning how to manage and support the distributed computing technologies (i.e., networks and distributed applications) and to employ some of these technologies to improve the management processes (Umar, 1993).
Pc5	Business domain knowledge	The skills/knowledge of IT and business executives, at a deep level, to understand and be able to participate in the others' key processes and to respect each other's unique contribution and challenges (Reich & Benbasat, 2000).
Pc6	Programming language	The skills/knowledge of algorithm development, programming, computer concepts and the design and application of data and file structures including the logical and physical structures of both programs and data (Gorgone et al., 2002).
Pc7	Telecommunications and network	The technical knowledge for data, voice, image, and video communications and computer networks to effectively communicate with technical, operational and management people in telecommunications and network (Gorgone & Gray, 2000).
Pc8	Operating systems	The skills and knowledge of how systems software efficiently allocate hardware resources to applications and includes tasks such as prompting the user for certain actions, allocating RAM locations for software and data, instructing the CPU to run or stop, allocating CPU time to different programs running at the same time, and instructing coprocessors and peripheral equipment (Oz, 2000).
Pc9	Systems integration	The skills/knowledge to develop an integrated technical architecture (hardware, software, networks, and data) to serve organizational needs (Gorgone & Gray, 2000).
Pc10	Project management	The skills/knowledge to manage projects within an organizational context, including the processes related to initiating, planning, executing, controlling, reporting, closing a project as well as project integration, scope, time, cost, quality control, and risk management (Gorgone & Gray, 2000).
Pc11	Information technology management	The skills/knowledge concerning where and how to deploy information technologies effectively and profitably for meeting strategic business objectives (Lee et al., 1995).
Pc12	Analysis and judgment	The skill to choose an appropriate response based on the perceived factors in a given situation, with reference to the acquired knowledge and skills (Sandwich, 1993).

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Table 2 (*continued*)

Code	Skill/knowledge	Description
Pc13	Communication and coordination	The skill to bridge two ideas, and create a total meaning having far greater impact that logical, discursive explanations (Stephens & Loughman, 1994); coordinate IT activities in ways that support other functional managers, suppliers, and customers (Mata et al., 1995).
Pc14	Teamworking	The skills/knowledge to achieve team goals about individual accomplishment and how well an IS staff member secures cooperation and progresses toward user and organizational goals (Klein et al., 2001).

Table 3
Profile of the respondents

Demographics	Classification	Frequency	Percent (%)	Cumulative (%)
Organizational position	Supervisory level manager	47	40.9	40.9
	Middle level manager	44	38.2	79.1
	Top level manager	24	20.9	100
Industry type	Manufacturing	61	53	53
	Service	54	47	100
Education level	Senior high school	16	13.9	13.9
	Junior College/University	64	55.7	69.6
	Master degree	33	28.7	98.3
	Ph.D. degree	2	1.7	100
Professional experience (years)	<1	5	4.3	4.3
	1–3	33	28.7	33
	3–6	39	33.9	67
	6–10	15	13.0	80
	>10	23	20.0	100
Number of employees in the MIS department	1–5	19	16.5	16.5
	6–10	20	17.4	33.9
	11–25	38	33.0	67
	26–100	32	27.8	94.8
	>100	6	5.2	100

educational background and over 3 years of professional experience in MIS departments. The ratio of respondents with professional experience over 3 years was 67%. Sixty-six percent of the sampled companies had more than 10 employees in the MIS department.

4. Data analysis and results

4.1. Measurement validation

Factor analysis was used to investigate the 20 critical IS professional activities in more detail to reduce the variables into a smaller number of factors. Bartlett's sphericity test showed that the *p*-values were less than 0.001. This test result suggested that factor analysis was worth pursuing.

The 115 responses were examined using principle-component factor analysis as the extraction technique and varimax as the orthogonal rotation method. To derive a stable

factor structure, three commonly employed decision rules were applied to eliminate scales: (1) eigenvalue less than 1; (2) loadings of less than 0.5 on all scale factors; and (3) loadings greater than 0.4 on two or more scale factors (Fuller & Swanson, 1992). The factor analysis evaluation and scale elimination were repeated. Five of critical activities had loadings less than 0.5 on any factor or loadings greater than 0.4 on two or more factors were eliminated.

