



Keeping up-to-date with information technology: Testing a model of technological knowledge renewal effectiveness for IT professionals

Guang Rong, Varun Grover *

Department of Management, Clemson University, 101 Surrine Hall, Clemson, SC 29634-1305, United States

ARTICLE INFO

Article history:

Received 27 May 2006

Received in revised form 31 July 2008

Accepted 1 July 2009

Available online 17 July 2009

Keywords:

Knowledge renewal effectiveness

Knowledge management

IT dynamism

Career orientation

Tolerance of ambiguity

Delegation

Job satisfaction

ABSTRACT

In a rapidly changing IT environment, IT professionals need to keep abreast of technological knowledge. We examined how well this is achieved by developing a motivational model of “technological knowledge renewal effectiveness.” We hypothesized that (1) renewal effectiveness was influenced by the IT professional’s career orientation, perceived IT dynamism, tolerance of ambiguity, delegation; and (2) that this positively affected both intrinsic and extrinsic job satisfaction. Survey data from 126 IT professionals was used to test the hypotheses. The results generally supported the research model. We discussed the implications of these results in both research and practice.

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1. Introduction

In order to stay professionally competent, IT professionals need to stay aware of the latest technological innovations and retain their professional knowledge base. This renewal process involves continuous learning, systematic maintenance, enhancement, and broadening of knowledge [28], often an onerous challenge in a rapidly changing technological environment.

Knowledge renewal is both important for IT professionals and critical in maintaining the competitiveness of the organization. Knowledge is a critical success factor for organizations. Since an organization’s collective knowledge directly influences its performance, individual employees must keep their knowledge up to date in order to maintain and retain organizational competitiveness. Renewal involves IT professionals at all levels, including both technical and non-technical ones.

While technological and business knowledge are closely related, literature has treated these two types of knowledge as different in nature (e.g. [19]). We distinguished technological knowledge as being more specialized and closely tied to the IT artifact. Table 1 illustrates the distinction between the types of knowledge. Technological knowledge is outdated at a much faster

rate than managerial knowledge due to ongoing innovations in technology. IT professionals rely on effective technological knowledge renewal to stay on top of their jobs. The increasing demand for updated technological knowledge caused by dynamic IT innovations, calls for more research examining technological knowledge renewal.

Existing studies provide limited guidance on factors that influence individual’s knowledge renewal. Most prior work was conducted by psychology or management researchers [31]. Their focus was mainly on the impact of either individual demographic differences or organizational factors such as “updating climate.” They ignore many other meaningful driving forces of knowledge renewal that supplement demographic factors [3]. Second, there is a paucity of research on the consequences of knowledge renewal; it may influence an employee’s working outcomes (such as job satisfaction), which may further impact the organizations’ well being.

We examined both the antecedents and consequences of knowledge renewal. By examining consequences, we determine its value, and by exploring its antecedents, we provide guidance to organizations on successful knowledge renewal. Specifically, we focused on the question of knowledge renewal at the individual unit of analysis. The target of our study was IT professionals working in technical areas. Our research question was:

What factors contribute to the effective technological knowledge renewal, and how does the effectiveness of technological knowledge renewal influence individual job satisfaction?

* Corresponding author. Tel.: +1 864 656 3773; fax: +1 864 656 6768.

E-mail address: vgrover@clemson.edu (V. Grover).

URL: <http://people.clemson.edu/~vgrover/grover.htm>

Table 1
Illustration of technological and business knowledge.

Technological Knowledge	Business Knowledge
<ul style="list-style-type: none"> • Programming • Model building • Model application • Database development • Data access • Use of software packages 	<ul style="list-style-type: none"> • General management • Monitor and control • Planning • Organization skills • Leadership skills • Training

2. Literature review

2.1. Research on knowledge renewal and obsolescence

Researchers have examined the issue of professional obsolescence, a topic closely related to knowledge renewal. *Obsolescence* examines the discrepancy between the changing rates of job requirements and the rates of acquiring knowledge and skills. In essence, it reflects the extent to which professionals lack in knowledge of up-to-date methods needed to maintain effective performance in their current or near-future job roles. While most research on obsolescence focuses on renewing activities or coping mechanisms, we focused on the effectiveness of knowledge renewing activities.

Motivation plays an important role in dealing with obsolescence. Researchers argue that a positively motivated person can control many of the factors in order to avoid obsolescence. Prior studies indicated different effects from intrinsic and extrinsic motivation. Extrinsic motivation, such as rewards, is not a significant factor in coping with obsolescence. In contrast, intrinsic motivators, such as career expectations, overcoming job challenges, and need for competence, are supposed to have significant effects. Two important categories of motivators for knowledge renewal are: career development factors (e.g., career expectations, and the need for competence), and job nature factors (e.g., the workplace challenges).

Researchers have tried to identify effective coping mechanisms to combat obsolescence [3]. They can be professional or organizational. Professional activities include reading journals, and attending professional seminars and conferences while organizational activities include interacting with other employees and delegating the renewing responsibility to organizational units. Both types of coping mechanisms can facilitate employees' knowledge renewal, and enhance knowledge currency.

Generally, the literature suffers from two major limitations. First, it lacks theory-based models, thereby compromising their robustness. Second, almost all studies focus on renewing activities instead of the effectiveness of renewing, the key construct. Such an activity-based approach is limited. By defining renewing in terms of its effectiveness, investigation of broader consequences for the firm is possible. The IS field lacks studies on IT professionals' knowledge renewal issues, especially in technological knowledge renewal, which is important in the contemporary business context.

Therefore, our study was constructed to address limitations by (1) defining the key construct as "renewal effectiveness" rather than renewing activities, (2) tailoring the research by focusing on technological knowledge renewal, (3) taking renewing activities as important antecedents of renewal effectiveness, and (4) using theory to guide variable selection and model support.

2.2. Individual motivation factors

Several theories in organizational psychology are important for deriving predictors of renewal effectiveness; the role of personal dispositional traits in coping with rapid IT change also appeared to be important [11].

2.2.1. Intrinsic motivation theory

This theory argues that energizing force for action stems from an internal tension or arousal that requires knowledge renewal. Individuals are motivated if they wish to obtain a specific competence or meet a challenge. This theory has been applied in skill acquisition research. Empirical studies have suggested that competence and challenge have significant impact on acquiring skills which, with knowledge renewal, involve the same learning processes. While skill acquisition targets only skills, knowledge renewal requires a broader domain of both explicit and tacit knowledge. We believe that motivators for skill acquisition impact knowledge renewal also. Intrinsic motivations such as competence and challenge drive individuals to devote more attention to renewing knowledge. Therefore, we believe *competence* and *challenge* are potentially important motivators for knowledge renewal.

2.2.2. Expectancy theory

This theory proposes that individuals choose to exert more effort if they expect a desired outcome. Expectancy includes both the desirable goal and self-evaluation of the ability to attain it.

