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The Mediating Effects of Bidirectional Knowledge Transfer on System Implementation Success

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A B S T R A C T

Although knowledge transfer between two different parties occurs in IS development projects, the majority of prior studies focused on knowledge transfer from IT consultants to clients. Considering two parts of knowledge transfer in IS development projects, we must consider both 'where knowledge is transferred from' and 'where it is transferred to'. Therefore, in this study, we attempt to describe two different routes of knowledge transfer, such as knowledge transfer from an IT consultant to a client and knowledge transfer from a client to an IT consultant. In this regard, we have examined the effect of two different routes of knowledge transfer on system implementation success in IS development project. Specifically, we adopted the knowledge stock-flow theory to examine the causal relationship between IT consulting firms and clients in terms of knowledge transfer and eventual system implementation success. Survey data collected from 213 pairs of individuals (both clients and IT consultants) were used to test the model using three different analytic approaches such as PLS (partial least squares) and two types of mediated regression techniques. We found that knowledge transfers partially mediated both the relationships between IT consultants' IT skills (project members' business knowledge) and system implementation success. Furthermore, the effects of each knowledge transfer were distinguished by depending on the types of system, such as ERP or groupware. Our attempts have significant implications for both research and practice given the importance of effective knowledge transfer to IT consulting.

Keywords: Knowledge Transfer, Knowledge Stock and Flow Theory, System Implementation Success

Ⅰ. Introduction

Knowledge management has been received great attention and become one of critical success factors in obtaining and sustaining competitive advantage in the current hyper competitive markets. In context of knowledge management, knowledge transfer between two different parties has great impact on the success of system implementation, and the factors influencing knowledge transfer become more important concerns for system implementation success. The knowledge transfer can be approached in one

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of two ways: 1) an abrupt, one time-transfer that results in a permanent installation on a specific day or 2) gradual transfer over a given time period (Awad and Ghaziri, 2004). The latter case is closely related to the IS development projects. Usually, in this case, a receiving group becomes a part of developer's team. Once one phase of the system is ready to use, responsibility is transferred to the receiving groups, which then examine the markup of the partial system. The transfer involves the sharing of training, methodologies, experiences, and techniques. Eventually, the rest of the system is transferred, allowing the receiving group to take full responsibility for the system's operation and maintenance. In line with this, many of IS researchers had focused on one directional knowledge transfer (e.g., Ko et al., 2005; Xu and Ma, 2008). Knowledge transfer can be related to the transmission of knowledge (e.g., experience, lessons learned, know-how) and use of transmitted knowledge. It is conveying the knowledge of one source to another source. In this regard, the goal of knowledge transfer was to promote and facilitate knowledge sharing, collaboration, and networking (Awad and Ghaziri, 2004). It is done directly done by working together, communicating, and learning by doing through face-to-face discussions, or embedding knowledge through procedures, mentoring, or document exchange. Therefore, in order to understand knowledge transfer, it is essential to consider both 'where knowledge is transferred from' and 'where it is transferred to'.

Although much of IS research has conducted knowledge transfer, the previous studies have focused on one directional knowledge transfer. For example, an ERP system contains a great deal of codified knowledge, both in the software structure provided by IT vendors as well as in the process knowledge and business rules developed by the client firms. Since the successful ERP implementation success requires a wide range of knowledge between the partners, firms cannot implement ERP perfectly without external help, such as technical support from IT vendors (Wang et al., 2007). After all, the success of IS development projects can be determined by the effectiveness of the knowledge transfer between them. It implies that bidirectional knowledge transfer including both "where knowledge is transferred from" and "where knowledge is transferred to," need to be discussed simultaneously.

Thus, we assume that it is necessary to develop and test a bidirectional knowledge transfer-based model in IS development projects by employing two parts: one part describes the knowledge transfer from an IT consultant to a client, and the other part also describes the knowledge transfer from a client to an IT consultant. More specifically, we attempt to examine the mediating effects of knowledge transfer from both sides in the IS development project context. We also examine the effects of two different routes of knowledge transfer moderated by the types of systems. For example, the ERP system reflects a substantial amount of codified knowledge not only in terms of the software structure provided by the vendor, but also in terms of the process knowledge and business rules developed by the client (Ko et al., 2005; Xu and Ma, 2008). In ERP implementation success, IT consultants possess ERP knowledge while key users possess business knowledge in the initiation of a specific project. Effective implementation success requires the IT consultants to absorb business process knowledge from key users and key users learn ERP knowledge from IT consultants. On the other hand, in the case of groupware implementation success, it requires minimal business knowledge from clients because it is considered to be implemented when the system is technically installed. Therefore, we also attempt to investigate whether the impact of knowledge transfer from clients would be greater than that of the knowledge transfer from IT vendors by depending on the nature of IS development projects.

The remainder of the paper is organized as follows. The next section provides a brief background on knowledge transfer and some of the research that has been conducted in this realm, particularly focusing on those studies which relate to our research context. Then, we introduce our research model and hypotheses, followed by the data analysis and results of our study. The implications of our findings are then discussed.

Ⅱ. Literature Review

2.1. Knowledge Transfer

Many researchers have defined knowledge transfer in various ways. At the individual level, knowledge transfer has been defined as how knowledge acquired in one situation applies to another (Singley and Anderson, 1989). It is also considered as the transmission of knowledge (e.g., experiences, lessons learned and expertise) and the use of transmitted knowledge (Awad and Ghaziri, 2004). At the organizational level, knowledge transfer has been defined as "the process through which one unit (e.g., group, department, or division) is affected by the experience of another" (Argote and Ingram, 1999, p. 151). The knowledge transfer (e.g., routine or best practices) at the organizational level can be observed through changes in knowledge or performance of the recipient units.

Although prior research has adopted the source-recipient model which refers to the characteristics of the source and the recipient of knowledge, it focuses on the knowledge transfer from IT consultants to clients (e.g., Ko et al., 2005). The source and recipient model refer to the characteristics of a knowledge source and recipient which can influence the process of knowledge transfer. In the context of IS development project, we define knowledge transfer as the transfer of a source (e.g., IT consultants)'s IT-related knowledge to designated recipients (e.g., clients). By adopting a "source-recipient" model, Ko et al. (2005) developed and tested an integrated model of knowledge transfer (from consultant to client) in the context of ERP implementation. However, they explored knowledge flow only from consultant to client, but knowledge flows in both directions. Therefore, we developed and tested an integrated model to explore two different routes of knowledge transfer between IT consultants and clients vice versa, which ultimately lead to implementation success. In our study, there are two parts in the model: part one describes the knowledge transfer from IT consultant to clients, and the other the business knowledge from clients to IT consultants. The knowledge exists at four levels: individual, group, organizational, and inter-organizational. We explored knowledge transfer across organizations at a pair of individuals including both clients and IT consultants in a same project.

In sum, considering the importance of bidirectional knowledge transfer, it is important to consider *where knowledge is transferred from* and *where it is transferred to* simultaneously, because knowledge would flow bi-directionally between partners. Therefore, to overcome the limitations in that previous studies focused on the knowledge transfer from IT consultant to clients, we tried to examine the impact of bi-directional knowledge transfer on system implementation success in order to deeply understand two different routes of knowledge transfer in IS implementation success.