Factor analyses were performed in critical activities again to determine whether the factor structure remained stable. Three iterations yielded a stable set of four factors (i.e., *enterprise system planning & implementation*, *education & training*, *system evaluation & supporting*, and *standard setting*), as shown in Table 4, which shows the stable factor matrix after rotation of eigenvalue and factor loadings. These explained 67.79 percent of the variance in the data set. *Cronbach's alpha* was used to test the data set reliability. Because the *alpha* values were greater than 0.6 for all of the factors, the data reliability could be assured.

4.2. Descriptive professional activities statistics perceived by IS managers

The importance of the 15 critical IS professional activities, based on the management levels, is summarized in Appendix A. Top and middle management had nearly the same top five professional activities (four out of five and all belong to the *enterprise system planning & implementation* factor) except that top management had Pa10, *manage/plan feasibility/approval process for new systems and technology*; while middle management had Pa5, *manage IS crisis*. Middle and supervisory management both ranked *manage IS crisis* (Pa5) and *manage/plan systems development/implementation* (Pa7) in the list of the top five professional activities. These results are shown in Table 5.

More specifically, IS managers at different management levels perceived the importance of IS critical activities somewhat differently. For instance, top and middle played similar roles in their organizations. However, top IS executives focused more on strategic and visionary orientations. They ranked *manage/plan feasibility/approval process for new systems and technology* (Pa9) and *manage/plan corporate IS strategies, strategic applications, technology architecture* (Pa10) as more important activities than those for middle level IS managers. Similarly, supervisory IS managers focused more on the IS operational issues and ranked *reskill IS personnel* (Pa3) and *integrate existing and new business applications* (Pa12) as more important activities than middle IS managers. In short, top management tended to be more concerned with strategic planning issues, middle management with management control issues, and supervisory management with operational control issues.

4.3. Effects of industry type and management level on critical IS professional activities

Prior to the two-way MANOVA analysis, a Box's M-test ($F = 1.33$, Sig. $= 0.108$; $F = 1.34$, Sig. $= 0.57$) showed that the observed covariance matrices for the dependent variables were equal across groups. This test result suggested that further MANOVA test was worth pursuing. The two-way MANOVA analysis indicated that there was no interaction between the management level and industry type for the professional activity categories ($F = 1.01$, Sig. $= 0.433$). The two-way MANOVA result shown in Table 6 indicated that the perception of the importance of IS critical professional activities was significantly different among the management levels ($F = 3.69$, Sig. $= 0.000$), but not significantly different for various industry types ($F = 1.42$, Sig. $= 0.232$). Therefore, the industry type related analysis will be omitted in the rest of this paper.

Table 4
Varimax rotated factor matrix of 15-item IS professional activity instrument

Critical IS activity		Factor 1 Enterprise system planning & implementation	Factor 2 Education & training	Factor 3 System evaluation & supporting	Factor 4 Standard setting
Pa10	Manage/plan feasibility/approval process for new systems and technology	0.80	0.17	0.27	−0.10
Pa8	Analyze business problems and IS solutions	0.80	−0.03	−0.01	0.33
Pa9	Manage/plan corporate IS strategies, strategic applications, technology architecture	0.78	0.14	−0.07	0.33
Pa11	Support information access and security	0.68	0.14	0.38	0.04
Pa12	Integrate existing and new business applications	0.65	0.29	0.27	0.03
Pa20	Manage vender partnerships	0.64	0.05	0.39	0.27
Pa7	Manage/plan systems development/implementation	0.64	0.17	0.13	0.30
Pa3	Reskill IS personnel	0.26	0.81	−0.02	0.11
Pa5	Manage IS crisis	−0.02	0.77	0.28	0.09
Pa4	Train and educate end users	0.19	0.67	0.10	0.21
Pa15	Support end-user computing	0.02	0.26	0.73	0.07
Pa19	Facilitate and monitor contract progress	0.34	−0.14	0.69	0.17
Pa16	Implement system evaluation processes	0.25	0.22	0.67	0.12
Pa1	Establish IS documentation standard	0.20	0.18	0.16	0.90
Pa2	Establish IS operation standard	0.26	0.24	0.18	0.85
	Eigenvalues	3.97	2.10	2.06	2.04
	% of Variance	26.44	14.02	13.72	13.61
	α coefficient	0.88	0.75	0.62	0.92

