Rethinking User Participation in Information Systems Development: A Knowledge Perspective

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Submitted to the Graduate Faculty of

Katz Graduate School of Business in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2006

UNIVERSITY OF PITTSBURGH

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RETHINKING USER PARTICIPATION IN INFORMATION SYSTEMS DEVELOPMENT: A KNOWLEDGE PERSPECTIVE

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Participation of users in the information systems development (ISD) process has been widely advocated by both academicians and practitioners. Most researchers utilize user participation as a behavioral construct when studying various ISD outcomes. However, both the ISD literature and the Participative Decision-Making (PDM) literature imply the insufficiency of the behavioral approach to participation, especially when studying ISD productivity outcomes. This research adopts an efficacy approach to participation, and proposes knowledge participation as a new construct to assess the effectiveness of participative activities performed by users in an ISD process. The construct of knowledge participation is studied to ascertain whether it has more predicative power than user participation when predicting productivity-related ISD outcomes. In addition, team cognition, specified here by its two elements – shared awareness of expertise location and shared task understanding, are proposed as a mediating mechanism that transforms the effect of knowledge participation on ISD productivity outcomes such as team performance and system quality. Some ISD environmental factors, such as business context complexity, system complexity, management support, and project size are studied as control variables. An experimental study and a field study are designed to test the proposed research model.

Keywords

User participation, knowledge participation, information systems development, knowledge utilization, team cognition.

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1.1. INTRODUCTION

Since the 1960s when computers started to be utilized in business, the participation of users in system development has been advocated as a critical ingredient in a successful information system development (ISD) process (Garrity, 1963; King and Cleland, 1971, 1975; Swanson, 1974; Barki and Hartwick, 1989; Hartwick and Barki, 1994). In the literature, user participative efforts are typically captured by "user participation", which is defined as "the various design related behaviors and activities that the target users or their representatives perform in the systems development process" (Barki and Hartwick, 1989). The existing research largely supports the proposition that user participation is positively linked to system success.

There are three research streams in the study of user participation effects to ISD processes, distinguished by different aspects of ISD success in terms of:

1. productivity outcomes (e.g., system quality, project team performance),
2. attitudinal outcomes (e.g., user satisfaction, system use, system resistance), and
3. process outcomes (e.g., user-developer interactions, user-developer relationship).

Of the three research streams, study of ISD productivity focuses directly on the performance of ISD processes by measuring the effectiveness of project teams or the quality of produced products. As these measures have important influence on the other two aspects of ISD success, many researchers agree that the merits of user participation center around its productivity benefits. A common reasoning is that through participation, users are able to provide valuable input and feedback to a systems development process, helping the project team to achieve high quality systems, "which in turn will cause its frequent system use and user satisfaction" (Hwang and Thorn, 1999; p. 233-234).

This study focuses on how and to what extent users bring productivity benefits to ISD processes as the research topic.

1.2. IMPORTANCE OF TOPIC

Empirical studies have produced equivocal results regarding the user participation – ISD productivity relationship, even with the development of sounder research methodology and better measurement (Cavaye, 1995). Indeed, some studies argued that user participation might impair, rather than improve, the performance of ISD project teams (e.g., Brodbeck, 2001). In addition, a growing body of qualitative research and normative literature has identified possible obstacles, drawbacks, or even negative effects arising from the practice of user participation, such as user-developer conflict (Robey et al., 1993; Howcroft and Wilson, 2003), communication gaps (Wilson et al., 1996), communication lapses (Gallivan and Keil, 2003), and increased ISD workload (Hawk and Dos Santos, 1991; Brodbeck, 2001). These findings challenge the simplicity of assuming univariant positive effects of user participation on ISD productivity.

The user participation – ISD productivity relationship has fundamental importance to both MIS research and system development practice. Theoretically, this relationship serves as one primary basis for advocating user participation by both the research literature and the prescriptive literature (Kirsch and Beath, 1996). Methodologically, the validity of this relationship is a prerequisite for explorations of any potential mediation that may help to explain how users affect ISD project teams to pursue successful project development (Judd and Kenny, 1981; Baron and Kenny, 1986). In addition, the acceptance of the user participation – ISD productivity relationship has provoked the development of some innovative system development methods that rely on heavy user participation, such as prototyping (Hardgrave and Wilson, 1999), user-centered system design (Norman and Draper, 1986; Vredenburg et al., 2002), and rapid application development (Beynon-Davis et al., 2000). The adoption of these non-traditional system development techniques has reshaped ISD practices in terms of team configuration (Hartwick and Barki, 1994; Wixom and Watson, 2001), management styles (Lu and Wang, 1997), and project team leadership (Franz, 1985). Organizational structures are also changed in a way to support the practice of user participation (Butler and Fitzgerald, 2001), and/or the adoption of these system development methods (Loftin and Moosbruker, 1982; Eisenhardt and Tabrizi, 1995; Dube, 1998).

Given its importance to organizations in general and to ISD in particular, it is important for academics to prove and clarify the user participation – ISD productivity relationship.

1.3. Overview of Thesis

The objective of this study is to provide a better understanding of how users or their representatives affect the performance of ISD processes (assessed by productivity-related outcomes) through their participative efforts. To this end, previous studies in this field are reviewed on their theoretical grounds as well as their empirical findings; a knowledge theory of user participation is proposed to study the productivity benefits of user participative efforts using a knowledge perspective.

The rest of this thesis is organized in ten chapters:

- In chapter 2 the participation literature is reviewed with special attention to the underlying theories, measurement, and empirical evidence regarding the participation – productivity relationship.
- In chapter 3 the user participation literature is reviewed on the underlying theories, conflicting observations, and different research approaches on the user participation – productivity relationship.
- In chapter 4, a meta-analysis is conducted to summarize previous empirical studies of the effects of user participation.
- In chapter 5, the current theory of user participation is challenged, and new thinking about how user participation takes effects in ISD processes is discussed.
- In chapter 6 a knowledge theory of user participation is developed. A new construct, knowledge participation, is proposed to assess the effectiveness of user participation. Knowledge participation is conceptualized as the amount of knowledge that users contribute to an ISD process via participation. Team cognition – the knowledge structures between user participants and system developers – is proposed as the mediating mechanism that transforms the effects of knowledge participation into ISD productivity outcomes.
- In chapter 7, a research model is developed to test the effects of knowledge participation on ISD productivity outcomes. Team cognition is specified by two

important elements: awareness of expertise location and shared task understanding. ISD productivity outcomes are measured with two constructs of ISD project team performance and system quality.

- In chapter 8, construct measurement is discussed.
- In chapter 9, an experimental study is designed to test some key propositions.
- In chapter 10, a field study is conducted to test validity of the knowledge participation construct as well as the research model.
- This dissertation ends with chapter 11, a summarization and discussion of the research findings. Limitations of this study are discussed. Implications and suggestions for future study are also provided on the investigation of productivity benefits of user participation.

2.0. PARTICIPATION IN ORGANIZATIONAL SETTINGS

Compared with many other disciplines in business and the social sciences, Information Systems (IS) is a relatively young field. In its initial development stage, IS was perceived as an applied discipline that almost exclusively drew on other, more fundamental, reference disciplines (Keen, 1980). This is particularly true for the study of user participation, an area in which many scholars credited the research of participation in general organizational settings, i.e., participative decision-making (PDM), as its main theoretical ground (Ives and Olson, 1984; Cavaye, 1995). Therefore, it is helpful to discuss participation research in the PDM literature before addressing the effects of user participation in ISD.

2.1. DEFINING PARTICIPATION

Participation was first investigated in the setting of group decision-making, in the form of a management practice that encourages employees who are to execute the decisions or who are affected by the decisions to participate in the decision-making process (Locke and Schweiger, 1979). So comes the term "participative decision-making".

The involved parties are now extended to all relevant stakeholders and participants are not limited to subordinates or employees that are under direct supervision of managers. As defined by Heller and colleagues (1998), participation refers to "the totality of forms, i.e. direct (personal) or indirect (through representatives or institutions) and of intensities; i.e. ranging from minimal to comprehensive, by which individuals, groups, collectives secure their interests or contribute to the choice process through self-determined choices among possible actions during the decision process" (p. 42).

The research on PDM takes general organizational settings as its investigation context. In contrast, user participation is restricted to ISD process, and can be considered as "a special case of PDM in which system developers and users substituted for superiors and subordinates" (Ives and Olson, 1984; p. 587). Users or their representatives participate in ISD to help project teams produce quality systems, for example, by ensuring the target system to meet their needs and information requirements (Ives and Olson, 1984; Hwang and Thorn, 1999; Howcroft and Wilson, 2003). Therefore, the PDM literature is often suggested as a theoretical "starting point" for user participation studies (Ives and Olson, 1984; Doll and Torkzadeh, 1989).

2.2. PARTICIPATION THEORIES

Supporters of PDM advocate more employee participation in management decision-making processes, arguing that increased inputs from subordinates bring benefits to organization in general, and to a focused decision in particular. Expected benefits fall into two categories: increased job satisfaction and improved productivity (Locke and Schweiger, 1979). The category of job satisfaction includes increased morale and job satisfaction, and their related outcomes such as reduced turnover, absenteeism, and conflict. The category of productivity includes higher production, better decision quality, better production quality, and reduced costs. Two theories, human relations theory and human resources theory, help explain what different benefits participation brings to the two categories.

2.2.1. Human Relations Theory

The *Human Relations Theory* of PDM argues that as long as subordinates feel they are participating and are being consulted, their ego needs will be satisfied and they will be more cooperative (Miles, 1965). The development of the theory could be tracked to 1920's, when managers shifted their perception of employees from an appendage to a machine (i.e., seeking only economic rewards from their work) to a "whole man" (requiring a sense of satisfaction beyond economic needs). As Bendix (1956) noted, "the failure to treat workers as human beings came to be regarded as the cause of low morale, poor craftsmanship, unresponsiveness, and confusion" (p. 294). The solution suggested by the human relations theory is participation, a practice that encourages workers' participative attempts in managerial decision-making process in order to make them "feel a useful and important part of the overall effort (of the organization)" (Miles, 1965; p. 149).

Human relations theory utilizes a "quantity" concept of participation (Ritche and Miles, 1970). Subordinate satisfaction is improved as a direct result of more participation, and such improved satisfaction helps superiors carry out their decisions with subordinate cooperation. PDM is therefore viewed as a means of accomplishing the ultimate goal of building a cooperative and compliant work force and reducing subordinate resistance to managerial decisions. In other words, managers work with workers to help them be satisfied with decisions that are related to their jobs.

The quantity concept of participation focuses on the amount of participative activities that workers have conducted, while ignoring the practical relevance of these activities to a target decision making process. This theory implies that if participation is considered primarily for the quantity rather than the nature of the activities, productivity outcomes, such as decision quality and group performance, are not addressed directly and therefore may not be relevant. As Lowin (1968) pointed out, “PDM programs which are restricted to peripheral issues are … inherently limited in potential effectiveness” (Lowin, 1968; p. 80).

2.2.2. Human Resources Theory

Emerging from 1960s, a series of books (e.g., McGregor, 1960; Likert, 1961; and Haire, 1962) called for managers’ attention on fully utilizing workers capability rather than merely satisfying their ego needs. Participation is useful for its own sake in that skillful and knowledgeable employees are the best people to make decisions in their own areas (where they are directly involved in and are affected by the resulting decisions). This thinking is the basis for human resources theory (Miles, 1965). Under human resources theory, the main input is the “creational contributions” that workers make to managerial decision making processes, and the expected outcome of participation will be “the (improved) decision making and the total performance efficiency of the organization” (Miles, 1965; p. 152); increased satisfaction among workers is viewed as a by-product of PDM - “the result of their having made significant contribution to organizational success” (p. 152).

Human resources theory employs a quality concept of participation and addresses productivity as the direct outcome (Ritche and Miles, 1971). This theory adopts a cognitive approach to the decision-making process, viewing subordinates as reservoirs of untapped resources (knowledge, expertise, skills and capability of performing responsible behaviors) and PDM as a means of utilizing those resources to improve decision quality and the total performance efficiency of the organization. In other words, managers work with workers to utilize their capabilities.

The quality concept of participation categorizes the nature participative activities in terms of their cognitive relevance to a target decision making process. Participative activities are considered of high quality if they have the potential to influence managerial decisions by providing knowledge and skills. The amount of participation is not a concern, especially when participative activities have little knowledge contribution - these activities are often unimportant, negligible, or restricted mostly to peripheral issues – therefore have limited potential to affect the resulted decisions. Productivity outcomes, such as decision quality and job performance, are determined by the quality, rather than the quantity, of participation.

2.3. PARTICIPATIVE MEASUREMENT AND CONTINGENCY APPROACH

The two theories suggest the use of different participation constructs, “participation quantity” versus “participation quality”, to study job-satisfaction related outcomes versus productivity-related outcomes. In practice, both participation quantity and participation quality have been used, with the former dominating the research literature.

2.3.1. Measuring Participation by Quality

In the PDM literature, participation quality has been used only rarely. The avoidance of participation quality might be attributed to the difficulty in operationalizing the construct. Human resources theory suggests that participation quality be conceptualized as the effectiveness of a participant's contribution of needed *knowledge* and *expertise* to a decision-making process. In taking this view, the operationalization of the construct would inevitably involve the measuring of knowledge. Without a good understanding of the contents of the contribution, it would be meaningless to evaluate the effectiveness of the contribution. However, as indicated by measurement theory, knowledge is extremely difficult to measure due to its highly abstract nature[1]. In addition, Polanyi (1966) argued that any individual knowledge has a tacit dimension, of which "we can tell nothing without relying on our awareness of things may not be able to tell" (p. 4). Tacit knowledge is difficult to write down, to formalize (Nonaka, 1991), and has so far resisted operationalization (Ambrosini and Bowman, 2001).

In practice, Lowin (1968) defined "participation quality" as the relevance and importance of participative activities. Thus, the cognitively-rooted quality concept was developed as a perception construct to reflect participants' confidence in their participative efforts. In another empirical study, Ritchie and Miles (1970) further revised the quality construct in their test of Human Resources Theory. They employed managers' attitudes toward their subordinates as a proxy for participation quality: subordinates who have managers' trust and confidence in their jobs were able to perform high quality participation, and subordinates who lacked such trust and

[1] Measurement error is omnipresent in any construct measure (Campbell, 1969). Measurement theory indicates that abstract constructs are more prone to large measurement errors than concrete constructs. An overwhelming error variance could confound an otherwise statistically significant finding. This belief was empirically tested by Cote and Buckle (1987), who found that for abstract constructs, such as attitudes, measurement error variance on average

confidence from their managers could only perform low quality participation. To justify the revision against potential perceptual bias, Ritchie and Miles (1970) argued: based ontheir judgment of subordinates' capability of bringing contributions to a decision making process, superiors limit the participation of incapable subordinates to routine or peripheral issues, while they assign high quality participation to capable subordinates and consult them to more important issues and in a more meaningful manner to utilize their ideas (p. 348-349). They tested their models with a laboratory experiment and found support for their hypotheses. But the departure of the key construct from its theoretical origin, and strong manipulation of its experimental design, impaired the study's credibility as well as the generalizability of the findings to real business environment.

2.3.2. Measuring Participation by Quantity

In the PDM literature, participation is commonly measured by quantity, including studies that address productivity as their dependent variable. The predominance of the use of participation quantity might be attributed to the conceptual simplicity that enables the participation construct being easily measured or manipulated in different research contexts.

Participation quantity can be manipulated in experimental studies as "participation" vs. "no participation" (e.g., Sagie et al., 1990; Latham et al., 1994), or measured by survey instruments in field studies by asking subjects (either workers or managers) for the amount of participative activities that workers have executed during decision making processes, or the

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accounted for 70.2% of the observed variance in measures, while the mean error of all the constructs they tested was about 58.3%.

extent of influence (considered as perceived participation) workers have exerted over the decision in question (e.g., Lischeron and Wall, 1975).

Participation quantity can also be measured or manipulated by participation forms under the assumption that certain forms present more participation than others. For example, Vroom and Yetton (1973) proposed a contingency model in which managers should allow different degrees of participation from workers under different situations in order to improve effectiveness. Hunton and colleagues (1998) studied the effects of participation with and without instrumental voice during decision making processes. The most extensive study on participation forms is probably Cotton and colleagues' (1988) meta-analysis. In this article, they classified participation forms into five categories: (a) formal vs. informal PDM; (b) direct vs. indirect PDM; (c) short vs. long-term PDM; (d) degree of employee influence in the decision making process, and (e) the content of the involved decision. Although their conclusion that certain forms of participation have strong positive effects has received much debate (e.g., Leana et al., 1990; Cotton et al., 1990), the validity of these participation forms have been accepted by many researchers (Wagner, 1994).

2.3.3. Contingency Approach to Test the Participation – Productivity Relationship

In the PDM literature, the participation – job satisfaction relationship has received strong support from empirical research (Locke and Schweiger, 1979; Schweiger and Leana, 1986). In contrast, studies on the participation – productivity relationship have produced much mixed results. In an extensive review of research based on this paradigm, Locke and Schweiger (1979) found that PDM improved production in only 10 out of 46 studies (22%) and it negatively affected production in 10 studies (22%). The results led Locke and colleagues (1986) to conclude that “while participation may improve productivity, participation does not consistently have this effect and, in some cases, is actually less effective than nonparticipation” (p. 69).

According to human resources theory, the weak participation – productivity relationship is due to the lack of counting the nature of participative activities when participation is measured by quantity. Participative activities may not be equally effective among workers and in different situations. Therefore, contingency approaches that incorporate important contextual factors are necessary to justify the participation – productivity relationship.

An influential contingency model was developed by Locke and Schweiger (1979). In this study, Locke and Schweiger theorized two frameworks, cognitive vs. motivational framework, to explain participation effects on productivity vs. attitudinal outcomes. A “cognitive mechanism” was proposed as an intervening mechanism that brings about productivity benefits (such as increased productive efficiency, enhanced decision quality, lower costs, and reduced conflict). The cognitive mechanism includes more upward communication, better utilization of information, and better understanding by employees of the job and the rationale underlying decisions. For this mechanism to have an effect on productivity, contextual factors must be considered. Some commonly suggested contextual factors include motivation, organizational factors, task attributes, group characteristics, leader attributes etc. Among them, having knowledgeable participants is a key requirement for effective PDM. In case of unknowledgeable participants, “PDM would be wasteful of time and effort at best, and harmful to decision quality (if those with less knowledge outvoted the most knowledgeable member) or to efficiency (caused by delays) at worst” (p. 318). Assuming that productivity, and not satisfaction, was the major goal of a profit-making organization, Locke and Schweiger further concluded that “subordinate knowledge is the single most important contextual factor determining the usefulness of PDM" (p. 266).

However, applying the contingency approach will inevitably confront the challenge of measuring knowledge. Given the importance of subordinate knowledge, any contingency model missing such a "single most important factor" could be questioned. However, subordinate knowledge is rarely incorporated in the research on participation effects. As Wagner and colleagues (1997) noted in another participation review study, "in virtually all participation-performance research, information relevant to information spread and impactedness has not been reported" (p.57). They further argued that the lack of incorporating participants' knowledge into their tests as a main reason for most studies failing to conclude positive results based onLocke and Schweiger's (1979) cognitive framework.

2.4. Empirical Research Findings

As an important management practice, participation has received much research attention primarily in the field of organizational behavior, and others such as psychology (e.g., Lind and Tyler, 1988; Lind et al., 1990; Hunton et al., 1998), marketing (e.g., Guiltinan et al., 1980; Campbell and Finch, 2004), and education (e.g., Conway, 1984; Bacharach et al., 1990; Taylor et al., 1994). Numerous empirical studies have tested the participation-outcome relationship, and their results are not consistent (Locke and Schweiger, 1979; Schweiger and Leana, 1986). In this situation, comprehensive literature review is a highly appreciated endeavor to examine a literature body for an overall pattern of findings, or "conclusive answers" to a focused research question. Such an endeavor will help us assess the state of current knowledge, identify “gaps” to direct future research, and advance theory and practices (Guzzo et al., 1987).

Locke and Schweiger’s (1979) influential narrative review study often served as a starting point for the development of new theoretical frameworks of PDM (Wagner et al., 1997). Numerous meta-analyses provided evidence to support or to contest these new theories (e.g., Cotton et al., 1988; Leana et al., 1990; Wagner, 1994), although their results were hardly conclusive because weak findings were often argued to be a result of methodological flaws (Leana et al., 1990) or imperfect testing models (Wagner et al., 1997).

Wagner’s (1994) meta-analysis is a representative one in this area. Wagner quantitatively synthesized research findings from 52 empirical studies of participation. He classified dependant variables into two categories: performance and satisfaction. Results show that participation has statistically strong, and practically small, effects on performance and satisfaction. Mean correlation coefficients ranged from 0.06 to 0.23 (Figure 1 on p. 319), all considered as small in terms of the $r<0.30$ magnitude heuristic suggested by Cohen (1977). To ensure the accuracy and consistency of the findings, Wagner cross-compared 10 other review studies (including both narrative reviews and meta-analyses) and found similar patterns with great consistency. These results challenged the effectiveness of participation as a “silver bullet” in management, with evidence that “contrary to commonly held beliefs, participation truly has no strong, general effects on performance or satisfaction” (p. 326). Wagner (1994) further raised question about the practical significance of participation as a means of enhancing employees’ productivity at work.

3.0. USER PARTICIPATION IN ISD

3.1. DEFINING USER PARTICIPATION

Although the effects of participation are still in debate in the field of organizational behavior and human resources, two derivative concepts, user participation and user involvement, have achieved much consensus among both IS researchers and system development practitioners on their potential to help ISD project teams achieve project success.

Until late 1980s, the terms “user participation” and “user involvement” were used interchangeably in the MIS literature. For instance, Ives and Olson (1984) defined “user involvement” as “participation in the system development process by representatives of the target user group” (p.587). Their proposition of an “involvement taxonomy”, a set of categories of different involvement practices including “No Involvement”, “Symbolic Involvement”, “Involvement by Advice”, “Involvement by Weak Control”, “Involvement by Doing”, and “Involvement by Strong Control”, has been adopted in later studies to describe the various degrees of user participation. The two terms generally took a behavioral tone and dealt with users’ activities in an ISD process (Barki and Hartwick, 1989). The term “involvement” was used to connote the deeper, more committed level of users that was assumed to lead to ISD success (Kirsch and Beath, 1996). However, this interpretation is at odds with the literature in other fields dealing with similar constructs (Barki and Hartwick, 1989; McKeen et al., 1994).

Barki and Harwick's (1989) theoretical study made the first conceptual distinction between user involvement and user participation. After reviewing the study of involvement in the fields of psychology, marketing, and organizational behavior, Barki and Hartwick suggested the term "user involvement" be used when referring to a subjective psychological state and defined as "the importance and personal relevance that users attach either to a given system or to MIS in general" (p. 19); they maintained a behavioral conceptualization for "user participation" and suggested the term be used when "referring to the various design-related behaviors and activities that target users or their representatives perform during the system development process". As it provides conceptual clarity with sound foundations demonstrated in other areas, this distinction has been widely accepted among IS researchers (Kirsch and Beath, 1996). In this study, we reserve the terms "participation" and "user participation" for the execution of these participative activities.

3.2. User Participation Theory

Although no such an explicit label, there exists in the ISD literature a common "theory" of user participation and its relationship to ISD productivity (Ives and Olson, 1984); the reasoning centers on the cognitive effectiveness of user participation.

Users or their representatives are able to bring productivity benefits to an ISD project team because of their knowledge and expertise (Kujala, 2003). Users are experts in their own field and have deep knowledge of the business application that a proposed system is to support.

Since poorly understood requirements of the application domain are often seen as resulting in poor-quality systems (Mumford, 1995), User participation is encouraged as a means of eliciting more accurate user requirements (Howcroft and Wilson, 2003). It is through participation that users or their representatives provide developers the knowledge and information they need to produce a high-quality design (Hwang and Thorn, 1999; Browne and Rogich, 2001).

This line of reasoning suggests a cognitive mechanism to explain the effects of user participation by studying knowledge activities between users and system developers. Because users know best what they really need, both functionality and usability of target system depend on a transfer of knowledge from users to system developers. This knowledge transfer is a complicated process, and system developers often do not have the time, motivation, or prior knowledge to get to know the users' needs (Grudin 1991). User participation is therefore considered an effective solution for establishing a consistent flow of knowledge than to simply involve users in the process. Thus, user participation is a crucial condition for ISD project teams to improve productivity and achieve overall success. In addition, certain types of ISD methods, such as rapid prototyping, have been advocated by many researchers as exemplar user participation practices that lead to higher ISD productivity, as measured both in cost and in time (Baroudi *et al*. 1986; Bewley *et al*., 1983; Boehm *et al*., 1984; Gomaa, 1983; Karat, 1990; Mantei and Teorey, 1988; Strohm, 1991).

3.3. Previous Reviews on User Participation Effects

The premise that user participation is critical to ISD success has provoked numerous studies to investigate the effects of user participation on various ISD outcomes, which can be classified in two categories: attitudinal outcomes and productivity outcomes. To conclude to what extent in general user participation affects these ISD outcomes, researchers often search through previous empirical studies for convergent patterns of their research findings.

Ives and Olson (1984) and Cavaye (1995) are two frequently-cited narrative reviews in this field. The two reviews covered empirical studies published during the time periods of 1959 – 1981 and 1982 – 1992 respectively, and observed with remarkable consistency that only one third of the reviewed studies had concluded statistically significant benefits of user participation on system success. Close examination of their reviews suggests that many studies employed user satisfaction as the dependent variable, on which the effect of user participation had been often concluded as positive and significant; in contrast, few studies investigated productivity outcomes, (Cavaye (1995) did not locate one study in this category), in which the effect of user participation was found to be comparatively weak or even negative. Their results are summarized in Table 1.

Table 1. Results Summarized from Ives and Olson (1984) and Cavaye (1995)

Studies	System Success Measures	Testing Results		
		Positive	inclusive	Negative
Ives and Olson (1984)	System Quality	2	2	2
	System Usage	1	5	0
	User behavior / Attitudes	2	4	1
	Information Satisfaction	5	7	0
	Total	10	18	3
Cavaye (1995)[1]	Influence	1	1	1
	User information satisfaction	4	2	2
	Use	2	0	0
	Other[2]	0	2	1
	Total	7	5	4

Note:

1. Cavaye (1995) reviewed 19 studies during 1982-1992, of which 7 arrived at positive results, 9 inclusive results, and 3 negative results (Table 2 on page 317). But the dependent variables were identified of 16 out of the 19 reviewed studies (Table 4 on page 318); the other 3 studies were not discussed regarding their dependent variables.
2. The type of “other” dependent variable includes progressive use of IT and conflict resolution.