Some researchers have applied this theory to examine the driving forces of renewal activities: individuals will acquire relevant knowledge, skills, and abilities (KSAs) if they believe that they are capable of doing so, and that these are instrumental in attaining valued rewards.

For knowledge renewal, if renewal effectiveness is the means of achieving the goal (e.g., of staying competent), employees will put more effort to renewing knowledge. This points to an important factor, competence-focused *career orientation*. Employees self select their career path as either technical or managerial, based on their interest, expectation of valued outcome, and self-evaluated ability. Career orientation is, in essence, personalized need for competence, which requires knowledge renewal. Thus, *career orientation* encompasses both effort and ability. It is an important predictor of knowledge renewal effectiveness.

2.2.3. Goal setting theory

This theory states that conscious motivation affects effort and performance, especially for people who choose to be purposeful and proactive [18]. Empirical studies indicate that the most difficult goals produce the highest level of effort and performance.

Goal setting theory stresses the direct impact of goal difficulty on behavior. Routine jobs, administrative duties, or narrowly focused jobs result in skill decay, because such jobs fail to require development of new skills. Researchers have found that the degree of *job challenge* is the key factor in fostering knowledge renewal.

2.2.4. Personal dispositional traits

Some researchers suggest the role of dispositional traits in knowledge renewal. Studies have focused narrowly on demographic factors, such as age and education, generally ignoring underlying cognitive factors. To address this problem, dispositional traits that address individual cognitive differences at a higher abstraction level need to be examined to find the important factors for knowledge renewal. Tolerance for ambiguity is one such trait; it reflects "the tendency to perceive ambiguous situations as desirable." It is associated with the willingness of persons to change their opinion, as well as to tolerate and cope with new experiences, and is negatively related to anxiety level. Individuals with higher levels of tolerance for ambiguity tend to be more willing to cope with changes, modify their opinions, obtain new experiences, and renew knowledge.

While knowledge renewal effectiveness is a useful construct, we examined its consequences in order to better understand its effect and value. For instance, it may influence an employee's job

performance. Here, we examine this impact through the affective state of the employee–job satisfaction. As one of the key constructs measuring work outcomes, job satisfaction includes satisfaction with both the intrinsic and extrinsic features of the job.

Thus motivation theories lead to three potential motivators for technological knowledge renewal effectiveness: competence-based career orientation, job challenge, and tolerance for ambiguity, which influences job satisfaction.

3. Research model

3.1. Technological knowledge renewal effectiveness

The key construct of our study was perceived technological knowledge renewal effectiveness (RE) of IT professionals. It addresses the degree to which the knowledge renewal outcome meets the knowledge requirement for the work role. It stresses the outcome rather than the renewing process. This performance based construct has more implications for management and the impact of knowledge management in organizations. The perception of effectiveness is a more meaningful predictor of work-related outcomes, such as job satisfaction and turnover. For our study, we considered technological knowledge renewal effectiveness, to be the degree to which IT professionals perceive that they maintained up-to-date knowledge to achieve effective performance in their work. This reflects both efforts expended in achieving up-to-date knowledge and its importance in effective job outcomes.

3.2. Antecedents: motivating factors

Motivational factors for knowledge renewal are shown in Table 2. Career orientation concerns personnel's aspiration, values, perceptions, and affective reactions to job experiences. Employees shape their career decisions based on their self-perceived needs, values, and talents.

Among the career orientations, technical and managerial competence dominate for IT workers. In the IS context, technically oriented employees strongly prefer to remain specialists in the IS function without taking on managerial responsibilities. We can expect that employees with a technical career orientation are intrinsically motivated to achieving a level of competence as a specialist in IS functions. They will exert effort to obtain this desired outcome, based on their self-evaluated expectations and instrumentality. Therefore, they will work harder to renew technological knowledge, and be able to improve due to their talent and ability. Thus, we argue that IT professionals with a technical competence career orientation will be more effective in technological knowledge renewal.

In contrast, managerially oriented employees are not as aggressively motivated to renew technological knowledge and their goals of managerial competence drive them to place attention and effort on managerial knowledge. We would not expect managerial competence orientation to be as significant predictor of technological knowledge renewal effectiveness as technical

competence orientation. Therefore, the following hypotheses were proposed:

Hypothesis 1a. Technical competence career orientation has a positive impact on technological knowledge renewal effectiveness.

Hypothesis 1b. Managerial competence career orientation has less significant impact on technological knowledge renewal effectiveness than technical competence career orientation.

Researchers have argued that jobs with high challenge motivate and foster renewing. IT dynamism is an important dimension of environmental dynamism, caused by rapid changes in the technological sector of the external environment. Perceptions of IT dynamism present a challenge for IT professionals, as they constantly need to renew technological knowledge. This could have two opposing effects on technological knowledge renewal effectiveness. On one hand, dynamism creates a demand for constant learning, posing a heavy burden on employees [21]. On the other hand, such a challenge may also serve as a key intrinsic motivator. Goal setting theory suggests that higher goals lead to more effort. When IT professionals perceive the IT dynamism in their professional or working environment, they see the job as a challenge. Accordingly they have to set higher goals to keep updated on technological knowledge, since they rely on it. Therefore, when perceived as a challenge by IT workers, IT dynamism can drive them to work harder to overcome it.

So, IT dynamism may have a negative impact on the ability to renew, while increasing the effort expended on renewing. We believe that the devoted effort driven by the perceived challenge will outweigh the increased difficulty caused by the IT dynamism. It is this perception that sets the effort expended in order to achieve a level of competence. Therefore, we proposed:

Hypothesis 2. Perceived IT dynamism has a positive impact on technological knowledge renewal effectiveness.

Tolerance for ambiguity can influence knowledge renewal effectiveness. Ambiguity involves uncertain, inconsistent, contrary, contradictory, or unclear information. Technological innovations are likely to create multiple, inconsistent and unclear meanings, creating barriers for people who cannot tolerate ambiguity. Thus, renewing knowledge related to technological innovations is undesirable and tough for them. Conversely, people with high tolerance for ambiguity feel comfortable with it and view it as desirable rather than a source of threat. People are more open to new experiences and new ideas. They are willing to cope with new situations, change their opinions, and obtain new knowledge. This attitude helps employees to overcome ambiguities and uncertainties in knowledge renewal. It improves the ability to deal with the ambiguity embedded in the renewing process itself. Therefore, we argue that IT professionals with higher tolerance for ambiguity are more effective in technological knowledge renewal.

Hypothesis 3. Tolerance for ambiguity has a positive impact on technological knowledge renewal effectiveness.

3.3. Coping mechanisms

Obsolescence researchers believe that active coping activities can help employees control many factors in keeping updated. These activities can improve the knowledge currency of employees, and thus their renewal effectiveness.

The literature suggests two categories of renewal activities: one is to acquire and renew knowledge directly through professional activities and the other category is to interact with other employees or specific IT units through organizational structures. These types of activities reflect “delegation” of renewal and can

Table 2
research constructs supported by individual motivational theories.