Table 5
The top five critical IS professional activities by management levels

Rank	Management levels								
	Top ($n = 24$)			Middle ($n = 44$)			Supervisory ($n = 47$)		
	Factor	P.A.	Mean	Factor	P.A.	Mean	Factor	P.A.	Mean
1	1	Pa08	4.33	1	Pa08	4.05	2	Pa05	4.3
2	1	Pa11	4.25	1	Pa07	3.98	2	Pa03	4.06
3	1	Pa09	4.21	2	Pa05	3.98	1	Pa12	3.85
4	1	Pa10	4.17	1	Pa11	3.95	1	Pa07	3.77
5	1	Pa07	4.13	1	Pa09	3.84	1	Pa10	3.64

Table 6
Two-way MANOVA for the management level and industry type

Effect	Wilks' Lambda	F statistics	Sig.
Industry type	0.95	1.42	0.232
Management level	0.77	3.69	0.000*
Industry type × Management level	0.93	1.01	0.433

* $p < 0.01$.

Table 7
Results of one-way MANOVA

Activity factor	F statistics	Sig.
Factor 1: Enterprise system planning and implementation	5.622	0.00**
Factor 2: Education & training	3.719	0.03*
Factor 3: System evaluation and maintenance	0.000	1.00
Factor 4: Standard setting	3.817	0.03*

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

To validate whether the four professional activity factors were equally important to the three levels of management, one-way MANOVA testing was again used; the results are shown in Table 7. As it shown, different levels of management perceived the importance of *enterprise system planning and implementation*, *education* & *training*, and *standard setting* related professional activity factors differently.

The Scheffe's test was further applied to discriminating the differing importance of each critical activity as perceived by the three management levels. As shown in Table 8, the results indicated that top IS management perceived *enterprise system planning* & *implementation* and *standard setting* as more critical IS activities than did supervisory management. In addition, supervisory IS managers considered the perceptual importance of *educating* & *training* with greater importance than middle management. There was no significant difference in the perceived importance of *system evaluation* & *maintenance* among the three management levels. These interesting findings are worthy of additional follow-up surveys in future studies.

4.4. Analysis of importance of IS professional activities

The t-test was utilized to analyze the data set to further investigate the perceived importance of the critical professional activities for each management level. The results, as

Table 8
Scheffe's multiple comparisons of activity factors among management levels

Activity factor	Between management levels	Mean difference	Sig.
Factor 1: Enterprise system planning and implementation	Supervisory vs. middle	−7.83	0.16
	Middle vs. top	−8.16	0.26
	Top vs. supervisory	15.98	0.01*
Factor 2: Education & training	Supervisory vs. middle	10.24	0.04*
	Middle vs. top	−1.05	0.98
	Top vs. supervisory	−9.20	0.16
Factor 3: System evaluation and maintenance	Supervisory vs. middle	0.08	1.00
	Middle vs. top	−0.09	1.00
	Top vs. supervisory	0.02	1.00
Factor 4: Standard setting	Supervisory vs. middle	−8.55	0.15
	Middle vs. top	−4.68	0.67
	Top vs. supervisory	13.23	0.04*

* $p < 0.05$.

shown in Table 9, indicated that surprisingly, the top management ranked more professional activities as more important than the middle and supervisory management levels. Middle management ranked more professional activities higher in importance than did supervisory management. These findings indicated that from supervisory to middle management, enhancing their capability to perform professional activities such as *support information access and security* (Pa11), *manage/plan corporate IS strategies, strategic applications, technology architecture* (Pa9), *manage/plan systems development/implementation* (Pa7), *analyze business problems and IS solutions* (Pa8) were most important. Similarly,

Table 9
t-Test of perceived importance of professional activity by management levels