4.0. META-ANALYSIS

Although it is a popular method in IS research (Palvia et al., 2003; 2004), narrative literature review has been criticized by methodologists on its lack of commonly accepted or standardized procedures (Green and Hall, 1984; Hunter and Schmidt, 1990; Rosenthal and DiMatteo, 2001). "Researchers are relatively free to design their review strategy in terms of selecting relevant papers, categorizing research characteristics, and framing outcomes" (King and He, 2005; p. 667), and thus, tend to (consciously or unconsciously) make judgmental conclusions based ontheir background, understanding, or established point-of-view.

A recent trend in research synthesis is to conduct a quantitative review procedure, i.e., meta-analysis, to statistically integrate research results of a literature body (Rosenthal and DiMatteo, 2001; Field, 2001). However, meta-analysis has been rarely applied in IS (King and He, 2005). The only attempt devoted to the user participation topic is Hwang and Thorn's (1999) meta-analysis. In this article, Hwang and Thorn synthesized research findings from 25 empirical studies (published during 1976-1996) and concluded that user participation had a significantly positive effect on ISD outcomes. On the two types of outcomes that had been studied most often, system quality (mean correlation $r = 0.308$, p-value < 0.001) and user satisfaction (mean correlation $r = 0.285$, p-value < 0.001), the effects of user participation are strong in significance and moderate in magnitudes (Cohen, 1992). This conclusion is contradictory to that of the two previous narrative reviews. It is also at odds with the findings of participation effects in other fields (e.g., Wagner (1994) and Wagner et al. (1997), among many other participation meta-analyses in the field of organizational behavior and human resources). Close examination of this meta-analysis raises questions on article selection and results coding. One concern is that studies with negative results were under-represented. Although the authors acknowledged that the user participation literature has yielded "varying results", they located one negative correlation out of 35 sampled effect sizes (see their Table 2 on page 232). As thus, the results could be inaccurate and misleading.

Having a conclusive answer to the general effects of user participation to ISD processes is fundamental to the development and justification of user participation theory. Following the guideline suggested by King and He (2005), I conduct a meta-analysis with a broad coverage of 72 empirical studies. Detailed procedures are reported in the following sections.

4.1. A Brief Introduction of Meta-Analysis

Although not a popular method in IS, meta-analysis is the most commonly used quantitative research synthesis method in the social and behavioral sciences (Hedges and Olkin, 1985). This method grew in popularity since Glass coined the phrase "meta-analysis" in 1976,

> *Meta-analysis refers to the analysis of analyses ... the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings. It connotes a rigorous alternative to the casual, narrative discussions of research studies which typify our attempts to make sense of the rapidly expanding research literature* (Glass, 1976; p.3).

Meta-analysis has been advocated by numerous methodologists as a superior review method to the traditional narrative review method (e.g., Glass, 1976; Hedges and Olkin, 1985; Wolf, 1986; Hunter and Schmidt, 1990; Rosenthal, 1991; Rosenthal and DiMatteo, 2001). A main advantage of meta-analysis is that this method is much less judgmental and subjective than other literature review methods due to its use of quantitative research results and standardized procedure to analyze these results (King and He, 2005).

Basically, a meta-analysis is to calculate a weighted average effect from sampled empirical findings on an interested relationship. This is the same approach used in physical sciences to synthesize results from various laboratory studies (Hedges, 1987).

4.2. PROCEDURE

Although there is no single universally-agreed-upon technique as how to meta-analytically integrate an empirical literature body (Hall et al., 1995), the basic procedures for conducting a meta-analysis are well-understood (Rosenthal and DiMatteo, 2001). Following the guideline suggested by King and He (2005), I conducted a meta-analysis as follows.

4.2.1. Selection of Relevant Studies

To systematically select as many as possible relevant studies, I searched through the following databases with the keywords “user participation, user involvement, or user engagement”.

a. Business Source Premier (EBSCO Host database), a primary business research database, from which about 173 studies are identified, with a wide publication coverage of 1974 - February 2006.

b. Social Science Citation Index (SSCI), another business research database collecting business research since 1992. This database is used to double-check for relevant studies.

c. Digital Dissertations, a database contains citations, abstracts, and/or full texts of doctoral dissertations for all subject areas from over 1,000 accredited colleges and universities in North America and Europe. From this database, 22 doctoral dissertations are identified as relevant.

In addition, bibliographies of previous review studies (i.e., Ives and Olson, 1984; Cavaye, 1995; and Hwang and Thorn, 1999) are scrutinized for additional relevant studies. The comprehensive search resulted in 210 articles in total. Of these, 138 articles were eliminated because they were (a) not empirical studies, or (b) did not involve a direct statistical test on user participation, or (c) were not available either online or through the University of Pittsburgh's Research Library. The resulting 72 studies (including 16 unpublished PhD dissertations) provided data for this meta-analysis. The complete references of these studies are provided in Appendix A.

4.2.2. The Classification of Independent and Dependent Variables

A sampled study was first judged as a user participation study or a user involvement study, based on its detailed measure or assessment of users' participative role in ISD.

Various ISD outcomes have been employed as dependent variables. Following the commonly-accepted scheme in the PDM literature (e.g., Locke and Schweiger, 1979; Cotton et al., 1988; Wagner, 1994; and Wagner et al., 1997) and the user participation literature (e.g., Ives and Olson, 1984; Hwang and Thorn, 1999; and Markus and Mao, 2004), I classified dependent variables into two types – attitudinal outcomes and productivity outcomes. The two types and further categorizations of ISD outcomes are discussed below:

1. Attitudinal Outcomes

Attitudinal outcomes refer to the psychological state as well as consequent behaviors of users or other stakeholders with target systems. These outcomes are classified into two categories: user satisfaction and system use.

a. User Satisfaction

User satisfaction refers to the extent to which users feel target systems or their deliverables (e.g., data and reports derived from using the system) meet their needs, requirements, and expectations. Direct consequences of satisfaction with a system, such as Carayon and Karsh's (2000) job satisfaction, are also classified into this category. User satisfaction is the most common outcome variable used in ISD literature (Ives and Olson, 1984).

b. System Use

This category of attitudinal outcome includes the perceived use, intention to use, real use (often measured by system log-on time), or resistance to use of target systems among users. Some direct determinator of intention to use, i.e., perceived ease of use and perceived usefulness, and system adoption indices at super-individual levels, such as Jarvenpaa and Ives' (1990) progressive use of IT with a firm and Wixom and Watsor's (2001) organizational implementation success, are also classified into this category.

2. Productivity-Related Outcomes

a. Individual Impact

Individual impact refers to the extent to which target systems help users enhance their job performance or increase their task productivity. Individual impact is often used in experimental studies, where subjects' task productivity can be readily measured.

b. Team Performance

Team performance measures the extent to which ISD project teams are effective on delivering quality systems. Team performance is often measured on the meet of budget, schedule, users' needs, and information requirements. Some conceptually-narrow constructs, such as Brodbeck's (2001) team viability that focuses on within-team cooperation, are also considered in this category.

c. Organizational Impact

Organizational impact refers to the extent to which target systems help organizations to enhance overall performance. An exemplar variable in this category is Palanisamy and Sushil's (2002) IS enablement for competitive advantage.

d. Project Quality

Project quality is often measured on the extent to which target systems are efficient, reliable, accurate, easy, and secure to produce the information that users need. Besides composite instruments to assess relevant system features (e.g., Rivart et al.'s (1997) 14-item instrument, and Barki et al.'s (2001) 18-item instrument), variables that focus on certain aspects of system quality, such as Palanisamy's (2005) IS flexibility, Brodbeck's (2001) system changeability, Wixom and Watson's (2001) data quality, are included in this category.

e. Project Success

Project success refers to the overall performance of ISD project developments with a focus on efficiency and productivity (e.g., completing the project on time, on budget, with the proper functionality). Variables that assess ISD project performance by measuring the acceptance or resistance of target systems among users (e.g., Wixom and Watson's (2001) organizational implementation success) are moved to system use category. Besides comprehensive assessment of various success criteria (e.g., Yoon et al.'s (1998) overall success, Brodbeck's (2001) composite performance index), some variables focus on the implementation stage of system development, such as Wixom and Watson's (2001) project implementation success and Gottschalk's (1999) plan implementation success.

4.2.3. The Statistics Collected for the Meta-Analysis

To conduct a meta-analysis, basic statistics include effect sizes (the most popular form is Pearson's correlation coefficients *r*) and sample sizes; construct reliabilities and measurement error indexes may be included to justify results against possible measurement errors; some research contexts are often included to analyze possible moderating effects (King and He, 2005).

In this study, I collected Pearson's *r*, sample size, ISD developmental environment (traditional developer-centered environment, user-centered environment, or cross-systems non-conclusive environment) as a possible moderator, and number of items of user participation instrument as an index of measurement complexity. Construct reliabilities were not collected in that the sampled studies had employed various instruments, ranging from a single-item instrument to measure the overall perception of the extent of user participation (e.g., Saleem, 1996; Yetton et al., 2000), to a 44-item instrument to measure the execution of many detailed activities (e.g., Hartwick and Barki, 2001). Different instruments might not be compatible, although they basically measured the same construct. Instead, the number of items used in each instrument may serve as an indicator of measurement accuracy, with the premise that surveying more detailed activities would lead to accurate assessment – an approach advocated by Ives and Olson (1984) and notably practiced by Barki, Hartwick, and colleagues (e.g., Hartwick and Barki, 1994, 2001; Barki et al., 2001).

4.2.4. The Treatment of Effect Sizes

Effect sizes were Pearson's correlation coefficients in this meta-analysis. Most studies reported correlation coefficients between user participation and outcome variables. If a study has more than one effect size regarding a particular relationship based onthe classification of dependent variables, the effects were scrutinized for their similarities (are they close in magnitude) and contexts (are they calculated from the same sample). The following decision rule was used to ensure the accuracy and consistency of coding these research results.

1. If multiple effect sizes were calculated from the sample population, and their magnitudes of effect sizes were close, these effect sizes were combined by calculating their average. This approach is suggested by Rosenthal and DiMatteo (2001) as a conservative way to reduce bias toward certain study (if multiple effect sizes were treated separately, the same study would be over-weighted in that each effect size would be treated with the same weight of other single studies). One example is Wixom and Watson's (2001) study of the implementation of data warehouse. In this study the effects of user participation were tested on system quality (r = 0.005) and

data quality (r = 0.052). Their average (r = 0.0285) is used for project quality in this meta-analysis.

2. Multiple effect sizes would be treated separately if (1) they were very different in magnitude; or (2) they were calculated from different sample populations. For example, on a study of user-led development, Lawrence and Low (1993) surveyed end-user communities for two systems developed in a large Australian government corporation. The sample populations for the two systems were not identical. The resulting effects were coded separately in this meta-analysis.

4.2.5. Meta-Analytic Calculation

In total, 72 studies provided 120 effect sizes for this meta-analysis. The sampled studies and their research results (effect sizes and sample sizes) are reported in Table 2 for user participation studies, and in Table 3 for user involvement studies.

Table 2. Effect Sizes and Sample Sizes of Sampled User Participation Studies

Studies	Attitudinal Outcomes		Productivity Outcomes				
	User Satisfaction	System Use	Individual Impact	Team Performance	Org. Impact	Project Quality	Project Success
Swanson (1974)	0.51 (37)	0.28 (37)					
Sartore (1976)	0 (14)		0 (14)				
Edstrom (1977)							0.51 (16)
Maish (1979)						0.2 (56)	
Ginzberg (1981)	0.21 (20)	-0.06 (27)					
Ginzberg (1981) b							0.39 (35)
King and Rodriquez (1981)	0 (45)		0 (45)				
Olson and Ives (1981)	0.07 (83)					0.13 (83)	
Weitzel (1984)						-0.01 (75)	
Baroudi et al. (1986)	0.18 (200)	0.28 (200)					
Beatty (1986)	0.42 (250)						
Franz and Robey (1986)		0.29 (118)					
Kim and Lee (1986)		0.2 (134)					
Pyle (1986)						0.27 (55)	
Doll and Torkzadeh (1989)	0.32 (618)						
Barki and Huff (1990)	0.68 (42)	0.64 (42)					
Doll and Torkzadeh (1991)	0.32 (443)						
Jarvenpaa and Ives (1991)		0.39 (55)					
Allingham and O'Connor (1992)	0.34 (77)						
Farhoomand (1992)							0.15 (204)
Hardgrave (1993)							0.18 (100)

Studies	Attitudinal Outcomes		Productivity Outcomes				
	User Satisfaction	System Use	Individual Impact	Team Performance	Org. Impact	Project Quality	Project Success
Leonard-Barton and Sinha (1993)	0.55 (34)					-0.09 (34)	
Ngin (1993)		0.19 (523)					
Hartwick and Barki (1994)		0.18 (127)					
Igbaria and Guimaraes (1994)	0.45 (185)	0.4 (185)				0.27 (185)	
McKeen et al. (1994)	0.41 (151)						
Seddon and Kiew (1994)	0.46 (101)	0.62 (101)				0.37 (101)	
Steinbart and Accola (1994)	0.42 (78)		0.06 (78)				
Sioukas (1995)	0.41 (75)						
Wastell and Sewards (1995)							0 (92)
Yoon and Guimaraes (1995)	0.34 (69)	0.12 (69)					
Yoon et al. (1995)	0.34 (69)						
Choe (1996)	0.35 (101)	0.37 (101)					
Guimaraes et al. (1996)	0.09 (114)	0.2 (114)					
Heinbokel et al. (1996)				-0.38 (26)			-0.47 (25)
Hunton (1996)			0.20 (726)				
Saleem (1996)	0.29 (60)	0.37 (60)					
	0.20 (520)						
Stanford (1996)		0.11 (212)					
Guimaraes et al. (1997)	0.40 (62)						0.27 (62)
Hunton and Beeler (1997)			0.29 (162)				
Hunton and Price (1997)	0.19 (144)		0.58 (144)				
Jackson et al. (1997)		-0.15 (111)					

Studies	Attitudinal Outcomes		Productivity Outcomes				
	User Satisfaction	System Use	Individual Impact	Team Performance	Org. Impact	Project Quality	Project Success
Lu and Wang (1997)	0.48 (52)						
	0.38 (31)						
	0.54 (89)						
Mak and Schmitt (1997)		0.11 (73)					
McKeen and Guimaraes (1997)	0.42 (151)						
Sherman (1997)	0.15 (607)						
Choe (1998)	0.25 (450)	0.33 (450)					
Foster Jr. and Franz (1998)		0.31 (148)					
Yoon et al. (1998)	0.40 (62)						0.27 (62)
Zeffane et al. (1998)						0.11 (308)	
Foster Jr. and Franz (1999)		0.42 (87)				-0.05 (87)	
Gottschalk (1999)							0.23 (151)
Hardgrave et al. (1999)	0.17 (111)						
Carayon and Karsh (2000)	0.45 (49)						
Lin and Shao (2000)	0.37 (32)						
Swanson (2000)	0.12 (194)						
Yetton et al. (2000)				0.36 (74)			
		-0.06 (74)		-0.01 (74)			
Banna (2001)					0.11 (83)		
Barki et al. (2001)						-0.01 (75)	
Brodbeck (2001)				-0.59 (21)		-0.50 (21)	-0.62 (21)
Doll and Deng (2001)	0.36 (239)		0.05 (239)				
	0.37 (163)		0.25 (163)				

Studies	Attitudinal Outcomes		Productivity Outcomes				
	User Satisfaction	System Use	Individual Impact	Team Performance	Org. Impact	Project Quality	Project Success
Palanisamy and Sushil (2001)	0.52 (104)						
Wixom and Watson (2001)		0.35 (111)				0.03 (111)	0.34 (111)
Lawrence et al. (2002)	0 (180)	0 (180)	-0.25 (90)				
Palanisamy and Sushil (2002)					0.17 (27)		
Parker (2002)		0.14 (69)					
Procaccino (2002)				0.36 (147)			
Tarnow (2002)							0.30 (69)
Woods (2002)	0.18 (96)	0.28 (96)					
Poku (2003)		0.35 (169)					
Palanisamy (2005)						0.26 (296)	

Note:

1. Effect sizes are Pearson's correlation coefficients; sample sizes are reported in parenthesis.
2. In total, 71 studies provided 109 effect sizes.

Table 3. Effect Sizes and Sample Sizes of Sampled User Involvement Studies

Studies	Attitudinal Outcomes		Productivity Outcomes				
	User Satisfaction	System Use	Individual Impact	Team Performance	Org. Impact	Project Quality	Project Success
Jarvenpaa and Ives (1991)		0.34 (55)					
Lawrence and Low (1993)	0.72 (59)						
	0.66 (96)						
Hartwick and Barki (1994)		0.44 (127)					
Stanford (1996)		0.11 (212)					
Hunton and Beeler (1997)					0.18 (162)		
Jackson et al. (1997)		0.20 (111)					
Sherman (1997)	0.64 (391)				0.61 (391)	0.50 (391)	
Lin and Shao (2000)	0.63 (32)						

Note:

1. Effect sizes are Pearson's correlation coefficients; sample sizes are reported in parenthesis.
2. In total, 8 studies provided 11 effect sizes.

Hedges-Olkin's (1985) random effects method was used as the primary calculation procedure for the meta-analysis. Hedges-Olkin (1985) is one of three well-developed meta-analytic procedures that have been widely applied in social and behavioral sciences (Field, 2001; 2003). Basically, effect sizes are first transformed into Fisher's *z*; weights of individual studies are calculated based on sample sizes (using a chi-square analysis of sampling errors); a homogeneity test (chi-square test) is performed to justify the use of certain effect-size-integration model (in this case, the random model); then, a weighted average is calculated from transformed effect sizes, so do the associating standard deviation, Z-statistic, and 95% confidence intervals. Finally, these statistics are transformed back to their standard forms for interpretation.

Key statistics and results of the meta-analysis are presented in Table 4 and Table 5.

Table 4. Meta-Analysis Results of User Participation Effects

	Attitudinal Outcomes			Productivity Outcomes					
	Overall	User Satis.	System Use	Overall	Indiv. Impact	Team Perf.	Org. Impact	Project Quality	Project Success
Number of Samples	68	41	27	41	9	5	2	13	12
Total Sample Sizes	9875	6202	3673	4548	1661	342	110	1487	948
Average Sample Size	145	151	136	111	185	68	55	114	79
Homogeneity Test (Q)	79.692	44.309	31.398	60.435	10.077	5.781	0.034	15.128	19.343
p-value (Q)	0.138	0.295	0.214	0.020	0.26	0.216	0.854	0.235	0.055
Integrated Effect Size	0.294	0.320	0.255	0.134	0.163	-0.015	0.135	0.119	0.160
p-value (*r*, 2-sided)	0.000	0.000	0.000	0.000	0.033	1.000	0.389	0.011	0.013
95% Low (*r*)	0.257	0.274	0.19	0.070	0.013	-0.333	-0.172	0.027	0.034
95% High (*r*)	0.330	0.364	0.317	0.197	0.305	0.306	0.419	0.209	0.282
Suggested Sample Size	88	74	118	435	293	-	425	549	302

Table 5. Meta-Analysis Results of User Involvement Effects

	Attitudinal Outcomes			Productivity Outcomes					
	Overall	User Satis.	System Use	Overall	Indiv. Impact	Team Perf.	Org. Impact	Project Quality	Project Success
Number of Samples	8	4	4	3	2	0	0	1[a]	0
Total Sample Size	1083	578	505	944	553	-	-	-	-
Average Sample Size	135	145	126	315	277	-	-	-	-
Homogeneity Test (Q)	5.870	0.67	2.517	2.684	1	-	-	-	-
p-value (Q)	0.555	0.88	0.472	0.261	0.317	-	-	-	-
Integrated Effect Size	0.489	0.661	0.268	0.450	0.418	-	-	-	-
p-value (*r*, 2-sided)	0.000	0.000	0.003	0.000	0.086	-	-	-	-
95% Low (*r*)	0.297	0.58	0.095	0.223	-0.063	-	-	-	-
95% High (*r*)	0.644	0.728	0.424	0.631	0.741	-	-	-	-
Suggested Sample Size	30	15	106	36	42	-	-	-	-

Note:

1. The only study in this category was conducted by Sherman (1997) with a high effect size of 0.502 and a large sample size of 391.

4.2.6. Concerns of the Meta-Analysis

Although employing a rigorous and quantitative procedure, a meta-analysis could be questioned on issues such as publication bias, "apples and oranges", and small sample sizes (King and He, 2005). These concerns should be dealt with to justify the reliability and generalizability of the meta-analytic results.

- Publication Bias

Publication bias refers to the observation that significant results are more likely to be published while non-significant results tend to be relegated to file drawers. If only published studies are surveyed in a meta-analysis, the results may not represent a total research population and therefore suffer publication bias.

The best solution to avoid publication bias is to search multiple databases in a systematic way and sample studies from various sources (Rosenthal and DiMatteo, 2001). In this study, I have searched through three research databases as well as the bibliographies of previous review studies for relevant articles. Besides published journal articles, the final sample also includes 16 unpublished PhD dissertations. A comparison among different samples of dissertations only, with dissertations, and without dissertations was conducted and the results are reported in Table 6. Examination on the integrated effect sizes and the associated confidence intervals suggests that inclusion or exclusion of unpublished dissertations does not affect the general results of user participation effects on either attitudinal outcomes or productivity outcomes. Therefore, publication bias should not be a concern for this meta-analysis.

Table 6. Integrated Effect Sizes of Dissertations, with Dissertations, and without Dissertations

	User Participation Effects on Attitudinal Outcomes			User Participation Effects on Productivity Outcomes		
	Dissertations Only	With Dissertations	Without Dissertations	Dissertations Only	With Dissertations	Without Dissertations
Number of Samples	10	68	58	10	41	33
Total Sample Size	2230	9875	7645	1350	4548	3801
Average Sample Size	223	145	132	135	111	115
Integrated Effect Size	0.214	0.294	0.310	0.238	0.134	0.116
p-value (2-sided)	0.000	0.000	0.000	0.016	0.000	0.003
95% Low	0.138	0.257	0.268	0.046	0.070	0.040
95% High	0.288	0.330	0.350	0.414	0.197	0.191

Note:

1. Due to the small number of dissertations, analysis is not conducted for their subcategories of attitudinal outcomes and productivity outcomes.

- Apples and Oranges

One criticism of meta-analysis is that it may compare "apples and oranges," aggregating results derived from studies with incommensurable research goals, measures, and procedures. This problem is not of dominant significance, especially when we want results that are generalizable to "fruits", or to a broad research domain (King and He, 2005).

Studies sampled for this meta-analysis used different measurements to capture user participation, including manipulations, single-item instruments, and multiple-item instruments that range from as simple as of 2 items to as comprehensive as of 44 items. Because the purpose of this meta-analysis is to study user participation as a general phenomenon in ISD contexts, not a particular practice standard or a certain system development technique, these measures are treated equally in this meta-analysis.

As to the dependent variables, special attention has been placed to avoid "the problem of attempting aggregation of too diverse a sampling of studies" (King and He, 2005; p. 672). Each effect size was categorized based on the detailed measure, not the label, of its dependent variable. For example, Wixom and Watson (2001) used "organizational implementation success" and "project implementation success" as two dependent variables in their study. The former was placed in the category of system use because it measured political resistance as an important dimension; the latter was placed in the category of project success in that it measured "implementation-level success in completing the project on time, on budget, with the proper functionality" (p. 30). As thus, the concern of comparing "apples and oranges" should be largely alleviated for this meta-analysis.

- Small Sample Size

This meta-analysis sampled as many as 72 empirical studies of user participation and use involvement, the most aggressive attempt in terms of sampling. In contrast, another meta-analysis on this topic, Hwang and Thorn (1999), sampled 25 studies. The broad coverage of relevant studies adds credibility to the results of the meta-analysis as representing the investigated research domain (King and He, 2005).

However, one should note that several categories, such as team performance and organizational impact, have included few empirical studies. This reflects that ISD outcomes in those categories have been under-investigated in the literature. Because the statistical power of meta-analysis depends on both the number of studies and the total cumulated sample sizes (King and He, 2005), results in those categories should be interpreted with caution.

4.3. DISCUSSION OF THE RESULTS

In general, user participation and user involvement have statistically strong and positive effects on both attitudinal and productivity outcomes. Further analysis of the results reveals that:

1. Although not a focus of this thesis, the effects of user involvement were studied as a separate topic in the meta-analysis. In total, eight studies were identified as user involvement studies, all addressing attitudinal outcomes; three out of the eight studies also investigated the user involvement – ISD productivity relationship, including two focusing on individual impacts and one addressing project quality. The very limited sample size of user involvement studies restricts the generalizability of the meta-analysis on this topic and the results should be interpreted with caution.

2. Of the user participation research, the most commonly-used dependent variables are user satisfaction (used in 41 studies) and system use (used in 27 studies), all following into the type of attitudinal outcomes. In contrast, less number of studies investigated ISD productivity outcomes. Particularly on super-individual impacts of ISD such as team performance and organizational impact, only five and two studies addressed them respectively.
3. In general, the effects of user participation on attitudinal outcomes are statistically significant and moderate in magnitudes. The average effect of user participation on attitudinal outcomes (0.294 in overall, 0.32 on user satisfaction, and 0.255 on system use) falls in the range of $r = 0.3$ and is assessed as moderate by common heuristics in the social and behavioral sciences (Cohen, 1992).
4. In contrast, the effects of user participation on ISD productivity are statistically significant but small in magnitudes. The integrated overall effect of 0.134 falls in the range of $r < 0.2$ and is typically assessed as small in the social and behavioral sciences (Cohen, 1992).
5. The effect of user participation is particularly weak on project quality ($r = 0.119$) and on team performance. The latter has a slightly negative mean correlation coefficient ($r = -0.082$). The associated p-value suggests that in general user participation should not be considered as a predictor for team performance.
6. The average sample sizes of the sampled studies addressing team performance, organizational impact, and overall project success, are comparatively small (68, 55, and 79 respectively), indicating the difficulty of collecting data at super-individual levels.