	Intrinsic Motivation	Expectancy Theory	Goal-Setting Theory	Dispositional Trait
Career Orientation	√√	√√		
Challenge–IT Dynamism	√√		√√	
Tolerance for Ambiguity				√√

√√ indicates that the construct derives its basis from the motivational theory (column).

both enhance knowledge renewal effectiveness. Through professional delegation (e.g., reading professional literature, attending conferences), employees have a chance to participate in the learning process so as to absorb and internalize the knowledge. Alternatively, rather than obtaining knowledge from professional activities, employees obtain new knowledge from other employees. This structural delegation involves a different source of knowledge but can also influence knowledge renewal [30] by “shifting” some of the scanning and learning processes to other entities. Both professional and structural delegations therefore seem to ensure easier and more effective knowledge renewal. The following hypotheses were proposed:

Hypothesis 4a. Professional delegation has a positive impact on technological knowledge renewal effectiveness.

Hypothesis 4b. Structural delegation has a positive impact on technological knowledge renewal effectiveness.

3.4. Consequence—job satisfaction

While no research has examined the relationship between knowledge renewal effectiveness and job satisfaction, some research in obsolescence and job satisfaction does suggest such a relationship. Researchers believe that obsolescence leads to employee dissatisfaction, and knowledge enlargement has a positive impact on job satisfaction. Studies have examined and validated the positive impact of self-esteem and self-efficacy on job satisfaction. Similarly, sense of competence is described as a more useful variable than self-esteem for assessing work-related outcomes. Individuals with high perceived renewal effectiveness will engage in a broader array of behaviors, tasks, and responsibilities that will reinforce their self-esteem, self-efficacy, or sense of competence. Moreover, they can deal more effectively with difficulty and challenges, and cope better with changed job requirements. They are therefore more likely to attain valued outcomes, and derive satisfaction from their job [14].

The process can be intrinsic or extrinsic. When the valued outcomes are autonomy, career opportunities, responsibilities, or recognitions, intrinsic job satisfaction will occur; when the valued outcomes are working environments, job security, or pay, extrinsic job satisfaction will occur. We proposed separate hypotheses for these in order to explore the relative strength of their relationship with technological renewal effectiveness. While we expected both relationships to be positive, any major difference in the strength

would have interesting implications of how organizations might use reward systems to encourage technological renewal effectiveness. Therefore,

Hypothesis 5a. Technological knowledge renewal effectiveness has a positive impact on intrinsic job satisfaction.

Hypothesis 5b. Technological knowledge renewal effectiveness has a positive impact on extrinsic job satisfaction.

Overall, the research model is presented in Fig. 1 and definitions of all constructs are presented in Table 3.

4. Methodology

4.1. Research design

A survey of IT personnel with at least one-year working experience was conducted in order to measure our constructs. The working experience requirement was intended to ensure that respondents had sufficient working history to form career orientation, and to evaluate their renewal effectiveness and job satisfaction. Since technological knowledge renewal is a task for IT professionals at all levels, the sample included diverse types of IT professionals.

The instrument was first given to a group of 11 faculty and doctoral students who reviewed the items and provided feedback on content and clarity. A pilot study was then conducted to get feedback on the questionnaire. Respondents were employees of an IT division in a large research oriented public US university. Twenty-six employees participated in the study. Five respondents with insufficient working experience were excluded from the analysis. After the survey, a panel discussion was organized to obtain verbal feedback on questionnaire clarity from all respondents of the pilot study. In general, the instrument was well received by the pilot group and subjected to minimal changes.

Official data collection was conducted using members of an online discussion forum as the sample frame. The website, that hosted the forum, claimed to be the number one developer site and was dedicated to helping the members by providing the most robust and up-to-date technical information and code. It covered topics such as IT management, networking, web development, hardware and systems, as well as software development. Its members were from various industries, working in different positions. They were active IT professionals who sought updated technological knowledge and dealt with current technological

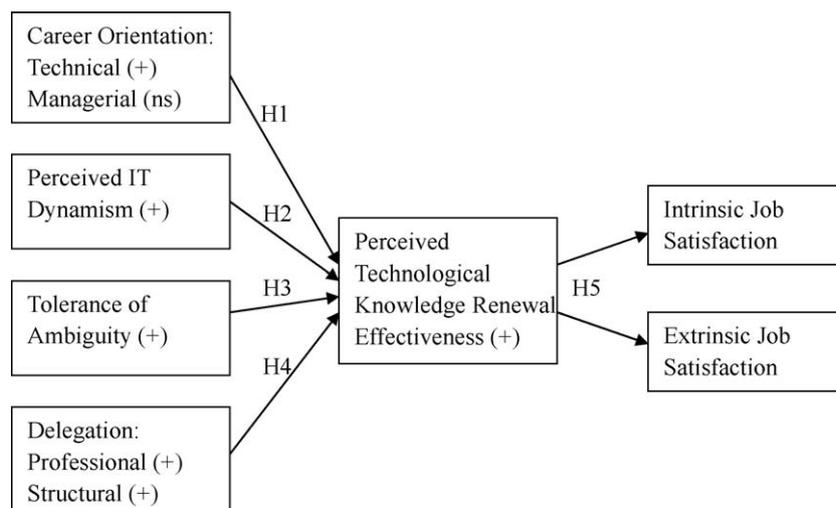


Fig. 1. Research model—knowledge renewal effectiveness.

Table 3
Definitions of constructs.

Construct	Definition	Key References
Technological Knowledge Renewal Effectiveness	The degree to which IT professionals maintain up-to-date knowledge to achieve effective performance in their work roles.	[16]
Career Orientation	An individual's career decision shaped by his/her self perceived needs, values, and talents. Technical competence career orientation refers to career decision to be technically competent. Managerial competence career orientation refers to career decision to be managerially competent.	[13]
IT Dynamism	The degree to which the changes in the external job-related IT environment are volatile and rapid.	[20]
Tolerance of ambiguity	The tendency to perceive ambiguous situations as desirable.	[1]
Delegation	Delegate information acquisition responsibilities to other individuals or agencies. Structural delegation refers to delegating through organizational structures. Professional delegation refers to delegating through professional activities.	[7]
Job Satisfaction	The degree of a pleasurable or positive emotional state resulting from the appraisal of one's job or job experiences, regarding the intrinsic and extrinsic features of the job. Intrinsic job satisfaction refers to satisfaction with the intrinsic aspects of a job, that is, aspects related to a person's feeling about the job itself and the opportunity provided by the employment for self-actualization and personal growth. Extrinsic job satisfaction refers to satisfaction with the extrinsic aspects of a job, that is, aspects in job that are associated or directly administered by supervisors (e.g. pay) or organization conditions.	[33]

issues. The diversity and size of the member base indicated broad representation of IT professionals in the sample frame. The members' active participation in the online discussion forum suggested that they were the group of people who dealt more with current technological issues and cared about knowledge renewal.