Meanwhile, prior studies have employed knowledge transfer as the dependent variable (Reagans and McEvily, 2003; Szulanski, 1996; Ko et al., 2005). Because of knowledge transfer as an outcome variable, they tend to characterize knowledge transfer through a kind of knowledge internalization (i.e., recipient's learning). Since knowledge transfer between two different parties has great impact on success of IT implementation, unlike previous studies, we have used knowledge transfer in two different routes as mediating variables to become more important concerns for success of IT implementation.

2.2. Knowledge Transfer from Stock-Flow Theory Perspective

Knowledge stock-flow theory, which was proposed by Dierickx and Cool (1989), is a dynamic organizational learning process by using production flows to metaphorically describe the stock-flow relationship in an organizational learning. According to the knowledge stock-flow theory, stocks of knowledge are accumulated knowledge assets which are internal to the firm, while flows of knowledge are represented by knowledge that streams into the firm (Dierickx and Cool, 1989).

In our study context, IT consulting is a service, which supports firms redesign their business process under the dimensions of technology, strategy, people and so forth (Basil and Tang, 1997). In return, IT consultants have to learn from their clients as well, even of clients offer a change to exchange knowledge (Sveiby, 1997). Some of researcher have highlighted the importance of IT consultant's competence (Bessant and Rush, 1995; Jang and Lee, 1998). These studies have suggested that the critical role of IT consultants is serving as external knowledge stock as well as facilitating inter-firm knowledge transfer (Wang et al., 2007).

Based on the knowledge stock-flow theory, we proposed that IT consultants' IT skills in IT consulting firms and project members' business knowledge in client firms are two critical factors affecting the knowledge transfer during IS development project, which in turn lead to system implementation success. Effective knowledge transfer from IT consulting firms to the client will leave the client better positioned to maintain and evolve its system, thus leading to a better fit between the system and the client's processes (Wang et al., 2007). Furthermore, in order to lead to a system implementation better matched with client's process requirements, more effective knowledge transfer from the project' managers' sides would be necessary.

With respect to system implementation success, knowledge transfer from IT consultants to clients is represented by water flowing into the tub, and the amount of water in the tub represents the stock of the client's absorptive capacity (Wang et al., 2007). In this case, in the IT consulting firm, knowledge transfer from clients to the IT consulting firm can be also represented by water flowing into its tub, and the amount of water in its tub represents the stock of the IT consultant's absorptive capacity. Thus, in our study, IT consultant's IT skills (or project members' business knowledge) can be represented by the source of the water that is the knowledge stock of external sources, which is related to the flow to the internal process in each parties such as IT consulting firms and clients.

When stocks and flows (i.e., IT skills from IT vendors and business process knowledge from clients) are sufficient, system implementation as outcome of knowledge transfer can be successful. That is, for an effective knowledge transfer for system implementation success, IT consultants must give their clients sufficient IT skills while the clients also have ability to transfer their business knowledge. After all, both IT consultants and project managers should have abilities to transfer their own skills or knowledge to their partners in the project.

Previous studies on employing knowledge stock-flow theoretical lenses have suggested that knowledge transfer play a role on bidirectional process based on metaphor of stock and flows. For example, Sveiby (1997) mentioned that consultants learn from their clients, even selecting organizations that can provide opportunities for knowledge sharing. Bontis et al. (2002) also examined the relationship between organizational learning system and business performance. They found that there was a positive relationship between stocks of learning and business performance and a negative relationship between the misalignment of stocks and flows in an organizational learning system and business performance.

In the context of IS development project, effective knowledge transfer from a competent consulting firm to the client will leave the client better positioned to maintain and evolve its system, thus leading to a better fit between the system and the client's processes (Davenport, 2000). Thus, in this study, we attempt to knowledge stock-flow theory as theoretical lenses to explain why we consider two different routes of knowledge transfer in IS development project are important. Specifically, we have examined how two different routes of knowledge transfer can mediate the relationship between IT consultants' IT skills/ project members' business knowledge on system implementation success. We have also examined how the effects of two different routes of knowledge transfer are different by depending on the types of systems.

Ⅲ. Research Model and Hypotheses

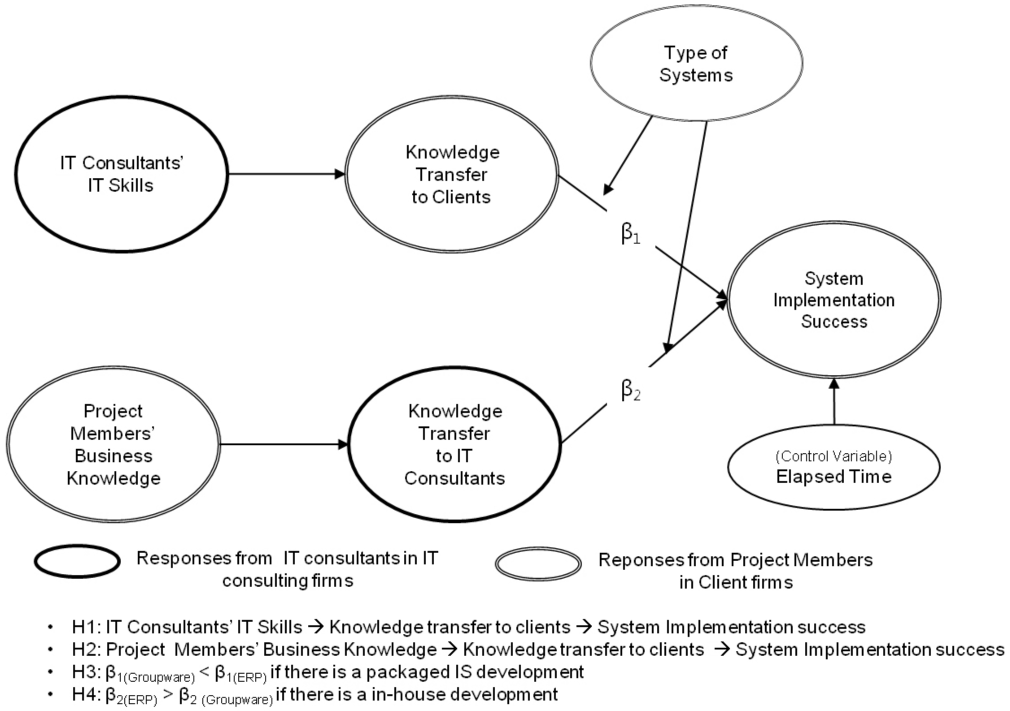
3.1. Research Model

We attempted to examine where knowledge is transferred from and how it is transferred between IT consulting firms and clients. <Figure 1> illustrates the proposed research model, which explains how two different routes of knowledge transfer influence system implementation as well as examine how the effects of two knowledge transfer on system implementation is depending upon the type of systems.

3.2. Research Hypotheses

In general, firms often seek some necessary expertise from external sources such as consulting firms. IT consultants could be knowledge providers as well as facilitators for IS implementation success. They help client firms to configure and derive values from ERP packages, providing both product knowledge and process guidance (Timbrell and Gable, 2001; Volkoff and Sawyer, 2001). IT consultants' IT skills can be viewed as an external knowledge stock that provides the needed knowledge to the firm adopting the ERP package. As a result, competent consultants, that is, those with valuable external stocks, are more likely to facilitate the transfer of the knowledge required for ERP implementation success to clients than less competent ones.