The conclusion 2 and 3 imply that user participation has a stronger effect on ISD attitudinal outcomes than that on ISD productivity outcomes. Examination on the confidence intervals of the two types of outcomes suggests the difference is significant at $\alpha = 0.05$ level.

As many studies have investigated both types of outcomes, it is possible to perform a within-study comparison of user participation effects on the two types of ISD outcomes. Within-study comparison removes possible confounding factors arising from the use of different research contexts, different samples, and different data analysis techniques across studies. Thus, it will provide more rigorous and accurate result.

From the literature, I have identified fifteen user participation studies that performed have addressed both types of ISD outcomes. A z^* test is conducted of each individual study to compare user participation effects on the two types of outcomes. Stouffer's Z procedure is used to integrate individual z^*'s and test on the overall difference. Their results are summarized in Table 7.

Table 7. Evidences of Difference Effects of User Participation

Papers	Attitudinal Outcomes[1]	Productivity Outcomes[1]	Sample Size	z*-test[2]
1. Sartore 1976	0	0	14	0
2. King and Rodriquez 1981	0	0	45	0
3. Olson and Ives 1981	0.07	0.13	83	-0.383
4. Leonard-Barton and Sinha 1993	0.55	-0.09	34	2.790**
5. Igbaria and Guimaraes 1994	0.425	0.27	185	1.688
6. Seddon and Kiew 1994	0.537	0.367	101	1.499
7. Steinbart and Accola 1994	0.42	0.06	78	2.374*
8. Guimaraes et al. 1997	0.40	0.27	62	0.797
9. Hunton and Price 1997	0.193	0.58	144	-3.921***
10. Yoon et al. 1998	0.40	0.27	62	0.797
11. Foster Jr. and Franz 1999	0.42	-0.05	87	3.226**
12. Yetton et al. 2000	-0.06	-0.01	74	-0.298
13. Doll and Deng 2001[3]	0.368	0.253	163	1.136
	0.362	0.051	239	3.566***
14. Wixom and Watson 2001	0.353	0.182	111	1.356
15. Lawrence et al. 2002	0	-0.246	150	2.153*
On Average	0.277[4]	0.127[4]	102	4.195***[5]

Note:

1. The statistics are the average correlation coefficients reported in the two outcome categories.
2. The null hypothesis tested here is that user participation has a correlation coefficient with attitudinal outcomes equal to that with productivity outcomes. The test statistic makes use of the Fisher z transformation for each of the two correlation coefficients. z* is calculated as the difference between the two Fisher z transformations divided by square root of 2/(sample size - 3). When sample size is reasonably large (i.e., >=25), z* presents an approximately standard normal distribution.
3. Doll and Deng (2001) tested the effects of user participation in two different subgroups involving the use of non-collaborative vs. collaborative applications. The results from the two subgroups are sampled here separately.
4. These statistics are the means of individual effect sizes in their categories.
5. The overall z* is calculated by combining individual z*s using Stouffer's Z procedure. The computational formula is $Z = \frac{1}{\sqrt{k}} \sum_{i=1}^{k} (z*_i)$, where *k* is the number of sampled data sets.
6. Significance scale: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-sided).

The fifteen studies clearly demonstrate that user participation has a comparatively stronger (larger in magnitudes and smaller in *p*-values) effect on attitudinal outcomes than that on productivity outcomes. The integration analysis substantiates the difference with a *p*-value less than 0.001.

5.0. RETHINKING USER PARTICIPATION

As revealed in the meta-analysis in Chapter 4, the productivity benefits of user participation are not as strong as the common user participation theory suggests. A comparison of the empirical findings of user participation with that of participation effects in general organizational settings (i.e., PDM) may provide insights on the observed contradiction, imply limitation of current theory, and provoke new thinking on how user participation takes effects in ISD processes.

5.1. COMPARING USER PARTICIPATION EFFECTS IN ISD WITH PARTICIPATION EFFECTS IN PDM

Numerous narrative reviews and meta-analyses have been conducted in the PDM literature to synthesize the effects of participation on satisfaction and productivity. Among them, Wagner and colleagues (1997) reviewed 86 published studies and conducted a meta-analysis on 124 correlation coefficients obtained from them. The number of sampled effect sizes is close to that of the meta-analysis conducted in Chapter 4. As to meta-analytic procedures, Wagner and colleagues selected Hunter and Schmidt's (1990) procedure, and I used Hedges-Olkin's (1985) random effects model. The two procedures have been compared in several studies (e.g., Johnson et al., 1995; and Field, 2001) with conclusion that the two will produce similar results from the same data set. In fact, meta-analysis is usually advocated as a "formalized systematic review" procedure (Hunter and Schmidt, 1990). "Given the same set of data or sampled effect sizes from a literature body, different researchers should arrive at the same conclusion via meta-analysis" (King and He, 2005; p. 673).

Therefore, I use the results from Wagner et al. (1997) as a reference to compare participation effects in ISD with that in PDM. The comparison focuses on overall effects of participation since different schemes were employed to classify sampled studies into detailed outcome categories in the two meta-analyses. The results are summarized in Table 8.

Table 8. Comparison between the Results of Wagner et al. (1997) and This Meta-Analysis

Participation Effects		Wagner et al., 1997[1]	This Meta-analysis
on Attitudinal Outcomes	Number of Sampled Effect Sizes	69	68
	Total Sample	13585	9875
	Integrated Effect Size	0.3	0.294
	95% Low	0.28	0.257
	95% High	0.32	0.330
on Productivity Outcomes	Number of Sampled Effect Sizes	55	41
	Total Sample	5287	4548
	Integrated Effect Size	0.21	0.134
	95% Low	0.18	0.070
	95% High	0.24	0.197

Note:

1. Data of Wagner et al. (1997) are collected from their Table 2 of Meta-analysis results on page 56.
2. Wagner et al. (1997) used satisfaction for attitudinal outcomes, and performance for productivity outcomes.

Both meta-analyses conclude that participation has positive effects on both attitudinal outcomes and productivity outcomes. Close examination of the integrated effect sizes reveals that the concluded participation effects are almost identical on attitudinal outcomes in the two meta-analyses, but very different on productivity outcomes, as suggested by their rarely overlapped 95% confidence intervals. A comparison[2] between the two integrated effect sizes on productivity substantiates a statistically significant difference ($Z = 2.09$, p-value = 0.018).

The difference of participation effects on productivity between the two meta-analyses may reflect different participation practices in the context of their research domains. PDM take general organizational setting as its research context, and there is no common rule to guide participation. Workers involve in decision making processes in various forms in adapt to different decision environments. In contrast, the user participation literature studies participation in restricted ISD contexts, where semi-standard procedures do exist to guide user participation practices. The prescriptive literature (e.g., textbooks, handbooks, and others that provide guidelines and recommendations to ISD practices) is quite consistent on how user participation should be practiced. ISD project teams have commonly accepted these guidelines. As observed by Kirsch and Beath (1996), the practice of user participation helps ISD project teams to develop systems in a smooth and formalized manner. As thus, user participation may be over-practiced if most ISD project teams follow these participation procedures. When exceeding the capability of user participants, participation may not deliver the expected productivity benefits.

Another implication from the comparison of the two meta-analyses is that participation has a smaller effect on productivity than that on attitudinal outcomes. Following the human

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[2] The comparison is based on a Z-test, treating the two integrated effect sizes and their associated variances as population estimations that are generalizable beyond the restricted data samples. The formula is $z = \frac{r_1 - r_2}{\sqrt{\delta_1^2 + \delta_2^2}}$.

resources theory as well as the cognitive framework of participation proposed by Locke and Schweiger (1979), the small effect of participation may be a result of ignoring participants' knowledge and expertise as the significant determinant of productivity.

In line of this reasoning, Wagner and colleagues (1997) tested the moderating effects of cognitive framework on the study of participation, and failed to conclude any improvement on the results. Wagner and colleagues attributed this to the lack of report in their sampled studies on the extent to which the knowledge and expertise of involved workers are necessary and needed for production reasons.

Similarly, empirical research on user participation has rarely reported or assessed the knowledge and expertise of user participants. One exception is Saleem (1996), where the expertise of user participants was manipulated in an experimental study and assessed in a field study. The dependent variables used in that study included system use, system resistance, and user satisfaction, all were attitudinal outcomes.

Theoretical and qualitative studies have repeatedly highlighted the importance of users' knowledge and expertise. For example, Ives and Olson (1984) proposed a cognitive framework of user participation, Curtis et al. (1988) found many ISD project teams lack needed business knowledge to develop quality systems, Kirsch and Beath (1996) observed that unknowledgeable user participants did not contribute meaningfully during system development processes, and Damodaran (1996) discussed the selection of appropriate user participants as a strategy to achieve development success, to name a few. However, user participants' knowledge and expertise have rarely been included in empirical studies.

5.2. CHALLENGING USER PARTICIPATION THEORY

User participation is advocated because system developers "do not usually possess the knowledge and experience of the current and future users" (Damodaran, 1996; p. 366). For this reason, one may expect that the participation effect on productivity should be stronger in ISD contexts than that in general organizational settings, the research contexts of PDM. Evidence of the meta-analysis fails to substantiate this expectation; in fact, the results conclude that the opposite is true, as discussed in the conclusive section of chapter 4.

Many researchers have noticed that the effects of user participation are weak or contradictory to theoretical expectations. Much of the discussion focuses on measurement issues, arguing that equivocal results were most caused by the inaccurate assessment of user participation. In their influential review study, Ives and Olson (1984) provided guidelines to better capture the effects of user participation, including three solutions to improve the research on user participation: (a) to solidify a conceptual foundation to guide measurement development; (b) to avoid the use of general opinion measures; and (c) to employ a rigorous program of measurement validation.

Subsequent researchers have developed better measurement and employed sounder research methodologies (Cavaye, 1994). However, empirical studies still produce equivocal results regarding user participation effects on ISD productivity outcomes, implying a necessity to rethink user participation theory.

At its cognitive core, user participation theory highlights the importance of users' business knowledge and expertise, and proposes user participation as an effective solution to bring ISD project teams the needed knowledge. The theory assumes a high correlation, if not an equivalence, between participation and the effectiveness of transferring the needed knowledge to system developers. In other words, the execution of certain set of activities has been assigned with the potential effectiveness of these activities. The assumption could be problematic. As pointed out by Hartwick and Barki (2001), participation should "not (be) viewed as reflecting the type, style, timing, or effectiveness of these activities" (Hartwick and Barki, 2001; p. 32). In some extreme cases, participation could be symbolic activities that provide no input to ISD processes (Kirsch and Beath, 1996). Simply assuming the effectiveness of participation without investigating the nature of these activities could lead to insignificant or contradictory results.

6.0. A KNOWLEDGE THEORY OF USER PARTICIPATION

This study proposes a knowledge theory to explain how users bring productivity benefits to ISD project teams. Under the theory, a new construct, "knowledge participation", is proposed to capture users' knowledge contribution to ISD processes; and a cognitive intervening mechanism, "team cognition", is proposed to transfer knowledge inputs from users into ISD productivity outcomes.

6.1. KNOWLEDGE PARTICIPATION AS A NEW CONSTRUCT

Both the PDM literature and the ISD literature suggest that when addressing productivity-related outcomes, the effectiveness of participation is a more important determinant than the quantity of participation. Following Human Resources Theory, a viewpoint developed here is that participation quality should be conceptualized as the effectiveness of a participant's contribution of needed *knowledge* and *expertise* to a decision-making process.

To capture the effectiveness of users' participative activities in ISD, one needs to: 1) identify the activities; and 2) assess the effectiveness of those activities using an approach that is consistent with the desired outcome. ISD research has studied the typical activities and behaviors of user participants, and identified their key dimensions or categories. Given the good understanding of the activities of participation in ISD, it is appropriate for us to move to the next step toward understanding the effectiveness of participation.

This study proposes "knowledge participation" as a new construct to assess the effectiveness of participation. Knowledge participation is conceptualized as the amount of knowledge that users contribute to an ISD process via participation. This concept has two elements: the "participation" element refers to users' participative activities, main categories of which have been identified and well studied in previous research (e.g., Doll and Torkzadeh, 1989; Baroudi et al., 1986; Hartwick and Barki, 1994, 2001); and the "knowledge" element refers to the information and expertise that user participants bring to an ISD process, a cognitive approach to assess the effectiveness of participation. To justify the proposition of this new construct, it is necessary for us to review the development of user participation construct for its reliability and comprehensiveness of reflecting user participative activities, and then to review the ISD and the knowledge acquisition literature for the credibility and measurability of application domain knowledge to capture the effectiveness of participation. Construct operationalization will also be discussed.

6.1.1. Development of User Participation Construct

User participation has been studied over four decades. But the measurement of this construct had been criticized for lack of validity. For instance, Ives and Olson (1984) criticized the user participation instruments from previous studies for: 1) the lack of a conceptual foundation to guide measurement development; and 2) the absence of a rigorous program of measurement validation. Following their call for rigorous attention to measurement, many researchers pursued the construct improvement to better capture users' participative behaviors in an ISD process. Among them, Barki and Hartwick's effort is one of the most influential work.

In their 1989 paper, Barki and Hartwick (1989) conceptually distinguish user participation from user involvement, referring the latter as subjective psychological state and defining it as "the importance and personal relevance that users attach either to a given system or to MIS in general" (p. 19); they maintained a behavioral conceptualization for "user participation" and suggested the term be used when "referring to the various design related behaviors and activities that target users or their representatives perform during the system development process". This distinction provides conceptual clarity with sound foundations demonstrated in other areas, and has been widely accepted among IS researchers (Kirsch and Beath, 1996).

The behavioral conceptualization of user participation directs the operationalization of the construct. It suggests the construct of user participation be measured by "asking users to indicate the frequency, the extent or the degree to which they have performed specific ISD-related assignments, activities, and behaviors" (Hartwick and Barki, 2001; p.32). Following this guideline, Hartwick and Barki developed and validated an instrument with 4 broad dimensions: "responsibility" (i.e., the performance of activities and assignments reflecting overall leadership or accountability for the project), "user-IS relationship" (i.e., the performance of development activities reflecting users' formal review, evaluation, and approval of work done by the IS staff), "hands-on activity" (i.e., the performance of specific physical design and implementation tasks) (Barki and Hartwick, 1994), and "communication activity" (i.e., activities involving exchanges of facts, needs, opinions, visions, and concerns regarding the project among the users and between users and other project stakeholders) (Hartwick and Barki, 2001). Following a rigorous procedure of construct validation and testing, they produced an instrument of 38 behaviorally-anchored items (Hartwick and Barki, 2001).

Hartwick and Barki's instrument stands out as a high quality instrument in IS as it demonstrates both a solid conceptual foundation and a strictly tested validity of the construct. In addition, by focusing on specific behaviors and activities, Hartwick and Barki's instrument is behaviorally anchored, therefore reducing perceptual and reporting biases often associated with instruments asking for a subject's general opinions (Hartwick and Barki, 2001).

Hartwick and Barki (2001) acknowledged the conceptual difference between user participation and its effectiveness. For instance, certain types or styles of participative behaviors may be more appropriate or effective than others, but they may present similar amount or extent of participation. They further contended:

> "It would be too simplistic or naive to expect level of participation as a simple count or frequency variable to have a strong effect on, say, user satisfaction or system success…We view our research as identifying the key dimensions or categories of activities that need to be taken into account when assessing user participation" (Hartwick and Barki, 2001; p. 33).

As the key dimensions of user participative activities have been identified, I propose to step further to assess these activities on their effectiveness of bringing needed resources to impact ISD productivity. As suggested by Hartwick and Barki, "It is through such research that the true magnitude of participation's impact on system success will begin to emerge" (Hartwick and Barki, 2001; p.33).

6.1.2. Knowledge as Participation Effectiveness

The ISD literature generally suggests knowledge as the key dimension to assess the effectiveness of participation. ISD project development is knowledge intensive work (Faraj and Sproull, 2000). This determines the nature of user participation as to provide users' knowledge and skills to development tasks (Ravichandran and Rai, 1999). The PDM literature also suggests knowledge contribution as a key element of participation effectiveness, especially when productivity-related variables are the desired outcomes of investigation.

In addition, users' knowledge and expertise, often labeled in ISD literature as *application domain knowledge*, or the "knowledge of application domain area and client operations" (Faraj and Sproull, 2000; p. 1559), is a prerequisite for the successful development of an ISD project (Boland, 1978; Ives and Olson, 1984; Newman and Noble, 1990; Walz et al., 1993; Faraj and Sproull, 2000) but it is often thinly spread through the project team (Curtis et al., 1988; Kraut and Streeter, 1995). The lack of application domain knowledge may lead to inaccurate or incomplete information requirements, which has been claimed as a key factor for many IS failures (Cooper and Swanson, 1979; Davis, 1982; Telem, 1988). Therefore, system developers always consider it a big challenge to efficiently obtain application domain knowledge. And, it is this concern that drives the development of various technologies and methods to facilitate the acquisition of such knowledge (Byrd et al. 1992).

Users have accumulated rich application domain knowledge through a long period of exposure to their job context. They are the best candidates to provide such expertise (Lucas, 1974), and to help the ISD project team obtain accurate user requirements and sound understanding of the organizational context that the system is to support (Ives and Olson, 1984; Damodaran, 1996; Kujala, 2003). In system development practices, most design and development activities between user participants and system designers focus on users' application domain knowledge (Walz et al., 1993), and user participants are typically assigned or assumed with a primary role of supplying domain knowledge to the project team (Kirsch and Beath, 1996).

6.1.3. Constructing A Knowledge Participation Measure

The conceptualization of "knowledge participation" suggests the construct be operationalized by measuring the amount of *knowledge* provided by users or their representatives through *typical participative activities* during an ISD process. The *typical participative activities* performed by users have been studied under the user participation construct and their scopes and dimensions have been documented in the literature. The *knowledge* refers to the *explicit* knowledge that users or their representatives provide to system development processes. It does not include the inexplicit variety of knowledge, i.e., tacit knowledge which could not be articulated and therefore resist being transferred to other people through communication. Applying Alavi and Leidner's (2001) taxonomy of knowledge, explicit knowledge can be viewed as an object, or "a thing to be stored and manipulated" (p. 110). As a result of being provided to an ISD process, this type of knowledge has already been coded formally on documents, or informally through verbal expressions. Therefore, it allows accurate measures to capture the amount of the knowledge.

Thus, the operationalization of knowledge participation will involve measuring the amount of explicit knowledge (e.g., suggestions, comments, concerns, and recommendations) that user participants bring to ISD project teams via executing a defined set of participative activities.

6.2. TEAM COGNITION AS A MEDIATING MECHANISM FOR KNOWLEDGE PARTICIPATION

6.2.1. Importance of Team Cognition for Team Processes

Modern organizations are increasingly adopting the team approach as a way of accomplishing tasks which surpass the capabilities of single individuals (Glassop, 2002). In addition to issues of time and resource coordination, teams are often created with the expectation that they will enable organizations to "better utilize expertise, minimize the impact of increasing workload on one individual, and maximize the use of increasingly more sophisticated technology" (Smith-Jentsch et al., 2001; p. 179]. ISD project teams are an important example of this trend (Faraj and Sproull, 2000).

ISD projects are typically complex, dynamic, and involve unstructured tasks (Kraut and Streeter, 1995; Brodbeck, 2001). Execution of these projects requires knowledge and expertise from many domains (Curtis et al., 1988). Teams are viewed as a primary mechanism for leveraging the specialized knowledge of individual team members (Cooke et al., 2001; Lewis, 2003). Ideally, an ISD project team is staffed so that both the levels and the distribution of knowledge within the team match those required for the successful completion of the project (Walz et al., 1993).

However, the mere presence of individuals with diverse knowledge is an insufficient condition for a software project team to achieve high performance (Faraj and Sproull, 2000). The potential value of a team can only be realized if team members utilize their unique expertise in conjunction with the knowledge of other members (Nonaka and Takeuchi, 1995). *Team cognition* plays an important role in that it “allow(s) team members to draw on their own well-structured knowledge as a basis for selecting actions that are consistent and coordinated with those of their teammates” (Mathieu et al., 2000; p. 274).

Team cognition refers to the mental models collectively held by a group of individuals which enable them to accomplish tasks by acting as a coordinated unit. These structures function as mental templates which are imposed on information environments to give them form and meaning, providing a cognitive foundation for action (Walsh, 1995).

There is general recognition that team cognition affects team performance by directly impacting members’ interactions with one another (Cannon-Bowers et al., 1993; Walsh, 1995; Milliken and Martins, 1996). Team cognition enables members to formulate accurate teamwork and taskwork predictions (Katz and Tushman, 1979; Cannon-Bowers et al., 1993), adapt their activities and behaviors in a collaborative way, and thereby increase overall team effectiveness (Salas, and Cannon-Bowers, 2001; Cannon-Bowers and Salas, 2001; Lewis, 2004). Without well-formed team cognition structures, team members will not be able to efficiently share knowledge and information, coordinate each other’s activities, resolve conflicts, or negotiate agreed-upon solutions (Walsh, 1995; Cannon-Bowers and Salas, 2001; Hollingshead, 2001).

In the IS literature, team cognition has been suggested as a critical mechanism for knowledge activities being executed effectively in ISD project teams (Kraut and Streeter, 1995; Faraj and Sproull, 2000; Levesque et al., 2001). Team cognition helps ISD project teams manage their members' knowledge, expertise, and skills as integrated assets (Walz et al., 1993), assign tasks to people with the most capability (Faraj and Sproull, 2000), and coordinate their actions and adapt their behavior to the demands of the project and the expectations of other members (Cannon-Bowers et al., 1993; Levesque et al., 2001). It is through team cognition that ISD project teams locate, access, and utilize knowledge resources embedded in individual members to pursue project development success.

6.2.2. The Contents of Team Cognition

Team cognition has been described in terms of shared cognition (Cannon-Bowers et al., 1993), metacognition (Hinsz, 2004), team mental models (Katz and Tushman, 1979), collective cognition (Fussell and Krauss, 1992), transactive memory (Wegner, 1987), shared mental models (Cannon-Bowers et al., 1993; Stout et al., 1996), and team knowledge (Cooke et al, 2000; 2001). In a discussion of the construct, Cannon-Bowers and Salas (2001) suggested that four broad categories must be considered: task-specific knowledge (e.g., the specific procedures, sequences, actions, and strategies necessary to perform a particular task), task-related knowledge (e.g., generic knowledge about what make up effective teamwork), knowledge of teammates (i.e., knowledge of members in a particular team, including their preferences, strengths, weakness, and tendencies), and attitudes/beliefs (i.e., evaluative belief structures that affect members' perceptions about the task/environment). The measurement of team cognition is further complicated by interwoven factors, including the task and the surrounding environment (Cooke et al, 2000; 2001). For example, the team cognition of a clinic operating team (including a surgeon and a nurse) could be very different from that of a software development team, in that the former requires that portions of members' knowledge bases be shared or identical, while in the latter, compatible, but different, knowledge and skills are assumed to be beneficial to team effectiveness (Faraj and Sproull, 2000).

Researchers have not reached consensus on the precise makeup of team cognition (Cannon-Bowers and Salas, 2001), and measures and methods focusing on this construct are sparse (Cannon-Bowers and Salas, 2001; Cooke et al., 2001; Mohammed and Dumville, 2001). The objective of this study is not to provide a new solution to team cognition issues, but to understand how the knowledge structures which exist between user participants and system developers mediate the effects of knowledge participation on ISD productivity outcomes. To this end, I identify two elements that have been suggested in the ISD literature – shared awareness of expertise location and shared task understanding – to capture the maturity of team cognition in ISD project teams.

6.2.3. Two Elements of Team Cognition

Shared awareness of expertise location refers to the awareness of each team member's specialized knowledge and unique expertise; shared task understanding characterizes the degree to which members share an understanding of the focal software development task. In Cannon-Bowers and Salas' (2001) taxonomy of perspectives on team cognition, the former (expertise location) can be viewed as an element of team-specific team cognition that "only holds when team membership remains constant" (p. 197); and the latter (task understanding) can be viewed as an element of task-specific team cognition that cannot be generalized to other tasks. Considering user participants and system developers as two distinct subgroups cooperating in teams, the two elements of team cognition will capture knowledge structures between the two subgroups and help us understand how they affect certain knowledge activities, e.g., utilizing knowledge inputs from users, in ISD project teams.

- Shared Awareness of Expertise location

Shared awareness of expertise location is an important element of team cognition in ISD project teams. When people form a team, they need to develop "metaknowledge" of one another's knowledge and expertise, so that they can efficiently and effectively assign tasks to those who have the necessary knowledge and skills as well as identify those whose knowledge might be useful in a given situation. This metaknowledge also allows team members to draw on others' expertise to solve problems that arise during the life of the project. Shared awareness of each other's knowledge and expertise plays a key integrative and coordinative function in ISD project teams (Faraj and Sproull, 2000; p. 1557).

Shared awareness of expertise location is derived from the theory of transactive memory (Faraj and Sproull, 2000). Wegner (1987) defined transactive memory as the knowledge possessed by group members, coupled with an awareness of who knows what. However, social cognition researchers typically focus on the shared awareness of knowledge location, or the transactive memory system, as a crucial component of the social cognitive mechanisms for coordinating learning, storage, and retrieval among individuals (Hollingshead, 2001). From this perspective, the transactive memory system can be seen as an "index." Members' shared awareness of other members' knowledge and expertise is an indicator of the degree to which the team has formed transactive memory (Moreland and Myaskovsky, 2000; Stasser et al., 2000; Austin, 2003).

While transactive memory systems may include other aspects of team knowledge, such as credibility (members' beliefs of the reliability of other members' knowledge) and coordination (effective, orchestrated knowledge processing) (Lewis, 2003), an awareness of members' specialized knowledge and unique expertise is viewed as the central element of this form of team cognition.

- Shared Task understanding

Shared task understanding is another critical element of team cognition in teams. Mutually shared understanding of a focal task, including the involved procedures, sequences, actions, and strategies, helps team members form common explanations and expectations for the task, and in turn, coordinate activities in a harmonious and efficient fashion (Cannon-Bowers et al., 1993; Levesque et al., 2001). This element of team cognition is particularly important for ISD project teams. As various people work together on a complex ISD project, they need to develop a common view of relevant development issues such as "what the software they are constructing should do, how it should be organized, and how it should fit with other software systems already in place or undergoing parallel development" (Kraut and Streeter, 1995; p. 69).

