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Knowledge Sharing in Information Systems Development: A Social Interdependence Perspective

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1. Introduction

As organizations increasingly rely on information systems (IS) for strategic and operational purposes, information systems development (ISD) has become an important organizational activity. ISD involves the analysis, design, and implementation of information technology (IT) systems and applications to support business functions (Xia and Lee, 2005). It is typically a knowledge-intensive process requiring diverse expertise, with business and IT knowledge being the most critical constituents. Knowledge regarding business requirements and business processes/workflow is needed to provide the logic driving the new IS while IT knowledge related to the use and technical possibilities of the new system is needed by business professionals to fully realize the potential of the new IS (Ko et al., 2005; Rus and Lindvall, 2002). The extent to which such knowledge is effectively shared between business and external IT professionals has been shown to be a key antecedent of ISD project performance (Joshi et al., 2007; Ko et al., 2005).

However, knowledge sharing between business and IT professionals can be challenging as their domains of expertise and paradigms differ. These differences are the inevitable result of specialization where each group is trained in different technical languages to interpret issues from the perspectives of their line of work (Dougherty, 1992). This creates a feeling of distance that exacerbates project governance challenges (Tiwana, 2009) and impedes knowledge sharing between them. The dearth of business and IT knowledge sharing can be a significant risk to ISD projects (Gemino, 2007-2008). Therefore, it is important to understand what influences knowledge sharing between business and IT professionals during ISD.

The challenge of sharing knowledge between business and IT professionals during ISD is compounded when IT professionals are hired from outside the business organization. In such teams, external IT consultants are typically bound by formal contracts and the gap between business and IT professionals is further widened by differences in organizational context. Engaging external IT consultants or vendors is a growing trend, with the worldwide IT services market totaling US$819 billion in 2008 (Gartner, 2008). However, knowledge sharing between the business subgroup and the external IT consultant subgroup in an ISD project team has received little research attention (Ko et al., 2005). This study addresses the gap by examining whether goal, task, and reward interdependencies influence knowledge sharing between the subgroups of business professionals and external IT consultants based on the social interdependence theory (Deutsch, 1949; Pee et al., 2007). The research question posed is: *How does perceived social interdependence influence knowledge sharing between the business subgroup and the external IT consultant subgroup during ISD?*

Through a survey of 95 matched pairs of business subgroup and external IT consultant subgroup in commercial ISD project teams, we test whether perceived goal, task, and reward interdependencies have significant effects on knowledge sharing. Noting that ISD project teams engaging external IT consultants may include in-house IT professionals belonging to the client organizations who may enhance knowledge sharing between the two subgroups, we control for the influences of in-house IT professionals as boundary bridges.

This study's key contribution to research is in understanding how social interdependence is related to knowledge sharing between the business subgroup and the external IT consultant subgroup during ISD. Through examining the relative influence of different types of interdependence on knowledge sharing, findings of this study can also provide directions for practitioners in developing interventions to enhance knowledge sharing in ISD[1].

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[1] An earlier abridged version of this paper was presented at the 3rd Annual International Research Workshop on IT Project Management (IRWITPM 2008) - sponsored by the AIS SIGITProjMgmt, Paris,

2. Conceptual Background

We first define knowledge sharing in ISD and compare it with other similar concepts in the IS literature. Prior studies related to knowledge sharing between business and IT professionals are then reviewed to identify gaps in the existing literature. We then describe the relevance and use of the theory of social interdependence, which posits that goal, task, and reward interdependencies promote interactions, for explaining knowledge sharing between the subgroups of business professionals and external IT consultants during ISD.

2.1 Defining Knowledge Sharing in IS Development

Knowledge sharing implies a relationship between two parties – one that possesses the knowledge and the other that requires the knowledge (Hendriks, 1999). It has been defined as a conscious act to participate in knowledge exchange even when there is no external compulsion to do so (Davenport, 1997). It has also been defined as revealing the presence of pertinent knowledge without necessarily transmitting it in its entirety (Tiwana and McLean, 2005). Building on these definitions, we define *knowledge sharing* in our study's context as the extent to which the subgroups of business professionals and external IT consultants consciously reveal the presence of and exchange pertinent knowledge with one another[2].

Central to the concept of knowledge sharing is the idea of knowledge exchange between participants. Participants (i.e., business professionals and external IT consultants in our study) engage in two-way interactions and shift between the roles of knowledge source and recipient in knowledge sharing. Thus knowledge sharing refers to the bidirectional exchange of knowledge and differs from other concepts such as knowledge transfer, which refers to the unidirectional flow of knowledge from a source to the recipient (Joshi et al., 2007).

2.2 Review of Studies on Knowledge Sharing between Business and IT Professionals

Prior studies on knowledge sharing between business and IT professionals have provided insights on its antecedents. In reviewing the studies, we organize the antecedents identified based on the key elements of communication proposed in the communication perspective (Berlo, 1960). Organizing the antecedents allows us to better summarize the state of research on knowledge sharing and identify gaps in prior research. The communication perspective identifies sender, receiver, channel, transmission, and effect as the basic elements of communication (see Table 1). The perspective is relevant for understanding knowledge sharing because these elements are inherent in knowledge sharing[3] (Joshi et al., 2007). In the context of knowledge sharing, *sender* corresponds to the source contributing knowledge in a particular exchange. *Receiver* is the entity which acquires the knowledge. *Channel* corresponds to the medium through which knowledge is shared (e.g., face-to-face meetings, computer, phone, documents). *Transmission* refers to the actual process and activity of sending and receiving knowledge through designated channels. Its effectiveness is affected by factors such as motivation and nature of a social relationship. *Effect* refers to the outcome of knowledge sharing such as performance, learning, and satisfaction.

In previous studies, encoding competency, which indicates a source's command of language and ability to express knowledge clearly, has been identified as a key characteristic of knowledge source (Ko et al., 2005). Other influential knowledge source attributes include source's expertise, experience, and credibility (Faraj and Sproull, 2000; Joshi et al., 2007; Sarker et al., 2005). For knowledge

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France, December 12-13th, 2008.

[2] This paper focuses on the extent to which knowledge is shared between the subgroups of business professionals and external IT consultants. The extent to which the knowledge shared is integrated into the final IS is outside the scope of this paper.

[3] This study focuses on the sharing of knowledge such as business requirements, business processes/workflow, and technical possibilities of the new IS rather than the communication of data and information in an ISD project.

recipients, their absorptive capacity allows them to recognize the importance and value of new knowledge, assimilate it, and apply it based on their existing stock of related knowledge (Ko et al., 2005; Tiwana and McLean, 2005). Channel richness is a characteristic of the communication channel that may impact knowledge sharing (Lind and Zmud, 1991). Rich channels that provide opportunities for immediate feedback, a broader range of message cues, and capabilities to personalize messages allow knowledge sharing partners to overcome different frames of reference.

Table 1. Factors Related to Knowledge Sharing between Business and IT Professionals

Element of Communication		**Factor**
Sender (Knowledge Source)		- Encoding competency (Ko et al., 2005) - Expertise / capability (Faraj and Sproull, 2000; Joshi et al., 2007; Sarker et al., 2005) - Professional experience (Faraj and Sproull, 2000) - Source credibility (Joshi et al., 2007, Ko et al., 2005; Sarker et al., 2005)
Receiver (Knowledge Recipient)		- Absorptive capacity (Ko et al., 2005; Tiwana and McLean, 2005) - Decoding competency (Ko et al., 2005)
Channel		- Channel richness (Lind and Zmud, 1991)
Transmission	Motivation	- Extrinsic motivation (Ko et al., 2005) - Intrinsic motivation (Ko et al., 2005)
	Relationship	- Arduousness of relationship (Ko et al., 2005) - Cultural collectivism (Sarker et al., 2005) - Mutual influence (Nelson and Cooprider, 1996) - Mutual trust (Nelson and Cooprider, 1996) - Shared understanding (Ko et al., 2005)
Effect		- Performance (Faraj and Sproull, 2000; Nelson and Cooprider, 1996; Patnayakuni et al., 2006) - Project completion (Mitchell, 2006) - Team creativity (Lind and Zmud, 1991; Tiwana and McLean, 2005)

Knowledge sharing not only depends on the attributes of source, recipient, and channel but is also affected by the context within which knowledge sharing takes place. Recognizing this, prior studies have examined the effects of motivation and social relationship on knowledge sharing (Ko et al., 2005; Nelson and Cooprider, 1996; Sarker et al., 2005). In the context of ISD, motivational factors have largely been conceptualized in terms of intrinsic and extrinsic motivations (e.g., Ko et al., 2005). The nature of social relationships may also impact knowledge sharing (Argote et al., 2003; Darr et al., 1995). Ko et al. (2005) found that knowledge exchange pairs that have little shared understanding and arduous relationships are less likely to interact. Relationships that lack mutual trust also present challenges for knowledge sharing (Nelson and Cooprider, 1996). With regard to the effects of knowledge sharing, prior studies have investigated both immediate (e.g., creativity) and downstream effects (e.g., project completion and performance) (Mitchell, 2006; Tiwana and McLean, 2005).