Factor	Critical IS activity		Management levels (test value = 3.5)		
			Top ($n = 24$)	Middle ($n = 44$)	Supervisory ($n = 47$)
4	Pa1	Establish IS documentation standard	**		
4	Pa2	Establish IS operation standard	**		
2	Pa3	Reskill IS personnel	**	*	**
2	Pa5	Manage IS crisis	*	**	**
1	Pa7	Manage/plan systems development/implementation	**	**	
1	Pa8	Analyze business problems and IS solutions	**	**	
1	Pa9	Manage/plan corporate IS strategies, strategic applications, technology architecture	**	*	
1	Pa11	Support information access and security	**	**	
1	Pa10	Manage/plan feasibility/approval process for new systems and technology	**		
1	Pa12	Integrate existing and new business applications	**		*
1	Pa20	Manage vender partnerships	*		
		Total	11	6	3

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

Table 10
Frequency analysis of IS critical professional activities and skills/knowledge

Management level	Factor	P.A.	Pc1	Pc2	Pc3	Pc4	Pc5	Pc6	Pc7	Pc8	Pc9	Pc10	Pc11	Pc12	Pc13	Pc14	*N*
Top level	4	Pa1	*	*	*		*	*			*	*					19
	4	Pa2	*	*			*				*	*		*			19
	2	Pa3			*			*	*	*	*						18
	2	Pa5							*	*	*			*			17
	1	Pa7	*	*	*	*	*				*	*	*				20
	1	Pa8	*				*				*	*		*			21
	1	Pa9	*	*			*				*			*			22
	1	Pa10	*				*				*			*			21
	1	Pa11			*				*								21
	1	Pa12	*		*					*	*						19
	1	Pa20					*							*	*	*	19
Middle level	2	Pa3			*		*	*	*	*	*						32
	2	Pa5			*									*			33
	1	Pa7	*	*	*		*				*	*					33
	1	Pa8	*				*				*			*			35
	1	Pa9					*				*			*			30
	1	Pa11			*		*			*							35
Supervisory level	2	Pa3					*			*							38
	2	Pa5			*				*	*				*			39
	1	Pa12			*		*				*	*					31
No of ratios ⩾ 50%			**9**	**5**	**11**	**1**	**14**	**3**	**5**	**7**	**14**	**6**	**1**	**10**	**1**	**1**	↗

*The ratios of frequencies are greater than 50%.

from middle to top management, enhancing their capability to perform professional activities such as *manage/plan feasibility/approval process for new systems and technology* (Pa10), *manage vender partnerships* (Pa20), *establish IS documentation standard* (Pa1), *establish IS operation standard* (Pa2) were most important.

4.5. Analysis of the relationship between critical professional activities and skills/knowledge

The frequency ratio approach was used in our analysis of the relationship between the professional activities and skills/knowledge. The frequency ratio was calculated using the summation of the frequencies of skill/knowledge required to perform the professional activities selected by IS managers at each level of management as discussed in Table 9. This frequency ratio was used to determine which skill/knowledge was important in performing each professional activity at each management level. If the ratio was greater than 50%, it was considered an important skill/knowledge for executing the associated professional activity. That is, more than half of the managers at each level considered the skill/knowledge necessary for them to carry out their professional activities. Interestingly, to perform a particular professional activity, the requisite skills/knowledge varies for different management levels. For instance, to perform reskill IS personnel (Pa3), top, middle, and supervisory managements required 5, 6, and 2 professional skills/knowledge, respectively. These results are summarized as in Table 10.

In summary, Table 10 shows the professional activity for each management level and the corresponding skills and knowledge required to perform those activities. To perform the professional activities proficiently, all levels of management required the following skills: *database management* (Pc3), *business domain knowledge* (Pc5), *telecommunications and network* (Pc7), *operating systems* (Pc8), *systems integration* (Pc9), *project management* (Pc10), and *analysis and judgment* (Pc12). Middle management required the above skills plus systems *analysis and design* (Pc1), *system life cycle management* (Pc2), and *programming language* (Pc6). Top management required the same skill set as middle management plus *distributed systems* (Pc4), *information technology management* (Pc11), *communication and coordination* (Pc13), and *teamwork* (Pc14). This shows that the professional activity and skills/knowledge portfolios by management level. Among the 14 professional skills/knowledge, *database management* (Pc3), *business domain knowledge* (Pc5), *systems integration* (Pc9), *analysis and judgment* (Pc12) were the most widely required skills/knowledge in terms of the frequency cited (as shown in the bottom of Table 10). Conversely, *distributed systems* (Pc4), *information technology management* (Pc11), *communication and coordination* (Pc13), and *teamworking* (Pc14) skills were ranked the least important.