Data were collected using an online questionnaire. Potential respondents were contacted through the "contact" link for each member provided by the forum. A potential problem of this sampling method is that there is no way to examine whether the membership account was still active and whether their contact email (registered at the forum) was still valid. So it was impossible to estimate how many contact messages were actually received by the members.

2,000 members were selected randomly from more than 150,000 in the forum. Of these, 229 accessed the instrument that provided through a web-based link. 127 of these people completed the questionnaire. The response rate was thus around 55% for those that accessed the instrument and 6.5% for the overall sample. The material of one respondent with less than a year of working experience was deleted. The final sample of online data thus included 126 cases.

4.2. Measures of variables

Variables were measured using existing validated scales if available, or using scales developed based on definitions.

4.2.1. Knowledge renewal effectiveness

While no previous study had directly measured this construct, four items were generated based on the definition by ref. [16,26], to address the degree to which IT professionals maintain up-to-date knowledge or skills to achieve effective performance in either their current or future work roles. Such a self-reported variable measured the perception of renewal effectiveness by employees themselves.

4.2.2. Career orientation

The short-form career orientation inventory instrument, developed by [12] and further validated by [19], was adopted for this study. Ten items were used to measure technical competence and managerial competence career orientation.

4.2.3. IT dynamism

This was defined as the degree to which the changes in the external job-related IT environment were volatile and rapid.

Measurements of similar constructs, such as environmental uncertainty and environmental dynamism, emphasized the rate of change in specific environment. Based on measurement of dynamism [20], 3 items were generated to evaluate the rate of change of the job-related technical environment and technologies.

4.2.4. Tolerance for ambiguity

The well-developed 50-item measure of ambiguity tolerance (MAT-50) included eight dimensions: philosophy, interpersonal communication, public image, job-related, problem-solving, social, habit, and art forms [23]. Based on this instrument, [1] developed a short form of work-related tolerance for ambiguity measure, including the job-related and problem-solving dimensions, which fit for organizational context. It actually measured the *intolerance* for ambiguity. This 7-item measure of work-related intolerance for ambiguity was adopted for this study, as a second order factor, covering both job and problem-solving intolerance ambiguity.

4.2.5. Delegation

Pazy [26] measured knowledge renewing activities using five items: number of weekly hours of reading professional literature, number of professional journals regularly read, number of courses, seminars, and conferences attended during the past two years. Kozlowski and Farr [17] defined professional activities as meetings, conventions, and publishing research. Similarly, Culnan [8] compared direct use of external knowledge database and literature researching, with chauffeuring through intermediaries such as organizational units/libraries. Choudhury and Sampler [7] compared different approaches for acquiring environmental information, including organizational central unit, subordinate, or by the users themselves. Based on existing measures and the concepts of structural and professional delegation, a measure for each type of delegation was created. The measure of structural delegation included three items revised from [7] study to assess delegation through subordinate, IT unit, and technical support staffs. The measure of professional delegation used two items from [26]. This study did not include the Internet as an important medium for learning. Therefore, a third item was added to measure renewing activities through Internet.

4.2.6. Job satisfaction

This was defined as the degree to which a person reported satisfaction with intrinsic and extrinsic features of the job [33]. The intrinsic job ones referred to job content and the tasks that led to

Table 4
Measures of factors.

Variable	# of Items	Source
Technological Knowledge Renewal Effectiveness (RE)	4	Generated based on definition by [16] and definition and scale by [26]
Career Orientation	10	Adopted from [12,19]
Technical Competence (TC)	5	
Managerial Competence (MC)	5	
IT Dynamism (ID)	3	Revised from [20]
Tolerance for Ambiguity (TA)	6	Measure of Intolerance for Ambiguity, adopted from [1], which uses portion of [23]'s original instrument. It includes two dimensions: TA for job (TAJ) and TA for problem solving (TAP).
Delegation (DL)	6	Revised based on:
Structural Delegation (DLS)	3	Revised from [7]
Professional Delegation (DLP)	3	DL4, DL5 revised from [26]; DL6 generated
Job Satisfaction (JS)	15	Adopted from [33]
Intrinsic Job Satisfaction (IJS)	7	
Extrinsic Job Satisfaction (EJS)	8	

self-expression and self-actualization, while extrinsic ones referred to job features determined by external events or other people [32,33]; the measure was 15-items of intrinsic and extrinsic job satisfaction, which had been validated in other studies [22]. Detailed measures are summarized in Table 4.

5. Data analysis and results

5.1. Sample characteristics

Demographic information of the 126 respondents is presented in Table 5. Most of the respondents were male, not atypical for IT professionals. The majority of them were younger than 35 years old, with the majority (53%) having 6 or more years of working experience in IT field. Bachelor and master degrees were common. Around half of them were in technical positions, such as programmer, analyst, or software engineer. The sample did include employees with jobs of both the technical and managerial nature. Even though the forum was geared toward technological knowledge, the sample was not biased with respect to respondents' career orientation. Respondents came from diverse industries including software, telecommunication, manufacturing, and financial. This sample, with a wide variety of jobs and organizational settings, was representative of the IT professionals working in different industries.

Half the sample was more technically oriented (50%), and around half was more managerially oriented (49%), and the rest were equally oriented (1%). Career orientation was determined by the score of managerial competence career orientation (MC in Appendix A) and technical competence career orientation (TC in Appendix A). Employees who are more technically oriented have higher TC score than MC score. It should be noted that this indicator of career orientation is different from job nature. For instance, when we separately categorized the job title and the reported job responsibility and skills required for the job, 71% of the jobs were technical (e.g., programmer) and 29% were managerial (e.g., project manager). The different percentage of career orientation and job nature indicates that job nature and career orientation are two different constructs. Employees working on a technical job can have managerial competence career orientation—as described in prior literature.

5.2. Validity and reliability

Constructs were assessed for their validity and reliability prior to testing of hypotheses. Face validity and content validity were assessed through the grounding of measures in the literature. Also,

10 doctoral students were asked to carefully review the construct definitions and measures to ensure that the domain of each construct was adequately represented.

Construct validity was evaluated based on factor analysis. Exploratory factor analysis (EFA) was first conducted to identify poor loading items. Four cross-loading items (ID3, RE3, RE4, TC1) were deleted from the items pool. Confirmatory factor analysis (CFA) was then conducted using PLS. Convergent validity was tested by examining two criteria (1) significant factor loadings for all items, and (2) all loadings were greater than 0.5 [10]. There were 3 items with loadings lower than 0.5 (MC5, TA2, JS11). For the items identified as problematic at both EFA and CFA stages, some were reverse items (ID3, RE3, RE4); some were not straightforward (MC5); and some just did not converge with other items measuring the same construct (TA2, TA2, JS11). These items with low convergent validity were removed from the item pool. The remaining items showed no cross-loading problem and all had significant factor loadings. The results of CFA for remaining items are presented in Table 6. Discriminant validity was evaluated by the average variance extracted (AVE) according to the following criteria: (1) AVEs should be greater than 0.5 [10], and (2) values of square root of AVEs should be much greater than correlations between latent variables [6]. All items met both criteria. Values of AVE, square root of AVE, and correlations between latent variables are presented in Table 6. The results in Table 6 and Table 7 indicate good convergent and discriminant validity, and thus good construct validity. All constructs had composite reliability (CR) greater than the 0.7 desired minimum proposed by [24] as presented in Table 7. The final instrument contains, in total, 40 items (see Appendix A).