In ISD involving external IT consultants, project teams are typically formed temporarily for the purpose of a specific project and often involve members who do not have prior collaboration history. In such circumstances, it is important to build relationships quickly and effectively. It is therefore helpful to identify antecedents that project managers can influence more directly to increase knowledge sharing. Interdependence between business and external IT professionals, which may influence subgroups' interactions (Johnson, 2003), can potentially be directly manipulated by managers. For example, reward interdependence can be created intentionally by designing rewards (van Vijfeijken et al., 2002) such that business professionals and external IT consultants are compensated based on the overall quality of the resultant IS in addition to their individual contribution (e.g., work hours) towards the system and communicating this reward interdependence to them. Therefore, examining goal, task, and reward interdependencies between the two subgroups may offer helpful practical insights for increasing knowledge sharing.

2.3 Theory of Social Interdependence

The theory of social interdependence describes how members or subunits of a group interact in cooperative work situations (Deutsch, 1949). The theory has its origin in Lewin's Field Theory (Lewin, 1935), which proposes that a group is "a dynamic whole so that a change in the state of any member or subgroup changes the state of any other member or subgroup" (Johnson and Johnson, 2005, p.288). This study focuses on the interdependence between the *subgroups* of business and external IT consultants in an ISD project team. Likewise, previous studies have examined the behaviors of subgroups based on the theory of social interdependence (e.g., Hoegl et al., 2004; Tjosvold, 1988; Wong et al., 2005). For example, Tjosvold (1988) studied the effect of goal interdependence among functional groups in an organization (e.g., information systems, business development, and finance) on their collaboration and exchange of information and resources to serve customers based on this perspective.

According to the theory of social interdependence, interdependencies in goals, tasks, and rewards between subgroups result in promotive *interaction*, which refers to subgroups' simultaneous or sequential actions that influence the immediate and future outcomes of the other subgroups involved in the situation (Johnson, 2003). Interaction is characterized by subgroups engaging in actions such as providing each other with assistance and exchanging needed resources such as information and materials (Johnson, 2003). In the context of ISD projects, an important form of interaction is the sharing of knowledge resources between the subgroups of business and IT professionals, since ISD is a process of sense making that involves social interaction, cooperation, and learning to co-construct a system through a continual process of communication and negotiation among various stakeholders holding disparate views and knowledge (Joshi et al., 2007). To successfully build an IS, external IT consultants require knowledge about business needs and workflow from business professionals (Joshi et al., 2007) while business professionals need knowledge about the use and technical possibilities of the new IS from IT consultants (Ko et al., 2005; Rus and Lindvall, 2002).

In the context of ISD, interdependencies such as task interdependence have been found to play an important role (Andres and Zmud, 2001-2002), suggesting that the theory of social interdependence may be relevant for understanding knowledge sharing in ISD projects. In this study, we focus on perceived social interdependence rather than actual interdependence considering that interdependence is unlikely to influence behavior if it is not perceived or believed to be present (Deutsch, 1949). Similarly, Johnson and Johnson (2005) highlighted that behavior is determined by how the situation is perceived, rather than by objective assessment. The three aspects of social interdependence (i.e., goal, task, and reward) are detailed next.

Perceived goal interdependence refers to the extent to which a subgroup believes that its goals can be achieved only when the goals of the other subgroup are also met (Weldon and Weingart, 1993). Perceived goal interdependence goes beyond goal alignment in that it requires the subgroups' goals to not only be compatible but also reliant on the goal attainment of one another. In the context of ISD, the external IT consultant subgroup's goals may include delivering a high quality system and applying the latest technology. The business subgroup's goals may include having a system that adequately supports its business needs and completing the ISD project within schedule and budget. The theory of social interdependence suggests that interactions will be promoted when the subgroups' goals are perceived as interdependent (Deutsch, 1949).

Perceived task interdependence refers to the extent to which a subgroup believes that it depends on the other subgroup for being able to carry out its work (van der Vegt and van de Vliert, 2005). Tasks confronting a group can significantly affect their decisions and behaviors (DeSanctis and Gallupe, 1987). In the context of ISD, task interdependence results from the division of labor between business professionals and external IT consultants who possess different expertise and contribute complementarily to the project. For example, during the initial phases of ISD, subgroups' tasks may be highly interdependent in that the business professionals' expertise is needed to identify business requirements while the external IT consultants' expertise is needed to translate the requirements into a technical system design. When these subgroups' tasks are perceived as interdependent, the subgroups are likely to believe that task completion requires collective action and they may therefore be more motivated to share knowledge with one another.

It is important to note that while the terms task interdependence and goal interdependence have sometimes been used interchangeably in prior research, they are conceptually and empirically distinct (Wageman, 1995). In an ISD project, subgroups may have an overall interdependent goal (e.g., develop a high quality IS that can adequately address business needs) but they may perceive little task interdependence during the project (e.g., it is believed that the external IT consultant subgroup is experienced enough to know what system functionalities are needed and that they are able to carry out most tasks of the project without much involvement from the business subgroup).

Perceived reward interdependence refers to the degree to which a subgroup believes that their rewards depend on the performance of the other subgroup (Wageman, 1995). Organizations typically implement performance-related pay systems, which explicitly link financial rewards to performance. In the context of ISD, business and external IT consultant subgroups are likely to perceive reward interdependence when part of the subgroup reward is based on the evaluation of the other subgroup. While extrinsic motivation identified in prior studies (see Table 1) also underlines the importance of rewards, it focuses more on the availability of rewards. Reward interdependence, on the other hand, considers the assignment of rewards to a subgroup as related to the performance of the other subgroup.

Based on the theory of social interdependence, we expect goal, task, and reward interdependencies to influence knowledge sharing during ISD and develop our model and hypotheses accordingly.

3. Research Model and Hypotheses

The proposed model posits that perceived goal, task, and reward interdependencies between the business subgroup and the external IT consultant subgroup influence the extent of knowledge sharing between them during ISD (see Figure 1). Perceived goal interdependence is also hypothesized to influence perceived task interdependence. Knowledge sharing is in turn expected to influence ISD project phase performance. We hypothesize that the influences of various aspects of social interdependence on ISD project phase performance are fully mediated by knowledge sharing. We measure ISD project phase performance instead of project performance since we study business and external IT consultant subgroups in a specific project phase to avoid retrospective bias, as explained later in the Data Collection section. Therefore, the unit of analysis in this study is a dyad of business subgroup and external IT consultant subgroup in an ISD project team in a particular phase. In addition to the hypothesized relationships, the effects of prior collaboration history, boundary bridging activity of internal IT personnel, project phase, team size, project complexity, and project contract type are also controlled for. The rationale for each hypothesis is discussed below.