Shared task understanding is derived from the theory of shared mental models. Shared mental models are "knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and in turn, to coordinate their actions and adapt their behavior to demands of the task and other team members" (Cannon-Bowers et al., 1993; p. 228). It is this ability to quickly adapt individual actions to the needs of team process that enables a team to be successful in dynamic environments (Mathieu et al., 2000). For example, because of their shared understanding of the task, an effective clinic operating team does not need intensive communications among members when performing surgery.

While several different knowledge structures have been discussed in the literature[3], the shared understanding of the focal task is a core component (Stout et al., 1996) and has been employed here as a main dimension on which to assess the overall shared mental models (Stout et al., 1999; Mathieu et al., 2000; Levesque et al., 2001). When team members share a common view of task demands and project objectives, they are better able to anticipate the actions of other team members (Klimoski and Mohammed, 1994). Such a common understanding enables individuals to indirectly coordinate their independently-performed work efforts while minimizing the need for more costly coordinative mechanisms. This is particularly important for teams working under conditions in which communication is restricted or difficult because of a heavy workload, time pressure, or other environmental features (Mathieu et al., 2000) – typical conditions for software project teams (Kraut and Streeter, 1995).

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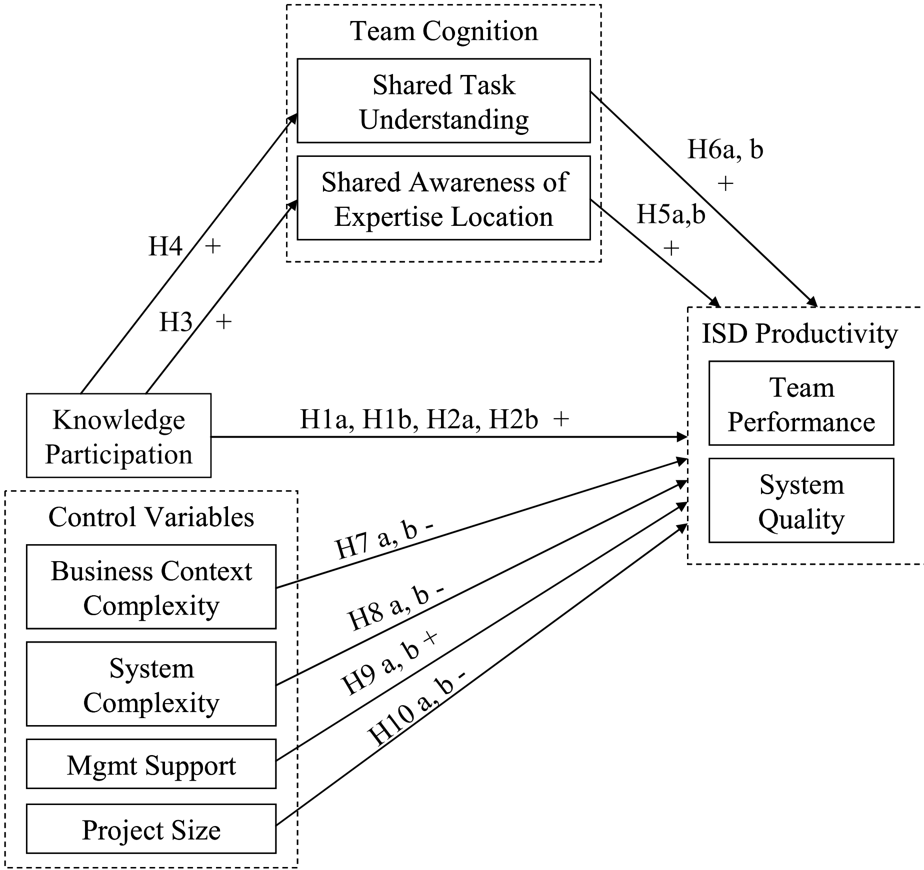
[3] For example, Cannon-Bowers and colleagues (1993) have suggested four types of mental models need to be shared in a team, including the understanding of the involved technology/equipment, the knowledge about how the task can be accomplished, the shared conceptions of how the team interacts, and the knowing of each other's knowledge, skills, attitudes, and preferences.

7.0. RESEARCH MODEL AND HYPOTHESES

A research model is developed to test the validity of the knowledge participation construct, and the mediating role of team cognition, in affecting ISD productivity. The model is presented in Figure 1. The directions of the hypotheses are also shown in the figure. Constructs involved in the model include knowledge participation and user participation, shared awareness of expertise location, shared task understanding, team performance, and system quality. Several contextual factors, such as business context complexity, system complexity, management support, and project size, are included as control variables. These constructs and their hypothesized roles in the research model are explained in this chapter. The effect of user participation is also discussed as a reference to assess the proposed superior predictive power of knowledge participation.

Figure 1. Research Model



7.1. THE DIRECT EFFECTS OF PARTICIPATION ON ISD PRODUCTIVITY

The ISD literature generally suggests *User Participation* as a key predictor of ISD productivity (Hwang and Thorn, 1999; Markus and Mao, 2003), although empirical studies have produced mixed results (Ives and Olson, 1984; Cavaye, 1995). Meta-analysis of previous empirical studies reveals that user participation does not predict ISD productivity as strongly as user participation theory suggests.

It is the central proposition of this study that *Knowledge Participation* captures the effectiveness of participation, therefore may predict ISD productivity better than *User Participation* does. *Knowledge Participation* as the focal construct should be tested not only for its construct validity, but also with regard to its proposed superior predicative power to that of *User Participation*. For this purpose, the effects of user participation on ISD productivity are also hypothesized to be tested and compared with that of knowledge participation.

In this study, two variables are identified as important indicators of ISD productivity: “Team Performance” and “System Quality”.

7.1.1. ISD Productivity Measured by Team Performance

In the ISD literature, *Team Performance* is often defined as the extent to which an ISD project team “is able to meet established quality and cost and time objectives” (Hoegl and

Genuenden, 2001; p. 438). Team performance is an important indicator of IS project success (Jones and Harrison, 1996), and reflects the immediate goals that an ISD project team pursues.

Often, users or their representatives are invited to participate into ISD processes for the purpose of helping ISD project teams achieve overall development success (Ives and Olson, 1994). User participants are expected to bring productivity benefits because of their business knowledge and expertise. With high level of knowledge participation, ISD project teams can obtain needed business knowledge and expertise that otherwise system developers may not have or be able to access, therefore increase the chances for the team to achieve quality performance.

Hypothesis 1a: Knowledge Participation will have a positive effect on Team Performance.

As discussed before, the ISD literature suggests user participation as an important determinant of team performance (e.g., Yetton et al., 2000; Markus and Mao, 2004), but the argument has received little support from empirical research. Meta-analysis on the user participation – team performance relationship fails to indicate statistical significance. Because user participation is a behavioral construct (Barki and Hartwick, 1989; McKeen et al, 1994) and does not capture the effectiveness of participation (Damodaran, 1996; Barki and Hartwick, 2001), I argue that user participation will have a limited effect on team performance when compared with the proposed superior predictive power of knowledge participation.

Hypothesis 1b: Compared with Knowledge Participation, User Participation will have a weaker effect on Team Performance.

7.1.2. ISD Productivity Measured by System Quality

As a key indicator of ISD productivity, *System Quality* is typically measured in terms of ease-of-use, functionality, reliability, flexibility, data quality, portability, integration, and importance (DeLone and McLean, 2003). Ives and Olson (1984) summarized the benefits of user participation on system quality in terms of four aspects (p. 587):

1. Providing a more accurate and complete assessment of user information requirements;
2. Providing expertise about the organization the system is to support, expertise usually unavailable within the information systems group;
3. Avoiding development of unacceptable or unimportant features;
4. Improving user understanding of the system.

The proposed benefits of user participation center on the provision and utilization of users' business knowledge and expertise. "Information requirements" explain the functionalities of target systems that users expect to solve their business problems; "expertise about the organization" reflect the knowledge of the working environment that target systems are to support; "unimportant features" set priority of needed features with a special attention on those irrelevant and therefore uneconomic to develop. The fourth aspect involves a "constructive conflict model", that "understanding of the system" helps users discuss problems with system developers in a constructive manner, leading conflicts to be satisfactory solved (Robey and Farrow, 1982). And this cognitive problem-solving process no doubt is sustained by knowledge activities between team members.

As discussed before, user participation as a behavioral construct may ill-illustrate the amount of knowledge and expertise that user participants bring to ISD project teams. Meta-analysis also reveals that user participation predicts system quality poorly. In contrast, knowledge participation will be a better predictor by assessing directly the amount of knowledge that user participants contribute to ISD processes.

Hypothesis 2a: Knowledge Participation will have a positive effect on System Quality.

Hypothesis 2b: Compared with Knowledge Participation, User Participation will have a weaker effect on System Quality.

7.2. MEDIATING ROLE OF TEAM COGNITION

ISD is knowledge-intensive work. Productivity benefits of users' participative efforts, e.g., improved team performance and better quality of the developed system, are realized by knowledge activities within ISD project teams. Knowledge participation captures the amount of knowledge and expertise that user participants bring to ISD project teams; and for these valuable knowledge resources to be transformed into quality products, appropriate team cognition needs to be developed for team members to access and utilize these knowledge resources to their full scales.

It is not easy for ISD project teams to develop team cognition structures because team members who typically come from different backgrounds and possess different knowledge. More challenging is caused by the fact that many teams are newly formed, "depending on project requirements and who is available" (Faraj and Sproull, 2000; p. 1554). The lack of previous cooperation experiences between team members gives rise to the necessity to develop team cognition so that team members can work in a well-coordinated fashion. Only with the development of high level of team cognition can ISD project teams work efficiently and effectively, and deliver quality projects as expected (He et al., 2006). Following this line of reasoning, I propose that team cognition intervenes with the relationship between knowledge participation and ISD productivity outcomes as a mediating mechanism.

For the purpose of this study, the concept of team cognition focuses on the collective knowledge structures between two primary sub-groups of an ISD project team: system developers and user representatives. The two groups are distinct in that their knowledge and expertise specialize in sharply different fields – business application and system development (Kujala, 2003). Two elements of team cognition are identified as particularly important to an ISD project team: shared awareness of expertise location and shared task understanding.

7.2.1. Shared Awareness of Expertise Location as a Mediator

Shared awareness of expertise location is an important type of team cognition structure within ISD project teams, defined here as the shared awareness between system developers and user participants of the location of specialized knowledge and unique expertise in the other subgroup (user participants or system developers). This concept was derived from the theory of transactive memory and has been applied in Faraj and Sproull (2000) to investigate coordination in ISD project teams.

There are many ways for team members to know each other's expertise. According to the theory of transactive memory, shared awareness of expertise location results from interactions between members, such as close relationship (Wegner, 1987) and training together (Liang et al., 1995), and role assignment and expertise notification. In an experimental study, Moreland and Myaskovsky (2000) found the latter (role assignment and expertise notification) was a more effective method to develop shared awareness of expertise location in teams than the former (or communication in their study).

Knowledge participation reflects the extent to which user participants effectively contribute to an ISD process by supplying knowledge to the project team. When supplying knowledge, user participants will inevitably interact with system developers. In most cases, the more knowledge a user participant has supplied, the more frequently or intensively the person has interacted with system developers. Consequently, team members have a better chance of knowing each other and developing shared awareness of expertise location. In addition, user participation is often practiced with role assignment, i.e., granting the involved users as user representatives. By assigning a person the role of user representative, other team members assume the person of great expertise in the application domain area (Kirsch and Beath, 1996). Role assignment helps the development of shared awareness of expertise location within the team. Even with no previous contacts, system developers are encouraged to consult a user representative about business issues just because of his/her job title.

Hypothesis 3: Knowledge Participation will have a positively effect on Shared Awareness of Expertise Location.

The team cognition literature provides strong empirical evidence that teams perform better if they have developed mature understanding of each other’s knowledge, expertise, and skills (e.g., Liang et al., 1995; Hollingshead, 1998; Moreland and Myaskovsky, 2000; Lewis, 2004). By developing shared awareness of expertise location, team members know each other’s areas of expertise better. Team efficiency improves because members can anticipate, rather than simply react to, each other’s behavior (Murnighan and Conlon, 1991). Members also have quick and coordinated access to one another’s specialized expertise, resulting in an expanded pool of knowledge and expertise for decision-making (Hollingshead, 1998). Team tasks are more likely to be assigned to the right people who are most able to solve them, not only improving team effectiveness but also avoiding redundancy of effort (Hollingshead, 1998; Moreland and Myaskovsky, 2000). Knowing the location of important knowledge and expertise is particularly important for knowledge-worker teams to achieve quality performance, in that they represent a critical point of leverage allowing teams to better utilize members' expertise and realize the value of embedded team knowledge (Lewis, 2004).

Shared awareness of expertise location is not a novel concept in the ISD literature. In a study of 69 software development teams, Faraj and Sproull (2000) reported that shared awareness of) expertise location had a strong and positive impact on team performance.

Hypothesis 5a: Shared Awareness of Expertise Location will have a positive effect on Team Performance.

Hypothesis 5b: Shared Awareness of Expertise Location will have a positive effect on System Quality.

7.2.2. Shared Task Understanding as a Mediator

Shared task understanding is another important element of team cognition for ISD project teams. For ISD project teams, different people working on a common project need to agree on a common definition of what they are building, sharing information, and mesh their activities. The formation of such a common view is based on good understanding of the focal task (Kraut and Streeler, 1995).

According to the theory of shared mental models, shared task understanding results from interactions between team members when working on a common task. With increased experience with each other and the task, teammates would exhibit greater convergence among their mental models on how their team will function to fulfill the task (Matheiu et al., 2000; Levesque et al., 2001). A recent longitudinal study of software development (He et al., 2006) has confirmed the evolution of shared task understanding in ISD project teams given the interaction among team members.

Knowledge Participation can be viewed as a tool to facilitate the development of shared task understanding. By providing knowledge, users explain their specialized areas as well as their requirements, suggestions, and concerns of the project to system developers. Consequently, the level of interpersonal experience will be inevitably increased. In addition, the provided knowledge, which is both task-relevant and valued by system developers, will lead to a better understanding among team members on various task-related issues. With high level of knowledge participation, the two subgroups of user participants and system developers will have a good chance to develop shared understanding on a focal task.

Hypothesis 3: Knowledge Participation will have a positive effect on Shared Task Understanding.

In the ISD context, communication gaps often exist between users and system developers in that each group has its particular jargon and terminologies that may not be comprehensible to the other group (Abdul-Gader and Kozar, 1990). Communication gaps hinder collaborate activities in an ISD team. The formation of shared task understanding will reduce these communication obstacles by "making it unnecessary to construct understanding from scratch each time similar stimuli are encountered" (Vandenbosch and Higgins, 1996; p. 200), and therefore facilitate effective teamwork between user participants and system developers, enhancing the overall performance of the ISD team. In a longitudinal study of student ISD teams, He et al. (2006) found that teams with high level of shared task understanding not only rated their performance as high, but also delivered products (database applications in the study) with better quality.

Robey and Farrow's (1982) constructive conflict model also provide support of the importance of shared task understanding, in that interactions between user participants and system developers help users "better understand the system", and discuss problems with system developers in a constructive manner, leading conflicts to be satisfactory solved. Although conflicts are obstacles to system development, conflict solution helps ISD project teams to achieve high performance (Robey et al., 1993).

Hypothesis 6a: Shared Task Understanding will have a positive effect on Team Performance.

Hypothesis 6b: Shared Task Understanding will have a positive effect on System Quality.

7.3. ISD ENVIRONMENTAL FACTORS AS CONTROL VARIABLES

In the ISD literature, many researchers agree that user participation may not be equally effective in various situations (Anderson, 1985), and suggest a contingency approach to study the effects of participation (Ives and Olson, 1984; Tait and Vessey, 1988; McKeen et al., 1994; Saleem, 1996). Numerous ISD environmental factors that may shape the effects of user participation have been identified and examined in the ISD literature (for review, see McKeen et al., 1994). Contingency models help increase the predictive power of user participation (McKeen et al., 1994), and identify situations in which user participation is particularly helpful for ISD project teams to achieve development success. However, as indicated by the meta-analysis, the use of contingency models does not dramatically change the research findings of user participation effects.

In this study I propose knowledge participation as a better construct to predict ISD productivity outcomes than the construct of user participation. By measuring the embodied knowledge rather than counting the apparent execution of certain set of activities, knowledge participation is argued to capture the meaningful contribution of user participative efforts; the contributed knowledge, according to knowledge theory of user participation, is a valuable resource that system developers can rely on for better performance and enhanced productivity. As thus, knowledge participation should be effective across various situations. In other words, it does not require any special environment for knowledge participation to be effective on productivity outcomes. As long as needed business knowledge is provided to ISD project teams, productivity benefits should be expected. As thus, the contingency approach suggested for the study of user participation may not be appropriate for the study of knowledge participation.

ISD is a highly complex process, and its outcomes depend not only on the diligent work of project teams, but also various environmental factors that support or hinder the development process. These environmental factors, while not shaping the effects of knowledge participation, may affect ISD productivity outcomes directly. Empirical studies have demonstrated that some environmental factors are critical for ISD project teams to achieve development success. These factors are treated as control variables in this study, because they "are not of direct importance to the theory" and their "relationship to the dependent variable may have been established empirically previously" (King and He, 2005; p. 884).

From the literature I identified four factors as possible control variables. The four factors are business context complexity, system complexity, management support, and project size.

7.3.1. Business Context Complexity and System Complexity

According to McKeen et al. (1994), *Business Context Complexity*[4] refers to the ambiguity and uncertainty that surround the practice of business, and *System Complexity* refers to the ambiguity and uncertainty that surround the practice of system development. Both factors reflect the difficulty of developing target systems in terms of the business context and technology context.

In situations where business context complexity is high, system developers may find it difficult to work out solutions to satisfy business needs, with or without high level of knowledge participation. Even with the provision of needed knowledge from users, system developers may feel frustrated if: (a) the business context is very difficult to comprehend, even the users may not have a clear understanding of the application domain; (b) information requirements fluctuate during the development process because of the dynamics in the external business environment; (c) information requirements fluctuate due to internal organizational change; or (b) when there are various solutions but their consequences are not well understood, so that the selection of the most appropriate one to ground a target system is an art rather than a science.

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[4] McKeen et al. (1994) used "task complexity" for the term. I believe "business context complexity" is a more appropriate term in that "business context" takes a broad view of the application domain which a target system project is going to support, whether the objective of the project has been defined or not; while "task" may suggest a well-defined project objective, contradictory to the meaning of uncertainty as the conceptual foundation for this construct.

Hypothesis 7a: Business Context Complexity will have a negative effect on Team Performance.

Hypothesis 7b: Business Context Complexity will have a negative effect on System Quality.

Similarly, in situations where system complexity is high, ISD project teams have to spent more time and effort clarifying many technical issues during the development process. System complexity is often caused by the use of new technology (e.g., hardware, software, or an unfamiliar ISD method) or a lack of understanding and training on the technology (McKeen et al., 1994). As a result, high system complexity inevitably increases the technical risk of developing target systems, therefore hindering an ISD project team's ability to achieve high performance and deliver quality products.

Hypothesis 8a: System Complexity will have a negative effect on Team Performance.

Hypothesis 8b: System Complexity will have a negative effect on System Quality.

7.3.2. Management Support

Management support is another commonly suggested control variables in the ISD literature. Sufficient support from management helps ISD project teams acquire important resources (e.g., financial assets such as generous budget and flexible schedule) and overcome political obstacles when support from other business units or departments are needed.

Hypothesis 9a: Management Support will have a positive effect on Team Performance.

Hypothesis 9b: Management Support will have a positive effect on System Quality.

7.3.3. Project Size

Project size is another often tested control variable in the ISD literature. Project size reflects the overall complexity of system development in terms of number of involved developers, time, and/or lines of codes that need to be programmed. Large projects are much more difficult to complete successfully than the small ones. In a field study of the design process for large systems, Curtis and colleagues (1988) found that (a) large projects require knowledge and expertise from different domains and fields; among them the business knowledge is particularly thinly spread within ISD project teams; (b) long development lifecycles make a project prone to fluctuating information requirements or other environmental changes; and (c) artificial (often political) barriers exist for communication among team members, making it difficult to leverage individuals' knowledge and expertise.

Hypothesis 10a: Project Size will have a negative effect on Team Performance.

Hypothesis 10b: Project Size will have a negative effect on System Quality.

8.0. MEASUREMENT OF VARIABLES

This research involves six key constructs: knowledge participation, user participation, shared awareness of expertise location, shared task understanding, team performance, and system quality. In addition, four control variables of business context complexity, system complexity, management support, and project size, are also included in the research model. Most constructs are measured with validated instruments from previous studies. The measurement of each construct is discussed in this chapter. Detailed measures used in an experimental study are reported in Appendix B, and measures used in a field study are reported in Appendix C.

8.1. KNOWLEDGE PARTICIPATION

Knowledge Participation is a central construct proposed in this research. It is conceptualized as the amount of knowledge that users contribute to an ISD process via participation. To operationalize the construct, we need 1) to identify key participative activities and behaviors performed by users; then 2) to assess the amount of knowledge that users provided through executing each identified activity or behavior. Accordingly, a 2-step assessment strategy is designed to capture knowledge participation. The first step is to identify key participative activities or behaviors using Barki and Hartwick's (1994, 2001) "yes or no" bipolar instrument; if the answer to performing a certain activity is "yes", the next step assesses the amount of knowledge provided through performing that activity. The Figure 2 presents some items that are used to measure the construct of knowledge participation:

Figure 2. Sample Items in Knowledge Participation Instrument

During the system development process, did you perform the following activities/responsibilities? If yes, to what extent did you provide **your reasons, comments, suggestions, or other relevant information** to the project team when executing the activity/responsibility?

		Not Much			Moderate			Very Much
…estimating project and system costs?	☐ Yes ☐ No	1	2	3	4	5	6	7
…determining system objectives?	☐ Yes ☐ No	1	2	3	4	5	6	7
…estimating project and system benefits?	☐ Yes ☐ No	1	2	3	4	5	6	7

8.2. ISD PRODUCTIVITY MEASUREMENT

This study uses two constructs, team performance and system quality, to assess the productivity of ISD project development.

8.2.1. Team Performance

While many different dimensions and items have been suggested in ISD literature for measuring team performance (Jones and Harrison, 1996), there seems to be a general agreement among both researchers and practitioners that certain factors characterize successful teams.

Thamhain and Wilemon (1992) interviewed more than 500 software engineering professionals and found that more than 90% of them mentioned three measures as the most important criteria: technical success, on-time performance and on-budget/within resources performance. The three criteria have been commonly adopted in the measures of this construct (e.g., Robey et al., 1993; Jones and Harrison, 1996; Faraj and Sproull, 2000).

In this study I adopted the survey instrument of Robey et al. (1993) on team performance. Respondents of a later field study included user participants and system developers who had recently completed certain ISD projects. The items asked respondents to indicate the extent to which their teams meet budget and schedule, produce product with quantity and quality, and interact with people inside and outside the teams.

Self-evaluation bias should not be a serious concern for this measure. Self-evaluation of performance has been widely adopted in the areas of organizational behavior and human resources management on the premise that individuals are best judges of their own performance. (Campbell and Lee, 1988). It is an appropriate technology for IS project teams in particular (Jones and Harrison, 1996), in that ISD complexity often prevents other people from fully understanding, not to mention evaluating, the development process. In addition, collecting responses from both user participants and system developers help reduce “common source bias” and improve the accuracy of the measure.

8.2.2. System Quality

System Quality was assessed with 14 items adapted from Rivard et al. (1997). Respondents of a later field study included user participants, system developers, and project supervisors. The items asked respondents to indicate, on 5-point scales ranging from 1 (strongly disagree) to 5 (strongly agree), the extent to which they believed the system was reliable, adaptable, easy to understand and use, and provided precise, complete, and useful output. Barki and Hartwick (2002) tested this instrument and concluded high reliability (in their study, Cronbach alphas were 0.91 and 0.93 for users and IS staff samples, respectively).

8.3. TEAM COGNITION MEASUREMENT

For the purposes of this study, two elements of team cognition, shared awareness of expertise location and shared task understanding, are used to reflect the team cognition structures between user participants and system developers in ISD project teams.

8.3.1. Shared Awareness of Expertise Location

The "shared awareness of expertise location" construct was measured with a 4-item instrument adopted from Faraj and Sproull (2000). Respondents were asked to use a 1-5 scale to rate the extent of the team's understanding of each other's knowledge and expertise in terms of: (1) the existence of knowledge "map" in the team; (2) the association between task assignments and members' knowledge; (3) knowing each other's special knowledge and skills; and (4) knowing whom has the relevant knowledge for his/her work.

8.3.2. Shared Task Understanding

The "shared task understanding" construct was measured with a 4-item instrument based on Kraut and Streeter's (1995) comments on having a shared view of the project. Respondents were asked to use a 1-5 scale to rate the extent to which their teams shared a common understanding of the development technology, the application domain, the development procedures, and the overall vision of the ISD project.

Both constructs have been validated by He et al. (2006)[5] in their study of the formation and evolution of team cognition in ISD project teams. User participants and system developers were the target respondents for the two constructs.

8.4. CONTROL VARIABLES

In this study, four ISD contextual factors, business context complexity, system complexity, management support, and project size, are investigated as control variables. Previous studies provide evidence that these factors likely affect ISD project development success.

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[5] In this study, He et al. (2006) discussed the use of the two elements rather than their broader veils of transactive memory systems and shared mental models. Although two focal concepts are present in the team cognition literature, researchers are still debating on their precise contents and how to measure them (Cannon-Bowers and Salas, 2001). Some recent attempts, such as the survey instrument of transactive memory systems developed in Lewis (2003), and within-team agreement scores used in Mathieu et al. (2000) and Levesque et al. (2001), were discussed as inappropriate, and the two elements were found to be particularly important and effective, for the teams in their study (He et al., 2006).

8.4.1. Business Context Complexity

The “Business Context Complexity” construct was adapted from a survey measure of “task complexity” developed by Barki and his colleagues’ (1993, 2001). Derived from the concept of uncertainty in the task environment, this construct was operationalized as the extent of lack of clearly-defined knowledge in the application domain area, specifically the knowledge that forms the base on which business procedures are articulated and information requirements are specified. User participants were the target respondents for this construct.