Meanwhile, Johsi et al. (2004) mentioned that IT project teams are typically composed of multiple members whose backgrounds and skill levels vary and who play different roles (e.g., analysts, designers and developers). Thus, successful system implementation success requires a substantial knowledge transfer between team members in order to achieve a shared frame of reference (Christensen and Bang, 2003).



<Figure 1> Research Model

In particular, to align IT and business strategies, IT vendors should participate actively in IT projects. Such efforts require a combination of technical and business knowledge. In particular, IS outsourcing, in which clients outsource some or all of their IS functions to one or more outside vendors (Lee, 2001), has been regarded as an important business strategy for client firms in terms of acquiring new technical and business knowledge from their vendors (Blumenberg et al., 2007; Ko et al., 2005).

Wang et al. (2007) argued that outsourcing IS functions to high-quality vendors is likely to provide client firms with some knowledge that is costly or difficult to develop internally. Further, IS outsourcing may allow client firms to update their technical and business knowledge base to better address the changing business environments. Ko et al. (2005) reported that some client firms acquire new knowledge regarding system implementation success, operation and maintenance from their consultants in order to be able to maintain their IS independent of their consultants. Edguer and Pervan (2004) found that firms are increasingly focusing on IS outsourcing to acquire some expertise they lack within the boundaries of their organizations. The above discussion suggests that IT vendors with the capability of IT development projects are likely to facilitate knowledge transfer from IT vendors to clients.

Therefore, the influence of the IT consultant's IT skills on system implementation success is likely to be mediated by a knowledge transfer from IT vendors to clients. This leads us to our first hypothesis:

H1: IT consultant's IT skills promote system implementation *success because it increases the knowledge transfer to clients. Specifically, the relationship between IT consultants' IT skills and system implementation success will be mediated by the knowledge transfer to clients.*

Although there may be a knowledge transfer to clients through designated sources within the system implementation success, knowledge transfer can also occur from clients to IT vendors, which may play a critical role in how clients' business processes are adapted to or customized for their new information technology. As a project manager of client firms participates in certain projects, firms have to convey their knowledge about any misalignment between the desired and actual functionalities to IT vendors. End users in the clients may make innovative use of new technologies and thus require system modifications, which facilitate knowledge transfer from clients to IT vendors (Santhanam et al., 2007). Therefore, IT vendors may learn more about their clients' business processes and understand how the new IS can enable the execution of such processes through this knowledge transfer (Faraj and Sproull, 2000; Gray and Durcikova, 2005; Kim et al., 2011). Meanwhile, although no study has provided empirical evidence of a causal relationship between effective knowledge transfer and successful IS implementation success, Davenport (2000) indicated that knowledge transfer can help client firms to better maintain and upgrade their information systems and realize positive returns on their IT investment (e.g. ERP). Gable et al. (1998) also suggested that effective knowledge management, particularly knowledge sharing, can provide clients with substantial commercial and practical benefits over the information systems. Thus, it can be argued that transferring knowledge to clients is a critical success factor in ERP implementation success. Because IT vendors effectively transfer IT- and business-related knowledge to their clients, they are likely to satisfy the needs of their clients and achieve the expected benefits. For example, Volkoff and Sawyer (2001) argued that IT consultants can help their clients configure and derive some value from ERP projects by providing product as well as through process guidance. When such knowledge is transferred in an effective manner from IT consultants to project participants in clients, the clients have a better understanding of the functionality of the ERP package and its embedded process models, which should facilitate the development of a system that can better accommodate its process requirements. This suggests that increased knowledge transfer to IT vendors can facilitate a successful system implementation success.

The above discussion suggests a reverse path or a reverse source-recipient combination by which clients and IT vendors engage in a system-related knowledge transfer from clients to IT vendors as well as from IT vendors to clients. Although previous IS research has provided no empirical evidence of a direct relationship between consultants and knowledge transfer, we can present that the influence of clients' business knowledge on system implementation success is likely to be mediated by a knowledge transfer from clients to IT vendors. Thus, we can state the following hypothesis:

H2: Project members' business knowledge promotes system implementation success because it increases the knowledge transfer to IT consultants. Specifically, the relationship between project members' business knowledge and system implementation success will be mediated by the knowledge transfer to IT consultants.

Although ERP development projects require a lot of experiences from clients' business knowledge, IT consultants' IT skills in groupware development projects can be integrated and embodied in the system. It means that transmitting knowledge to and absorbing knowledge from each other might be less important to adopt the system (Sarker et al., 2005; Soh et al., 2000). Firms often seek the required expertise on system implementation from external sources such as IT consulting firms which have best-practice solutions. According to Timbrell and Gable (2001), IT consultants could be knowledge providers as well as facilitators during the implementation. They support client firms to configure and derive value from the systems by providing both product knowledge and process guidance. Through guided learning, formal training, and knowledge creation activities, IT consultants can help clients acquire the needed IT skills for a successful implementation. Thus, we assume that knowledge transfer to clients can have positive effects on system implementation success in packaged IS development projects, such as groupware, rather than ERP projects which required configuration efforts. Consequently, we can assume that more effective knowledge transfer to clients will lead to a successful implementation in groupware development project, not requiring a certain level of competence or capabilities to deal with the challenges imposed during the implementation process. Therefore, based upon the above, we propose the following hypothesis.

H3: The type of systems will moderate the relationship between knowledge transfer to clients and system implementation success, and the strength of the relationship will be greater as the type of system is a groupware development project.

Generally, ERP systems are configurable packages that integrate the business processes of an organization into a shared database. Its success depends on the client's knowledge. It reflects a substantial amount of codified knowledge not only in terms of the software structure provided by the IT consulting firms, but also in terms of the process knowledge and business rules developed by the client. Thus, ERP implementation success should requires knowledge of various activities associated with configuring and testing ERP modules, installing software and training employees in preparation for the ongoing operation, maintenance and support of a customized vendor-supported system (Ko et al., 2005; Xu and Ma, 2008). In line with this, clients should offer their own business knowledge to IT consultants in order to match the system functionality with current business process or procedures.

ERP implementation would be challenged to either match the functionality of the ERP system to the way that the firm currently does business or find ways to change current business process (Laughlin, 1999). It is important to exactly match processes offered by the ERP system and those required by the client during the IS development project to achieve successful ERP implementation. In order for a better fit between functionalities and processes, the IT consultants should have better understanding of business process in the client firm. Thus, when the clients have transferred business knowledge to IT consultants, this would increase the likelihood of resulting in an implemented system provides a better fit with its process requirements (Wang et al., 2007). Therefore, we assume that knowledge transfer to IT consultants in the ERP development project is much more important than knowledge transfer to clients. Thus, based upon the discussion, we propose the following hypothesis.