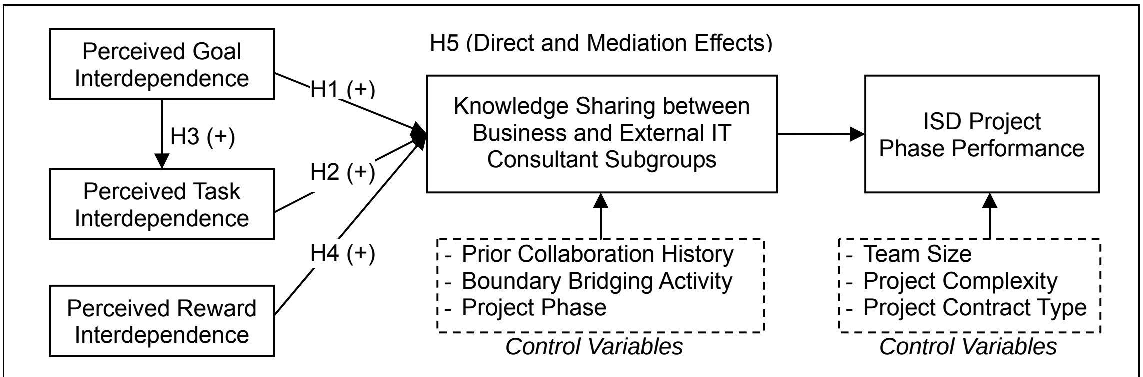

Figure 1. Research Model and Hypotheses

3.1 Perceived Goal Interdependence

With different backgrounds, expertise, and roles in an ISD project, the subgroups of business professionals and external IT consultants often have goals of their own in addition to the project goals (Andres and Zmud, 2001-2002). When the subgroups' goals are perceived as interdependent, they will tend to promote their mutual goal attainment by coordinating and cooperating with each other through interactions (Deutsch, 1949). For example, the business subgroup may seek to develop a system that can adequately address business needs and aim to complete the project within the stipulated budget and time. On the other hand, the external IT consultants may endeavor to develop a high quality IS and employ the latest technology to diversify their portfolio (Robey et al., 1989). In this case, the first goals of the two subgroups are largely interdependent as the business subgroup counts on the expertise of external IT consultants to build the IS and the external IT consultant subgroup relies on the judgment of business professionals in evaluating the quality of the resultant IS. Awareness of this interdependence can induce the subgroups to work jointly to achieve their mutually supporting goals. Indeed, Amason and Schweiger (1997) have shown that cooperative goals lead to more accurate information exchange. In contrast, the subgroups' second goals may be in conflict as new technology tends to be more expensive and requires more time to learn, which may increase the time and cost of a project. If this conflict becomes a dominating concern, the subgroups may behave uncooperatively towards each other to prevent the other subgroup from achieving its goal since one's success is at the expense of the other. Thus we expect goal interdependence to be positively related to knowledge sharing.

H1: Perceived goal interdependence between the business and external IT consultant subgroups is positively related to knowledge sharing between them.

3.2 Perceived Task Interdependence

In ISD, task interdependence exists in various project phases such as requirements analysis and system testing. During requirements analysis, business needs must be identified and interpreted from the technical perspective. To facilitate this task, external IT consultants need the cooperation of business professionals to share their knowledge while business professionals rely on external IT consultants' expertise to translate their requirements accurately into system design. During system testing, business professionals depend on external IT consultants to convey their knowledge about the functionalities of the new IS to proceed with testing while external IT consultants need the feedback of the business subgroup to fine tune the IS. These task interdependencies create a situation of reciprocity whereby knowledge sharing is seen as a form of social exchange (Bock et al., 2005). The knowledge contributing subgroup anticipates returns for sharing their knowledge with the other subgroup, most directly in the form of knowledge that is relevant to their own task completion. Task interdependence also creates a situation where subgroups' problems and solutions are intertwined to determine task completion. When subgroups are aware of their task interdependencies, they are likely to establish joint control of tasks and assist each other in a growth-oriented manner (Salaway, 1987). Previous studies have shown that task interdependence stimulates the exchange of knowledge on project requirements, task assignments, and development progress (Straus and McGrath, 1994). Thus, we hypothesize that:

H2: Perceived task interdependence between the business and external IT consultant subgroups is positively related to knowledge sharing between them.

Prior research suggests that goal interdependence and task interdependence may be interrelated (Weldon and Weingart, 1993). Goals direct the attention and effort of group members and, in the process, may stimulate task strategies that emphasize collective performance (Saavedra et al., 1993). Subgroups perceive their goals as interdependent when they believe that the goal attainment of one subgroup relies on that of the other subgroup. This may predispose the subgroups to facilitate each other's goal achievement by planning, coordinating, and executing tasks jointly. They may develop collaboration strategies to maximize efficiency and goal accomplishment, in view of their goal interdependence (Mitchell and Silver, 1990). In contrast, when subgroups perceive their goals as independent, there is a lack of motivation to cooperate and they are likely to decouple their tasks and work on their own. They may be less concerned about the other subgroup and instead pay more attention to planning and executing their own tasks such that their own goals are realized. Accordingly, we hypothesize that task interdependence may be influenced by goal interdependence:

H3: Perceived goal interdependence is positively related to perceived task interdependence between the business and external IT consultant subgroups.

3.3 Perceived Reward Interdependence

The structure of the reward system can provide a strong signal to employees about the type of behavior and outcomes expected (Aladwani et al., 2000). Studies of conventional teams have shown that carefully implemented rewards can foster team spirit, enhance members' willingness to contribute to the team's success (e.g., DeMatteo et al., 1998), and facilitate knowledge sharing (Siemsen et al., 2007). If the subgroups are aware that their rewards are contingent upon the other subgroup's performance, they may be more willing to share knowledge with the other subgroup when requested to maximize their collective rewards (Hackman, 1987). In support of this argument, Abdel-Hamid et al. (1994) found that cooperative rewards can lead to greater interaction in software development projects. On the contrary, if the subgroups' rewards are perceived to be independent (e.g., determined by their own work hours), they may be less enthusiastic about sharing knowledge as there is little incentive for them to help the other subgroup. Therefore, we hypothesize that:

H4: Perceived reward interdependence between the business and external IT consultant subgroups is positively related to knowledge sharing between them.

3.4 The Mediating Role of Knowledge Sharing

We posit that the effects of goal, task, and reward interdependencies on ISD project phase performance are mediated by the extent of knowledge sharing between the subgroups of business professionals and external IT consultants. In other words, knowledge sharing is the underlying mechanism explaining why social interdependence influences performance in ISD. Knowledge sharing has been identified as a strong predictor of performance in ISD. It improves performance by bridging different perspectives, producing what Leonard-Barton (1995) called creative abrasion and leads to innovative solutions to business problems (Hansen, 2002). Having shared, accurate, and complete requirements is fundamental for increasing ISD efficiency and meeting users' needs, and these directly influence the performance of ISD (Vessey and Conger, 1993).

H5: Knowledge sharing between the business and external IT consultant subgroups is positively related to ISD project phase performance.

As discussed in preceding sections, knowledge sharing is likely to follow perceived goal, task, and reward interdependencies as these interdependencies motivate subgroups to interact and support each other. These interdependencies are structural properties in that they characterize the relationships between subgroups (McGrath, 1984). They set the conditions under which interactions take place and provide the necessary conditions for subgroups to perform well as a team. However, if subgroups do not act to work on the project tasks, they are unlikely to perform, even when supportive conditions exist. Therefore, actions are the key to linking social interdependence and ISD performance. We consider knowledge sharing as the key cooperative action that subgroups engage in while developing IS. It is critical because ISD requires both business and IT expertise yet neither the business subgroup nor the external IT consultant subgroup have the required understanding of each other's domain. We argue that performance depends on what has been done (i.e., the extent of knowledge sharing), rather than what structural properties are perceived to be. Accordingly, we hypothesize that knowledge sharing fully mediates the relationships between the different aspects of social interdependence and ISD project phase performance. This leads to the following hypotheses:

H5a: The influence of perceived goal interdependence on ISD project phase performance is fully mediated by knowledge sharing between the business and external IT consultant subgroups.

H5b: The influence of perceived task interdependence on ISD project phase performance is fully mediated by knowledge sharing between the business and external IT consultant subgroups.

H5c: The influence of perceived reward interdependence on ISD project phase performance is fully mediated by knowledge sharing between the business and external IT consultant subgroups.