5.3. Common method bias

Common method bias is one of the main sources of measurement error, which can threaten the validity of the conclusions about the relationships between measures [2]. While the effects of this bias are mitigated through the use of different anchors for the scales, it is difficult to isolate and eliminate. We tested whether this bias was a major factor. Harman's single-factor test, one of the most widely used techniques to address the issue of common method bias, was conducted. All of the variables were loaded into an exploratory factor analysis and the unrotated factor solution was examined [27]. The results did not show evidence of either (1) a single factor emerging from the factor analysis or (2) one general factor accounting for the majority of the covariance among the measures. Therefore, we concluded that common method variance was not a significant factor in the results.

Table 5
Sample characteristics.

	Number	Percentage
Gender		
Female	10	7.9
Male	116	92.1
Age		
below 25	28	22.2
26–35	70	55.6
36–45	21	16.7
45 or above	7	5.6
Years in IS field (self-reported)		
1 to 5	59	46.8
6 to 10	45	35.7
11 to 20	16	12.7
20 above	6	4.8
Highest Education Level		
Associate or below	28	22.2
B.S.	46	36.5
Master	43	34.1
Ph.D.	9	7.1
Job Title		
Programmer/Analyst	32	25.4
Software Engineer	38	30.2
Sales/Education	2	1.6
Systems/Data Architect	5	4.0
User/Tech. Support	4	3.2
Network Design	2	1.6
Systems Administration	4	3.2
Database Management	2	1.6
Project Leader	11	8.7
Management	3	2.4
Other	23	18.3
Industry (self-reported)		
Academic/Education	5	4.0
Aerospace/Aviation	3	2.4
Bio	1	0.8
Business (Advertising, Banking, Finance, Stock, Supply Chain Execution)	10	7.9
Engineering	1	0.8
Government	3	2.4
Healthcare	3	2.4
IT	56	44.4
IT	15	11.9
IT Service, Security, Consulting, Training	7	5.6
Software Development	25	19.8
Telecommunication	5	4.0
Web Design and Development	4	3.2
Manufacturing	7	5.6
Automobile	1	0.8
Garment	1	0.8
Manufacturing	5	4.0
Semiconductor	1	0.8
Power (Electricity, Oil Field)	3	2.4
Service (Gambling, Retailing, Consulting, Statistics, Training, Storage)	9	7.1
Unemployed	1	0.8
Unrecognizable	10	7.9
Missing	14	11.1

Table 6
Convergent validity: factor loadings with significance test^a.

Item	Loading	t-Statistic
IT Dynamism		
ID1	0.84	9.89
ID2	0.87	14.38
Technological Knowledge Renewal Effectiveness		
RE1	0.77	13.66
RE2	0.74	10.78
RE5	0.82	19.73
RE6	0.78	17.76
Intrinsic Job Satisfaction		
JS1	0.75	7.80
JS2	0.81	12.27
JS3	0.77	7.23
JS4	0.78	6.63
JS5	0.64	4.65
JS6	0.80	12.94
JS7	0.62	6.07
Extrinsic Job Satisfaction		
JS8	0.63	6.69
JS9	0.74	8.86
JS10	0.79	17.31
JS12	0.71	5.35
JS13	0.74	5.03
JS14	0.68	6.26
JS15	0.72	9.14
Managerial Competence Career Orientation		
MC1	0.78	3.57
MC2	0.72	3.47
MC3	0.63	3.01
MC4	0.93	3.66
Technical Competence Career Orientation		
TC2	0.85	4.81
TC3	0.89	5.26
TC4	0.59	2.97
TC5	0.63	2.94
Structural Delegation		
DL1	0.86	4.31
DL2	0.92	5.15
DL3	0.92	6.46
Professional Delegation		
DL4	0.64	3.74
DL5	0.87	17.58
DL6	0.83	9.56
Intolerance for Ambiguity ^b		
TAjob	0.79	3.99
TA1	0.84	3.89
TA3	0.84	3.94
TAproblem	0.86	4.16
TA4	0.59	3.35
TA5	0.73	3.74
TA6	0.80	4.85
TA7	0.80	4.82

^a Items are in Appendix A.

^b Procedure of evaluating second-order factors follows previous studies [25].

5.4. Testing of hypotheses

PLS is used to test the research model. PLS is useful for analyzing structural models with multiple-item constructs and mediating constructs. It allows latent construct to be modeled either as formative or reflective indicators. It is better suited for theory development research. The results are presented in Fig. 2.

Technical competence career orientation is positively related to renewal effectiveness ($t = 1.66, p = 0.49$), while managerial competence career orientation is not a significant predictor ($t = 1.18, p = 0.12$). Hypothesis 1 is supported. IT dynamism is strongly related to renewal effectiveness ($t = 3.17, p < 0.001$). Hypothesis 2 is strongly supported. Intolerance for ambiguity (negatively

construed) is negatively related to renewal effectiveness ($t = 2.32, p = 0.01$) thereby supporting Hypothesis 3. Professional delegation is positively related to renewal effectiveness ($t = 2.50, p < 0.01$). Hypothesis 4a is supported. However, structural delegation has no significant impact on renewal effectiveness ($t = 1.22, p = 0.11$). Hypothesis 4b is not supported. Twenty three percent of the variance of renewal effectiveness is explained by the set of predictors.

For the right side model (Hypotheses 5a and 5b), renewal effectiveness is a significant predictor for both intrinsic job satisfaction ($t = 4.68, p < 0.001$) and extrinsic job satisfaction ($t = 4.11, p < 0.001$). Nine percent of the variance of intrinsic job satisfaction and 11% of the variance of extrinsic job satisfaction is

Table 7
Discriminant validity and reliability: AVE, square-root of AVE, correlations between latent variables, and composite reliability (CR).

	CR	AVE	Renewal Effectiveness	Technical Competence	Managerial Competence	IT Dynamism	Intolerance for Ambiguity	Delegation Structural	Delegation Professional	Intrinsic Job Satisfaction	Extrinsic Job Satisfaction
Renewal Effectiveness	0.86	0.60	0.78								
Technological Competence	0.84	0.57	0.17	0.75							
Managerial Competence	0.86	0.60	0.13	0.02	0.78						
IT Dynamism	0.84	0.73	0.35	0.06	0.07	0.85					
Intolerance for Ambiguity	0.81	0.68	0.20	0.19	0.04	0.16	0.83				
Delegation—Structural	0.93	0.81	-0.10	0.06	0.18	-0.01	-0.26	0.90			
Delegation—Professional	0.83	0.62	0.30	0.34	0.23	0.25	-0.14	0.06	0.79		
Intrinsic Job Satisfaction	0.89	0.55	0.29	0.07	0.07	0.27	0.15	0.08	0.14	0.74	
Extrinsic Job Satisfaction	0.88	0.52	0.33	0.09	0.06	0.19	0.09	0.08	0.15	0.64	0.72

Notes: Diagonal—square root of AVE.