H4: The type of systems will moderate the relationship *between knowledge transfer to IT consultants and system implementation success, and the strength of the relationship will be greater as the type of system is an ERP development project.*

3.3. Construct Measurement

To ensure a high level of measurement reliability, we employed various research constructs and measures from previous studies, making some modifications to suit the context of the present study. The questionnaire employed seven-point Likert-type scales ranging from "strongly disagree" (1) to "strongly agree" (7) (see the <Appendix A>). <Table 1> shows the construct operationalization in our study.

In this study, Project manager's business knowledge was operationalized using five-item scale adapted and modified from Byrd and Turner (2000), which was designed to assess the extent of understanding business knowledge, such as business functions and process. IT consultants' IT skills was operationalized using four items adapted from Byrd and Turner (2000), which was captured the extent of having technical capabilities, such as programming and understanding the IT development process and operating systems. Both knowledge transfer to clients and IT consultants were operationalized using a three item scale from O'Dell and Grayson (1998), Szulanski (1996), Zander and Kogut (1995). These measures were designed to tap into the extent to which clients and IT vendors shared their relevant knowledge or ideas during IT development projects. Our dependent variable, system implementation success, was operationalized using a five-item scale designed to capture the extent which new information systems are implemented (Karlsen and Gottschalk, 2004).

Ⅳ. Data Analysis and Results

Our data analysis proceeded in three stages. The first stage involved a descriptive analysis and a test of our data quality, the second stage was directed at testing the psychometric properties for our measurement scales, and the third stage focused on hypotheses testing and model analysis. Our data was analyzed using the partial least squares (PLS) technique, using the Smart PLS 2.0 software and SPSS 18.0 software.

<Table 1> Construct Measurement

Constructs	Definitions	Key References
Project manager's business knowledge	The extent of understanding business knowledge, such as business functions	Byrd and Turner, 2000
IT consultant's IT skills	The extent of having technical capabilities, such as programming and understanding the IT development process and operating systems	Byrd and Turner, 2000
Knowledge transfer to clients	The extent to which clients and IT vendors shared their relevant knowledge or ideas during IT development projects from the IT consulting firm standpoint.	O'Dell and Grayson, 1998; Szulanski, 1996; Zander and Kogut, 1995
Knowledge transfer to IT consultants	The extent to which clients and IT vendors shared their relevant knowledge or ideas during IT development projects from the client firm standpoint.	O'Dell and Grayson, 1998; Szulanski, 1996; Zander and Kogut, 1995
System implementation success	The extent to which new information systems are implemented	Karlsen and Gottschalk, 2004

4.1. Data Collection

In the complex systems implementation situation in IS, knowledge is transferred interfirm, between specific individuals in consulting firms to specific individuals in user firms in an ongoing process (Ko et al., 2005). In our study, the unit of analysis is specific pairs of individuals (both consultant and clients), which is the most relevant unit of analysis in IT projects. From the initial sample of 306 pairs of participants who were involved in IT projects, we obtained 282 pairs for usable responses (a response rate of 92.15%). Because we were interested in studying bidirectional knowledge transfer between two different parties by depending on the types of systems, we thus restricted our analysis to be only involved in both ERP and groupware implementation success projects A total of 213 pairs, which indicate that for each project we surveyed both clients and IT vendors, met this threshold and these cases were retained for further analysis.

In general, Partial least squares (PLS) uses a component-based estimation method, maximizes the variance explained in the dependent variable, does not require the multivariate normality of data and is less demanding in terms of sample size (10). For these reasons, we used Smart PLS 2.0 to analyze the data. We first evaluated the measurement and structural models separately for the customized IT and packaged IT developments before conducting cross-group comparisons.

4.2. Demographic Characteristics

<Table 2> shows the demographic characteristics of the respondents. Each of these 213 responses re-

<Table 2> Demographic Profiles

Respondents in client firms				Respondents in IT consulting firms			
Items	Category	Freq.	Ratio	Items	Category	Freq.	Ratio
Gender	Male	187	87.8%	Gender	Male	169	79.3%
	Female	26	12.2%		Female	44	20.7%
Age	21-30	19	8.9%	Age	21-30	19	8.9%
	31-40	108	50.7%		31-40	129	60.6%
	41-50	83	39.0%		41-50	54	25.4%
	Over 51	3	1.4%		Over 51	11	5.2%
Position	Staff	12	5.6%	Position	Staff	33	15.5%
	Deputy Manager	43	20.2%		Deputy Manager	36	16.9%
	Section Chief	98	46.0%		Section Chief	102	47.9%
	Department Manager	38	17.8%		Department Manager	40	18.8%
	Executives	22	10.3%		Executives	2	0.9%
# of Employees	<=20	12	5.6%	# of Employees	<=20	7	3.3%
	21-50	11	5.2%		21-50	9	4.2%
	51-100	10	4.7%		51-100	7	3.3%
	101-300	25	11.7%		101-300	24	11.3%
	301-500	10	4.7%		301-500	2	0.9%
	501-1000	11	5.2%		501-1000	9	4.2%
	Over 1,001	134	62.9%		Over 1,001	155	72.8%

flected a project involving each client and IT consulting firms. Most respondents in client firms (87.9%) were in the 31-50 age group and 46.0% of total respondents in client firms were section chiefs. In addition, respondents in IT consulting firms were in the 31-40 age group (60.6%) and 47.9% of total respondents in IT consulting firms were also section chiefs.

4.3. Measurement Model

We assessed the measurement model for convergent and discriminant validities (Hair et al., 1998). Two different assessments were made for the convergent validity: 1) individual item reliability and 2) construct reliability. Individual item reliability was assessed by examining the item-to-construct loadings for each construct that was measured with multiple indicators. In order for the shared variance between each item and its associated construct to exceed the error variance, the standardized loadings should be greater than 0.70. As can be seen in Appendix B, all of our item-to-construct loadings exceeded the desired threshold. The next step in establishing the measurement reliability was to examine the internal consistency for each block of measures (that is, construct reliability). This was done by examining the composite reliability, Cronbach's alpha and the average variance extracted (AVE) for each block of measures, as shown in <Table 3>. Composite reliability scores and Cronbach's alpha scores both measure the internal consistency within a given construct's items. The threshold values for composite reliability and Cronbach's alpha are not absolute ones, but our

<Table 3> Descriptive Statistics and Reliability of Constructs

Total Group (213)	Mean	St.d	Cronbach's Alpha	Composite Reliability	AVE
Project Members' Business Knowledge	5.669	1.105	0.946	0.958	0.822
IT Consultants' IT Skills	5.248	1.018	0.897	0.927	0.760
Knowledge Transfer to Clients	5.793	1.164	0.946	0.966	0.903
Knowledge Transfer to IT consultants	5.761	1.048	0.904	0.940	0.838
System Implementation Success	5.224	0.982	0.927	0.945	0.775
Groupware (*n*=141)	Mean	St.d	Cronbach's Alpha	Composite Reliability	AVE
Project Members' Business Knowledge	5.725	1.196	0.947	0.960	0.828
IT Consultants' IT Skills	5.082	1.106	0.916	0.939	0.795
Knowledge Transfer to Clients	5.816	1.154	0.957	0.972	0.921
Knowledge Transfer to IT consultants	5.702	1.051	0.914	0.946	0.853
System Implementation Success	5.244	1.024	0.932	0.949	0.787
ERP (*n*=72)	Mean	St.d	Cronbach's Alpha	Composite Reliability	AVE
Project Members' Business Knowledge	5.575	1.058	0.942	0.811	0.955
IT Consultants' IT Skills	5.288	1.081	0.857	0.695	0.901
Knowledge Transfer to Clients	5.556	1.192	0.923	0.866	0.951
Knowledge Transfer to IT consultants	5.880	0.995	0.880	0.806	0.926
System Implementation Success	5.317	1.071	0.917	0.750	0.937

measures appear to be more than acceptable by the established criteria. As shown in <Table 3>, all of the constructs in our measurement model exhibited composite reliabilities of 0.936 or higher, and they all exhibited Cronbach's alpha of 0.921 or higher.