3.5 Control Variables

In addition to the constructs discussed above, other factors that may influence knowledge sharing and ISD project phase performance are also included in the proposed model as control variables. Previous studies have suggested that well-established ISD teams are likely to have developed shared understanding on many issues and continue to assume this shared perspective for future issues (e.g., Faraj and Sproull, 2005). Hence, it is important to control for the effect of *prior collaboration history* on knowledge sharing.

Boundary bridging activity, which refers to the extent to which the activities of business and external IT consultant subgroups are coordinated by internal IT personnel in this study (Ancona and Caldwell, 1992), may also encourage knowledge sharing. Internal IT personnel from the client organization are considered as important boundary spanners because as members of the client organization, they share better rapport with the business subgroup while possessing some common domain knowledge with the external IT consultant subgroup.

Different *project phases* may require different levels of knowledge sharing. For example, the requirements analysis phase often involves more knowledge sharing than the rollout phase because knowledge from both business and IT professionals are needed to specify business needs and evaluate their technical feasibility (Tiwana and McLean, 2005). Therefore, the effect of project phase on knowledge sharing is controlled for.

Project *team size* may influence ISD project phase performance (Campion et al., 1993). It may be more challenging for a large team to perform well given the potential increase in conflict among members as team size grows. Therefore, we also control for the effect of team size.

Project complexity may also influence performance in ISD. Studies have observed that the level of overall group performance decreases as project complexity increases (e.g., Roberts et al., 2004-5) as complex projects have more challenges to overcome. Thus, the effect of project complexity is also controlled for.

Project contract type may also influence the level of performance (Misra, 2004). Projects on time-and-material basis may emphasize more on these aspects when reporting performance as compared to fixed-cost projects. Therefore, we also control for this variable.

4. Research Methodology

The proposed model was tested empirically with data collected through a survey. To develop the survey instrument, we followed the step-by-step procedure recommended by Churchill (1979). The survey instrument was then assessed with the sorting procedure suggested by Moore and Benbasat (1991) to initially verify its construct validity.

4.1 Construct Operationalization

We generated potential items for measuring the constructs in the proposed model from existing scales. They were then reworded to fit the context of this study. The final measures are listed in the Appendix. All items except for those measuring the control variables of prior collaboration history, project phase, team size, and project contract type were measured using seven-point Likert scales.

The scales of *perceived goal interdependence*, *perceived task interdependence*, *perceived reward interdependence*, and *knowledge sharing* consist of both general and multiplicative measures (Nelson and Cooprider, 1996). A *general measure* asks respondents to indicate the overall interdependence between the business and external IT consultant subgroups (e.g., "the goal attainment of the business subgroup and the external IT consultant subgroup were highly interdependent"). Responses of the two subgroups are averaged to obtain the score of each item. A *multiplicative* measure is a function of: a) a respondent's perception of his/her subgroup's dependency on the other subgroup, and b) the respondent's perception of the other subgroup's dependency on his/her subgroup (i.e., A's dependency on B and B's dependency on A). These responses are then multiplied to obtain the score for each item. Similar operationalization of constructs using both general and multiplicative measures has been applied to assess mutual trust, mutual influence (Nelson and Cooprider, 1996), shared understanding, and arduousness of relationship (Ko et al., 2005) between IS and business professionals in prior studies.

Perceived goal interdependence was operationalized in terms of the extent to which the subgroups relied on one another in the attainment of their goals through one general measure and two multiplicative measures. The items were adapted from studies of team work in organizational behavior research (van der Vegt and Janssen, 2003) or developed based on the description of the concept provided by Weldon and Weingart (1993).

Perceived task interdependence was operationalized in terms of the main workflow design adopted to complete the tasks in a project phase with one general measure and three multiplicative measures. Items for this construct were adapted from van de Ven and Ferry (1980). The multiplicative measures were based on the forms of task interdependence identified by Thompson (2003): pooled, sequential, and reciprocal. Pooled interdependence is perceived when subgroups work independently of each other (item TI2). In contrast, sequential interdependence is perceived when subgroups work together in an assembly-line fashion to complete a task (item TI3). Reciprocal interdependence describes the relationship found between subgroups that work together in a back and forth manner, adjusting to the actions and needs of each other as they complete a task (item TI4). Among these designs, pooled interdependence has the least task interdependence while reciprocal interdependence has the highest level of task interdependence. These three items form a Guttman-type scale since all project phases have tasks that have pooled interdependence, more complicated phases may have tasks that have sequential as well as pooled interdependence, and the most complex phases may have tasks that have reciprocal, sequential, and pooled interdependence (Thompson, 2003).

Perceived reward interdependence was assessed in terms of the degree to which subgroups' rewards, credit, and recognition were perceived as interdependent through one general measure and two multiplicative measures. Two items were developed based on the description of the concept provided by Wageman (1995) and one was adapted from Campion et al.'s (1993) scale of interdependent feedback and rewards.

Knowledge sharing was operationalized in terms of the perceived extent to which the subgroups exchanged specialized knowledge with each other during a project phase with one general measure and two multiplicative measures. Items were developed based on Faraj and Sproull's (2000) scale of expertise coordination. The items measure the extent to which the subgroups share, exchange, and make their specialized knowledge available to one another during ISD.

ISD project phase performance was measured in terms of the perceived efficiency and effectiveness of the ISD project phase as per Henderson and Lee (1992). Dimensions of efficiency include productivity of team's operation and adherence to budget and schedule. Measures of effectiveness include quality of deliverables and attainment of project phase objectives.

For the control variables, *prior collaboration history* was assessed in terms of the number of members who had worked together before the project. *Boundary bridging activity* was measured in terms of the extent to which internal IT personnel effectively resolved problems, coordinated activities, and facilitated communication between the business and external IT consultant subgroups. Items were adapted from Ancona and Caldwell's (1992) scale of ambassadorial and task coordinator activity. *Project phase* refers to the last completed phase of a project (i.e., system planning, requirements analysis, system analysis and design, development and testing, rollout). *Team size* was measured by the number of business professionals, external IT consultants, and internal IT personnel in a project team. *Project complexity* was operationalized in terms of novelty of the technology (van de Ven and Ferry, 1998) and difficulty in completing the tasks in a project phase (Wallace et al., 2004). *Project contract type* was measured as a categorical variable indicated by respondents as either fixed-cost or time-and-material based.

To initially assess the construct validity of the proposed instrument and identify any further refinement, the unlabeled and labeled sorting procedures proposed by Moore and Benbasat (1991) were conducted. Results indicated that inter-judge raw agreement scores averaged 0.95, Kappa scores averaged 0.95, and placement ratio of items within targeted constructs averaged 0.98. All results were satisfactory, suggesting that the instrument possesses adequate construct validity.

4.2 Data Collection

The unit of analysis in this study is a dyad of business subgroup and external IT consultant subgroup in an ISD project team in a particular phase. Due to the lack of a complete list of ISD projects, it was infeasible to conduct random sampling. Instead, we contacted more than 50 IT vendors (e.g., IT consulting companies and system integration companies) and business organizations to identify ongoing ISD projects. We used two criteria to select valid projects: First, the project team should involve both business professionals and external IT consultants. Second, the project should have completed at least the first phase (i.e., IS planning) to ensure sufficient interaction between the two subgroups. As per previous literature (Markus and Tanis, 2000) and the projects in our sample, five ISD phases were identified: system planning, requirements analysis, system analysis and design, development and testing, and rollout.

To minimize retrospective bias, we assessed all constructs with respect to a particular project phase in ongoing projects (or just completed projects). This is because respondents' perception of interdependence may be biased by the final project outcome and differ from what it was when actual knowledge sharing occurred. For example, the business and external IT consultant subgroups of a project team might have had reward interdependency which they were not aware of during the project. Consequently, they shared little knowledge with one another during the project and the quality of the resultant IS was poor. They were also poorly rewarded. Observing these outcomes may make them realize after the completion of the project that their rewards were actually interdependent. When responding to the survey questionnaire, they may report this realized (i.e., high) reward interdependence rather the perceived (i.e., low) interdependence during the project, introducing bias to the data. Although providing clear instructions on the time frame of interest in the questionnaire may be able to alleviate some of this error, it is still considered more robust to confine the project sample to ongoing or just completed projects.