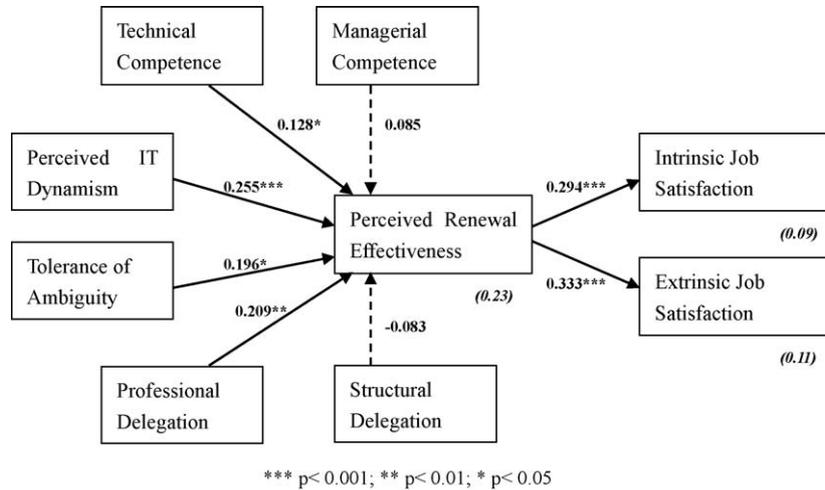


Fig. 2. Research results. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 8
Results of hypotheses testing.

Hypothesis	Supported
Hypothesis 1a: Technical competence career orientation has a positive impact on technological knowledge renewal effectiveness	Yes
Hypothesis 1b: Managerial competence career orientation has less significant impact on technological knowledge renewal effectiveness than technical competence career orientation	Yes
Hypothesis 2: Perceived IT dynamism has a positive impact on technological knowledge renewal effectiveness	Yes
Hypothesis 3: Tolerance for ambiguity has a positive impact on technological knowledge renewal effectiveness	Yes
Hypothesis 4a: Professional delegation has a positive impact on technological knowledge renewal effectiveness	Yes
Hypothesis 4b: Structural delegation has a positive impact on technological knowledge renewal effectiveness	No. Structural delegation has no significant impact on renewal effectiveness.
Hypothesis 5a: Technological knowledge renewal effectiveness has a positive impact on intrinsic job satisfaction	Yes
Hypothesis 5b: Technological knowledge renewal effectiveness has a positive impact on extrinsic job satisfaction	Yes

explained by technological knowledge renewal effectiveness. The summary of hypotheses testing results is presented in Table 8.

6. Discussion

This paper presents a study that investigates the determinants and consequence of technological knowledge renewal effectiveness of IT professionals. The determinants are mainly derived from self-driven motivations, which push professionals to devote more effort to renew knowledge, and enable them to do so more effectively.

As predicted in Hypothesis 1, employees with higher technical competence career orientation tend to be better updated. Technical competence career orientation is a significant predictor of technological knowledge renewal effectiveness, whereas managerial competence career orientation is not. This suggests that such self-assessed career orientation does influence employees' effort and activities taken to achieve their career goal, and

therefore influences renewal effectiveness. A technical orientation is chosen only when employees believe they can be competent in technological knowledge. The motivation (and ability) reflected in such an orientation leads to effective knowledge renewal.

Perceived IT dynamism is the strongest predictor of renewal effectiveness ($p < 0.001$). As suggested by intrinsic motivation and goal-setting theory, perceptions of dynamism drive employees to engage in more effort to overcome the challenge and realize their goals. This may be especially true for the young and highly educated IT professionals reflected in our sample. So the perceived dynamism poses a potential (internal) challenge for IT professionals and actually motivates them to do better, rather than impeding their ability to renew.

Tolerance for ambiguity has a significant positive impact on renewal effectiveness. The whole process of innovating, applying, adapting, and implementing technologies involves the problem of ambiguity. Therefore, dispositional nature of employees is mean-

ingful for many study areas, such as knowledge management and innovation implementation. Individuals with high tolerance for ambiguity are more willing to and more able to deal with ambiguity. They are more innovative and risk-taking in nature, and presumably will be among the first to acquire new knowledge in the organization.

Interestingly, professional and structural delegation influence renewal effectiveness differently. Professional delegation has a positive impact on renewal effectiveness, while structural delegation (contrary to expectation) has no significant impact. While somewhat speculative, perhaps the discrepancy lies in two aspects: involvement in learning, and the nature of technological knowledge. When using professional delegation, employees themselves are involved in the learning processes. They acquire the technological knowledge through external resources and professional activities, and absorb it for future use. This endured process of learning can actually both help and push the internalization of the knowledge. Therefore, employees perceive high effectiveness in knowledge renewal. In contrast, it can be argued that when using structural delegation, employees are less proactive in updating knowledge. They do not take initiatives to update knowledge purposefully. In addition, they do not engage in the first-hand learning experience. They go to their subordinates or IT units in their organizations when they need certain types of knowledge. Also, the nature of technological knowledge is quite tacit. While structural delegation might work for explicit knowledge, tacit knowledge of programming and technological know-how cannot be effectively transferred. Even though the employees are able to perform their job roles through such structural delegation, they may perceive that knowledge still resides with their subordinates or IT units. They are not the owner of the knowledge, but only a user of the knowledge. Since the knowledge is not fully possessed by them, they may perceive lower levels of renewal effectiveness. The passive nature of structural delegation is inherently incongruous with the active nature of renewal activities and their effectiveness.

Finally, as predicted, self-reported renewal effectiveness is a very significant predictor of intrinsic and extrinsic job satisfaction, with $p < .001$. This indicates that the perceived technological knowledge renewal effectiveness may satisfy IT professionals' intrinsic needs such as self-actualization, and extrinsic needs such as pay. This suggests that by nurturing renewal effectiveness, organizations benefit not only by having a better quality workforce, but also by having employees who are broadly satisfied with their jobs.

7. Implications

7.1. Implications for research

Previous studies tend to investigate the direct relationship between the work-related factors and work outcomes, such as the impact of career orientation on job satisfaction, impact of tolerance for ambiguity on job satisfaction, and impact of rapid IT innovations on work exhaustion. By introducing the concept of knowledge renewal effectiveness, we are able to investigate one of the major mechanisms through which these antecedents influence work outcomes. We demonstrate how knowledge renewal effectiveness mediates the relationship between motivational antecedents such as career orientation, IT dynamism, and tolerance for ambiguity on job satisfaction.