A similar construct of “requirements uncertainty” was developed by Nidumolu (1995). This construct incorporated three dimensions of 1) requirement instability, described by the extent of change in user requirements over the course of the project; 2) requirements diversity, described by the extent to which users differed amongst themselves in their requirements; and 3) requirements analyzability, measured by the extent to which a conversion process can be reduced to mechanical steps or objective procedures. Requirements uncertainty could be viewed as the other side of the coin of “business context complexity”, and was surveyed in a later field study to assess the severity of single source bias in the measurement of business context complexity. System developers were the target respondents.

8.4.2. System Complexity

The “System Complexity” construct was assessed using a survey instrument from McFarlan (1981). McFarlan’s instrument has been employed by Tait and Vessey (1988) and McKeen et al. (1994). In this research, McFarlan’s instrument was revised by discarding some old components, such as ambiguity of using CPU and other hardware, and introducing new components related to design, coding, testing and installation techniques. The target respondents were system developers.

8.4.3. Management Support

Management support was measured by a single item, asking respondents to rate on a 1-5 Likert scale that to what extent management provided overall support to their project teams. The target respondents were system developers and project supervisors.

8.4.4. Project Size

Project size was measured by a 3-item instrument adopted from Barki and Rivard (1993), asking respondents to rate on a 1-5 Likert scale that to what extent they believe the scheduled number of person-days, the scheduled number of months, and the dollar budget allocated to this project, were larger than other projects in their companies. The target respondents were system developers and project supervisors.

9.0. EXPERIMENTAL STUDY

The knowledge perspective to study ISD process is a novel approach that has been rarely used in the literature. In addition, "knowledge participation" is a new construct that needs to be validated on both its measurement reliability and normological validity. Given the originality of this study, an experimental study was designed to obtain preliminary support to main propositions. With well-controlled environment, the constructs of knowledge participation and user participation could be accurately assessed, and their effects could be compared without confounding factors possible in field studies.

9.1. PARTICIPANTS

In this study, 80 undergraduates acted as participants to partially fulfill a course requirement. The participants were predominantly composed of junior and senior business majors and were free to withdraw at any point, though none exercised this option.

9.2. MANIPULATION AND PROCEDURE

The experimental study was designed to simulate an important stage of ISD process - initial system analysis. System analysis has long been considered a critical stage, in which most of the important decisions about the system are made (Ginzberg, 1981), and user participation would be most effective in determining future system features and functionalities (Kujala, 2003).

The system analysis process was manipulated by assigning the participants to one of two roles to simulate either business managers or system developers. The 40 participants who played the role of business managers were provided with a case study of a classic-car retailing and service business (e.g., business background and main business procedures). The other 40 participants who played the role of system developers were provided with a reading about system analysis techniques (e.g., main components of a system analysis report and how to build a data relationship model). The role assignment was "explicit", in that all participants were aware of both conditions thereby allowing them to act consistent with their assigned roles. After reading the given materials (this process took about 15 minutes), students were instructed to form teams (37 teams in total). Each team had at least one business manager and one system developer. The team task was to produce a system analysis report. The purpose of the report was explained, and a guideline for the analysis was *suggested*, *not required*, as below.

1. What kind of system would you suggest for the business?
2. What is the objective of the system?
3. What is the expected cost for developing and implementing such a system?
4. What are the expected benefits from implementing the suggested system?
5. Draw a data relationship model and explain the system is to deal with what data and how to process them.

Students were instructed to communicate within their teams and to write the report in 20 minutes. The communication was to simulate a common user participation practice by which system developers and user participants discuss about relevant business context to which the target system was to support. After they finished discussion and submitted their reports, each student received a questionnaire tailored to his/her simulation role (i.e., business manager or system developer).

9.3. MEASURES

All but the two participation constructs were measured by the instruments discussed in the previous section. User Participation and Knowledge Participation were measured by a fraction of the suggested instruments due to the limitation of the experimental design.

Due to the context limitation, this experimental study could not simulate all the participative activities. Many regular user participative behaviors identified in Barki and Hartwick's (1994, 2001) work, such as hand-on activities (e.g., designing input/out form), users-developers relationship (e.g., evaluating an information requirements analysis developed by the IS staff), and communications with other users / system developers / managers, were not manipulated. The question items asking for the execution of these activities were considered as irrelevant, therefore were not included when measuring the two participation constructs. The instruments are provided in Appendix B.

9.4. RESULTS

9.4.1. Construct Correlations and Reliabilities

Data analysis is conducted at team level. The sample size (37 teams) is small but adequate for a pilot study. Due to the context limitation of the pilot study, three variables involved in the research model, business context complexity, system development complexity, and system quality, could not be measured. The means, standard deviations, correlations, and reliabilities of the variables are reported in Table 9.

Table 9. Constructs Involved in the Experimental Study - Means, Standard Deviations, Correlations, and Reliabilities

Variables	Mean	Std.	1	2	3	4	5
1. User Participation	4.97	2.95	0.821				
2. Knowledge Participation	4.02	0.97	0.732**	0.703			
3. Awareness of Expertise Location	4.93	0.86	-0.048	0.289*	0.851		
4. Shared Task Understanding	4.89	0.86	-0.080	0.171	0.681**	0.832	
5. Team Performance	4.93	0.86	0.038	0.320*	0.642**	0.606**	0.865

Note: Numbers on diagonals are reliabilities (Cronbach α)

*p<.10 (2-tailed)**p<.01 (2-tailed)

N=37

All the constructs are measured with high reliabilities, as illustrated by the Cronbach α's on the diagonal of the table. Regarding construct correlations, "knowledge participation" is significantly correlated with "team performance" and "shared awareness of expertise location". Its correlation with "shared task understanding" is moderate in effect but not significant, probably due to the small sample size. In contrast, "user participation" is insignificantly correlated with other constructs except "knowledge participation".

9.4.2. Construct Validity of Knowledge Participation

Knowledge participation is a central construct proposed in the present study to capture the effectiveness of User Participation in terms of explaining ISD productivity. Before testing the proposed hypotheses, knowledge participation should be assessed for its construct validity.

Construct validity looks at the extent to which a scale measures a theoretical variable of interest (Cronbach and Meehl, 1955). Here, the overall construct validity[6] of Knowledge Participation is assessed in terms of: content validity, internal consistency reliability, discriminant validity, predictive validity, and nomological validity

Content validity refers to the representativeness and comprehensiveness of the items used to create a scale. Knowledge participation is developed based on a well-established user participation instrument, whose representativeness has been validated in the literature. Regarding the comprehensiveness of the items, subjects who had been interviewed after the study commented that the items were plain and unambiguous; and they quickly figured out the 2-layer question structure: first ask "Yes" or "No" for the execution of a certain activity; if the answer is

[6] Barki and Hartwick (1994) suggested that a construct be assessed at two levels: at the overall construct level and the specific dimension level. Due to the experimental nature of the pilot study, User Participation and Knowledge

"Yes", then ask for the amount of knowledge provided through that activity. The collected data also revealed that only 1 out of 81 students was confused by this question structure and answered some items with both "No" and an assessment of the amount of knowledge. This record was dropped off from the final analysis.

Internal consistency reliability examines the extent to which the items used to assess a construct reflect a true common score for the construct. Cronbach alpha was 0.7030 for the 7-item Knowledge Participation, indicating that the construct's internal consistency is acceptable.

Discriminant validity examines the extent to which measures of different constructs are distinct. Specifically, correlations between distinct constructs should be significantly less than 1.00 ($p < .001$, for example). Correlations of Knowledge Participation with other constructs range between -0.080 and 0.732. The highest correlation is with User Participation ($r = 0.732$, $p < 0.001$), and is significantly less than 1.00 ($p < 0.001$), suggesting a strong discriminant validity.

Predictive validity examines the extent to which measures of a construct predict measures of other constructs that are expected to be related on the basis of theory. Knowledge Participation is proposed as a more appropriate construct than User Participation to explain and predict ISD productivity. Correlation analysis reveals that Knowledge Participation correlated strongly with team performance ($r = 0.320$, $p = 0.054$). In contrast, User Participation correlated weakly with team performance ($r = 0.038$, $p = 0.822$). The predictive validity of Knowledge Participation can be concluded.

Nomological validity investigates how well the focal construct functions within an entire network of constructs. In this study, Knowledge Participation is proposed as a construct to capture the effectiveness of User Participation. The participation theory suggests that User

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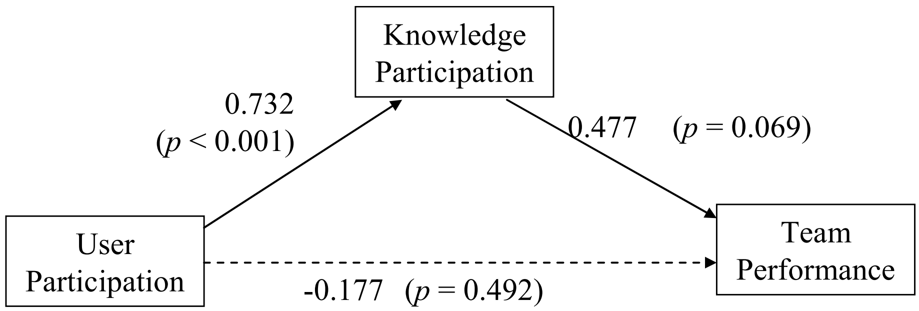
Participation could only be measured by a fraction of the suggested instrument for the manipulated activities. Therefore, dimension-level examination could not be performed here.

Participation have small impact on team performance unless the participation is effective (Damodaran, 1996; Barki and Hartwick, 2001), implying a mediating role of Knowledge Participation. The nomological validity of Knowledge Participation can be assessed by testing the following mediation model in Figure 3.

Figure 3. Nomological Validity of Knowledge Participation

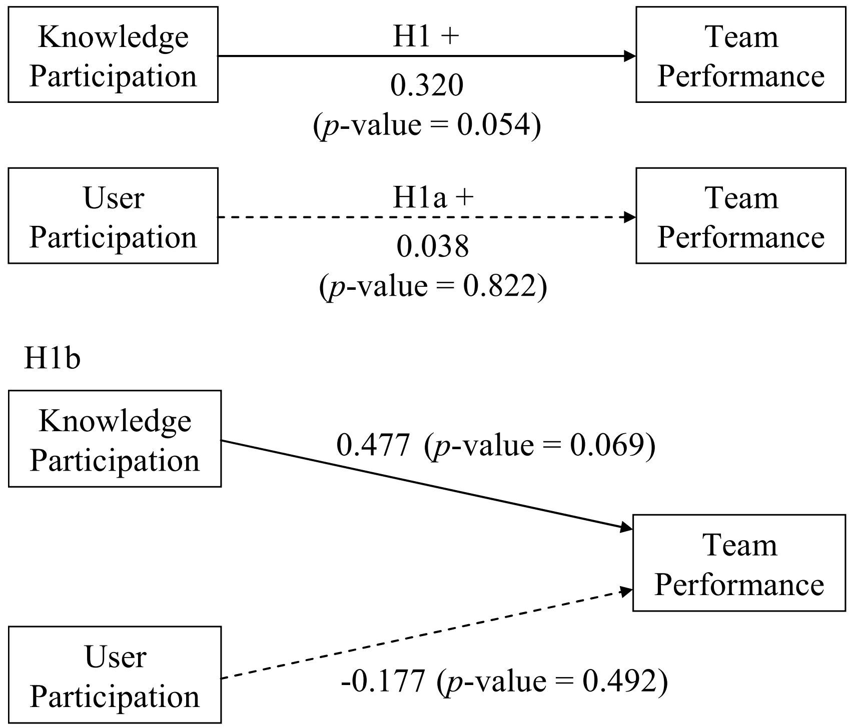


The resulting statistics from Figure 3 reveal that “knowledge participation” strongly mediates the relationship between “user participation” and “team performance”, indicating the nomological validity of the new construct is warranted.

9.4.3. Testing of Hypotheses

Hypotheses 1, 1-a, and 1-b studies compare Knowledge Participation and User Participation in terms of explaining team performance. The testing results are graphically presented in Figure 4.

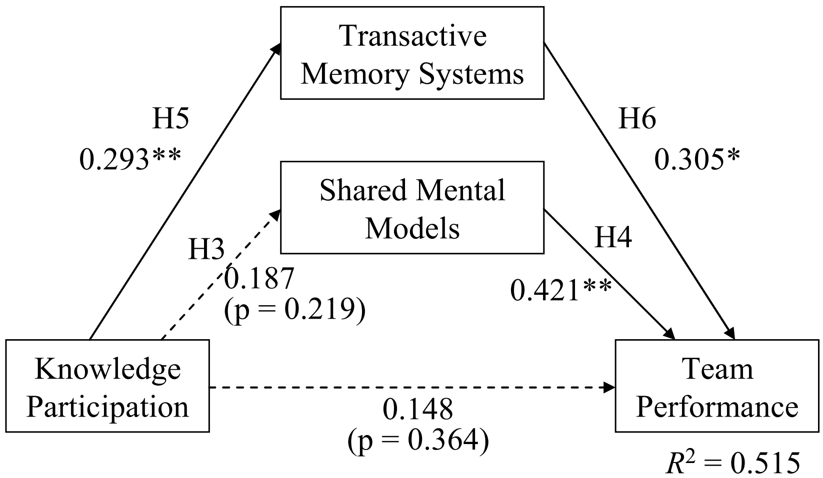
Figure 4. Testing results of H1, H1a, and H1b



Overall, Knowledge Participation presents strong predictive power in explaining team performance – an important indicator of ISD productivity. In contrast, the effect of User Participation is much weaker. This result supports the proposition that knowledge participation is an effective predictor for team performance; it is also consistent with the findings of the meta-analysis that user participation predicts team performance poorly.

Hypotheses 3, 4, 5a and 6a propose that Shared Awareness of Expertise Location and Shared Task Understanding mediate the relationship between Knowledge Participation and Team Performance. These hypotheses are tested with PLS-Graph (version 3.00). The results are graphically presented in Figure 5.

Figure 5. Testing Results of H3, H4, H5, and H6



Note: *p<.10 (2-tailed) **p<.05 (2-tailed)

N=37

The mediating effects of Shared Awareness of Expertise Location and Shared Task Understanding are generally supported. Most of the links are consistent with the propositions. As to the insignificant Knowledge Participation -> Shared Awareness of Expertise Location, the link is in hypothesized direction but not significant in effect. Small sample size may be the main reason of not concluding significance of the link. In addition, 51.5% of the variance of Team Performance is explained by the model, indicating a satisfying prediction power of the model.

10.0. FIELD STUDY

The experimental study validated main constructs and provided preliminary support for the key propositions. To test the overall research model in natural settings, a nation-wide survey was designed to collect data from practicing system developers and user participants involving in ISD projects.

10.1. SURVEY DESIGN

The context of this research is the ISD environment and the unit of analysis was system development project teams. Diversity within project teams is preferred. The main constructs measured by the survey included user participation, knowledge participation, awareness of expertise location, shared task understanding, team performance, system quality, business context complexity, system complexity, management support, and project size. Some control variables commonly suggested in the ISD literature, such respondent's age, gender, education, company size (number of employees at his/her organization), and team size (number of members in a project team), were also asked in the Internet-version of this survey[7]. The instruments are reported in Attachment 2b - Survey Package.

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[7] These questions were not included in the paper-based survey package mainly because of a practical concern of the length of the questionnaire.

To avoid "common source bias", many questions were answered by multiple respondents with different roles, e.g., system developers, user participants, and/or project managers. The exceptions are user participation and knowledge participation items, which were answered by key user participants because they are the best candidates for answering the questions regarding their own experiences (Barki and Hartwick, 1994; Hartwick and Barki, 2001), and technology complexity, which was answered by IS developers because the related technological issues fall primarily into their job responsibilities.

A two-stage, team-level-matched-survey was designed for this study. In the first stage, invitation letters explaining the purpose and the procedures of this research were sent to IS senior managers. The purpose was to get management support for this research project. Then, those who agreed to participate would receive survey packages including: (1) survey instruction, (2) a questionnaire for user representatives, and (3) a questionnaire for system developers. The survey instruction asked the senior manager to identify a recent ISD project, and to distribute different questionnaires to the project team members according to their roles in the project development. I also developed an Internet version of survey with the same set of questions. A link to the online survey was provided in both the invitation letter and survey package letter for the convenience of possible respondents.

Two weeks after sending out a survey package, if no response was received from an agreed participant, a reminder email would be sent to the contact person. After a re-explanation of the research purpose, the contact was asked to forward the linkage of the online survey to appropriate people who had involved in recent ISD projects.

The use of matched-survey ensures that the collected data are at team-level and are from appropriate respondents. In addition, common-source bias is largely attenuated in that respondents come from different backgrounds and have different roles in the surveyed projects. However, the complexity of the survey as well as the extra effort required for senior managers to serve as survey contacts may severely reduce the respondence rate.

10.2. DATA COLLECTION

From a marketing company I purchased a contact list of IS managers at about 3400 organizations. These organizations are mostly companies, but also includes educational institutions and government offices. Organization sizes range from small (i.e., having less than 250 employees) to large (i.e., having more than 1000 employees). Contacts are restricted to IS managers defined by their job titles, including CIO, IS manager, IT manager, project managers, and application manager.

Research invitation letters were sent to all the contacts, with a brief explanation of the research project and requirements of their support and supervision of the survey at their organizations. As an incentive to participation, I highlighted in the letter the importance of better understanding user participation in ISD and offered to report research findings at the completion of data collection and analysis.

Of the 3400 letters, 348 were returned due to invalid addresses. The percentage (about 10.3%) is higher than the industry standard (about 5%), indicating the quality of the contact list is disappointing. Of the remaining letters, 110 companies agreed to participate in this research. Survey packages were then mailed to these companies. If return surveys were not received within two weeks of sending out the survey packages, electronic reminders were emailed to contact people (often senior IS managers) to enhance respondence rate.

173 individuals representing 82 ISD project teams from 44 organizations responded to the surveys. The respondents include 76 user participants, 89 system developers, and 8 project managers. The demographics of the respondents and their organizations are reported in Table 10 and Table 11.

Table 10. Demographics of the Respondents

Individual Respondents		
Gender		
Female	35	
Male	58	
Not Reported[1]	80	
Total		173
Education		
High school	0	
Associate Degree	6	
Baccalaureate Degree	44	
Graduate Degree	43	
Not Reported[1]	80	
Total		173
Age		
<=25	2	
Between 26-35	14	
Between 36-45	63	
Between 46-55	14	
>=55	0	
Not Reported[1]	80	
Total		173

Note:

1. Only the online version of the survey questionnaire asked respondents to report their gender, education level, and age. Due to the restricted space, the paper-based questionnaire did not include these questions.

Table 11. Demographics of the Responded Organizations

Surveyed Organizations		
Location	1	
AZ		
CA	2	
FL	1	
IA	3	
IL	2	
KY	1	
MA	3	
MD	2	
MN	2	
MO	1	
NJ	2	
NV	1	
NY	6	
OH	3	
PA	9	
TN	1	
UT	3	
WA	1	
Total		44
Industry		
Construction Industries	1	
Manufacturing	12	
Transportation, Communication, and Utilities	2	
Wholesale Trade	1	
Retail Trade	1	
Finance, Insurance, and Real Estate	3	
Service Industries	20	
Public Administration	4	
Total		44
Organization Size		
< 250	7	
Between 250-499	5	
Between 500-999	18	
>=1000	14	
Total		44

Twenty-one returned or online-submitted surveys are not completed and have to be disregarded from the final data set. In total, there are 153 complete respondences collected from 69 ISD project teams, each team has at least one developer and one user participant.

10.3. MEASUREMENT VALIDITY

10.3.1. Instruments of User Participation and Knowledge Participation

User participation and knowledge participation are two foci constructs in this research. User participation is based on the comprehensive instruments developed and validated by Hartwick and Barki (2001). The original instruments include 38 items, of which 5 communication items were dropped from the final survey package because of their overlapping with others. The five dropped items and their remained rivals are:

Comm01: How often did you communicate informally with other users concerning the project?

Comm02: How often did you exchange facts, opinions, and visions concerning the project with other users? (dropped because of overlapping with Comm01)

Comm03: How often did you discuss your reservations and concerns regarding the project with other users?

Comm04: How often did other users discuss their reservations and concerns regarding the project with you? (dropped because of overlapping with Comm03)

Comm05: How often did you communicate informally with the IS staff concerning the project?

Comm06: How often did you exchange facts, opinions, and visions concerning the project with the IS staff? (dropped because of overlapping with Comm05)

Comm07: How often did you discuss your reservations and concerns regarding the project with the IS staff?

Comm08: How often did the IS staff discuss their reservations and concerns regarding the project with you? (dropped because of overlapping with Comm07)

Comm09: How often did you communicate informally with senior management concerning the project?

Comm10: How often did you exchange facts, opinions, and visions concerning the project with senior management? (dropped because of overlapping with Comm09)

Comm11: How often did you discuss your reservations and concerns regarding the project with senior management?

Comm12: How often did senior management discuss their reservations and concerns regarding the project with you? (dropped because of overlapping with Comm11)

In the national survey 76 user participants provided complete response to the items of user participation and knowledge participation. Because the sample size is small in comparison with the numbers of involved items (32 items for user participation and 30 items for knowledge participation), the classic factor analysis may not provide reliable and accurate interpretations of the data.

The instrument of user participation has been validated in the literature. Knowledge participation is a new construct proposed in this study, but its instrument is built solely on the user participation items. Therefore, it is expected that the same underlining dimensions of user participation will also apply for knowledge participation items. Therefore, I decide to force an extraction in the data of the four broad dimensions that are suggested in the literature: responsibility, user-IS relationship, hand-on activity, and communication. Any item who does not load highly on the predicted dimension or cross-load heavily on a different dimension is dropped[8]. The resulted solutions are reported in Table 12 and Table 13 for user participation, and Table 14 and Table 15 for knowledge participation.

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[8] As a rule of thumb, a measurement item loads highly if its loading coefficient is above 0.60 and does not load highly if the coefficient is below 0.40 (Hair et al., 1998).

Table 12. Total Variance Explained for the Extraction Solution of User Participation

Component	Initial Eigenvalues	% of Variance	Cumulative %	Extraction Sums of Squared Loadings	% of Variance	Cumulative %
1	4.027	28.765	28.765	4.027	28.765	28.765
2	2.568	18.343	47.108	2.568	18.343	47.108
3	2.107	15.051	62.16	2.107	15.051	62.160
4	1.566	11.185	73.345	1.566	11.185	73.345
5	0.845	6.038	79.383			
6	0.721	5.147	84.531			
7	0.536	3.829	88.359			
8	0.511	3.65	92.009			
9	0.395	2.822	94.831			
10	0.235	1.677	96.508			
11	0.191	1.364	97.873			
12	0.169	1.205	99.077			
13	0.129	0.923	100			
14	0	0	100			

Note: The employed Extraction Method is Principal Component Analysis.

Table 13. Rotation Solution of User Participation

	Communication	Hand-on Activity	Responsibility	User-IS Relationship
HOA7	0.798			
HOA3	0.733			
HOA9	0.725			
HOA8	0.719			
HOA4	0.676			
COM05		0.962		
COM07		0.962		
COM09		0.837		
RESP09			0.886	
RESP10			0.833	
RESP08			0.81	
UIS4				0.878
UIS8				0.839
UIS9				0.768

Note:

1. Principal Component Analysis with rotation procedure of Varimax with Kaiser Normalization.
2. Loadings <0.35 are suppressed.

Table 14. Total Variance Explained for the Extraction Solution of Knowledge Participation

Component	Initial Eigenvalues	% of Variance	Cumulative %	Extraction Sums of Squared Loadings	% of Variance	Cumulative %
1	5.387	33.667	33.667	5.387	33.667	33.667
2	3.016	18.850	52.517	3.016	18.850	52.517
3	2.424	15.147	67.664	2.424	15.147	67.664
4	1.165	7.283	74.947	1.165	7.283	74.947
5	.884	5.522	80.469			
6	.633	3.956	84.425			
7	.584	3.648	88.073			
8	.473	2.956	91.029			
9	.362	2.263	93.292			
10	.317	1.979	95.272			
11	.219	1.367	96.639			
12	.181	1.129	97.768			
13	.137	.858	98.626			
14	.087	.541	99.167			
15	.077	.481	99.648			
16	.056	.352	100.000			
17	0	0	100.000			

Note: The employed Extraction Method is Principal Component Analysis.

Table 15. Rotation Solution of Knowledge Participation

	User-IS Relationship	Communication	Hand-on Activity	Responsibility
KUIS4	0.871			
KUIS8	0.842			
KUIS9	0.818			
KUIS7	0.800			
KUIS6	0.712			
KHOA9		0.894		
KHOA8		0.807		
KHOA3		0.786		
KHOA7		0.710		
KHOA4		0.547		
KCOM01			0.914	
KCOM03			0.890	
KCOM07			0.673	
KCOM05			0.667	
KRESP08				0.736
KRESP09				0.735
KRESP10				0.718

Note:

1. Principal Component Analysis with rotation procedure of Varimax with Kaiser Normalization.
2. Loadings <0.35 are suppressed.

The principal factor analysis results in 14 items for user participation, and 17 items for knowledge participation. These items loaded satisfactorily on the predicted four dimensions, and were remained for later analysis.

Correlations between the extracted user participation / knowledge participation dimensions were calculated along with the correlation analysis of other constructs (reported in Table 20). The correlation coefficients between the four user participation dimensions range from 0.07 to 0.38, close to the correlations (ranging from 0.11 to 0.48) reported in Hartwick and Barki (2001), the original work that validated the dimensions and measurement items used in this study. Thus, the survey attempt of this study on user participation could be viewed as a close replication of the Hartwick and Barki's (2001) work.

To test the distinction between the two constructs, the concluded 14 user participation items and 17 knowledge participation items were pooled together to perform another factor analysis. For the measures of the two constructs to be compared on the same scale basis, knowledge participation items were re-coded to a binary scale, with a coding rule that a value equal to or less than 3 was coded as 0 and a value larger than 3 was coded as 1. The coding rule can be interpreted as that 0 indicates a low level of knowledge participation and 1 indicates a high level of knowledge participation.