The guideline threshold for AVE is 0.5, meaning that 50% or more variance of the indicators is accounted for Chin (1998). As Appendix C indicates, all of the constructs in our measurement model exceeded the established criteria for AVE. Thus, all of the constructs in our measurement model exceeded the threshold judged to be acceptable for the construct reliability.

Having established the convergent validity, we then turned to the discriminant validity. We conducted two tests for the discriminant validity. First, we calculated each indicator's loading on its own construct as well as its cross-loading on all other constructs (see <Appendix B>). In the columns of the Table in Appendix B, the loadings for the indicators for each construct are higher than the cross-loadings for other constructs' indicators. Additionally, going across the rows, each indicator has a higher loading with its construct than a cross-loading with any other construct. This provides good evidence of discriminant validity (Fornell and Larcker, 1981). As a second test of discriminant validity, we considered whether the AVEs of the latent constructs were greater than the square of the correlations among the latent constructs (see <Appendix C>). When this is true, more variance is shared between the latent construct and its block of indicators than with another construct. As can be seen by reading across the rows of Tables in Appendix C, our measures passed this test, thus providing additional evidence of discriminant validity.

We conducted the mediation analysis using two different approaches. We began by examining the structural model using the partial least squares (PLS) analysis. To obtain a more detailed understanding of the mediation (i.e., the extent to which the influence of each independent variable on the dependent variable is transmitted through the mediator), we followed up with two types of mediations based regression approach.

4.4. PLS Analysis

This step in our data analysis was to examine the path significance and magnitude of each of our hypothesized effects, and the explanatory power of the proposed model. We conducted a PLS analysis because it provides the additional benefit of allowing us to examine all the paths in the proposed model simultaneously. <Figure 2> shows the results. We evaluated the explanatory power of the structural model by the R^2 value of the final dependent variable.

In this study, a strict significance level of 0.01 was used for all statistical tests. As shown in <Figure 2>, the final dependent variable in this study (system implementation success) has an R^2 value of 0.539, indicating that the model accounts for 53.9% of the variance in the dependent variable. Both R^2 values for the intermediate variables (knowledge transfer to clients and knowledge transfer to IT consultants) are 0.463 and 0.411, respectively. In our judgment, these R^2 were high enough for a meaningful interpretation of the path coefficients.

As shown in <Figure 2>, the path between IT consultants' IT skills (β = 0.681, t = 18.052) and knowledge transfer to clients, the path between knowledge transfer to clients and system implementation success (β = 0.368, t = 5.730), the path between project members' business knowledge (β = 0.641, t = 13.385) and knowledge transfer to IT consultants, the path between knowledge transfer to IT consultants and system implementation success

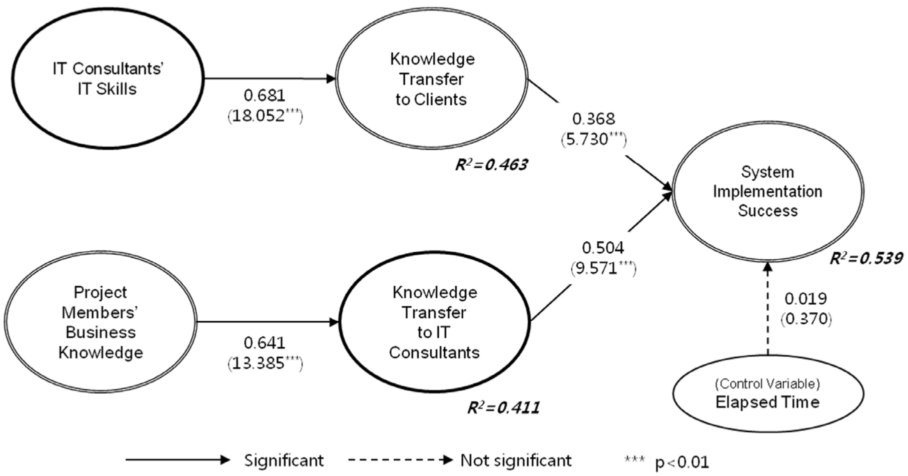
(β = 0.504, t = 9.571) were all significant at p < 0.01, suggesting that both knowledge transfer mediates the relationship between each independent variable and system implementation success. The elapsed time, as the control variable in our study, had no significant influence on system implementation success.

4.5. Regression Analysis

To drill down deeper on the mediation tested by the PLS analysis, we conducted a regression analysis following the Baron and Kenny (1986) approach. Based on their approach, we conducted the mediation analysis using a three-step process: 1) the independent variables predicting the dependent variable, 2) the mediating variable predicting the dependent variable and 3) both the independent variables and the mediators predicting the dependent variable. According to Baron and Kenny (1986), mediation is established when the following three conditions are met. First, the independent variable must affect the mediator in the first regression. Second, the independent variable must affect the dependent variable in the second regression. Third, the mediator must affect the dependent variable in the third regression. If all of these conditions are satisfied, the effect of the independent variable on the dependent variable should be less in the third equation than in the second (Baron and Kenny, 1986).

As shown in <Table 4>, the effects of both IT consultants' IT skills and project members' business knowledge on system implementation success are partially mediated by knowledge transfer to client/IT consultants, respectively. We also conducted Sobel's test to examine whether the influence of the independent variable on the dependent variable that is expressed through the mediator is statistically significant. As shown in <Table 4>, the Sobel test statistics are significant for both IT consultants' IT skills and project members' business knowledge, indicating that these variables have a significant indirect effect on system implementation success that is partially mediated by both knowledge transfer to clients and knowledge transfer to IT consultants.

Returning to our mediation hypotheses, these re-



<Figure 2> Path Analysis Results

sults convey strong support for H1 and H2, in that the effect of IT consultants' IT skills on system implementation success is partially mediated by the knowledge transfer to clients, the effect of project members' business knowledge on system implementation success is also partially mediated by knowledge transfer to IT consultants.

Although we conducted a Sobel test in order to determine the significance of the indirect effect of the mediator, we further conducted a bootstrapping analysis, which is the preferred method for analyzing data, in order to overcome the limitation of statistical methods which make assumptions about the sampling distributions. In line with this, Shrout and Bolger (2002) suggested that the use of this bootstrap could help with the mediation problems, in which the mediator and outcome variables are not normally distributed. This approach is to bootstrap the sampling distribution of *ab* and derive a confidence interval with the empirically derived bootstrapped sampling distribution. This provides a bootstrap estimate of the indirect effect *ab*, an estimated standard error and both 95% and 99% confidence intervals for the population value of *ab*.