The results indicate that an employee's career orientation influences perceived knowledge renewal effectiveness, which further leads to job satisfaction. While the impact of career orientation on renewal effectiveness has not been examined before, this study shows that people with different career orientations may perform differently in knowledge renewal. The match between the desired competence area and nature of

knowledge to be updated determines employees' knowledge renewing behavior and effectiveness. This is consistent with the arguments provided by previous research contending that the fit between competence orientation and the nature of the job improves IT workers' work outcomes, such as job satisfaction. Further, if the current job setting is compatible with career orientation, an IT professional is likely to be more motivated, because the resources and rewards provided by the job match their needs and preferences. Future research can examine the impact of job compatibility on renewal effectiveness.

Although no prior IS research has investigated this construct, tolerance for ambiguity seems likely to influence employees' effectiveness in coping with rapid changes. The significant effect of tolerance for ambiguity in the context of a rapidly changing IT environment, suggests that individual dispositions toward change might be desirable attributes for IS professionals. Learning disposition or individual absorptive capacity might be another related attribute that could facilitate renewal.

Studies in information processing and environmental scanning indicate that external changes and dynamism of technologies are the main causes of uncertainty, and may lead to information overload [9] and consequently place a burden for renewing [4]. Further, technology change is a major source of job stress and burnout among IT employees because of the need for continual reskilling. However, in this study we find support for "perceptions of IT dynamism" affecting work outcomes positively. These perceptions, which may differ from actual IT dynamism, are interpreted and internalized by employees themselves. This challenge works as a motivator for employees to meet their (demanding) job goals in light of these perceptions. The significance of this impact alerts future researchers to pay more attention to these positive implications of IT dynamism. Further, actual and perceived IT dynamism may affect effort and actions differently. It would be useful to theorize the difference between perceptual measures (which are arguably the major influencers of individual behavior) and objective ones on renewal behavior and its effectiveness.

The different impacts of structural and professional delegation on knowledge renewal stress the need to examine different coping mechanisms and their effects. Not all renewing activities can lead to higher perceived effectiveness and subsequent job satisfaction. Differentiating between active and passive learning mechanisms or the use of technology resources themselves (e.g., the Internet) to facilitate effective technological knowledge renewal offers fertile ground for further research. Perhaps better "matching" of renewing mechanisms for different individuals or types of knowledge can be further studied. For instance, as suggested by ref. [8], different groups of employees prefer different approaches to renew. Employees with different career orientation may adopt different renewing activities which may in turn influence renewal effectiveness. Or, the fit between renewing mechanisms (passive and active) for different types of knowledge (tacit and explicit) might yield better outcomes.

Renewal effectiveness affects both intrinsic and extrinsic job satisfaction.¹ This suggests that both intrinsic and extrinsic motivators could drive renewal effectiveness. While this study paid particular attention to intrinsic factors as motivators, future study can examine factors that represent the impact of extrinsic motivation such as organizational incentives or rewards on renewal effectiveness.

Prior research has discussed the role of organizational renewing climate in preventing obsolescence. Such climate can include extrinsic incentives, as discussed above. It can also provide

¹ From our results it can be seen that the strengths of the two relationships (Hypotheses 5a and 5b) are not significantly different. Therefore, when intrinsic and extrinsic mechanisms are not the focus, aggregated job satisfaction can be used.

facilitating mechanisms to improve renewing. Future studies can combine research on supporting climate with the concept of delegation to identify effective approaches to motivate and facilitate organizational renewing activities.

Finally, the key construct in the research model, knowledge renewal effectiveness, can be affected by both effort and ability. The focus of this study is more on effort. Ability is measured indirectly, and is mostly implied in the predictors. For instance, delegation extends an individual's reach and basically increases one's ability to renew. Career orientation is partly formed based on one's self-evaluation of ability. Tolerance for ambiguity implies one's willingness and ability to learn new knowledge and deal with the ambiguity existing in the renewing processes. Given these indirect impacts of ability, ability is not explicitly measured in the model. This opportunity may lead to the need to further add granularity to this study by separating variables reflecting individual ability to renew.

7.2. *Implications for practice*

This study provides implications for organizations to improve employees' knowledge currency, competence, and job satisfaction. It identifies important factors to enhance knowledge renewal and personnel management. These factors indicate that not all employees are equally motivated. Therefore, when designing incentives for renewing knowledge or evaluating performance, organizations should consider the impact of these individual factors.

Organizations should be careful to provide job settings that motivate employees, and find matches between organizational needs and individual needs. Matches between individual career orientation and job requirements are also desirable. Therefore, as a part of the job screening process, career orientation can be assessed. Those potential employees that are applying for technical jobs, but have a managerial career orientation would, based on this study, be less effective in keeping their knowledge-base updated. If this is an important consideration, then such employees should not be hired for these jobs in favor of those with a technical orientation. Similarly, ongoing assessment of career orientation can raise flags on mismatches. For employees with managerial competence orientation, rather than trying to motivate them, organizations can reduce their technological knowledge renewal responsibility, or shift their work roles which require less current technological knowledge. The rational is to let the right people do the right thing. It is not sufficient to simply assign work based on employees' job descriptions.

The results indicate that dynamism can work in a positive way. Organizations can try to influence employees' attitude toward the rapidly changing technological environment. Rather than focusing on the burden caused by the dynamism, organizations can create a climate or build a culture that encourages employees to face and overcome challenges, deal with changes, and cope with uncertainty. Resources and rewards compatible with knowledge renewal can also enhance their renewal effectiveness. Such climate can help shift the potential negative perception of IT dynamism toward positive attitude. Thus, continuous knowledge renewal can be cultivated as an enjoyable process instead of a burden.

The positive influence of professional activities suggests that organizations should encourage employees to participate more in such activities and promote employees' involvement in the learning process. There are indications in this study that structural delegation or "passing the buck" for technological knowledge renewal should be used with caution.

As a personal trait, it is difficult to change employees' tolerance for ambiguity. The organizations, however, can manage the recruiting process, by hiring employees a priori with desired

traits. This approach has been used by some companies. Their actual job advertisements increasingly emphasize personal attributes such as tolerance for ambiguity among IT professionals, along with specific technical skills [35].

Finally, the results suggest that to improve employees' job satisfaction, organizations should establish a routine that recognizes and values employees' knowledge currency. After all, their job satisfaction leads to retention and better performance, and thus the greater competence of the organization as a whole.

7.3. *Limitations*

This study uses a sample frame distributed across various organizations in different industries. However, it does not control for factors that may influence perceived renewal effectiveness, or job satisfaction. Individual work environment, such as job task or task responsibilities, for example, may influence employee's perception of renewal effectiveness. This group of factors may also influence job satisfaction [5]. Other studies have shown the potential impact of organizational overall environment such as organizational politics [34] and justice [29] on employee job satisfaction. Dispositional factors may affect perceived renewal effectiveness or job satisfaction [15] as well. While recognizing the potential impact of these factors, this study focused on the motivational factors that influence renewal effectiveness, and the impact of the renewal effectiveness on job satisfaction.