The results of the factor analysis are reported in Table 16. Except KHOA3, all the items loaded highly on the predicted dimension. The results lend additional support to the argument that knowledge participation is a different concept from user participation.

Table 16. Factor Analysis of the User Participation / Knowledge Participation Items

Items	1	2	3	4	5	6	7	8
1. RESP08						0.626		
2. RESP09						0.838		
3. RESP10						0.805		
4. UIS4							0.836	
5. UIS8							0.820	
6. UIS9							0.640	
7. COM05				0.959				
8. COM07				0.959				
9. COM09				0.825				
10. HOA3		0.711						
11. HOA4		0.684						
12. HOA7		0.766						
13. HOA8		0.760						
14. HOA9		0.664						
15. KRESP08								0.629
16. KRESP09								0.694
17. KRESP10								0.745
18. KUIS4	0.701							
19. KUIS6	0.787							
20. KUIS7	0.828							
21. KUIS8	0.664							
22. KUIS9	0.801							
23. KHOA3	0.406				0.453			
24. KHOA4					0.675			
25. KHOA7					0.702			
26. KHOA8					0.804			
27. KHOA9					0.790			
28. KCOM01			0.792					
29. KCOM03			0.759					
30. KCOM05			0.722					
31. KCOM07			0.775					

Note:

1. Principal Component Analysis with rotation procedure of Varimax with Kaiser Normalization.
2. Loadings <0.40 are suppressed.

10.3.2. Aggregation Analysis

The research units are ISD project teams and the data analysis is performed at team level. Before aggregating individual responses to the team level, it is necessary to confirm response homogeneity or agreement within each team. Inter-Rater Agreement (IRA) was used to perform the aggregation analysis. IRA refers to the *absolute consensus* in scores assigned by multiple raters to one or more targets. The index (coded as $r_{WG(1)}$ or $r_{WG(J)}$ based on the number of items to be rated) compares the observed within-group variances to an expected variance from random responses (Cohen et al., 2001). Compared with some other methods (e.g., Intraclass correlation coefficient, or ICC), a special feature of this index is that it measures within-group homogeneity without the consideration of between-group variances.

Aggregation analysis is performed on constructs of shared awareness of expertise, shared task understanding, team performance, system quality, project size, and management support, since these constructs were assessed by both system developers and user participants. Other constructs are answered by only one party. For example, knowledge participation and business context complexity were assessed only by user participants, and system complexity was assessed only by system developers.

The results of the aggregation analysis for each construct are reported in Table 17**Error! Reference source not found.**. Intra-rater agreements of these multi-item instruments – expertise location, task understandings, and team performance, and system quality – were very high ($r_{WG(J)}$> 0.7 is often used as a heuristic for judging high vs. low within-group homogeneity (Cohen et al., 2001). Therefore, aggregating individual responses to the team level is justified.

Table 17. Aggregation Analysis

Variables	Average IRA[1]
Shared Awareness of Expertise Location	0.928
Shared Task Understanding	0.910
Team Performance	0.871
System Quality	0.794
Management Support	0.806
Project Size	0.924

Note:

1. The calculation formula for IRA is: $r_{WG(J)} = \frac{J\left(1 - \frac{\bar{S}^2_{x_j}}{\sigma^2_E}\right)}{J\left(1 - \frac{\bar{S}^2_{x_j}}{\sigma^2_E}\right) + \left(\frac{\bar{S}^2_{x_j}}{\sigma^2_E}\right)}$, where $\bar{S}^2_{X_j}$ is the mean of the observed variances on the J items, and σ^2_E is the expected variance on variable X when there is a complete lack of agreement (variance based on a null distribution representing complete lack of agreement among judges).

10.3.3. Validity of Knowledge Participation Dimensions and Other Key Constructs

The validities of involved constructs are examined on their internal consistency reliability, convergent validity, and discriminant validity. The nomological validities are later assessed on their significance in the research model. I use PLS-Graph version 3.0 as the primary tool to assess these validities.

PLS performs a confirmatory factory analysis (CFA) of measurement models while also testing a nomological research model. Measurement items load onto a designated latent construct as reflections of the construct, not others. Construct validities are examined by studying "whether the pattern of loadings of the measurement items corresponds to the theoretically anticipated factors" (Gefen and Straub, 2005; p. 93). The procedures, statistics, and recommended decision rules used for validity testing are explained below:

a. Internal consistency reliability is assessed by Cronbach α reliability. Constructs with α>0.70 are considered reliable.

b. Convergent validity is assessed by the average variance extracted (AVE) of the construct in a nomological network (i.e., the research model for this study). The recommended level of satisfactory convergent validity is 0.5. Another approach is to test the significance or t-value of each measurement item loading, using a 0.05 alpha protection level as the threshold (Gefen and Straub, 2005).

c. Discriminant validity is assessed by correlation analysis and AVE analysis. To conclude whether constructs are statistically distinct, several testing approaches have been suggested in the literature, including (1) correlation coefficients plus twice the standard errors should not include 1.0 (Anderson and Gerbing, 1988); (2) variance extract estimates (AVE) should be greater than the square of the correlation between constructs (Fornell and Larcker, 1981); and (3) loadings of measurement items on their assigned latent variables should be larger in magnitude than any other loading (Gefen and Straub, 2005).

The testing results are reported in Table 18. User participation and knowledge participation are tested only on their dimensions. Further analysis that tests whether the four suggested dimensions of knowledge participation can be aggregated to a higher construct level will be performed later.

Close examination of the statistics reveals no violation of the afore-discussed decision rules on validity testing, except the construct of system quality with an AVE of 0.452, marginally smaller than the suggested 0.50 level. For the highest correlation coefficients among the constructs (r=0.769 between shared awareness of expertise location and shared task understanding), adding twice the associated standard deviation (=0.923) does not reach the warning level of 1. Comparison between the AVEs and the squares of highest correlation coefficients also satisfies Fornell and Larcker's (1982) decision rule for convergent validity. Therefore, validities of the tested constructs can be concluded.

Table 18. Construct Validity Analysis

Variables		Number of items	Reliability	AVE	Correlation Analysis[1]		
					Highest *r*	Std. deviation	Square of *r*
User Participation	Responsibility	3	0.893	0.735	0.708	0.084	0.501
	User-IS Relationship	3	0.877	0.704	0.728	0.083	0.530
	Hand-On Activity	5	0.862	0.557	0.730	0.083	0.533
	Communication	3	0.894	0.749	0.292	0.137	0.085
Knowledge Participation	Responsibility	3	0.863	0.677	0.708	0.084	0.501
	User-IS Relationship	5	0.916	0.687	0.728	0.083	0.530
	Hand-On Activity	5	0.876	0.586	0.730	0.083	0.533
	Communication	4	0.911	0.719	0.477	0.107	0.228
Shared Awareness of Expertise Location		4	0.901	0.694	0.769	0.077	0.591
Shared Task Understanding		4	0.935	0.782	0.769	0.077	0.591
Team Performance		6	0.925	0.674	0.643	0.092	0.413
System Quality		14	0.953	0.591	0.600	0.098	0.360
Business Context Complexity		5	0.876	0.644	0.352	0.123	0.124
System Complexity		11	0.879	0.452	0.390	0.130	0.152
Management Support		1	-	-	0.276	0.123	0.061
Project Size		3	0.820	0.604	0.352	0.123	0.124

Note:

1. Correlation analysis is to assess:
   (a) whether the highest correlation coefficient + 2 times of the standard deviation >= 1; and
   (b) whether the square of the highest correlation coefficient > AVE.

10.3.4. Construct Validity of Knowledge Participation

The construct of knowledge participation is operationalized based on Hartwick and Barki's (2001) user participation constructs. As afore-discussed, a same four-dimension structure is arbitrarily extracted from the data. The resulting 17 measurement items should reflect knowledge participation as a 2-layer latent variable. At the first layer these measurement items load onto the four assigned dimensions, whose values in turn load onto the knowledge participation construct. It is the knowledge participation construct, not its dimensions, takes effects in a nomological network.

PLS-Graph does not support a two-layer latent variable and each construct must be assessed by indicators (or items with explicit values). Therefore, I take two steps to build the knowledge participation construct:

Step 1: I first build four restricted models each of which incorporates only one knowledge participation dimension. Factorial values of these dimensions are calculated as latent variable scores from each model.

Step 2: Then I use the calculated values of the four dimensions as indicators and build the knowledge participation construct in the research model.

Before assessing the effects of knowledge participation in the research model, the validity of the 2-layer latent construct should be tested. Correlation analysis suggested by Gefen and Straub (2005) is employed for this test. Basically, this procedure is to examine the correlations between measurement items and latent constructs; the correlation coefficients with assigned constructs (or factorial loadings) should be higher than that with other constructs (or cross-loadings). The results are presented in Table 19.

Table 19. Loadings and Cross-loadings of Knowledge Participation Measurement Items on Latent Variables

	KRESP	KUIS	KHOA	KCOMM	KP	EL	TU	TP	SQ	SC	RA	MS	PS
KRESP08	**0.805**	0.436	0.165	0.472	0.672	0.386	0.351	0.324	0.324	-0.062	-0.206	-0.031	0.159
KRESP09	**0.784**	0.417	0.313	0.309	0.632	0.201	0.130	0.095	-0.005	-0.213	0.291	-0.187	0.206
KRESP10	**0.873**	0.366	0.364	0.432	0.707	0.423	0.270	0.456	0.167	0.015	-0.167	0.016	-0.034
KUIS4	0.178	**0.729**	0.308	-0.090	0.393	0.047	0.121	0.017	0.129	0.097	-0.087	-0.134	0.038
KUIS6	0.530	**0.910**	0.224	0.368	0.734	0.505	0.453	0.307	0.418	0.174	-0.090	-0.176	0.107
KUIS7	0.437	**0.891**	0.395	0.276	0.707	0.377	0.325	0.219	0.331	0.197	-0.153	-0.048	0.112
KUIS8	0.184	**0.734**	0.348	-0.071	0.415	0.121	0.193	0.063	0.104	-0.031	0.040	-0.098	0.140
KUIS9	0.357	**0.856**	0.116	0.072	0.512	0.304	0.291	0.248	0.372	0.101	-0.162	-0.158	0.047
KHOA3	0.159	0.238	**0.749**	0.070	0.382	0.097	0.293	-0.012	0.120	0.197	0.126	-0.171	0.209
KHOA4	0.286	0.299	**0.797**	0.270	0.538	0.244	0.416	0.305	0.209	0.219	0.035	-0.079	0.163
KHOA7	0.257	0.339	**0.700**	0.162	0.476	0.121	0.163	0.101	0.052	0.299	0.105	0.117	-0.013
KHOA8	0.327	0.202	**0.722**	0.123	0.442	0.005	0.195	-0.208	-0.112	-0.085	0.322	-0.163	0.341
KHOA9	0.234	0.023	**0.800**	0.207	0.394	0.162	0.264	-0.050	-0.091	0.022	0.343	-0.170	0.204
KCOM01	0.409	0.188	0.140	**0.838**	0.566	0.371	0.244	0.336	0.280	0.283	-0.194	0.060	0.014
KCOM03	0.376	0.308	0.194	**0.779**	0.593	0.250	0.122	0.247	0.267	0.256	-0.167	0.007	0.090
KCOM05	0.484	0.138	0.268	**0.890**	0.630	0.491	0.299	0.335	0.237	0.026	-0.147	-0.028	-0.175
KCOM07	0.434	0.225	0.230	**0.890**	0.634	0.461	0.284	0.161	0.222	-0.052	-0.024	-0.089	0.039

Note:

1. The correlation coefficients with assigned knowledge participation components are emphasized in boldface.
2. Abbreviations:

KRESP: the responsibility dimension of knowledge participation

KUIS: the user-IS relationship dimension of knowledge participation

KHOA: the hand-on activity dimension of knowledge participation

KCOMM: the communication dimension of

KP: knowledge participation

EL: shared awareness of expertise

knowledge participation		location
TU: shared task understanding	TP: team performance	SQ: system quality
SC: system complexity	RA: requirements ambiguity	MS: management support
PS: project size		

3. The same set of abbreviations will be used through the rest part of the study.

Close examination of the Table 19 reveals that:

a. all measurement items of knowledge participation correlate the highest with their assigned dimensions, confirming the validity of the internal structure of knowledge participation;

b. all measurement items of knowledge participation correlate the second highest with knowledge participation, suggesting a 2-layer structure of this construct.

To further test the validity of the 2-layer latent construct of knowledge participation in the research model, another correlation analysis is performed between all measurement items (for knowledge participation, the variable scores of its four dimensions are used as indicators) and all latent constructs employed in the study. The results are presented in Table 20.

Table 20. Loadings and Cross-loadings of Measurement Items on Latent Variables

	KP	EL	TU	TP	SQ	SC	RA	PS	MS
KRESP	**0.819**	0.439	0.330	0.406	0.247	-0.066	-0.138	0.103	-0.044
KHOA	**0.602**	0.210	0.398	0.132	0.110	0.224	0.198	0.230	-0.127
KUIS	**0.721**	0.416	0.390	0.265	0.384	0.152	-0.123	0.105	-0.143
KCOMM	**0.709**	0.479	0.292	0.321	0.292	0.140	-0.162	-0.032	-0.016
EL1	0.312	**0.755**	0.552	0.555	0.386	0.135	-0.309	-0.212	-0.064
EL2	0.584	**0.847**	0.749	0.598	0.429	0.118	-0.217	-0.098	-0.121
EL3	0.439	**0.909**	0.656	0.563	0.380	0.207	-0.308	-0.173	-0.015
EL4	0.471	**0.815**	0.629	0.450	0.419	0.017	-0.039	0.039	-0.195
TU1	0.324	0.621	**0.825**	0.536	0.452	0.345	-0.276	0.034	-0.011
TU2	0.418	0.683	**0.913**	0.491	0.388	0.165	-0.203	0.051	-0.192
TU3	0.430	0.678	**0.876**	0.474	0.312	0.032	-0.178	0.108	-0.149
TU4	0.522	0.769	**0.920**	0.653	0.544	0.225	-0.276	0.075	0.024
TP1	0.492	0.470	0.432	**0.722**	0.379	0.123	-0.09	-0.062	-0.051
TP2	0.347	0.680	0.633	**0.897**	0.424	0.157	-0.463	-0.219	0.066
TP3	0.247	0.455	0.458	**0.835**	0.480	0.123	-0.409	-0.139	0.068
TP4	0.326	0.562	0.601	**0.848**	0.478	0.208	-0.405	-0.219	0.102
TP5	0.348	0.533	0.464	**0.809**	0.649	0.218	-0.458	-0.112	0.196
TP6	0.250	0.462	0.399	**0.803**	0.564	0.271	-0.368	-0.171	0.006
SQ1	0.262	0.408	0.379	0.643	**0.735**	0.304	-0.361	-0.195	0.050
SQ2	0.190	0.353	0.343	0.431	**0.717**	0.429	-0.274	-0.046	0.228
SQ3	0.296	0.451	0.441	0.414	**0.731**	0.225	-0.238	-0.064	0.011
SQ4	0.321	0.292	0.274	0.389	**0.704**	0.267	-0.242	-0.002	0.085
SQ5	0.175	0.323	0.377	0.461	**0.666**	0.180	-0.238	-0.152	0.053
SQ6	0.153	0.280	0.332	0.547	**0.801**	0.422	-0.417	-0.211	0.182
SQ7	0.163	0.341	0.388	0.507	**0.730**	0.405	-0.277	-0.199	0.135
SQ8	0.280	0.369	0.394	0.510	**0.805**	0.479	-0.351	-0.214	0.215
SQ9	0.295	0.400	0.366	0.336	**0.826**	0.249	-0.353	0.003	0.13
SQ10	0.321	0.261	0.345	0.339	**0.765**	0.299	-0.365	-0.024	0.208
SQ11	0.428	0.366	0.330	0.382	**0.754**	0.190	-0.298	0.098	0.045
SQ12	0.464	0.355	0.285	0.436	**0.786**	0.280	-0.272	0.058	0.150
SQ13	0.395	0.471	0.508	0.503	**0.852**	0.372	-0.375	-0.048	0.017
SQ14	0.404	0.442	0.487	0.453	**0.861**	0.357	-0.442	-0.022	0.215
TC1	0.225	0.170	0.161	0.088	0.327	**0.581**	-0.267	0.076	0.002

	KP	EL	TU	TP	SQ	SC	RA	PS	MS
TC2	-0.133	-0.068	0.074	-0.106	0.301	**0.570**	-0.141	-0.046	-0.027
TC3	-0.099	0.135	0.038	-0.113	0.021	**0.379**	-0.143	-0.148	-0.149
TC4	0.239	0.156	0.135	0.098	0.268	**0.728**	-0.270	-0.034	-0.133
TC5	0.252	0.135	0.174	0.062	0.244	**0.651**	-0.309	0.024	-0.037
TC6	0.020	0.195	0.126	0.284	0.260	**0.792**	-0.455	-0.357	0.059
TC7	0.092	0.189	0.236	0.162	0.187	**0.724**	-0.565	-0.228	0.156
TC8	0.134	0.035	0.208	0.187	0.357	**0.787**	-0.424	-0.233	0.208
TC9	0.174	0.084	0.206	0.301	0.491	**0.830**	-0.354	-0.175	0.194
RA1	0.067	-0.076	-0.074	-0.149	-0.040	-0.150	**0.578**	0.257	-0.268
RA2	-0.041	-0.288	-0.228	-0.394	-0.337	-0.394	**0.863**	0.329	-0.078
RA3	-0.139	-0.188	-0.207	-0.293	-0.341	-0.401	**0.851**	0.275	-0.21
RA4	-0.131	-0.210	-0.274	-0.500	-0.463	-0.470	**0.870**	0.256	-0.356
PS1	0.110	-0.012	0.076	-0.155	-0.077	-0.175	0.373	**0.818**	-0.074
PS2	0.091	-0.065	0.079	-0.098	-0.148	-0.128	0.304	**0.834**	0.005
PS3	0.136	-0.210	0.032	-0.189	-0.032	-0.157	0.141	**0.670**	-0.155
MS	-0.128	-0.120	-0.085	0.089	0.169	0.114	-0.276	-0.104	**1**

Note:

1. The correlation coefficients with assigned latent constructs are emphasized in boldface.

The correlations in Table 20 reveal that the four knowledge participation dimensions correlate with knowledge participation much higher than with other constructs. As thus, the validity (both convergent and discriminant validity) of the 2-layer knowledge participation construct is confirmed.

In addition, all measurement items correlate higher with assigned constructs than with others, providing evidence to their construct validities.

The ISD literature suggests that user participation is a multi-dimensional construct. The factor analysis has confirmed that the four dimensions – responsibility, hand-on activity, user-IS relationship, and communication – reliably reflect the overall level of user participation in the sampled ISD project teams. Knowledge participation, which is built solely on the user participation instrument, presents almost identical factor loading patterns. Further construct validity test of knowledge participation supports a 2-layer structure of the construct. This finding justifies the operationalization of the knowledge participation construct and suggests user participants do perceive the four categories valid to describe their contributions to ISD processes.

10.4. HYPOTHESES TESTING

Although LISREL and other structural equation modeling (SEM) tools (e.g., AMOS) has the ability to examine a 2-layer measurement model along with the test of overall research model, the limited sample size restricted their use for this study. In contrast, PLS reserves the advantage of testing measurement model and research model at the same time; in addition, because of its special algorithm, PLS does not require large sample size[9] for reliable testing results. In this study, I use PLS-Graph version 3.0 to test hypotheses.

1. The Effects of Knowledge Participation vs. User Participation on ISD Productivity Outcomes – Testing of Hypotheses H1a, H1b, H2a, and H2b.

A key proposition of this study is that knowledge participation is a better predictor of ISD productivity outcomes than user participation. Hypotheses H1a, H1b, H2a, H2b devoted to this proposition.

Correlation analysis is employed to test the predictive power of knowledge participation vs. user participation on team performance and system quality. Because user participation and knowledge participation have the same four dimensions, I test and compare correlation coefficients of each dimension for a clear demonstration how these dimensions of knowledge participation and user participation affect ISD project development. This approach has been used by other researchers on their study of the different dimensions of user participation (e.g., Barki and Hartwick, 1994; Hartwick and Barki, 2001), or focusing on one dimension as an indicator of the overall user participation (e.g., Heinbokel et al., 1996; Hunton and Beeler, 1997; Hunton and Price, 1997; Yetton et al., 2000).

Correlation coefficients between the dimensions of knowledge participation and user participation, and other key constructs are reported in Table 19. Close examination of these correlations reveals that, in general, knowledge participation dimensions correlate stronger with

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[9] LISREL, for example, requires eight to ten times of involved items for a reliable model testing. This study employs comprehensive surveys of both user participants and system developers, and testing of the research model involves many multi-item constructs, including 14-item user participation, 17-item knowledge participation, 6-item team performance, 14-itme system quality, and others. In contrast, PLS requires moderate sample size based on the number of causal relationships.

ISD productivity – measured by team performance and system quality – than the user participation components do.

Table 21. Correlations Between User Participation Components, Knowledge Participation Components, and Other Key Constructs

	RESP	HOA	UIS	COM	KRESP	KHOA	KUIS	KCOMM	EL	TU	TP	SQ
RESP	1											
HOA	0.380	1										
UIS	0.091	0.110	1									
COM	0.192	0.333	0.071	1								
KRES	0.708	0.126	0.145	0.135	1							
KHOA	0.315	0.620	0.210	0.224	0.330	1						
KUIS	0.165	-0.021	0.728	0.086	0.396	0.304	1					
KCOM	0.301	0.036	-0.214	0.249	0.477	0.203	0.137	1				
EL	0.238	0.031	0.033	-0.074	0.397	0.157	0.296	0.439	1			
TU	0.221	0.192	0.149	-0.053	0.299	0.350	0.310	0.261	0.769	1		
TP	0.153	-0.028	0.023	-0.079	0.352	0.039	0.189	0.314	0.643	0.598	1	
SQ	0.016	-0.093	0.126	0.008	0.202	0.039	0.311	0.286	0.473	0.474	0.600	1

Note:

1. N ranges from 67 to 72.
2. *r* > 0.3 are significant at 0.0l; *r* > 0.23 are significant at 0.05 (two-tailed).

To give a more rigorous assessment of their differences, I use *z** test to compare the effects of knowledge participation dimensions on team performance and system quality with that of user participation dimensions; and Stouffer's Z[10] to aggregate the difference onto the construct level. *z** test is based on Fiser's *z* transformation of correlation coefficients to make them comparable. The resulting statistics are reported in Table 22.

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[10] Stouffer's *Z* is a popular vote-counting procedure that combines probabilities of multiple studies. The philosophy is that repeated results in the same direction across multiple studies, even when some are non-significant, may be more powerful evidence than a single significant result (Rosenthal and DiMatteo, 2001). This method is considered appropriate here in that if each of the four dimensions of knowledge participation and user participation present similar effect differences (i.e., in the same direction), these differences may be combined as a general pattern between the two constructs.

Table 22. Comparison Between the Effects of Knowledge Participation and User Participation

ISD Outcomes	Dimensions of Knowledge Participation / User Participation	Knowledge Participation Effects		User Participation Effects		Comparison[1]	
		Correlation Coefficients	Fisher's *z*	Correlation Coefficients	Fisher's *z*	*z** Test	*p*-value (2-sided)
Team Performance	Responsibility	0.352	0.368	0.153	0.154	1.239	0.215
	Hand-on Activity	0.039	0.039	-0.028	-0.028	0.388	0.698
	User-IS Relationship	0.189	0.191	0.023	0.023	0.972	0.331
	Communication	0.314	0.325	-0.079	-0.079	2.338	0.019
Integration with Stouffer's Z[2]						2.469	0.014
System Quality	Responsibility	0.202	0.205	0.016	0.016	1.094	0.274
	Hand-on Activity	0.039	0.039	-0.093	-0.093	0.764	0.445
	User-IS Relationship	0.311	0.322	0.126	0.127	1.129	0.259
	Communication	0.286	0.294	0.008	0.008	1.655	0.098
Integration with Stouffer's Z[2]						2.321	0.020

Note:

1. The null hypothesis tested here is that the effects of knowledge participation and its dimensions are not larger than the effects of user participation and its dimensions. A *p*-value suggests the level at which the null hypothesis is rejected.
2. Stouffer's Z statistic: $Z = \frac{1}{\sqrt{k}} \sum_{i=1}^{k} (Z_i)$, where *k* is the number of sampled tests.
3. Sample sizes are 70 for team performance, and 67 for system quality.

The direct comparison suggests that knowledge participation has a stronger effect on team performance/system quality than user participation does. Although most of the comparisons at dimension level yield insignificant results, all the statistics are in the same direction. The statistic integration Stouffer's *Z* reveals that on average, knowledge participation dimensions have a stronger correlation with team performance (p-value = 0.014) and with system quality (p-value = 0.020) than user participation components do. Therefore, hypotheses H1a, H1b, H2a, and H2b are supported.

A meta-analysis is used as another analytic technique to detect the effect difference between knowledge participation and user participation. Besides being applied on literature review, meta-analysis can also be used to combine results from a series of related tests. This is a popular approach especially in the field of software engineering, where much research involves modest experimental effects, small sample sizes, and hypothesis testing fails to conclude significant results due to low statistic power, this approach has been found to be particularly useful (King and He, 2005).

The analysis is described in Table 23. The correlations between the knowledge participation dimensions / user participation dimensions and ISD productivity outcomes are collected along with their sample sizes. Homogeneity test[11] is conducted to assess whether the effects of the dimensions are significantly different from each other. If insignificance is concluded, Hedges' fixed effect procedure is used to calculate average effect size of the

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[11] This test generates a decision rule specifying whether the variability in standardized effect sizes is statistically significant. The test is based on a chi-square assessment of the level of variance across study results relative to the sampling error variance across studies. This test is developed by Hedge and Olkin (1985), and is often referred to as homogeneity test, Q Statistics or Chi-Square Test. Non-significant results do not reject the notion that the tested effect sizes are sampled from the same population or reflect the same relationship. In a meta-analysis of a series of sub-studies or tests, the test is often conducted as a criterion whether these sub-studies or tests examine the same relationship. Only if the testing statistics are not significant will the following integration of their results be justified.

dimensions; the average effect size implies the construct effect of knowledge participation or user participation on ISD productivity outcomes.