<Table 4> Mediation Analysis following the Baron and Kenny (1986) Approach

	Step 1	Step 2	Step 3	Sobel Test
	I.V. → Mediators	I.V. → D.V.	I.V. and Mediator → D.V.	
Unstandardized Coefficients	0.654 (t = 6.117***)	0.492 (t = 4.793***)	IT = 0.243 (t = 2.064**) KTIT = 0.381 (t = 3.596***)	Z = 4.026
R^2	0.348	0.247	0.366	
Unstandardized Coefficients	0.554 (t = 5.513***)	0.653 (t = 8.837***)	BK = 0.440 (t = 5.283***) KTBK = 0.295 (t = 4.244***)	Z = 4.659
R^2	0.303	0.527	0.625	
Comments	Step 1 - The I.V. must affect the mediator. This condition is satisfied for IT consultants' IT skills as well as project managers' business knowledge. Step 2 - The I.V. must be shown to affect the D.V. Both IT consultants' IT skills and project members' business knowledge affect system implementation success. Step 3 - If there were perfect mediation, we would not expect to see a significant relationship controlling for the mediators. IT consultants' IT skills and project managers' business knowledge are partially mediated by the system implementation success, respectively. z-value = a*b/SQRT(b2*Sa2+a2*Sb2), where a = unstandardized regression coefficient for the association between IV and mediator, S_a =standard error of a, B = unstandardized regression coefficient for the association between mediator and DV, S_b = standard error of b.			

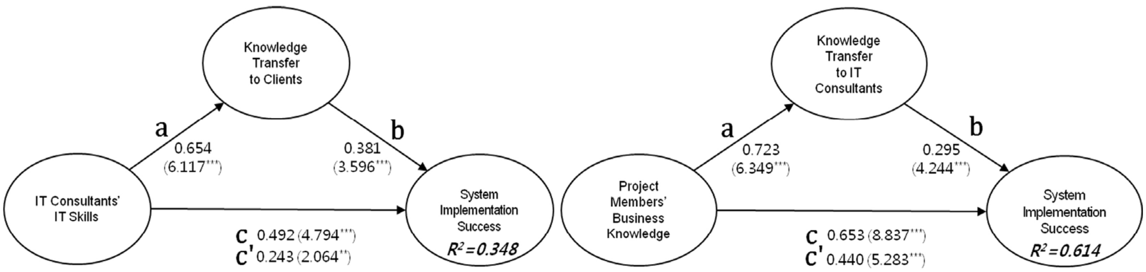
Note: Legend : IT= IT consultants' IT skills, BK=Project members' business knowledge, KTIT=Knowledge transfer to clients, KTBK= Knowledge transfer to IT consultants, IMP= System implementation success
** p < 0.01; *** p < 0.001.

As shown in <Figure 3>, the boot value of knowledge transfer to clients was 0.248 (ab path / c path = 0.380), which means that the knowledge transfer to client may play a mediating role in the relationship between IT consultant's IT skills and system implementation success. Furthermore, the boot value of knowledge transfer to IT consultants was 0.212 (ab path / c path = 0.431), which indicated that it also plays a mediating role in the relationship between project members' business knowledge and system implementation success. In addition, because zero is not in the 95% confidence interval, we can conclude that the indirect effects of each knowledge transfer are significantly different from zero at $p < 0.05$.

4.6. Comparisons on the Type of Systems

In order to test hypothesis H3 to H4, we performed a subgroup analysis (using PLS) in order to test the moderating effect of the types of system developed (i.e., ERP vs. Groupware).

Before conducting subgroup analysis, we followed the moderated regression analysis (MRA) procedure recommended by Sharma et al. (1981). In the rules of MRA, first, we can conclude that a variable is a pure moderator if there is an interaction effect and no direct effect with criterion or predictor variables. Second, if there is an interaction effect and a direct relationship with the predictor, the criterion variable, or both, we can conclude that the variable is a quasi-moderator. Third, if there is neither a direct effect nor a moderation effect but the detected interaction derives from unequal measurement errors across subsamples, we can conclude that the variable is a homologizer. Based on the MRA procedure, and applying a strict $p < 0.05$ significance threshold, we concluded that type of systems was a moderator, but that it is neither a pure moderator, nor a quasi-moderator. Instead, the type of system acts as a homologizer. A homologizer Z acts as moderator in that it influences the strength of the relationship



Bootstrap Results for Indirect Effects				
Mediators	Indirect Effects of IV on DV through Proposed Mediators (ab paths)		Bias Corrected Confidence Intervals	
	Boot	Bias	Lower	Upper
Knowledge transfer to Clients	0.248	-0.001	0.109	0.409
Knowledge transfer to IT Consultants	0.212	-0.002	0.101	0.391
Legend : a = IV to Mediator, b= Direct effects of Mediator on DV, C= Total Effect of IV on DV, C'= Direct Effect of IV on DV.				

<Figure 3> Bootstrap Results of Mediation Effects

between X (an independent variable) and Y (a dependent variable) but is not itself related to X or Y and does not interact with X. Under such circumstances Z exerts its influence through the error term and the appropriate way of analyzing the moderating effect of Z is by partitioning the dataset and performing a subgroup analysis.

In order to perform this analysis, we split the entire sample into two groups, such as ERP and groupware, after which we also tested both the validity and reliability by subgroup. Referring back to Appendices B and C, we can see that all items in the ERP (n = 72) demonstrate an acceptable range having acceptable loadings (0.752 to 0..953), as do all items in the groupware (n = 141) (0.824 to 0.968). In addition, the reliability indicators are all well above the accepted thresholds, and the AVEs are greater than 0.5. Following Carte and Russell (2003)'s suggestion, we assessed whether the latent constructs were perceived in a similar fashion between the ERP and groupware subgroups. An examination of Appendix B suggests that the loading patterns are the same and the factor loadings are very similar, thus permitting a between-group path comparison. In addition, we performed a measurement invariance analysis to further validate the similarity of measurement models between the two subgroups (Cheung and Rensvold, 2002). Appendix E provides support for measurement invariance on that basis, we concluded that meaningful path coefficient comparisons could be made across subgroup. Therefore, we tested the differences across these two models using the approach suggested by Chin et al. (2003) and used by Keil et al. (2000) by computing a t-statistic as follows:

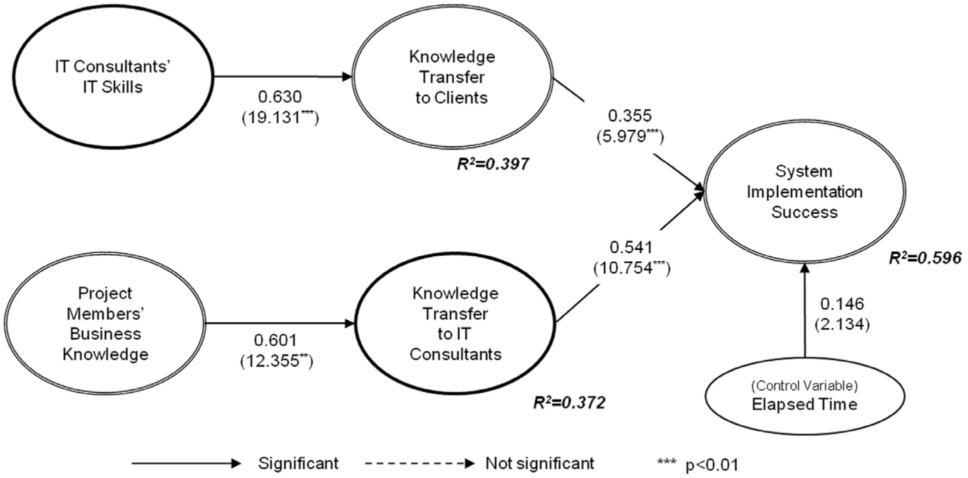
$$t=\frac{Path_{sample1}-Path_{sample2}}{\sqrt{\frac{(m-1)}{(m+n-2)}*SE^2_{sample1}+\frac{(n-1)}{(m+n-2)}*SE^2_{sample2}}*\sqrt{\frac{1}{m}+\frac{1}{n}}}.$$

We analyzed the structural model for ERP and groupware separately. The resulting models for both groups explained a significant amount of the variance in the dependent and mediating variables. Figures 4 and 5 illustrate the results of the analysis.

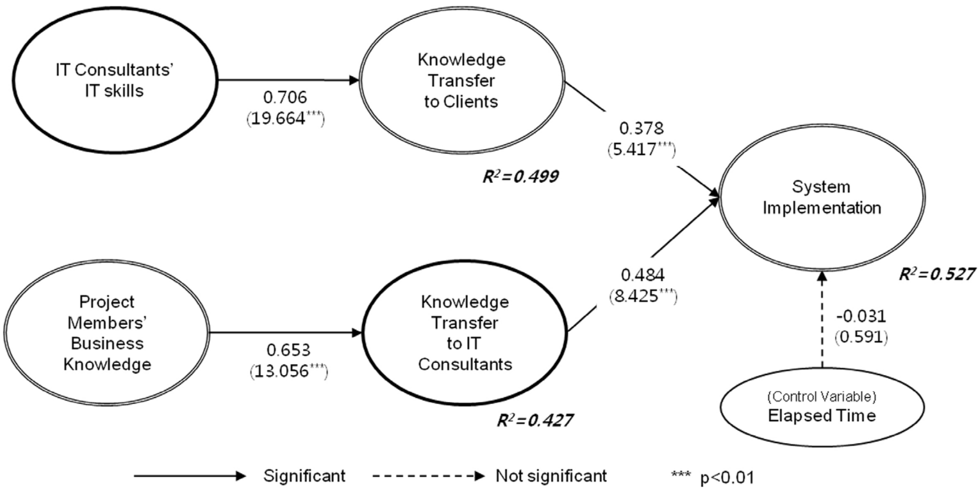
As shown in <Figures 4> and <Figure 5>, while knowledge transfer to IT vendors was more likely to influence the system implementation success in ERP (β = 0.541, t = 10.754, p < 0.001) rather than in groupware projects (β = 0.484, t = 8.425, p < 0.001), knowledge transfer to clients was more likely to influence the system implementation success in groupware projects (β = 0.378, t = 5.417, p < 0.001) rather than that of ERP projects (β = 0.355, t = 5.979, p < 0.001).

As shown in <Table 5>, a comparison of the path coefficients for knowledge transfer to clients → system implementation success across the two groups reveals that the strength of relationship between knowledge transfer to clients and system implementation success is larger for the groupware projects (β = 0.355, t = 5.979, p < 0.001) than for the groupware projects (β = 0.378, t = 5.417, p < 0.001). This result indicates that knowledge transfer to clients has a greater impact on system implementation success when the type of system is packaged, thus supporting H3.

Furthermore, the result of comparison across the two groups indicates the strength of the relationship between knowledge transfer to IT vendors, and the system implementation success is larger for ERP projects (β = 0.541, t = 10.754, p < 0.001) than for groupware projects (β = 0.484, t = 8.425, p < 0.001). More specifically, knowledge transfer from clients to IT vendors has a greater impact on system implementation success when the type of system involves customizations, thus supporting H4.



<Figure 4> ERP (n=72)



<Figure 5> Groupware (N=141)

<Table 5> Comparison Of Path Coefficients

#	Hypotheses	ERP Projects		Groupware Projects		T-statistics
		Path	S.E	Path	S.E	
3	Knowledge Transfer To Clients → System Implementation Success	0.355	0.053	0.378	0.053	2.996
4	Knowledge Transfer To It Consultants → System Implementation Success	0.541	0.052	0.484	0.055	7.286

Ⅴ. Discussion and Implications

In this study, we attempt to examine the effects of two different routes of knowledge transfer on system implementation success in IS development projects. To develop and test the bidirectional knowledge transfer model, we have considered two parts, such as the knowledge transfer to clients and the knowledge transfer to IT consultants. More specifically, we have attempted to examine the mediating effects of both knowledge transfers in the relationships between IT consultants' IT skills (project members' business knowledge) and system implementation success. We further examine whether knowledge transfer to IT consultants can facilitate the system implementation success rather than knowledge transfer to IT consultants depending on the type of systems. Our results indicate that the knowledge transfer can partially mediate both the relationship between IT consultants' IT skills (project members' business knowledge) and system implementation success. In addition, the effect of knowledge transfer to IT consultants in ERP development projects was much greater than that of Groupware development projects.

Although we present meaningful findings, this study also has some limitations.

First, we measured most of the independent variables at a single point in time by using perceptual Likert-type scales; thus, in order to test whether a common method bias posed a threat to the internal validity of our findings, based on Podsakoff et al. (2003)'s suggestion and Liang et al. (2007)'s analytical procedure, we added a common method factor to our PLS model and allowed the indicators of all the constructs to be related reflectively to the common method factor. Then for each indicator, we computed the variance explained by the principle constructs and by the common method factor.

As shown in Appendix D, the results indicate that although all the substantive factor loadings (on the hypothesized constructs) were significant and high (the lowest value=0.824), the method factor loadings (the highest value=0.056) were not. The average substantive factor loading was 0.824, whereas the average method factor loading was 0.003. These results indicate that the common method bias was not a serious problem in this study. Despite these limitations, the results have important theoretical and practical implications.

Another limitation of our study is that we did not examine the relationship between knowledge transfer and system implementation success by taking a longitudinal approach. In this regard, future research should examine the effects of a dual knowledge transfer on system implementation success because it is important for IT consultants to be given some business knowledge of the clients.

5.1. Theoretical Implications

This study makes three important contributions to IS research.

First, this study has examined the mediating effects of two different routes of knowledge transfer such a s knowledge transfer to clients and knowledge transfer to IT consultants on system implementation success. By attempting to test the mediating effects of these knowledge transfers, our results provide that empirical evidence of bi-directional knowledge transfers affect system implementation success. Using three different analytical approaches, we obtained a consistent pattern of the results, providing strong empirical support that: 1) the influence of IT consultants' IT skills on system implementation success is partially mediated by the knowledge transfer to clients and 2) the effect of project members' business knowledge on system implementation success is also partially mediated by the knowledge transfer to IT consultants.