It should be noted that some variables are measured using 2 or 3 item scales, which might require further validation. In addition, even though the analysis indicates no common method bias, future research can adopt more preventive techniques, such as obtaining independent variables and dependent variables from different sources and measuring them in different contexts [27] to minimize potential measurement errors.

This study took a more structured approach by testing a pre-defined model with a survey approach. Motivational theories as the theoretical base represent one lens through which we can understand this important phenomenon. To some extent this lens might constrain exploration of other interesting factors. Overall, our research served as an initial attempt to understanding technological knowledge renewal effectiveness.

8. **Conclusion**

IT applications and innovations have shifted their focus from data, to information, to knowledge. Knowledge has become a critical resource for the organization. Increasingly research is addressing knowledge management issues. Our study focused on knowledge renewal in a dynamic technological environment, a critically important issue that has received sparse attention.

We took a motivational perspective to examine the significant factors that lead to more effective renewal; we also considered the impact of effective renewal on employee job satisfaction. Results indicated that the role of technological knowledge renewal effectiveness was an important mediator in explaining the relationship between predictors, such as career orientation, IT dynamism, tolerance for ambiguity, and delegation, on job satisfaction. Organizations can manipulate these motivators to encourage employees' technological knowledge renewal, thus ensuring renewal effectiveness, and job satisfaction.

Knowledge renewal is a never-ending process. To create and sustain competitive advantage, organizations must hire IT professionals who are motivated to keep their technological knowledge up to date and create a superior renewal climate to create a first class capability. This study provides insights into how organizations can leverage this valuable resource and increase their chance of long-term success.

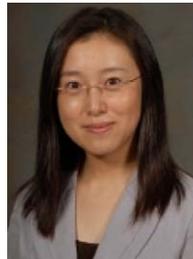
Appendix A. Survey instrument (final set of items)

Knowledge Renewal Effectiveness		Strongly disagree						Strongly agree						
RE1	The technological knowledge required by my job is current	1	2	3	4	5	6	7						
RE2	I have sufficient up-to-date technological knowledge for doing my current job well	1	2	3	4	5	6	7						
RE5	I have sufficient up-to-date technological knowledge to be competitive in the job market	1	2	3	4	5	6	7						
RE6	I possess up-to-date technological knowledge to maintain effective performance in the job planned for the future	1	2	3	4	5	6	7						
Managerial Competence		Least Important						Most Important						
MC1	The process of supervising, influencing, leading, and controlling people at all levels	1	2	3	4	5	6	7						
MC2	To be in charge of a whole organization	1	2	3	4	5	6	7						
MC3	To rise to a high position in general management	1	2	3	4	5	6	7						
		False											True	
MC4	To reach a level of responsibility in an organization whereby I would supervise others in various business functions and my role would primarily be to integrate their efforts	1	2	3	4	5	6	7						
Technical Competence		Least Important						Most Important						
TC2	Remaining in my specialized area as opposed to being promoted out of my area of expertise	1	2	3	4	5	6	7						
TC3	Remaining in my area of expertise throughout my career	1	2	3	4	5	6	7						
		False											True	
TC4	I would like to reach a level of responsibility in an organization whereby I would supervise others in various business functions and my role would primarily be to integrate their efforts	1	2	3	4	5	6	7						
TC5	I will feel successful in my career only if I become a high-level general manager in some organization	1	2	3	4	5	6	7						
IT Dynamism		Strongly Disagree						Strongly Agree						
ID1	The technical environment related to my job is static/dynamic	1	2	3	4	5	6	7						
ID2	Technologies pertaining to my job change never/always	1	2	3	4	5	6	7						
(In)Tolerance for Ambiguity		Strongly Disagree						Strongly Agree						
TA1	I function very poorly whenever there is a serious lack of communication in a job situation	1	2	3	4	5	6	7						
TA3	If I am uncertain about the responsibilities of a job, I get very anxious	1	2	3	4	5	6	7						
TA4	A problem has little attraction for me if I don't think it has a solution	1	2	3	4	5	6	7						
TA5	I do not like to get started in group projects unless I feel assured that the project will be successful	1	2	3	4	5	6	7						
TA6	In a decision-making situation in which there is not enough information to process the problem, I feel very uncomfortable	1	2	3	4	5	6	7						
TA7	I don't like to work on a problem unless there is a possibility of coming out with a clear-cut and unambiguous answer	1	2	3	4	5	6	7						
Delegation		Strongly Disagree						Strongly Agree						
DL1	I rely on my subordinates to search updated technological information for me	1	2	3	4	5	6	7						
DL2	I rely on the IT unit in my organization to keep my technological knowledge current	1	2	3	4	5	6	7						
DL3	I rely on the technical support staff in my organization to update my technological knowledge	1	2	3	4	5	6	7						
DL4	I rely on professional conferences and seminars to maintain current technological knowledge	1	2	3	4	5	6	7						
DL5	I rely on professional journals and magazines to update my technological knowledge	1	2	3	4	5	6	7						
DL6	I rely on online forums and discussion boards, and electronic newsletters to keep my technological knowledge current	1	2	3	4	5	6	7						
Intrinsic Job Satisfaction		Very Dissatisfied						Very Satisfied						
JS1	The freedom to choose your own method of working	1	2	3	4	5	6	7						
JS2	The recognition you get for good work	1	2	3	4	5	6	7						
JS3	The amount of responsibility you are given	1	2	3	4	5	6	7						
JS4	Your opportunity to use your abilities	1	2	3	4	5	6	7						
JS5	Your chance of promotion	1	2	3	4	5	6	7						
JS6	The attention paid to suggestions you make	1	2	3	4	5	6	7						
JS7	The amount of variety in your job	1	2	3	4	5	6	7						
Extrinsic Job Satisfaction		Very Dissatisfied						Very Satisfied						
JS8	The physical work conditions	1	2	3	4	5	6	7						
JS9	Your fellow workers	1	2	3	4	5	6	7						
JS10	Your immediate boss	1	2	3	4	5	6	7						
JS12	Relations between management and workers in your firm	1	2	3	4	5	6	7						
JS13	The way your firm is managed	1	2	3	4	5	6	7						
JS14	Your hours of work	1	2	3	4	5	6	7						
JS15	Your job security	1	2	3	4	5	6	7						

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Guang Rong is a doctoral student in the Department of Management at Clemson University. Her research interest includes knowledge management, project management, IT adoption, and trust in e-commerce. Her work has appeared in *Communications of the Association of Information Systems*, *Journal of Organizational and End User Computing*, and *Encyclopedia of Information Science and Technology* (2nd ed.).



Varun Grover is the William S. Lee (Duke Energy) Distinguished Professor of Information Systems at Clemson University. He has published extensively in the information systems field, with over 200 publications in refereed journals. Six recent articles have ranked him in the top four in research productivity in the top six Information Systems journals in the past decade. Dr. Grover is Senior Editor for *MIS Quarterly*, the *Journal of the AIS* and *Database*. He is currently working in the area of individual and organizational impacts of IT, IT value, and recently released his third book (with M. Lynne Markus) on process change.