Table 23. Integration of the Effects of Knowledge Participation / User Participation

Dimensions	Knowledge Participation Effects		User Participation Effects	
	Team Performance	System Quality	Team Performance	System Quality
Responsibility	0.352 (70)	0.202 (67)	0.153 (70)	0.016 (67)
Hand-on Activity	0.039 (70)	0.039 (67)	-0.028 (70)	-0.093 (67)
User-IS Relationship	0.189 (70)	0.311 (67)	0.023 (70)	0.126 (67)
Communication	0.314 (70)	0.286 (67)	-0.079 (70)	0.008 (67)
Homogeneity Test (Q)	4.338	3.077	1.985	1.530
p (Homogeneity)	0.227	0.380	0.576	0.675
Average Effect Size	0.227	0.212	0.017	0.014
p (Effect Size)	0.000	0.001	0.778	0.823

Note:

1. Sample sizes are reported in parentheses.

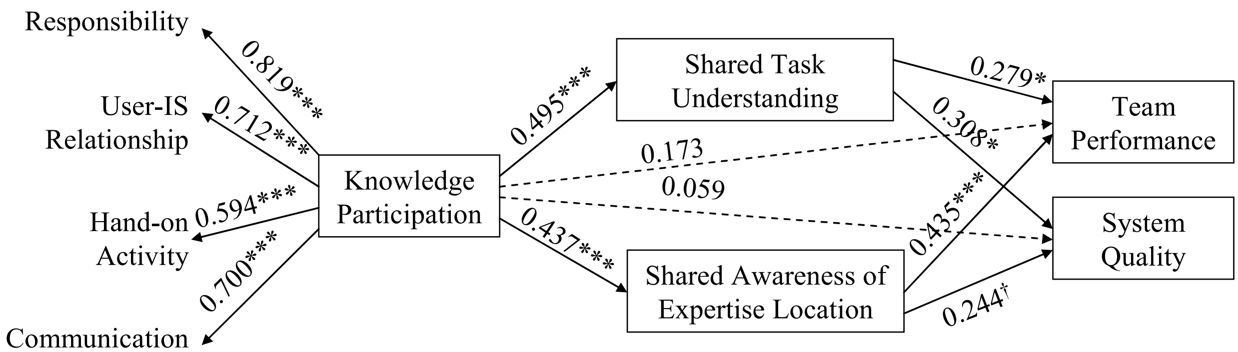
The results suggest that knowledge participation has a stronger effect on team performance/system quality than user participation does. The average effect size of knowledge participation components on team performance is 0.227, significantly at $\alpha < 0.001$ level; that on system quality is 0.212, significant at $\alpha = 0.001$ level. In contrast, none of the average effect sizes of user participation components on team performance and system quality are significant.

In addition, all the homogeneity tests yield insignificant results, therefore the null hypothesis cannot be rejected that the effects of the four knowledge participation dimensions reflect the same underlying effect. This result lends additional support to the 2-layer structure of knowledge participation construct. Later hypothesis tests will examine knowledge participation as a construct in the research model.

2. The Mediating Role of Team Cognition – Testing of Hypotheses H3, H4, H5a, H5b, H6a, and H6b.

PLS-Graph is employed to test the mediating role of team cognition, which is represented by two dimensions particularly important for ISD project teams – shared awareness of expertise location and shared task understanding. To highlight the effects of team cognition, control variables are not included in this test. The testing results are graphically presented in Figure 6.

Figure 6. The Mediating Role of Team Cognition



Note:

1. The four dimensions of knowledge participation are not placed in boxes because they are indicators of the latent construct.
2. Of the knowledge participation construct, composite reliability = 0.801, and AVE = 0.505.
3. *** for *p*-value <0.001; ** for *p*-value <0.01; * for *p*-value <0.05; and † for *p*-value <0.10.

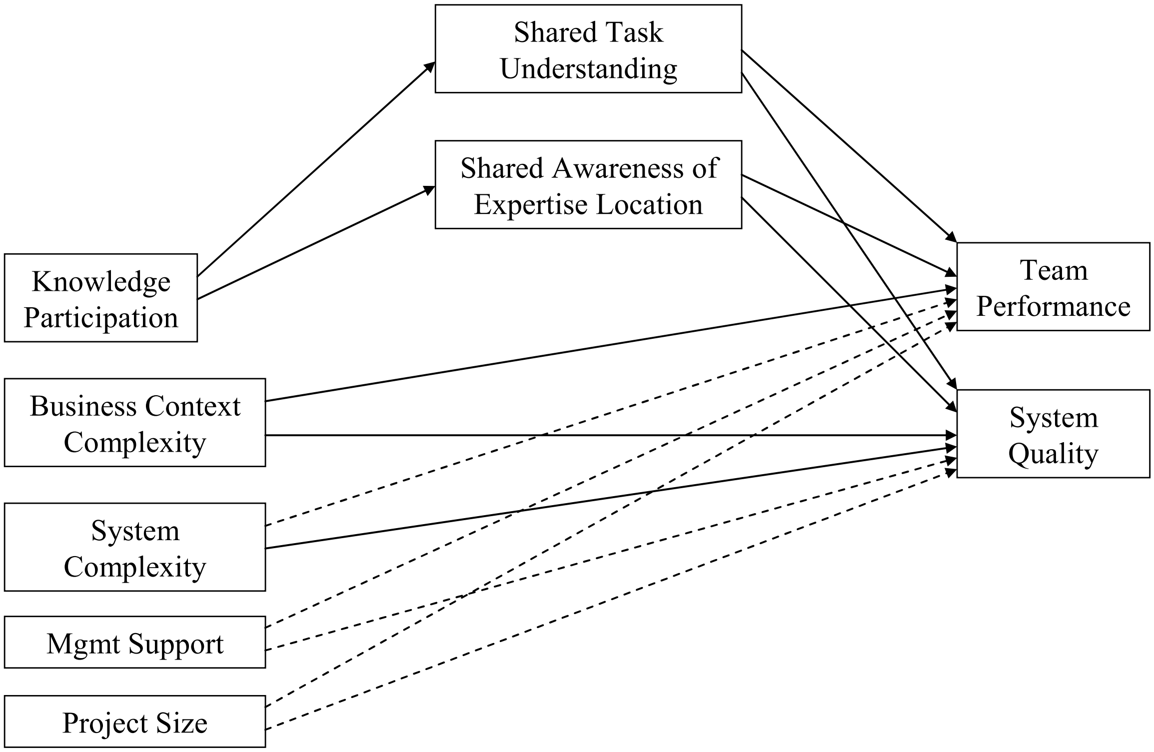
The above tests support the mediating role of team cognition in general. All path coefficients related with shared awareness of expertise location and shared task understanding are in the hypothesized direction and are statistically significant at α=0.10 level. Therefore, hypotheses regarding the mediating effects of shared awareness of expertise location and shared task understanding are supported.

In addition, in the model the direct effects of knowledge participation on team performance and system quality are not significant. This result implies a complete mediating effect of team cognition on the relationship between knowledge participation and ISD productivity outcomes.

3. Control Variables and Their Effects on ISD Productivity – Testing of Hypotheses H7a, H7b, H8a, H8b, H9a, H9b, H10a, and H10b.

Hypotheses H7a through H10b describe how the four control variables – business context complexity, system complexity, management support, and project size –affect ISD productivity directly. The testing is graphically presented in Figure 7 and the resulting statistics are reported in Table 22.

Figure 7. Testing Results of Control Variables



Note: Paths with bold lines are significant at α=0.10 level; and paths with dashed lines are insignificant.

Table 24. Path Coefficients of the Testing of Control Variables

Dependent Variables	Independent Variables						
	Knowledge Participation	Shared Awareness of Expertise Location	Shared Task Understanding	System Complexity	Business Context Complexity	Mgmt. Support	Project Size
Shared Awareness of Expertise Location	0.552***	-	-	-	-	-	-
Shared Task Understanding	0.486***	-	-	-	-	-	-
Team Performance	-	0.362*	$0.267^{\dagger}$	-0.047	-0.299**	0.030	-0.085
System Quality	-	$0.226^{\dagger}$	$0.225^{\dagger}$	0.257*	$-0.193^{\dagger}$	-0.109	0.043

Note: *** for *p*-value <0.001; ** for *p*-value <0.01; * for *p*-value <0.05; and † for *p*-value <0.10. All others are insignificant.

Not all the control variables have significant effects on ISD productivity. More specifically, the effects of management support, project size are not significant in the model; and the effect of system complexity on team performance is not significant. Analysis of the correlation matrix of the tested variables (see Table 25) also suggest that management support and project size do not correlate significantly with other constructs.

Table 25. Correlation Matrix of the Tested Variables

Variables	1	2	3	4	5	6	7	8	9
1. Knowledge Participation	**0.505**								
2. Shared Awareness of Expertise Location	0.552	**0.694**							
3. Shared Task Understanding	0.486	0.783	**0.782**						
4. Team Performance	0.404	0.652	0.618	**0.674**					
5. System Quality	0.394	0.476	0.498	0.608	**0.595**				
6. System Complexity	0.158	0.135	0.222	0.198	0.430	**0.452**			
7. Business Context Complexity	-0.111	-0.259	-0.273	-0.467	-0.440	-0.465	**0.664**		
8. Management Support	0.129	0.005	0.106	0.133	0.083	0.118	-0.167	**1**	
9. Project Size	0.143	-0.119	0.078	-0.190	-0.121	-0.175	0.343	0.192	**0.612**

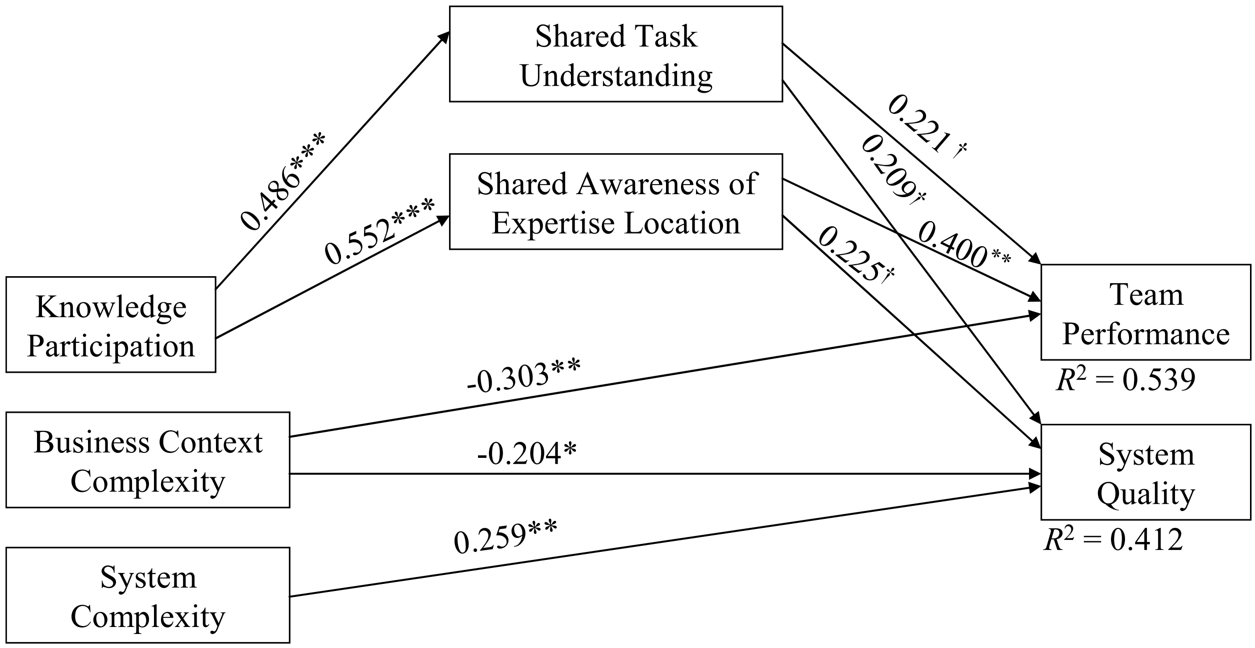
Note:

1. AVE of latent constructs are reported in bold on the diagonal;
2. $r > 0.330$ are significant at 0.0l; $r > 0.256$ are significant at 0.05 (two-tailed).

The effects of business context complexity on team performance and system quality, and the effect of system complexity on system quality, are statistically significant and in the predicted directions. It needs to note that business context complexity was measured on an easy – difficult continuum (BC1 and BC2 were reverted to comply with this continuum), and system complexity was measured on a difficult – easy continuum. The different signs of their related path coefficients support the propositions that the more complex of the underlying business context and the system development technologies, the lower level of the associated team performance and system quality.

In conclusion, hypotheses H7a, H7b, and H8b are supported; and hypotheses H8a, H9a, H9b, H10a, and H10b are not supported by the data. After dropping the insignificant control variables, a modified model-A from the data analysis emerges in Figure 8:

Figure 8. Modified Model-A with Control Variables



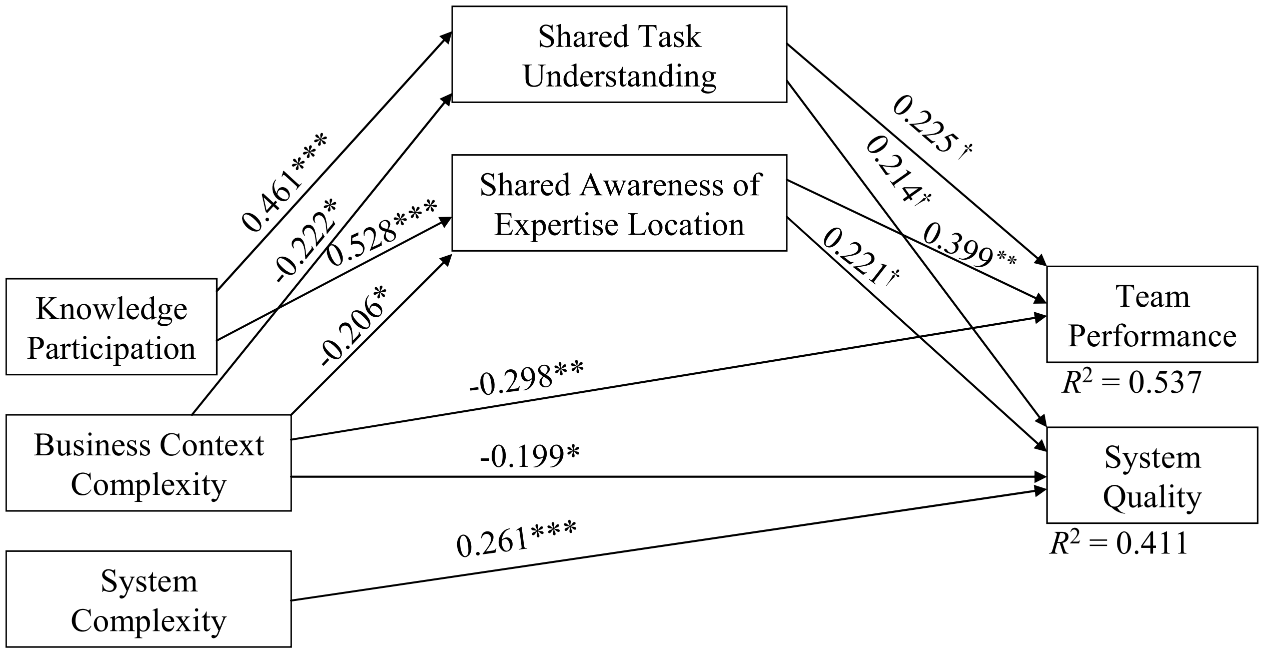
Note: *** for *p*-value <0.001; ** for *p*-value <0.01; * for *p*-value <0.05; and † for *p*-value <0.10.

4. A Further Analysis of Business Context Complexity

As presented in the modified model-A, business context complexity and system complexity are two important variables that have direct and significant impacts on ISD productivity. A close examination of Table 23 suggests that business context complexity significantly correlates with shared awareness of expertise location and shared task understanding at α=0.05 level. This implies that besides its direct impacts on team performance and system quality, business context complexity may also affect shared awareness of expertise location and shared task understanding. Adding the two causal links do not change much the magnitudes of other coefficients, but increase the explained variances of the two team cognition components (R^2 of shared awareness of expertise location was increased from 0.236 to 0.284; and R^2 of shared task understanding was increased from 0.305 to 0.345).

Figure 9 presents a modified model-B that fits best with the sampled data.

Figure 9. Modified Model-B



Note: *** for *p*-value <0.001; ** for *p*-value <0.01; * for *p*-value <0.05; and † for *p*-value <0.10.

11.0. SUMMARY AND DISCUSSION

In this thesis, I performed a meta-analysis on user participation effects, and proposed a knowledge theory to explain how user participants help ISD project teams improve productivity. To test the research model, I conducted an experimental study and a field study. In this chapter, I summarize the research findings and their implications, discuss limitations of the study, and provide suggestions to future research on the investigation of user participation effect on ISD productivity outcomes.

11.1. RESEARCH FINDINGS, IMPLICATIONS, AND CONTRIBUTIONS

11.1.1. Meta-analysis

To answer whether user participation impact on ISD productivity, I conducted a meta-analysis of previous empirical studies on this research topic. Results reveal that user participation has a significantly positive effect on ISD productivity, but the effect is not as large as user participation theory suggests. In contrast, user participation presents a larger effect on attitudinal outcomes.

The meta-analytic results are also compared with participation research in the PDM literature. Contradictory to a prevailing wisdom that participation is favorable to knowledge-intensive tasks including ISD projects, user participation does not bring productivity benefits as much as participation does in general organizational settings. This finding challenges the basic assumption of user participation theory that user participation is highly associated with meaningful user contribution.

The meta-analysis has a broad coverage of 72 empirical studies that can be found though the research library of the University of Pittsburgh. It is the most comprehensive attempt of literature sampling on the topic. Thus, the results are generalizable and reliable.

With conclusive answers to the general effects of user participation on ISD outcomes, the meta-analysis raises question on the appropriateness of employing user participation as a determinant for ISD productivity. The poor predictive power of user participation implies that performing certain set of activities does not guarantee increased chance of achieving ISD success. Although many researchers have concluded similarly from their individual observations, the quantitative nature of the meta-analysis substantiates the conclusion with rigorous procedure, provoking the rethinking of user participation with solid evidence.

11.1.2. Knowledge Theory of User Participation

With the evidence found from previous user participation studies, I proposed a knowledge theory of user participation to explain how user participants bring productivity benefits to ISD processes. As the core of the theory, “knowledge participation” was proposed as a new construct to assess the amount of knowledge that user participants bring to ISD processes, and team cognition, specified by its two elements of shared awareness of expertise location and shared task understanding, was proposed a mediating mechanism that transforms knowledge participation effects into ISD productivity.

To validate the theory, I conducted an experimental study and a field study to test the validity of knowledge participation construct as well as the overall research model in both “controlled” and “realistic” situations. The experimental study used students as the research subject and simulated ISD with a system analysis task. The field study surveyed real user participants and system developers across different organizations and ISD projects. The validity of knowledge participation construct was confirmed in both studies; and hypotheses deriving from the proposed knowledge theory of user participation received significant support from the data. In addition, the predictive power of knowledge participation on ISD productivity was compared with that of user participation. Results substantiate knowledge participation as a better construct to predict ISD productivity.

In the literature, productivity benefits of user participation are often explained with a cognitive mechanism, arguing that the provision of business knowledge and expertise from users enables ISD project teams to develop quality systems and achieve overall ISD success. However, the cognitive mechanism is often conceptually discussed but rarely empirically tested. This study attempts to assess users’ knowledge contribution to ISD processes, and proposes a knowledge model to test the validity of such contribution. The proposed knowledge theory of user participation is expected to provide a new theoretical lens on the investigation of user participation effects.

11.1.3. The Study of Control Variables

Although not a focus of the thesis project, four environmental factors were employed in the field study to investigate what contextual factors are favorable, and what are unfavorable, to ISD project development. The study of these control variables produced some interesting findings. Business context complexity was found to have negative effects on both team performance and system quality. In addition, further analysis revealed that business context complexity hinders the maturation of appropriate team cognition structures between user participants and system developers.

Literature review shows that many researchers did not incorporate business context complexity in their studies. The finding of the thesis project suggests that this environmental factor has significant impact on ISD productivity outcomes.

11.1.4. Managerial Implications

The findings of this research have some valuable implications to the ISD practice. The validated knowledge participation construct and its effects on both team performance and system quality suggest that the user participation practice should focus on the effective knowledge provision of users, not the various participation activities themselves. As demonstrated by the research results, users' execution of participative activities has little influence to ISD productivity; rather, the contributed business knowledge from user participants impacts significantly on the performance of ISD project teams as well as the quality of the produced systems. As thus, user participation should be viewed as a means by which users are able to provide their business knowledge to ISD project teams.

Much of the existing prescriptive literature provides guidelines on when and how users should be involved in ISD project development. This research takes one step further and suggests that the recommended participative activities are helpful only if they induce users to provide significant knowledge to ISD project teams.

11.2. LIMITATIONS

Although the results are encouraging, the thesis has several limitations. One is the small sample size in the field study. I collected data from 173 professional individuals or 82 ISD projects teams. Previous studies that investigated user participation effects at super-individual levels had similar sample sizes. As shown by the meta-analysis, the average sample sizes of studies addressing team performance, organizational impact, and overall project success are 68, 55, and 79 respectively. The small sample size restricted the selection of SEM software for hypothesis testing. I used PLS-Graph to test the research model, and placed special attention on the validity of involved constructs, especially the knowledge participation construct. Some hypothesized paths are marginally significant at α=0.10 level, possibly due to the small sample size.

The low respondent rate and the associated small sample size in the field study also raise a concern on the representativeness of the research sample. I contacted with some non-respondents trying to understand why they did not cooperate, and found that many organizations restrained their employees from participating in any survey projects. The research design of requesting matched responses at team level further deteriorated the chance of inducing participation from busy professionals. The following message I received from a senior IS manager might explain representatively for nonresponse:

> One problem I run into personally with your methodology is the number of people within the organization I have to reach out to in order to complete the documentation. Our company is extremely busy during a very difficult economic time … I have decided to severely limit the number of surveys we engage in within IT. You might not be surprised to learn I get asked on average once per week for such an investment. Granted, it is more typically from a vendor, consulting firm, or research firm, than academic research. Each individual is not overly burdensome, but I just can't dedicate so much time to this type of activity.
>
> *A message from a non-respondent*

I conducted a demographic analysis (Table 10 and Table 11) to show the diversity among the respondents as well as their organizations. However, low respondent rate increases the risk of nonresponse-induced errors (King and He, 2005). In the field study, most survey invitations were not answered, and it was impossible to perform a systematic comparison between respondents and nonrespondents. Thus, the generalizability of the research results should be dealt with caution.

A third limitation concerns with the measure of project size. Many studies have demonstrated a strong relationship between project size and performance. But the relationship cannot be concluded in this research. The unexpected finding could be caused by the relative measure of project size. In this study, project size was measured against the average projects in respondents' organizations. A large numbers (i.e., 4 or 5) indicated that the surveyed project had used more resources and had a longer schedule than an average project in the respondent's organization. In contrast, the dependent variables (team performance and system quality) were measured on a low-high continuum without comparison to any projects. Therefore, the use of relative measure to assess project size could be inappropriate for this study.

11.3. SUGGESTIONS TO FUTURE STUDY

Data collected for this thesis have validated the proposed knowledge participation construct and substantiated most of the associated hypotheses. The results provide some valuable implications to ISD practice. However, as results from single studies cannot serve as the basis for generalizable conclusions, future studies are needed to test the proposed knowledge theory of user participation.

11.3.1. Knowledge Participation Construct

The knowledge participation construct is built solely on a user participation instrument developed by Hartwick and Barki (2001). Although highly-recognized in the ISD literature, Hartwick and Barki's 38-item instrument is too comprehensive for a survey study, especially when many other constructs are to be investigated. In fact, in another study, Barki and colleagues (2001) used a reduced version of the instrument with 15 items.

Other user participation measures, such as Torkzadeh and Doll's (1990) 8-item instrument, may be employed in future research to assess knowledge participation. Using different user participation instruments to build and test knowledge participation not only helps economizes survey questionnaires and simplifies research design, but also provides generalizability to the construct. In addition, testing knowledge participation with different sets of user participative activities may lead to observations that which activities are instrumental and effective on improving ISD productivity and which activities are not, therefore has potential significance to ISD practices.

11.3.2. Team Cognition Construct

Team cognition is a broad concept. The two elements tested in the thesis, shared awareness of expertise location and shared task understanding, do not reflect a complete picture of team cognition in ISD project teams, although the two elements are argued to be important. Other elements or dimensions, such as shared attitudes and motivation, also deserve future investigation. For example, does knowledge participation improve the shared attitudes toward the target systems within ISD project teams? The knowledge theory of user participation suggests that with the provision of needed business knowledge, the morale of ISD project teams will be improved and developers will be more confident on developing quality systems, resulting in an increased level of team cognition on the aspect of shared attitudes. This proposition needs to be tested by future research.

11.3.3. Extending the Knowledge Theory of User Participation

The knowledge theory of user participation proposed in the thesis addresses ISD productivity outcomes. Using a knowledge approach to explain user participative efforts, the theory may be applied to other related areas such as project management and conflict management. Because ISD is knowledge-intensive work, the knowledge theory of user participation may provide new lens to study different phenomenon that involve users in ISD processes.

APPENDIX A: SAMPLED PAPERS OF THE META-ANALYSIS

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APPENDIX B: INSTRUMENTS IN THE EXPERIMANTAL STUDY

User Participation (7 item) α=0.821

During the system development process, did you perform the following activities / responsibilities?

1. taking on the leadership role in the development of the project?
2. estimating project and system costs?
3. managing the project?
4. overall success of the project and the system?
5. initiating the project?
6. determining system objectives?
7. estimating project and system benefits?

Knowledge Participation (6 item) α=0.703

To what extent did you provide **your reasons, comments, suggestions, or other relevant information** to the project team when executing each of the above activities/responsibilities (item 2 – item 7)?

Transactive Memory Systems (4 items) α=0.851

1. The team had a good "map" of each other's talents and skills.
2. Team members were assigned to tasks commensurate with their task-relevant knowledge and skill.
3. Team members knew what task-related skills and knowledge they each possess.
4. Team members knew who on the team has specialized skills and knowledge that is relevant to their work.