A total of 105 ISD project teams agreed to participate in our survey. They were from 13 IT consulting and system integration companies and 11 business organizations which had engaged external IT consultants to assist in ISD. Most business organizations had one ongoing project while the majority of IT vendors had multiple ongoing projects due to the nature of their business. We sought the assistance of a representative from each organization (e.g., director or chief information officer) to distribute the paper-based survey questionnaires. We collected data from both the managers of the business subgroup and the external IT consultant subgroup of each project team. This matched-pair design was necessary to measure interdependence between them. In the questionnaire, the terms of business subgroup, external IT consultant subgroup, internal IT personnel, project team, and project phase were clearly defined at the beginning to ensure that respondents interpreted all questions with a common frame of reference. Clear examples of knowledge (as opposed to data and information) shared in the ISD projects were also provided (e.g., business requirements, business processes/workflow, and technical possibilities of the new IS). Respondents were requested to answer all questions with respect to the last completed project phase. We also sought the help of the organization representatives to make follow-up telephone calls or send emails to increase response. Of the 105 project teams contacted, 95 teams responded over two months yielding a response rate of

90.5%.

4.3 Sample Demographics

Characteristics of the sample are presented in Table 2. Our sample spanned a broad range of industries. Most of the client organizations were medium and large private firms but there were also some public organizations such as educational institutions and government agencies. In terms of size, client organizations for 31 projects (32.6%) had less than 1000 employees, for 33 projects (34.7%) had 1000 to 4999 employees, and for 30 projects (31.6%) had more than 5000 employees. Most projects aimed to develop enterprise resource planning systems (37.9%) and enterprise information systems (18.9%) and were contracted on a fixed-cost basis (82.1%). The majority of projects in our sample were scheduled to complete in 7 to 23 months (64.2%). With regard to project phase, 23.2% had completed the system analysis and design phase, 22.1% had completed the development and testing phase, and 26.3% had completed the rollout phase. More than half of the teams (61%) had 10 to 49 members.

Table 2. Sample Demographics

Characteristic	Frequency	Percentage	Characteristic	Frequency	Percentage
Industry of Client Organization			***Last Completed Project Phase***		
Construction and engineering	3	3.2	System planning	15	15.8
Education	1	1.1	Requirements analysis	12	12.6
Finance: banking/insurance	18	18.9	System analysis and design	22	23.2
Manufacturing	28	29.5	Development and testing	21	22.1
Medical and legal services	1	1.1	Rollout	25	26.3
Petroleum and chemical	5	5.3	***Project Team Size***		
Trade: wholesale/retail	3	3.2	Less than 10	20	21.1
Transportation services	4	4.2	10 to 49	58	61
Utilities and communications	14	14.7	50 to 99	10	10.5
Others	18	18.9	100 or more	7	7.4
Number of Employees in Client Organization			***Number of Members in Business Subgroup***		
Less than 500	16	16.8	Less than 10	50	52.6
500 to 999	15	15.8	10 to 49	40	42.1
1000 to 4999	33	34.7	50 to 99	3	3.2
5000 or more	30	31.6	100 or more	2	2.1
Unspecified	1	1.1	***Number of Members in IT Consultant Subgroup***		
Type of Information System			Less than 10	53	55.8
Document management system	5	5.3	10 to 49	32	33.7
Enterprise information system	18	18.9	50 to 99	5	5.3
Enterprise resource planning	36	37.9	100 or more	5	5.3
Knowledge management system	6	6.3	***Members with Prior Experience with the Other Subgroup (Prior Collaboration History)***		
Transaction processing system	2	2.1			
Others	28	29.5	0	36	37.9
Type of Project Contract			1 to 5	50	52.6
Fixed-cost basis	78	82.1	6 to 9	2	2.1
Time-and-material basis	14	14.7	10 or more	6	6.3
Others	3	3.2	Unspecified	1	1.1
Scheduled Duration (Months)			***Number of Internal IT Personnel***		
Less than 3	6	6.3	None	2	2.1
3 to 6	21	22.1	1 to 5	74	77.9
7 to 12	40	42.1	6 to 9	7	7.4
13 to 23	21	22.1	10 or more	12	12.6
24 or more	7	7.4			

5. Data Analysis and Results

The proposed model was assessed using Partial Least Squares (PLS) analysis, a structural equation modeling technique that concurrently tests the psychometric properties of each measurement scale (measurement model) and analyzes the strength and direction of relationships among constructs (structural model) (Chin et al., 1996). PLS analysis was chosen because it is able to account for structural models with both formative and reflective manifest variables (Chin et al., 1996). In our study, goal, task, and reward interdependencies, knowledge sharing, and boundary bridging activity are considered reflective because they are each uni-dimensional and exclusion of an item does not alter the construct's meaning. In contrast, ISD project phase performance (conceptualized in terms of efficiency and effectiveness) and project complexity (conceptualized in terms of perceived novelty and difficulty) are considered formative because they are each a composite of multiple indicators. Each indicator captures different aspects of the construct and they are not expected to covary.

Specifically, PLS-Graph version 3.0 and bootstrap resampling method with 1000 resamples were employed. Bootstrap was chosen over Jacknife resampling because while Jacknife requires less computation, it was found to perform less satisfactorily compared to bootstrap in most cases (Dijkstra, 1983). All data was standardized before model testing as per PLS requirements and most variables (including the multiplicative measures) were analyzed as continuous variables. Project phase and project contract type were coded and analyzed as categorical variables.

To assess the adequacy of our sample, we calculated Cohen's power rather than applying the rule of thumb suggested by Chin et al. (1996) for PLS analysis since Cohen's formula has been shown to correctly predict power in most cases while the rule of thumb is valid for strong effect sizes (Goodhue et al., 2006). Cohen's power analysis indicated that our sample size is able to detect a small effect size of 0.10 at the alpha level of 0.05 and power level of 0.95 (Cohen, 1989).

5.1 Test of Measurement Model

Assessment of measurement model includes the evaluation of reliability, convergent validity, and discriminant validity. Reflective and formative constructs have to be treated differently because unlike reflective constructs, different dimensions of formative constructs are not expected to demonstrate internal consistency and correlations (Chin et al., 1996). Instead, absolute item weights are examined to assess the relevance and level of contribution of each item. Prior collaboration history, project phase, team size, and project contract type were measured with one item and were therefore not subjected to these tests.

Reliability of reflective constructs was assessed with Cronbach's alpha coefficient, composite reliability, and significance of item loading (see Table 3). All reflective constructs in our study achieved scores above the recommended value of 0.70 for Cronbach's alpha (Hair et al., 2005) and composite reliability (Chin et al., 1996). All item loadings were also significant at 0.001 level (Chin et al., 1996).

Convergent validity was assessed using average variance extracted (AVE) and factor analysis. All AVEs were above the required value of 0.50 (Chin et al., 1996). In the exploratory factor analysis (see Table 4), five factors corresponding to the reflective constructs in our model were extracted and Kaiser-Meyer-Olkin measure of sampling adequacy was 0.83 (which was well above the recommended value of 0.50). All item loadings on stipulated constructs were greater than 0.50 and all eigenvalues were greater than one as required.