5. Discussion and conclusions

This study investigated the importance of professional activities and the associated professional skills/knowledge for each level of management within IS departments. The results indicated that the importance of the professional activities was viewed in significantly different ways by each level of IS management; but was not viewed as significantly different by the two types of industry (i.e. manufacturing and service). One explanation for this result may be that, in general, for all firms, IS managers typically perform similar

Table 11
Portfolios of critical IS activities and professional skills/knowledge by management levels

	Factor	Top level		Middle level		Supervisory level	
IS manager's critical activities	4	Pa1	Establish IS documentation standard				
		Pa2	Establish IS operation standard				
	2	Pa3	Reskill IS personnel	Pa3	Reskill IS personnel	Pa3	Reskill IS personnel
		Pa5	Manage IS crisis	Pa5	Manage IS crisis	Pa5	Manage IS crisis
	1	Pa7	Manage/plan systems development/ implementation	Pa7	Manage/plan systems development/implementation		
		Pa8	Analyze business problems and IS solutions	Pa8	Analyze business problems and IS solutions		
		Pa9	Manage/plan corporate IS strategies, strategic applications, technology architecture	Pa9	Manage/plan corporate IS strategies, strategic applications, technology architecture		
		Pa11	Support information access and security	Pa11	Support information access and security		
		Pa12	Integrate existing and new business applications			Pa12	Integrate existing and new business applications
		Pa10	Manage/plan feasibility/approval process for new systems and technology				
		Pa20	Manage vender partnerships				
IS manager's skills/knowledge requirements		Pc1	Systems analysis and design	Pc1	Systems analysis and design		
		Pc2	System life cycle management	Pc2	System life cycle management		
		Pc3	Database management	Pc3	Database management	Pc3	Database management
		Pc4	Distributed systems				
		Pc5	Business domain knowledge	Pc5	Business domain knowledge	Pc5	Business domain knowledge
		Pc6	Programming language	Pc6	Programming language		
		Pc7	Telecommunications and network	Pc7	Telecommunications and network	Pc7	Telecommunications and network
				Pc8	Operating systems	Pc8	Operating systems
		Pc8	Operating systems	Pc9	Systems integration	Pc9	Systems integration
		Pc9	Systems integration	Pc10	Project management	Pc10	Project management
		Pc10	Project management				
		Pc11	Information technology management	Pc12	Analysis and judgment	Pc12	Analysis and judgment
		Pc12	Analysis and judgment				
		Pc13	Communication and coordination				
		Pc14	Teamworking				

functions when managing IS resources, influencing IS strategy, or assuming responsibility for the IS planning in order to cope with a firm's competitive environment. Different types of industry notwithstanding, there is a remarkable degree of homogeneity in IS professional activities regardless of industry. However, the different levels of management play different roles; thereby, necessitating different emphases on particular professional activities and skills/knowledge. The IS professional activities and skills/knowledge portfolios by management level are summarized in Table 11.

Our findings provide empirical insight into the ACM to explain the perceived importance of professional activities and the associated skills/knowledge for each level of IS management. The findings from this study have several implications for practitioners. IS manager's professional development training should not be conducted on an ad hoc basis; namely, the training courses must not be based only on the employer's intuitions, opinions of the human resource department staff or simply suggested by external consultants based on popular business environment trends. These kinds of educational training approaches will only provide some people with needed training, which is neither sufficient or efficient to meet real IS challenges in a highly competitive business environment.

The ACM associated with Table 11 is of particular value to those concerned with IS professional training and development in large organizations. It provides a template to help educators, IS training program curriculum developers identify the necessary professional activities and job skills/knowledge for each level of IS management. Practitioners can further develop clear skills portfolios that accurately account for the complete mix of job skills/knowledge required for all IS management levels in their own specific context. Once the job skills/knowledge for each IS management level have been identified, a parallel hierarchy of required training responses could be identified. The resulting hierarchy of job skills/knowledge then guides all IS organizational professional development activities.