Shared Mental Model (3 items) α=0.832

1. Team members had a common understanding of the application domain that the system was supposed to support.
2. Team members had a common understanding of the technologies used in the development process.
3. Overall, team members shared their visions of the project.

Team Performance (6 items) α=0.865

Please evaluate performance of the project team on

1. the amount of work the team produced.
2. the efficiency of team operations.
3. the team's adherence to budgets. (dropped as irrelevant)

4. the team's adherence to the schedule.
5. the quality of work the team produced.
6. the effectiveness of the team's interactions with people outside the team. (dropped as irrelevant)

APPENDIX C: INSTRUMENTS IN THE FIELD STUDY

User Participation / Knowledge Participation items

Respondents: user participants

Binary scale of Yes/No for User Participation, and 1-5 scale for Knowledge Participation to assess the amount of reasons, comments, suggestions, or other relevant information that respondent has provided to the project team when executing the activity, with 1: Not Much, 3: Moderate, 5: Very Much.

- **Responsibility**

  RESP01: Did you take on the leadership role in the development of the project?

  During the system development process, did you perform the following activities:

  RESP02: estimating project and system costs?

  RESP05: requesting additional funds to cover unforeseen time/cost overruns?

  RESP06: managing the project?

  RESP07: overall success of the project and the system?

  RESP08: initiating the project?

  RESP09: determining system objectives?

  RESP10: estimating project and system benefits?

- **User-IS Relationship**

  UIS1: Did the IS staff draw up a formal agreement of work to be done during the project?

  UIS2: Did you ask for changes to the formal agreement concerning work to be done by the IS staff during the project?

  UIS3: Did you sign off the formal agreement concerning work to be done by the IS staff during the project?

  UIS4: Did you evaluate an information requirements analysis developed by the IS staff concerning the system?

  UIS5: Did you accept and sign off an information requirements analysis developed by the IS staff concerning the system?

  UIS6: Did you review work done by the IS staff concerning the system?

  UIS7: Did you accept and sign off work done by the IS staff concerning the system?

  UIS8: Did you review an information requirements analysis developed by the IS staff concerning the system?

  UIS9: Did you evaluate work done by the IS staff concerning the system?

- **Hand-On Activity**

  HOA1: Did you help design or help design input/output forms?

  HOA2: Did you design or help design screen layouts?

  HOA3: Did you design or help design report formats?

  HOA4: Did you prepare/help prepare user manuals?

  HOA5: Did you design/help design the user training program?

  HOA6: Did you train/help train other users to use the system?

  HOA7: Did you design/help design system security procedures?

  HOA8: Did you set/help set system access priorities?

  HOA9: Did you determine/help determine data access privileges?

- **Communication**

  COM01: Did you exchange facts, opinions, and visions concerning the project with other users?

  COM03: Did you discuss your reservations and concerns regarding the project with other users?

  COM05: Did you exchange facts, opinions, and visions concerning the project with the IS staff?

  COM07: Did you discuss your reservations and concerns regarding the project with the IS staff?

  COM09: Did you exchange facts, opinions, and visions concerning the project with senior management?

  COM11: Did you discuss your reservations and concerns regarding the project with senior management?

Team Performance

Respondents: user participants, system developers, project managers

1-5 scale: 1: very low, 3: average, 5: very high

Please evaluate performance of the project team in terms of …

TP1: The amount of work the team produced.

TP2: The efficiency of team operations.

TP3: The team's adherence to budgets.

TP4: The team's adherence to the schedule.

TP5: The quality of work the team produced.

TP6: The effectiveness of the team's interactions with people outside the team.

Team Cognition Elements:

Respondents: user participants, system developers, project managers

1-5 scale: 1: strongly disagree, 3: neutral, 5: strongly agree

- **Shared Awareness of Expertise Location**

Do you agree the following statements?

EL1: The team had a good "map" of each other's talents and skills.

EL2: Team members were assigned to tasks commensurate with their task-relevant knowledge and skill.

EL3: Team members knew what task-related skills and knowledge they each possess.

EL4: Team members knew who on the team has specialized skills and knowledge that is relevant to their work.

- **Shared Task Understanding**

Do you agree the following statements?

TU1: Team members had a common understanding of the application domain that the system was supposed to support.

TU2: Team members had a common understanding of the technologies used in the development process.

TU3: Team members had a common understanding of the project development procedures.

TU4: Overall, team members shared their visions of the project.

System Quality

Respondents: user participants, system developers

1-5 scale: 1: strongly disagree, 3: neutral, 5: strongly agree

Do you agree with the following statements regarding the system quality delivered by the team?

SQ1: The system is reliable (it is always up and running, runs without errors, and does what it is supposed to do).

SQ2: It is easy to tell whether the system is functioning correctly.

SQ3: The system can recover from errors, accidents, and intrusions while maintaining data security and integrity.

SQ4: The system can easily be modified to meet changing user requirements.

SQ5: The system can easily be adapted to a new technical or organizational environment.

SQ6: The system is easy to maintain.

SQ7: The system is easy to understand.

SQ8: The system is easy to use.

SQ9: The output information produced by the system is precise.

SQ10: The output information produced by the system is complete.

SQ11: The output information produced by the system is useful.

SQ12: The output information produced by the system is up to date.

SQ13: The output information produced by the system is reliable.

SQ14: The system performs its functions quickly.

Business Context Complexity

Respondents: user participants

1-5 scale: 1: strongly disagree, 3: neutral, 5: strongly agree

Regarding the business context for which the project was supposed to support, do you agree with the following statements?

BC1: There exists a well-defined body of knowledge on which to base the execution of business activities.

BC2: It is easy to identify the sequence of steps needed for a successful execution of business activities.

BC3: The consequences of some executions are difficult to predict.

BC4: In general, one can immediately determine whether the activities were successfully performed upon the completion.

BC5: In my opinion, these business activities are routine.

System Complexity:

Respondents: system developers

1-5 scale: 1: Very Difficult, 3: Moderate, 5: Very Easy

How difficult was it to solve the problems that resulted from the use of each of the following:

SC1: The hardware platform

SC2: The software platform

SC3: The programming language(s)

SC4: The telecommunications technology

SC5: The database technology

SC6: The design techniques

SC7: The coding techniques

SC8: The testing techniques

SC9: The installation techniques

SC10: When completed, how many existing systems will be linked to this system? (give a number)

SC11: When developed, how many systems currently under development will be linked to this system? (give a number)

Note: the items of SC10 and SC11 are open-end and are not used in data analysis.

Project Size

Respondents: user participants, system developers

1-5 scale: 1: much lower, 3: average, 5: much higher

Compared to other IS projects developed in your organization,

PS1: the scheduled number of person-days for completing this project was

PS2: the scheduled number of months for completing this project was

PS3: the dollar budget allocated to this project was

PS4: the overall resources that management allocated to this project was

PS5: the overall “support” from top management was

Requirements Uncertainty

Respondents: system developers

1-5 scale: 1: strongly disagree, 3: neutral, 5: strongly agree

Do you agree with the following statements regarding requirements for the project?

RU1: Requirements fluctuated during the system development process.

RU2: Users of this system differed among themselves in the requirements to be met by it.

RU3: A lot of effort had to be spent in reconciling the requirements of various users of this system.

RU4: It was difficult to customize the system to one set of users without reducing support to other users.

Management Support

Respondents: user participants, system developers

1-5 scale: 1: much lower, 3: average, 5: much higher

MS1: Compared to other IS projects developed in your organization, The overall support from top management was …

APPENDIX D: FIELD STUDY - INVITATION LETTER

<Date>

<Mailing Address of Contact Person>

Dear <First Name of Contact Person>,

We would like to ask you to participate in a research study that we believe has great practical value and may be directly beneficial for you and your firm.

We are focusing on the issue of user participation in information systems development. Many, especially academics, think that user participation is "good" and that more user participation is even better. We question whether that is true.

So, we've spent over a year planning a study which should tell us when and where user participation is helpful and when and where it is not.

To perform the empirical phase of this study, we must gather data from business people who have participated in systems development projects and from their professional developer counterparts. These people may have participated in a wide range of projects from applications development to the customization of vendor-supplied systems.

We plan to do this in multiple firms and we believe that the aggregate results may be very instructive and useful to the field and to these firms. No individual's or firm's responses will be identified, but if you wish, we will provide you with a profile of your firm's aggregate responses compared to that of other firms.

What we require is management approval for, and cooperation with, distributing two different questionnaires – one for user participants and one for professional developers. We need "matched pair" responses from both. We'll provide explicit guidance on how to select the respondents and give guidance to them on how to participate. (All they will need to do is complete a questionnaire that should take about 10 minutes on either the internet or in hard copy.)

We believe that this project may serve to eliminate a lot of wasted effort in user participation, and focus attention on the kind of participation that is cost-effective.

If you would consider recommending that your firm participate in the study, please complete the enclosed sheet and mail it in the postage-paid envelope or respond with an email. We'll then contact you, or someone who you recommend, to discuss the details, to find out what level of management approval is necessary, and to determine the scope of your firm's participation.

Thanks for your consideration.

Sincerely,

William R. King
University Professor
Katz Graduate School of Business
University of Pittsburgh
billking@katz.pitt.edu

Jun He
PhD Candidate
Katz Graduate School of Business
University of Pittsburgh
junhe@katz.pitt.edu

(Please make corrections if necessary)

<Mailling Address of Contact Person>

Other Contact Information

Telephone ____________________________

Email ________________________________

☐ Yes, we may be interested in participating.

☐ Please send me the survey forms.

☐ Please contact another person who might be better able to help:

Name ____________________________

Position __________________________

Address __________________________

____

Telephone _________________________

Email _____________________________

☐ No, sorry, we can't participate.

You may reply by using the enclosed postage-paid envelope or by email to junhe@katz.pitt.edu

APPENDIX E: FIELD STUDY – SURVEY PACKAGE

Date

Dear <Contact name from contact list>,

Thank you very much for your support for our study of user participation during Information Systems Development (ISD) projects. We expect to determine whether the prevailing wisdom that high user involvement leads to better project outcomes is valid.

For our study, relevant ISD projects may include developing new software, upgrading an existing system, or installing a new system provided by a vendor. For an ISD project to be successful, users or their representatives (including outside customers, internal system users, and business analysts within an IS department) are often required to be involved in the development process either directly as project team members, or indirectly as consultants to provide needed knowledge and information to the project team.

This survey involves two different sets of questionnaires – one for user ISD participants and one for professional developers. Please help us specify one or more ISD projects, and distribute the questionnaires to people you think are relevant to this study. The questionnaires are also available online at http://www.surveymonkey.com/s.asp?u=132761659198.

We would like to get as many "pairs" – one developer and one user – as possible in your organization. As a result, we have included multiple copies of the survey. The envelopes are labeled "project 1", "project 2" et al., but there is no need that the matched pairs have worked on different projects. In other words, you might identify three pairs all of whom worked together on the same project.

It will take approximately 10 minutes for a participant to complete the questionnaire. The survey responses will be strictly confidential and data from this research will be reported only in the aggregate.

If you would like to have the research results, please also provide us your email address where we will send a summary of what we have found.

If you have questions about the survey or the procedures, you may contact the researchers specified below either by phone or by email.

Thank you very much for your time and support.

Sincerely,

William R. King
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Dear Sir/Madam:

Thank you very much for your participation in our study of user participation during Information Systems Development (ISD). This study has been approved and supported by the management of your organization.

For an ISD project to be successful, users or their representatives (including outside customers, internal system users, and business analysts within an IS department) are often required to involve in the development process either directly as project team members, or indirectly as consultants to provide needed knowledge and information to the project team. Users' various participative behaviors are generally considered as "good" development practices and the more the better. We question whether that is true. More specifically, we try to identify which practice is effective, and which practice might be ineffective or even burdensome to both users and developers.

As an important user participant of a recently completed project at your organization, your experience will help us better address the question. Please fill the attached questionnaire based onyour experience and knowledge. The survey is also available online at http://www.surveymonkey.com/s.asp?u=132761659198. It will take approximately 5-10 minutes to complete the questionnaire. Your information will be coded and will remain confidential, and data from this research will be reported only in the aggregate.

The survey form is coded so that we may "match" developer and user responses. These codes will be used for no other purposes.

If you have questions about the survey or the procedures, you may contact the researchers specified below either by phone or by email.

Thank you very much for your time and support.

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Questionnaire

Instruction: To develop a successful Information System, system developers undoubtedly consult you on the project, or ask you to join their team on a regular basis. This research studies how you participation behaviors and knowledge contributions impact on the performance of the project team.

We appreciate your willingness to respond to the following questions. Please answer in terms of your experience in a specific project development process in which you involved.

Project Name: ____

1. Were you a permanent member on the project team? ☐ Yes ☐ No

2. Did you take on the leadership role in the development of the project? ☐ Yes ☐ No

3. Regarding the business context for which the project was supposed to support, do you agree with the following statements?

		Strongly Disagree		Neutral		Strongly Agree
a	I have rich knowledge regarding the business context.	1	2	3	4	5
b	There exists a well-defined body of knowledge on which to base the execution of business activities.	1	2	3	4	5
c	It is easy to identify the sequence of steps needed for a successful execution of business activities.	1	2	3	4	5
d	The consequences of some executions are difficult to predict.	1	2	3	4	5
e	In general, one can immediately determine whether the activities were successfully performed upon the completion.	1	2	3	4	5
f	In my opinion, these business activities are routine.	1	2	3	4	5

4. During the system development process, did you perform the following activities/responsibilities? If yes, to what extent did you provide **your reasons, comments, suggestions, or other relevant information** to the project team when executing the responsibility?

			Not Much		Moderate		Very Much
a	estimating project and system costs?	☐ Yes ☐ No	1	2	3	4	5
b	requesting additional funds to cover unforeseen time/cost overruns?	☐ Yes ☐ No	1	2	3	4	5
c	managing the project?	☐ Yes ☐ No	1	2	3	4	5
d	overall success of the project and the system?	☐ Yes ☐ No	1	2	3	4	5
e	initiating the project?	☐ Yes ☐ No	1	2	3	4	5
f	determining system objectives?	☐ Yes ☐ No	1	2	3	4	5
g	estimating project and system benefits?	☐ Yes ☐ No	1	2	3	4	5

5. Did the IS staff draw up a formal agreement of work to be done during the project? ☐ Yes ☐ No

6. During the system development process, did you perform the following activities? If yes, to what extent did you provide **your comments, reservations, and/or concerns** to the project team when executing the activity?

			Not Much		Moderate		Very Much
a	Did you ask for changes to the formal agreement concerning work to be done by the IS staff during the project?	☐ Yes ☐ No	1	2	3	4	5
b	Did you sign off the formal agreement concerning work to be done by the IS staff during the project?	☐ Yes ☐ No	1	2	3	4	5
c	Did you evaluate an information requirements analysis developed by the IS staff concerning the system?	☐ Yes ☐ No	1	2	3	4	5
d	Did you accept and sign off an information requirements analysis developed by the IS staff concerning the system?	☐ Yes ☐ No	1	2	3	4	5
e	Did you review work done by the IS staff concerning the system?	☐ Yes ☐ No	1	2	3	4	5
f	Did you accept and sign off work done by the IS staff concerning the system?	☐ Yes ☐ No	1	2	3	4	5
g	Did you review an information requirements analysis developed by the IS staff concerning the system?	☐ Yes ☐ No	1	2	3	4	5
h	Did you evaluate work done by the IS staff concerning the system?	☐ Yes ☐ No	1	2	3	4	5
i	Did you help design or help design input/output forms?	☐ Yes ☐ No	1	2	3	4	5
j	Did you design or help design screen layouts?	☐ Yes ☐ No	1	2	3	4	5
k	Did you design or help design report formats?	☐ Yes ☐ No	1	2	3	4	5
l	Did you prepare/help prepare user manuals?	☐ Yes ☐ No	1	2	3	4	5
m	Did you design/help design the user training program?	☐ Yes ☐ No	1	2	3	4	5
n	Did you train/help train other users to use the system?	☐ Yes ☐ No	1	2	3	4	5
o	Did you design/help design system security procedures?	☐ Yes ☐ No	1	2	3	4	5
p	Did you set/help set system access priorities?	☐ Yes ☐ No	1	2	3	4	5
q	Did you determine/help determine data access privileges?	☐ Yes ☐ No	1	2	3	4	5

7. Please indicate to what frequency you communicate with other people on this project.

		Yes/No	Not Much 1	2	Moderate 3	4	Very Much 5
a	Did you exchange facts, opinions, and visions concerning the project with other users?	☐ Yes ☐ No	1	2	3	4	5
b	Did you discuss your reservations and concerns regarding the project with other users?	☐ Yes ☐ No	1	2	3	4	5
c	Did you exchange facts, opinions, and visions concerning the project with the IS staff?	☐ Yes ☐ No	1	2	3	4	5
d	Did you discuss your reservations and concerns regarding the project with the IS staff?	☐ Yes ☐ No	1	2	3	4	5
e	Did you exchange facts, opinions, and visions concerning the project with senior management?	☐ Yes ☐ No	1	2	3	4	5
f	Did you discuss your reservations and concerns regarding the project with senior management?	☐ Yes ☐ No	1	2	3	4	5

8. Please evaluate performance of the project team using a 1-5 scale: 1: very low; 3: average; 5: very high.

		Very Low 1	2	Average 3	4	Very High 5
a	The amount of work the team produced.	1	2	3	4	5
b	The efficiency of team operations.	1	2	3	4	5
c	The team's adherence to budgets.	1	2	3	4	5
d	The team's adherence to the schedule.	1	2	3	4	5
e	The quality of work the team produced.	1	2	3	4	5
f	The effectiveness of the team's interactions with people outside the team.	1	2	3	4	5

9. Do you agree with the following statements regarding knowledge sharing in the team?

		Strongly Disagree 1	2	Neutral 3	4	Strongly Agree 5
a	People in our team shared their special knowledge and expertise with one another.	1	2	3	4	5
b	If someone in our team had some special knowledge about how to perform the team task, he or she was **not** likely to tell the other member about it.	1	2	3	4	5
c	There was virtually **no** exchange of information, knowledge, or sharing of skills among members.	1	2	3	4	5
d	More knowledgeable team members freely provided other members with hard-to-find knowledge or specialized skills.	1	2	3	4	5
e	The team had a good "map" of each other’s talents and skills.	1	2	3	4	5
f	Team members were assigned to tasks commensurate with their task-relevant knowledge and skill.	1	2	3	4	5
g	Team members knew what task-related skills and knowledge they each possess.	1	2	3	4	5
h	Team members knew who on the team has specialized skills and knowledge that is relevant to their work.	1	2	3	4	5
i	Team members had a common understanding of the application domain that the system was supposed to support.	1	2	3	4	5
j	Team members had a common understanding of the technologies used in the development process.	1	2	3	4	5

		Strongly Disagree		Neutral		Strongly Agree
k	Team members had a common understanding of the project development procedures.	1	2	3	4	5
l	Overall, team members shared their visions of the project.	1	2	3	4	5

10. Do you agree with the following statements regarding the system quality delivered by the team?

		Strongly Disagree		Neutral		Strongly Agree	
a	The system is reliable (it is always up and running, runs without errors, and does what it is supposed to do).	1	2	3	4	5	N/A
b	It is easy to tell whether the system is functioning correctly.	1	2	3	4	5	N/A
c	The system can recover from errors, accidents, and intrusions while maintaining data security and integrity.	1	2	3	4	5	N/A
d	The system can easily be modified to meet changing user requirements.	1	2	3	4	5	N/A
e	The system can easily be adapted to a new technical or organizational environment.	1	2	3	4	5	N/A
f	The system is easy to maintain.	1	2	3	4	5	N/A
g	The system is easy to understand.	1	2	3	4	5	N/A
h	The system is easy to use.	1	2	3	4	5	N/A
i	The output information produced by the system is precise.	1	2	3	4	5	N/A
j	The output information produced by the system is complete.	1	2	3	4	5	N/A
k	The output information produced by the system is useful.	1	2	3	4	5	N/A
l	The output information produced by the system is up to date.	1	2	3	4	5	N/A
m	The output information produced by the system is reliable.	1	2	3	4	5	N/A
n	The system performs its functions quickly.	1	2	3	4	5	N/A

11. Do you agree with the following statements regarding your overall attitude toward the system?

		Strongly Disagree		Neutral		Strongly Agree
a	For me, personally, the system is good.	1	2	3	4	5
b	For me, personally, the system is terrific.	1	2	3	4	5
c	For me, personally, the system is useful.	1	2	3	4	5
d	For me, personally, the system is valuable.	1	2	3	4	5

Thanks for your help!

Date

Dear Sir/Madam:

Thank you very much for your support to and participation in our study of user participation during Information Systems Development (ISD). This study has been kindly approved and supported by the management of your organization.

For an ISD project to be successful, the project team is often urged to involve users or their representatives (including outside customers, internal system users, and business analysts within an IS department) in the development process either directly as project team members, or indirectly as consultants for needed knowledge and information. Users' various participative behaviors are generally considered as "good" development practices and the more the better. We question whether that is true. More specifically, we try to identify which practice is effective, and which practice might be ineffective or even burdensome to both users and developers.

As an important professional developer of a recently completed project at your organization, your experience will help us better address the question. Please fill the attached questionnaire based onyour experience and knowledge. The survey is also available online at http://www.surveymonkey.com/s.asp?u=132761659198. It will take approximately 5-10 minutes to complete the questionnaire. Your information will be coded and will remain confidential, and data from this research will be reported only in the aggregate.

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Questionnaire

Instruction: During a system development process, you undoubtedly need to consult with some potential users of the project you develop, or ask them to join your team on a regular basis. Please evaluate the contribution of users during the system develop process.

We appreciate your willingness to respond to the following questions. Please answer in terms of your experience in a specific project that you recently completed.

Project Name: ____

1. Were you a team leader on the project team? ☐ Yes ☐ No

2. How many people were there on the project team? ______________
   Among them, how many were system developers? ______________
   how many were user representatives? ______________

3. Please evaluate the extent of knowledge and expertise you have …

		Not much		Moderate		Very much
a	In system development in general	1	2	3	4	5
b	in the business context for which the project was to support	1	2	3	4	5

Project Information

4. Compared to other IS projects developed in your organization,

		Much Lower		Average		Much Higher
a	the scheduled number of person-days for completing this project was	1	2	3	4	5
b	the scheduled number of months for completing this project was	1	2	3	4	5
c	the dollar budget allocated to this project was	1	2	3	4	5
d	the overall resources that management allocated to this project was	1	2	3	4	5
e	the overall "support" from top management was	1	2	3	4	5

5. Do you agree with the following statements regarding requirements for the project?

		Strongly Disagree		Neutral		Strongly Agree
a	Requirements fluctuated during the system development process.	1	2	3	4	5
b	Users of this system differed among themselves in the requirements to be met by it.	1	2	3	4	5
c	A lot of effort had to be spent in reconciling the requirements of various users of this system.	1	2	3	4	5
d	It was difficult to customize the system to one set of users without reducing support to other users.	1	2	3	4	5

6. How difficult was it to solve the problems that resulted from the use of each of the following:

		Very Difficult		Moderate		Very Easy	
a	The hardware platform	1	2	3	4	5	N/A
b	The software platform	1	2	3	4	5	N/A
c	The programming language(s)	1	2	3	4	5	N/A
d	The telecommunications technology	1	2	3	4	5	N/A

		Very Difficult		Moderate		Very Easy	
e	The database technology	1	2	3	4	5	N/A
f	The design techniques	1	2	3	4	5	N/A
g	The coding techniques	1	2	3	4	5	N/A
h	The testing techniques	1	2	3	4	5	N/A
i	The installation techniques	1	2	3	4	5	N/A

7. When completed, how many existing systems will be linked to this system? ___________

8. When developed, how many systems currently under development will be linked to this system? ___________

9. Do you agree with the following statements regarding users' ***contribution*** to the project's development?

		Strongly Disagree		Neutral		Strongly Agree
a	Users or their representatives provided the project team rich knowledge of the application domain.	1	2	3	4	5
b	Users or their representatives clarified requirements for this project.	1	2	3	4	5
c	The participation of users during the project development was effective.	1	2	3	4	5
d	The participation of users during the project development helped the team to achieve overall development success.	1	2	3	4	5

10. Do you agree with the following statements regarding knowledge sharing in the team?

		Strongly Disagree		Neutral		Strongly Agree
a	People in our team shared their special knowledge and expertise with one another.	1	2	3	4	5
b	If someone in our team had some special knowledge about how to perform the team task, he or she was not likely to tell the other member about it.	1	2	3	4	5
c	There was virtually no exchange of information, knowledge, or sharing of skills among members.	1	2	3	4	5
d	More knowledgeable team members freely provided other members with hard-to-find knowledge or specialized skills.	1	2	3	4	5
e	The team had a good "map" of each other's talents and skills.	1	2	3	4	5
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k	Team members had a common understanding of the project development procedures.	1	2	3	4	5
l	Overall, team members shared their visions of the project.	1	2	3	4	5

11. Please evaluate performance of the project team using a 1-5 scale: 1: very low; 3: average; 5: very high.

		Very Low		Average		Very High
a	The amount of work the team produced.	1	2	3	4	5
b	The efficiency of team operations.	1	2	3	4	5
c	The team's adherence to budgets.	1	2	3	4	5
d	The team's adherence to the schedule.	1	2	3	4	5
e	The quality of work the team produced.	1	2	3	4	5
f	The effectiveness of the team's interactions with people outside the team.	1	2	3	4	5

Quality of the developed system

12. Do you agree with the following statements regarding the system quality delivered by the team?

		Strongly Disagree		Neutral		Strongly Agree	
a	The system is reliable (it is always up and running, runs without errors, and does what it is supposed to do).	1	2	3	4	5	N/A
b	It is easy to tell whether the system is functioning correctly.	1	2	3	4	5	N/A
c	The system can recover from errors, accidents, and intrusions while maintaining data security and integrity.	1	2	3	4	5	N/A
d	The system can easily be modified to meet changing user requirements.	1	2	3	4	5	N/A
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l	The output information produced by the system is up to date.	1	2	3	4	5	N/A
m	The output information produced by the system is reliable.	1	2	3	4	5	N/A
n	The system performs its functions quickly.	1	2	3	4	5	N/A

Thanks for your help!

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