Table 3. Psychometric Properties of Reflective and Formative Constructs

Reflective Construct	Item	Item Loading	Formative Construct	Item	Item Weight
Perceived Goal Interdependence (α=0.87, CR=0.92, AVE=0.79)	GI1	0.85***	Project Phase Performance	PPP1	0.24***
	GI2	0.91***		PPP2	0.21***
	GI3	0.91***		PPP3	0.22***
Perceived Task Interdependence (α=0.70, CR=0.85, AVE=0.75)	TI1	0.94***		PPP4	0.23***
	TI2,3,4#	0.79***		PPP5	0.23***
Perceived Reward Interdependence (α=0.81, CR=0.89, AVE=0.72)	RI1	0.82***	Project Complexity	PC1	0.29*
	RI2	0.88***		PC2	0.29*
	RI3	0.85***		PC3	0.34*
Knowledge Sharing (α=0.96, CR=0.97, AVE=0.93)	KS1	0.95***		PC4	0.24*
	KS2	0.97***			
	KS3	0.97***			
Boundary Bridging Activity (α=0.95, CR=0.97, AVE=0.91)	BBA1	0.96***			
	BBA2	0.96***			
	BBA3	0.95***			

α: Cronbach's Alpha; CR: Composite Reliability; AVE: Average Variance Extracted;
*Significant at p<0.05; ** p<0.01; *** p<0.001; #Item formed by Guttman Scale

Table 4. Factor Analysis of Reflective Constructs

Construct Items	**Components**				
	1	**2**	**3**	**4**	**5**
Perceived Goal Interdependence					
GI1	0.30	0.19	**0.69**	0.18	0.02
GI2	0.07	0.12	**0.87**	0.22	0.16
GI3	0.14	0.24	**0.89**	0.15	0.05
Perceived Task Interdependence					
TI1	0.07	0.07	0.10	-0.06	**0.94**
TI2,3,4	0.38	0.33	0.17	0.10	**0.63**
Perceived Reward Interdependence					
RI1	0.09	0.08	0.06	**0.91**	0.00
RI2	0.22	0.17	0.33	**0.76**	0.28
RI3	0.24	0.10	0.27	**0.72**	-0.26
Knowledge Sharing					
KS1	**0.92**	0.13	0.12	0.17	0.09
KS2	**0.91**	0.23	0.13	0.15	0.05
KS3	**0.90**	0.20	0.18	0.16	0.08
Boundary Bridging Activity					
BBA1	0.19	**0.91**	0.18	0.13	0.10
BBA2	0.12	**0.93**	0.18	0.12	0.04
BBA3	0.27	**0.90**	0.12	0.07	0.08
Eigenvalue	3.13	2.87	2.38	2.13	1.27
Variance Extracted	22.38	20.52	17.03	15.21	9.10
Cumulative Variance (%)	22.38	42.90	59.93	75.14	84.24
Unrotated Variance (%)	33.11	19.98	11.32	10.37	9.46

Discriminant validity was assessed by comparing AVEs and construct correlations as suggested by Gefen and Straub (2005). Results indicated that none of the construct correlations (non-diagonal entries in Table 5) exceeded the corresponding square root of AVE (diagonal entries), suggesting that the measures of each construct correlated more highly with their own items than with items measuring other constructs (Fornell and Larcker, 1981). Therefore, we concluded that the discriminant validity of all scales was adequate.

Table 5. Square Root of AVE vs. Correlation and Descriptive Statistics

	GI	TI	RI	KS	PPP	PCH	BBA	PP	TS	PC	PCT	Min.	Max.	Mean	S.D.
GI	**0.89**											4	7	5.67	0.72
TI	0.44	**0.86**										1	7	4.59	1.32
RI	0.53	0.41	**0.85**									1	7	4.52	1.12
KS	0.57	0.47	0.61	**0.96**								3	7	5.06	0.97
PPP	0.48	0.30	0.41	0.60	**N.A.***							1	7	5.21	0.92
PCH	0.01	0.02	0.11	-0.16	0.10	**N.A.***						0	23	3.05	4.37
BBA	0.48	0.37	0.53	0.57	0.02	-0.02	**0.96**					3	7	5.19	0.87
PP	0.02	0.10	0.04	-0.21	0.00	0.07	0.00	**N.A.***				1	5	2.46	1.17
TS	0.00	0.10	0.04	0.10	-0.04	0.33	0.13	0.33	**N.A.***			4	400	42.28	71.79
PC	0.22	0.15	0.12	0.31	-0.33	0.05	0.38	-0.07	0.04	**N.A.***		1	7	3.40	0.85
PCT	0.03	0.06	0.14	0.04	0.10	0.10	0.02	0.08	0.06	0.02	**N.A.***	1	2	1.15	0.34

* AVE is not applicable to single-item and formative constructs;
PCH = Prior Collaboration History; PP = Project Phase; TS = Team Size; PCT = Project Contract Type

To assess the extent of multicollinearity among constructs, variance inflation factor (VIF) was calculated. The resultant VIF scores ranged from 1.08 to 1.55, which were well below the threshold value of 3.3, suggesting that multicollinearity was unlikely to be a problem for our data (Diamantopoulos and Winklhofer, 2001). The extent of common method bias was also examined with Harman's one-factor test. The test involves entering all constructs into an unrotated principal components factor analysis and examining the resultant variance (Harman, 1960). The threat of common method bias is high if a single factor accounts for more than 50% of the variance (Harman, 1960; Mattila and Enz, 2002). Our results indicated that none of the factors significantly dominated the variance (see the last row of Table 4) and we therefore concluded that common method bias was unlikely.

For the formative constructs, absolute item weights were examined to determine the relative contribution of items constituting each construct (Chin et al., 1996). Results indicated that all item weights were significant (see Table 3). Multicollinearity among the indicators of each formative construct was also assessed by calculating VIF and the results did not indicate any problem (Petter et al., 2007). Since the measurement model was satisfactory, we proceeded to test the structural model.

5.2 Test of Structural Model

Results of our structural model analysis are shown in Table 6 and Figure 2. To test the hypotheses, statistical significance of corresponding path coefficients was assessed. All hypotheses were supported at 0.05 level[4]. Among the control variables, only boundary bridging activity had a significant effect. The model without control variables explained 34% of the variance in knowledge sharing and 54% of the variance in ISD project phase performance while the model with control variables explained 41% of the variance in knowledge sharing and 56% of the variance in ISD project phase performance. The changes in variance explained in the model with control variables were statistically insignificant. As a preliminary study exploring the effects of social interdependence in the context of ISD, the model is considered to have explained a satisfactory level of variance in knowledge sharing and ISD project phase performance.

[4] Most hypotheses remained supported at $p<0.05$ when the sample was split by project phase, indicating the robustness of these findings. Reward interdependence→knowledge sharing in the system planning phase and task interdependence→knowledge sharing in the requirements analysis phase were significant at $p<0.10$ instead, possibly due to the lack of power to detect effects as there were only 15 and 12 teams in these phases respectively (see Table 2).

Table 6. Test of Hypotheses

Constructs	Path Coefficient	T Value	Result
Model without Control Variables (R^2 for Knowledge Sharing=0.34, R^2 for ISD Project Phase Performance=0.54)			
GI → KS	0.26*	1.77	Significant
TI → KS	0.27*	2.20	Significant
GI → TI	0.38***	3.74	Significant
RI → KS	0.24*	1.75	Significant
KS → PPP	0.65***	4.61	Significant
GI → PPP	0.14	0.86	Not significant
TI → PPP	-0.04	0.28	Not significant
RI → PPP	0.04	0.21	Not significant
Model with Control Variables (R^2 for Knowledge Sharing=0.41, R^2 for ISD Project Phase Performance=0.56)			
GI → KS	0.27*	2.03	H1 supported
TI → KS	0.21*	1.98	H2 supported
GI → TI	0.39***	3.29	H3 supported
RI → KS	0.19*	1.95	H4 supported
KS → PPP	0.65***	3.32	H5 supported
GI → PPP	0.11	0.64	Not significant
TI → PPP	0.03	0.17	Not significant
RI → PPP	0.04	0.24	Not significant
PCH → KS	-0.20	1.41	Not significant
BBA → KS	0.20*	1.69	Significant
PP→ KS	0.16	0.83	Not significant
TS → PPP	-0.04	0.25	Not significant
PC→ PPP	-0.11	0.40	Not significant
PCT→ PPP	0.02	0.31	Not significant

*Significant at p<0.05 (one-tailed T-value: 1.66);*** p<0.001 (one-tailed T-value: 3.19);
PCH = Prior Collaboration History; PP = Project Phase; TS = Team Size; PCT = Project Contract Type