Understanding the importance of critical professional activities and the related skills/knowledge for each level of IS management may be critical in successful enterprise professional development. While this study has some interesting results, they should be interpreted with caution. Although the surveyed managers represent a wide diversity of organizations, the sample total of 115 subjects may not be sufficient enough to generalize on the complete population of IS managers. The lopsided sample size among the three management levels could also lower the significance of the study results. This work is a series of researches that focused on professional competency development. Further research directions are abundant. For instance, the results of this study are based on self-perceptions, yielding the limitation that the perceived importance may not equal the actual importance. Other research can compare different sized organizations and industry types, e.g., the software industry, to investigate IS management and professional competency.

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Appendix A. Descriptive statistic of critical professional activities by management levels

Code	Factor	IS critical activity	Management levels					
			Top ($n = 24$)		Middle ($n = 44$)		Supervisory ($n = 47$)	
			Mean	Rank	Mean	Rank	Mean	Rank
Pa7	1	Manage/plan systems development/ implementation	4.13	5	3.98	2	3.77	4
Pa8	1	Analyze business problems and IS solutions	4.33	1	4.05	1	3.4	10
Pa9	1	Manage/plan corporate IS strategies, strategic applications, technology architecture	4.21	3	3.84	5	3.3	13
Pa10	1	Manage/plan feasibility/ approval process for new systems and technology	4.17	4	3.68	9	3.64	5
Pa11	1	Support information access and security	4.25	2	3.95	4	3.64	5
Pa12	1	Integrate existing and new business applications	3.96	10	3.8	7	3.85	3
Pa20	1	Manage vendor partnerships	3.92	11	3.55	13	3.21	14
Pa3	2	Reskill IS personnel	4.08	6	3.82	6	4.06	2
Pa4	2	Train and educate end users	3.42	14	3.48	14	3.62	7
Pa5	2	Manage IS crisis	4	9	3.98	2	4.3	1
Pa15	3	Support end-user computing	3.08	15	3.18	15	3.13	15
Pa16	3	Implement system evaluation processes	3.79	13	3.61	11	3.49	8
Pa19	3	Facilitate and monitor contract progress	3.92	11	3.61	11	3.4	10
Pa1	4	Establish IS documentation standard	4.04	7	3.64	10	3.34	12
Pa2	4	Establish IS operation standard	4.04	7	3.77	8	3.47	9

References

Benamati, J., & Lederer, A. L. (2001). Coping with rapid changes in IT. *Communications of the ACM, 44*, 83–88.
Brown, C. V. (1999). Horizontal mechanisms under differing IS organization contexts. *MIS Quarterly, 23*, 421–454.
Byrne, D. J., & Moore, J. L. (1997). A comparison between the recommendations of computing curriculum 1991 and the views of software development managers in Ireland. *Computers & Education, 28*, 145–154.

Chau, P. Y. K. (1995). Factors used in the selection of packaged software in small businesses: views of owners and managers. *Information & Management, 29*, 71–78.

Clarke, V. A., & Teague, G. J. (1996). Characterizations of computing careers: students and professionals disagree. *Computers & Education, 26*, 241–246.

Couger, J. D., Davis, G. B., Dologite, D. G., Feinstein, D. L., Gorgone, J. T., Jenkin, A. M., et al. (1995). IS '95: Guideline for undergraduate IS curriculum. *MIS Quarterly, 19*, 341–359.

CSU Human Resource Administration. (1996, April 1). Classification and qualification standards: technical & support services – equipment systems specialist. Retrieved: July 7, 2004. Available from http://www.calstate.edu/HRAdm/pdf/R09/Equip_Systems_Specialist.pdf.

Cuevas, H. M., Fiore, S. M., Bowers, C. A., & Salas, E. (2004). Fostering constructive cognitive and metacognitive activity in computer-based complex task training environments. *Computers in Human Behavior, 20*, 225–241.

Earl, M. J., & Feeny, D. F. (1994). Is your CIO adding value? *Sloan Management Review, 35*, 11–19.

Feeny, D. F., Edwards, B. R., & Simpson, K. M. (1992). Understanding the CEO/CIO relationship. *MIS Quarterly, 16*, 435–448.

Feeny, D. F., & Willcocks, L. P. (1998). Core IS capabilities for exploiting information technology. *Sloan Management Review, 39*, 9–21.

Fuller, M. K., & Swanson, E. B. (1992). Information centers as organizational innovation: exploring the correlates of implementation success. *Journal of Management Information Systems, 9*, 47–67.

Gorgone, J. T., Davis, G. B., Valacich, J. S., Topi, H., Feinstein, D. L., & Longenecker, H. E. (2002). IS 2002: Model curriculum and guidelines for undergraduate degree programs in information systems. Association for Computing Machinery curricula recommendations. Retrieved: May 23, 2003. Available from http://www.acm.org/education/is2002.pdf.

Gorgone, J. T., & Gray, P. (2000). MSIS 2000: model curriculum and guidelines for graduate degree programs in information. *Communications of the AIS, 3*, 1–52.

Grover, V., Jeong, S. R., Kettinger, W. J., & Lee, C. (1993). The chief information officer: a study of management roles. *Journal of Management Information Systems, 10*, 107–130.

Hackman, J. R., & Oldham, G. R. (1980). *Work redesign*. MA: Addison-Weslley.

Harris, J. G., De Long, D. W., & Donnellon, A. (2001). Do you have what it takes to be an e-manager? *Strategy & Leadership, 29*, 10–14.

Heo, J., & Han, I. (2003). Performance measure of information systems (IS) in evolving computing environments: an empirical investigation. *Information and Management, 40*, 243–256.

Jackson, B. E., Schuler, R. S., & Rivero, J. C. (1989). Organizational characteristics as predictors of personnel practices. *Personnel Psychology, 42*, 727–786.

Kakabadse, A., & Korac-Kakabadse, N. (2000). Future role of IS/IT professionals. *The Journal of Management Development, 19*, 97–154.

Karimi, J., Gupta, Y. P., & Somers, T. M. (1996). The congruence between a firm's competitive strategy and information technology leader's rank and role. *Journal of Management Information Systems, 13*, 63–88.

Kester, L., Kirschner, P. A., van Merriënboer, J. J. G., & Baumer, A. (2001). Just-in-time information presentation and the acquisition of complex cognitive skills. *Computers in Human Behavior, 17*, 373–391.

King, K. P. (2002). Educational technology professional development as transformative learning opportunities. *Computers & Education, 39*, 283–297.

Klein, G., Jiang, J. J., & Sobol, M. G. (2001). A new view of IS personnel performance evaluation. *Communications of the ACM, 44*, 95–101.

Kruchten, P. (2003). *The rational unified process: An introduction* (3rd ed.). MA: Addison Wesley.

Laudon, K. C., & Laudon, J. P. (2002). *Management information systems: Managing the digital firm* (7th ed.). NJ: Prentice Hall.

Lee, D. M. S., Trauth, E. M., & Farwell, D. (1995). Critical skills/knowledge requirements of IS professionals: a joint academic/industry investigation. *MIS Quarterly, 19*, 313–340.

Lee, S., Koh, S., Yen, D., & Tang, H. L. (2002). Perception gaps between IS academics and IS practitioners: an exploratory study. *Information & Management, 40*, 51–61.

Longenecker, C. O., & Fink, L. S. (2001). Improving management performance in rapidly changing organizations. *Journal of Management Development, 20*, 7–18.

Markus, L. M., & Benjamin, R. I. (1997). The magic built theory in IT-enabled transformation. *Sloan Management Review, 38*, 55–68.

Mata, F. J., Fuest, W. L., & Barney, J. B. (1995). Information technology and sustained competitive advantage: a resource-based analysis. *MIS Quarterly, 19*, 487–504.

Mintzberg, H. (1973). *A comprehensive description of management work, the nature of management work*. New York: Harper and Row.

Montazemi, A. R., Cameron, D. A., & Gupta, K. M. (1996). An empirical study of factors affecting software package selection. *Journal of Management Information Systems, 13*(1), 89–105.