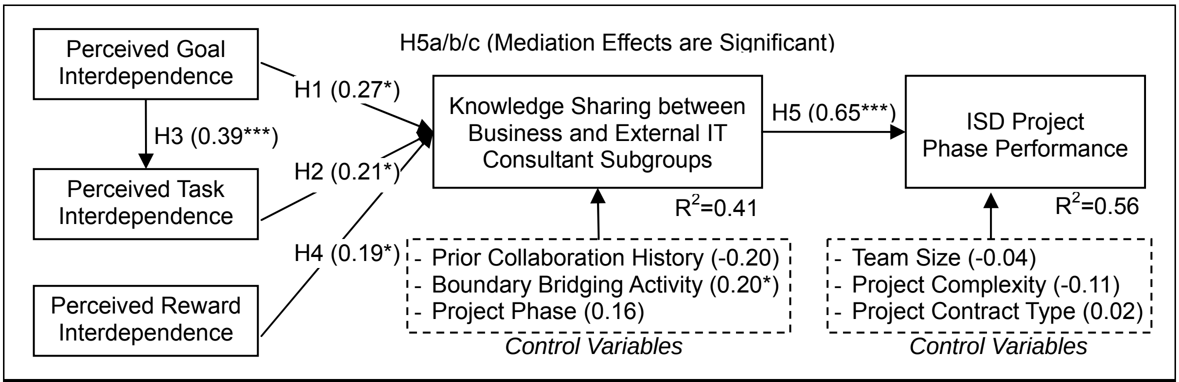

Figure 2. Test of Structural Model
***Significant at p < 0.05; ***p < 0.001**

To test the mediating role of knowledge sharing, we assessed the direct effects of goal interdependence, task interdependence, and reward interdependence on ISD project phase performance. Their direct effects on performance were all insignificant (see Table 6). In addition, the Sobel mediation test statistic and its variants (Aroian test statistic and Goodman test) were mostly significant (see Table 7). Thus, the mediation hypotheses H5a, H5b, and H5c were supported.

Table 7. Additional Tests for the Mediating Role of Knowledge Sharing				
Construct Mediated by Knowledge Sharing	**Sobel Test Statistic**	**Aroian Test Statistic**	**Goodman Test Statistic**	**Result**
Perceived Goal Interdependence	1.72*	1.67*	1.78*	H5a supported
Perceived Task Interdependence	1.69*	1.64	1.75*	H5b supported
Perceived Reward Interdependence	1.67*	1.62	1.73*	H5c supported
*Significant at p < 0.05				

6. Discussion and Implications

This study investigated the influence of social interdependence on knowledge sharing between the subgroups of business professionals and external IT consultants in ISD projects. As hypothesized, we found that perceived goal, task, and reward interdependencies are significantly related to knowledge sharing between the subgroups. Knowledge sharing fully mediated the relationship between these interdependencies and ISD project phase performance. Results also indicated that perceived goal interdependence significantly influenced perceived task interdependence.

We found that the control variables of prior collaboration history, project phase, team size, project complexity, and project contract type did not have significant effects. The model with control variables only explained 7% more variance in knowledge sharing and 2% more variance in ISD project phase performance compared to the model without control variables and the changes in variances explained were statistically insignificant. One possible reason for this finding may be that social interdependencies are stronger antecedents of knowledge sharing than prior collaboration history and project phase while knowledge sharing is a stronger antecedent of ISD project phase performance than team size, project complexity, and project contract type.

6.1 Implications for Research

The proposed model extends existing research by examining the effect of social interdependence on knowledge sharing between the subgroups of business professionals and external IT consultants in ISD projects. Our findings are consistent with previous knowledge management literature highlighting the importance of social factors in knowledge sharing (e.g., Wasko and Faraj, 2005) and the need to facilitate knowledge exchange in organizations (Bjørnson and Dingsøyr, 2008). As ISD requires substantial teamwork and social interaction, validating the relationship between social interdependence and knowledge sharing in ISD contributes relevant new insights to the phenomenon.

Further, this study contributes by demonstrating that the social interdependence theory is relevant for understanding knowledge sharing between the subgroups of business professionals and external IT consultants in ISD projects. Social interdependence theory has been studied most extensively in the context of training and learning (Johnson, 2003), where it has been demonstrated that fostering cooperation can successfully engage students in learning situations and help them achieve multiple educational goals. Our findings suggest that the theory has potential for explaining cooperative IS work contexts and future research may consider applying the theory to study other important phenomenon such as global virtual collaboration and offshore outsourcing.

This study also adds to existing literature on perceived goal and task interdependence by differentiating between these constructs conceptually and proposing operationalizations that exhibit discriminant validity. We have shown that they contribute differently to our understanding of knowledge sharing in ISD: goals provide general directions to a project while tasks refer to activities through which the goals are achieved. Perceived goal interdependence also influences perceived task interdependence. These subtle yet significant relationships should not be overlooked and future research may benefit from investigating their effects in greater detail.

This study also adds to the group-level studies of knowledge sharing by focusing on dyads of business and external IT consultant subgroups. It is important to study group-level knowledge sharing specifically because inter-group interactions may be different from interpersonal interactions. Unlike single individuals interacting with other single individuals, members of a group may develop social identity and affiliation (Tajfel and Turner, 1986) that leads them to display emergent characteristics that cannot be predicted directly from individual properties of their members (Moreland and Levine, 1992). In ISD project teams involving external IT consultants, the gap between business and IT professionals is likely to be further widened by differences in organizational contexts. It is therefore important to look beyond the behaviors of individual knowledge contributors or seekers and study group-level knowledge sharing, as was done in this study.

6.2 Implications for Practice

Although we did not assess specific managerial interventions for promoting knowledge sharing between the subgroups of business professionals and external IT consultants in ISD, the findings provide directions for developing such interventions. However, it is important to note that our suggestions for practice are implied from our findings. Their appropriateness must be considered in light of organizational specificities and their effectiveness should be established through further studies. In general, our findings suggest that increasing perceived social interdependence can increase knowledge sharing between subgroups. Managers can actively and explicitly communicate the extent to which business and external IT consultant subgroups' goals, tasks, and rewards are interdependent to increase the subgroups' awareness and change their perceptions.

We found that when subgroups see their goals as interdependent, they are inclined to share knowledge. This suggests that project managers should promote goal interdependence by setting up goals for the project as a whole and encourage the subgroups' buy in as early as possible. Possible means include clearly laying down the overall project goals and communicating them to both subgroups. Goals conveyed in terminologies that both subgroups understand and that have relevance for both subgroups may be better assimilated by them. While it is inevitable for individual subgroups to have private goals that may be in conflict, detecting potential conflicts and attempting to resolve them early may also promote knowledge sharing.

Our results indicate that perceived task interdependence is positively related to knowledge sharing and should therefore be enhanced. However, as task interdependence may increase communication overhead, it may not be desirable to increase interdependence for all tasks indiscriminately. Project managers may experiment with and focus on tasks that require both business and IT knowledge to complete successfully (e.g., requirements analysis, system testing and evaluation), and communicate the interdependence and expectations to both subgroups. This approach is consistent with the structural contingency theory, which suggests that task design should fit with task characteristics (Eppinger et al., 1991; Thompson, 2003). Perceived task interdependence may also be increased by setting interdependent goals for subgroups, as indicated by the significant relationship between goal and task interdependencies.

Perceived reward interdependence is also found to be related to knowledge sharing. Organizations may establish interdependent rewards for business and external IT consultant subgroups to increase their knowledge sharing. For example, rewards received by the external IT consultant subgroup can be tied to the quality of the final IS as judged by the business subgroup. At the same time, rewards received by the business subgroup can be linked to their participation and quality of feedback as judged by the external IT consultant subgroup.

We also found that one of the control variables, boundary bridging activity, has a significant effect on knowledge sharing between the business and external IT consultant subgroups. This suggests that having internal IT personnel who act as boundary bridges in ISD projects involving external IT consultants may be beneficial. Internal IT personnel can enhance knowledge sharing between the business and external IT consultant subgroups because they share some common ground with both subgroups: they belong to the same organization as the business subgroup and they posses IT knowledge that allows them to interact with the external IT consultant subgroup. Therefore, managers should consider including internal IT personnel in ISD projects assigned to external IT consultants when possible. It may be fruitful to study the role of internal IT personnel in such projects in more detail.