National Coordination Office for Information Technology Research and Development. (1994, Febuary). Information infrastructure technology and applications: report of the IITA task group. Retrieved: July 19, 2004. Available from http://www.itrd.gov/pubs/iita.

Neal, A., & Griffin, M. A. (1999). Developing a theory of performance for human resource management. *Asia Pacific Journal of Human Resources, 37*, 44–59.

Nelson, R. R. (1991). Educational needs as perceived by IS and end-user personnel: a survey of knowledge and skills requirements. *MIS Quarterly, 15*, 503–525.

Oser, R. L., Gualtieri, J. W., Cannon-Bowers, J. A., & Salas, E. (1999). Training team problem solving skills: an event-based approach. *Computers in Human Behavior, 15*, 441–462.

Oz, E. (2000). *Management information systems* (2nd ed.). MA: Course Technology/Thomson Learning.

Reddy, S. B., & Reddy, R. (2002). Competitive agility and the challenge of legacy information systems. *Industrial Management & Data Systems, 102*, 5–16.

Reich, B. H., & Benbasat, I. (2000). Factors that influence the social dimension of alignment between business and information technology objectives. *MIS Quarterly, 24*, 81–113.

Rifkin, K. I., Fineman, M., & Ruhnke, C. H. (1999). Developing technical managers: first you need a competency model. *Research Technology Management, 42*, 53–57.

Roberts, T. L., Gibson, M. L., & Fields, K. T. (1999). System development methodology implementation: perceived aspects of importance. *Information Resources Management Journal, 12*, 27–38.

Rockart, J. F., Earl, M. J., & Ross, J. W. (1996). Eight imperatives for the new IT organization. *Sloan Management Review, 38*, 43–55.

Rondeau, P. J., Vonderembse, M. A., & Ragu-Nathan, T. S. (2002). Investigating the level of end-user development and involvement among time-based competitors. *Decision Sciences, 33*, 149–160.

Ross, J. W., Beath, C. M., & Goodhue, D. L. (1996). Develop long-term competitiveness through IT assets. *Sloan Management Review, 38*(1), 31–42.

Sandwich, P. (1993). A hierarchy of management training requirements: the competency domain model. *Public Personnel Management, 22*, 43–62.

Search and Rescue Satellite-Aided Tracking. (1994, April 19). Standard S24.806 – Software development, maintenance, and user documentation. Retrieved: July, 22, 2004. Available from http://www.sarsat.noaa.gov/S24_806.pdf.

Stephens, C., & Loughman, T. (1994). The CIO's chief concern: communication. *Information & Management, 27*, 129–137.

Stephens, C. S., Ledbetter, W. N., Mitra, A., & Ford, F. N. (1992). Executive or functional manager? The nature of the CIO's job. *MIS Quarterly, 16*, 449–465.

Synnott, W. R., & Gruber, W. H. (1983). User involvement strategies for IRM professionals. *Data Management, 21*, 34–37.

Tam, K. Y., & Hui, K. L. (2001). A choice model for the selection of computer vendors and its empirical estimation. *Journal of Management Information Systems, 17*, 97–124.

Tennyson, R. D. (2001). Defining core competencies of an instructional technologist. *Computers in Human Behavior, 17*, 355–361.

Todd, P. A., McKeen, J. D., & Gallupe, R. B. (1995). The evolution of IS job skills: a content analysis of IS job advertisements from 1970 to 1990. *MIS Quarterly, 19*, 1–27.

Trauth, E. M., Farwell, D. W., & Lee, D. (1993). The IS expectation gap: industry expectations versus academic preparation. *MIS Quarterly, 17*, 293–303.

Umar, A. (1993). *Distributed computing: A practical synthesis of networks, client–server systems, distributed applications, and open system*. NJ: Prentice Hall.

van der Heijden, H. (2001). Measuring IT core capabilities for electronic commerce. *Journal of Information Technology, 16*, 13–22.

Wright, M. A. (1994). Protecting information: effective security controls. *Review of Business, 16*, 24–28.

Wu, J. H., Chen, Y. C., & Lin, H. H. (2004). Developing a set of management needs for IS managers: a study of necessary management activities and skills. *Information & Management, 41*, 413–429.