6.3 Limitations and Future Research

It is necessary to consider this study's limitations when interpreting its findings. First, random sampling was not feasible because a comprehensive listing of ISD projects was not available. Instead, the rationale for selecting respondents focused on maintaining internal validity, where a broad range of industries and targeted IS in the sample made it less likely that unmonitored variables influenced all the ISD project teams. However, the findings may not apply to project teams adopting other development methods such as agile methods that may not have distinct project phases (Nerur et al., 2005).

Second, to minimize retrospective bias in measuring subgroup interdependence and knowledge sharing, we collected all data with respect to a project phase. Consequently, interdependence, knowledge sharing, and ISD performance of the last completed phase were measured. We note that the effects of previous phases may influence respondents' perceptions of these constructs in the last completed phase. ISD project phase performance also may not always be indicative of the final project performance. Future work may consider studying project teams longitudinally. Changes in different phases may be tracked to understand how interdependence, extent of knowledge sharing, and performance in one phase can influence the following phases. Grover and Davenport (2001) suggest that knowledge processes are recursive and many cycles of sharing are concurrently occurring. This implies that the process of knowledge sharing in ISD may generate virtuous and vicious circles. For example, intensive knowledge sharing in one phase may generate performance benefits that motivate subgroups to share more knowledge in the following phases, generating a virtuous circle. Equally likely, teams that shared knowledge rigorously in one phase may develop a deep shared understanding that reduces their perceived need to exchange knowledge in the following phases, generating a vicious circle. Examining these dynamics can provide in-depth understanding on the phenomenon of knowledge sharing in ISD projects.

Third, ISD project phase performance was conceptualized as a formative construct comprising efficiency and effectiveness to maintain the parsimony of the proposed model. To gain a deeper understanding of the separate effects of social interdependence on these aspects of performance, future research may consider studying them as distinct constructs.

Fourth, responses from the business and external IT consultant subgroups to the general and multiplicative measures were combined by averaging and multiplication. These measures may therefore be sensitive to large differences in the business and external IT consultant subgroups' responses. Future research may consider operationalizing them as formative measures.

Fifth, the extent of knowledge sharing and ISD project phase performance were measured through subgroups' self reports. Self reporting is considered a suitable approach for this study because the respondents were "insiders". They were therefore likely to have unique perspectives and were better able to make judgments concerning the behavior exhibited. Nonetheless, future work may incorporate other measures to collect more objective data. While self reports are considered appropriate for measuring perceived social interdependence, it may be fruitful for future studies to examine the effects of actual social interdependence such as task interdependence by manipulating them in experiments.

Other than addressing the limitations of this study, future research may also further explore the constructs and relationships in the proposed model. For example, it may be fruitful to consider how various levels of goals (e.g., subgroups' goal, overall project goal, client organization's goal) influence knowledge sharing differently. It may also be useful to examine the fit between goal and task interdependencies and the extent of knowledge sharing to understand whether high knowledge sharing in low goal/task interdependence situations still increases performance. Future research may also examine subgroup-specific outcomes such as the extent of learning.

7. Conclusion

As the development of IS requires both business and IT expertise, cross-domain knowledge sharing is critical for the success of ISD projects. Our findings suggest that the social interdependence theory provides relevant insights on the antecedents of knowledge sharing between the subgroups of business professionals and external IT consultants in ISD projects. Compared to in-house ISD, cooperation and knowledge sharing in project teams involving external IT consultants are often fraught with more challenges due to the need to transcend organizational boundaries and a lack of group history or norms. Our findings suggest that social interdependence can effectively promote knowledge sharing in this potentially challenging situation. Through studying the concept of social interdependence, this study contributes new insights to the cumulative research on knowledge management in ISD projects, presents constructs and measures that may be adapted in future studies, and suggests avenues for future research. It also provides directions for practitioners to develop relevant courses of action to motivate business and external IT consultant subgroups to engage in productive knowledge sharing. Breaking through subgroup boundaries to share knowledge can enhance the performance of ISD. Studies along this direction are likely to facilitate the development of IS that can propel organizations to attain their business objectives.

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Appendix. Constructs Operationalization

Construct	Item	Source
Perceived Goal Interdependence	GI1: The goal attainment of the business subgroup and the IT consultant subgroup are highly interdependent. GI2*: The goal accomplishment of the business (IT consultant) subgroup depends very much on the goal accomplishment of the IT consultant (business) subgroup. GI3*: The achievement of goals of the business (IT consultant) subgroup greatly influences the achievement of goals of the IT consultant (business) subgroup.	- GI1 and GI2 developed based on Weldon and Weingart (1993) - GI3 adapted from van der Vegt and Janssen (2003)

Appendix. Constructs Operationalization (Continued)

Construct	Item	Source
Perceived Task Interdependence (Items TI2, TI3, and TI4 form a Guttman Scale)	TI1: The business subgroup and the IT consultant subgroup often work together concurrently to accomplish the project's tasks. TI2*: The business (IT consultant) subgroup often accomplishes its own tasks independently from the IT consultant (business) subgroup. TI3*: The business (IT consultant) subgroup's task completion often depends on the IT consultant (business) subgroup's tasks in a sequential direction. TI4*: The business (IT consultant) subgroup's task completion often depends on the IT consultant (business) subgroup's tasks in a reciprocal "back and forth" manner.	All items adapted from van de Ven and Ferry (1980).
Perceived Reward Interdependence	RI1: The rewards/credit/recognition received by the business subgroup and the IT consultant subgroup are highly interdependent. RI2*: The business (IT consultant) subgroup often receives rewards/credit/recognition only when the IT consultant (business) subgroup performed well. RI3*: The rewards/credit/recognition received by the business (IT consultant) subgroup are greatly influenced by the performance of the IT consultant (business) subgroup.	- RI1 and RI2 developed based on Wageman (1995) - RI3 adapted from Campion et al. (1993)
Knowledge Sharing	KS1: There is substantial exchange of knowledge between the business subgroup and the IT consultant subgroup. KS2*: When the business (IT consultant) subgroup has some specialized knowledge relevant to the project, they always inform the IT consultant (business) subgroup about it. KS3*: The business (IT consultant) subgroup always shares its specialized knowledge and expertise with the IT consultant (business) subgroup.	All items developed based on Faraj and Sproull (2000)
ISD Project Phase Performance	How well did the entire project team perform on the following so far? PPP1: Productivity of project team's operation PPP2: Project team's adherence to schedule PPP3: Project team's adherence to budget PPP4: Quality of the project team's deliverables PPP5: Project team's achievement of project objectives	All items adapted from Henderson and Lee (1992)
Project Complexity	PC1: There is a very clear known way to do the work in the project (reversed coded). PC2: There are very little established practices to complete the tasks in the project. PC3: The technology involved in developing the targeted IS is very new to our project team. PC4: Our project team has very little prior experience with the technology involved in developing the targeted IS.	- PC1 and PC2 adapted from Wallace et al. (2004) - PC3 and PC4 adapted from van de Ven and Ferry (1980)
Boundary Bridging Activity	BBA1: The internal IT personnel have effectively resolved problems between the business subgroup and the IT consultant subgroup. BBA2: The internal IT personnel have effectively coordinated activities between the business subgroup and the IT consultant subgroup. BBA3: The internal IT personnel have effectively facilitated communication between the business subgroup and the IT consultant subgroup.	All items adapted from Ancona and Caldwell (1992)

* This is a multiplicative measure where another question using the wording in the parentheses was also posed in the questionnaire and each item is eventually represented by multiplying the two responses together; # Prior collaboration history (PCH) was measured in terms of the number of members who had worked together before. Project phase (PP) is a categorical variable indicated by the last completed phase in the project (i.e., system planning, requirements analysis, system analysis and design, development and testing, rollout). Team size (TS) was measured by the number of business professionals, external IT consultants, and internal IT personnel in the project team. Project contract type (PCT) was measured as a categorical variable (i.e., either fixed-cost or time-and-material based).

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