Second, we develop and test our proposed research model by adopting the knowledge stock-flow theory perspective in order to examine the role of knowledge transfer from clients to IT consultants. While this theory has been suggested in the literature, this is the first study that provides empirical evidence suggesting that knowledge stock-flow theory may be fitted to explain the bi-directional knowledge transfers among partners for a specific project.

Finally, this study attempts to examine the effects of bi-directional knowledge transfer by distinguishing IT development projects into ERP projects and groupware projects. Our results indicate that knowledge transfer IT consultants was more likely to affect system implementation success in ERP projects than that of groupware projects. Further, the strength of the relationship between the knowledge transfer from IT vendors to clients is greater in groupware projects than that of ERP projects.

5.2. Practical Implications

The results have some practical implications for both clients and IT consulting firms. In particular, the results provide simple and powerful guidelines for enhancing the performance of IS development projects.

First, our results indicate that project managers with considerable IT experience should understand the factors that can influence the success of IS development projects. Because individuals transfer knowledge learned from one task to another (Argote, 1999), clients' stock of knowledge before the knowledge transfer may allow them to leverage the newly acquired knowledge in order to positively influence the successful system implementation success. In this regard, project managers can use these findings for selecting effective team members.

Second, this study found that there were bi-directional knowledge transfer process and moderating effects of types of system development. Based on our findings, it is important to understand the partners' knowledge exchange in terms of bi-directions. In particular, as the system project is more close to being customized, the knowledge transfer from clients to IT vendors could be critical.

Finally, project managers in both IT consultants and clients should better understand how knowledge transfer across organizational boundaries can be facilitated. Our results provide important implications for selecting the project personnel. IT consulting firms should choose those consultants who are not only familiar with IT and clients' business processes, but also owns possession of appropriate interpersonal skills. In addition, clients should choose members who have sufficient IT knowledge in order to increase the likelihood of project success. Thus, clients should choose those with prior experience in the IT realm and in working with consultants. Clients can also conceptualize the overall knowledge transfer process in two stages: from IT consultants to the most knowledgeable employees and then from these employees to non-participating employees.

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<Appendix A> Measurement Items for Key Constructs

Project Members' Business Knowledge in Clients

1. I am encouraged to learn about business functions.
2. I can interpret business problems and develop appropriate technical solutions.
3. I am knowledgeable about business functions.
4. I am knowledgeable about the environmental constraints under which the organization operates (e.g., government regulations and competition).
5. Solutions to problems between IT and business units are identified as specific job tasks in my organization.

IT Consultants' IT Skills in IT Consulting Firms

1. I am skilled in expert systems and artificial intelligence or decision support systems.
2. I am skilled in distributed processing or distributed computing.
3. I am skilled in network management and maintenance.
4. I am skilled in developing web-based applications.

Knowledge Transfer (to clients/ to IT consultants)

1. I transfer relevant knowledge and ideas about IT projects to the partner.
2. I find it useful to transfer knowledge to the partner.
3. I frequently apply relevant knowledge and expertise from the partner to my tasks.

The new information system…

1. makes us use it.
2. meets its intended users' needs.
3. has minimal start-up problems.
4. increases users' satisfaction.
5. is used extensively.

Notes: Three constructs, project members' business knowledge, knowledge transfer from clients to IT vendors and system implementation success, were measured for clients while two constructs were measured for IT consultants.

<Appendix B> Item-Factor Loading and Cross-Loading for Full Sample

Constructs	Items	Total Sample (*n*=213)					Groupware (*n*=141)	ERP (*n*=72)
		1	2	3	4	5		
Project Members' Business Knowledge	C1_1	0.903	0.566	0.436	0.632	0.647	0.907	0.893
	C1_2	0.929	0.599	0.509	0.635	0.667	0.945	0.891
	C1_3	0.894	0.589	0.484	0.492	0.620	0.908	0.868
	C1_4	0.850	0.622	0.502	0.497	0.630	0.824	0.907
	C1_5	0.954	0.648	0.523	0.621	0.661	0.958	0.942
IT Consultants' IT Skills	D2_1	0.647	0.835	0.699	0.537	0.681	0.874	0.752
	D2_2	0.579	0.905	0.664	0.393	0.557	0.916	0.875
	D2_3	0.548	0.881	0.478	0.352	0.525	0.884	0.891
	D2_4	0.505	0.864	0.440	0.262	0.481	0.892	0.810
Knowledge Transfer to Clients	F1_1	0.447	0.596	0.926	0.319	0.462	0.939	0.900
	F1_2	0.487	0.601	0.929	0.397	0.518	0.932	0.923
	F1_3	0.539	0.664	0.892	0.391	0.579	0.899	0.870
Knowledge Transfer to IT Consultants	F2_1	0.616	0.461	0.405	0.961	0.630	0.965	0.953
	F2_2	0.615	0.431	0.378	0.953	0.605	0.968	0.921
	F2_3	0.598	0.429	0.372	0.937	0.626	0.946	0.918
System Implementation Success	K1_1	0.664	0.617	0.582	0.639	0.901	0.910	0.882
	K1_2	0.601	0.565	0.541	0.590	0.884	0.885	0.885
	K1_3	0.607	0.540	0.467	0.512	0.846	0.843	0.857
	K1_4	0.623	0.565	0.455	0.543	0.870	0.886	0.830
	K1_5	0.635	0.607	0.452	0.574	0.899	0.910	0.873

Note: Legends: 1) Project Members' Business Knowledge; 2) IT Consultants' IT Skills; 3) Knowledge Transfer to Clients; 4) Knowledge Transfer to IT Consultants; 5) System Implementation Success

<Appendix C> Squared Pairwise Correlations and Assessment of Discriminant Validity

Total Group (*n*=213)	1)	2)	3)	4)	5)
Project Members' Business Knowledge	*0.907*				
IT Consultants' IT Skills	0.665	*0.872*			
Knowledge Transfer to Clients	0.641	0.463	*0.950*		
Knowledge Transfer to IT Consultants	0.540	0.681	0.405	*0.916*	
System Implementation Success	0.712	0.659	0.653	0.572	*0.880*
Groupware (*n*=141)	1)	2)	3)	4)	5)
Project Members' Business Knowledge	*0.910*				
IT Consultants' IT Skills	0.691	*0.891*			
Knowledge Transfer to Clients	0.653	0.502	*0.960*		
Knowledge Transfer to IT Consultants	0.546	0.706	0.401	*0.924*	
System Implementation Success	0.708	0.707	0.637	0.573	*0.887*
ERP (*n*=72)	1)	2)	3)	4)	5)
Project Members' Business Knowledge	*0.977*				
IT Consultants' IT Skills	0.601	*0.949*			
Knowledge Transfer to Clients	0.610	0.372	*0.975*		
Knowledge Transfer to IT Consultants	0.560	0.630	0.438	*0.962*	
System Implementation Success	0.726	0.543	0.690	0.586	*0.968*

Note: Legends: 1) Project Members' Business Knowledge; 2) IT Consultants' IT Skills; 3) Knowledge Transfer to Clients; 4) Knowledge Transfer to IT Consultants; 5) System Implementation Success

<Appendix D> Results for Common Method Bias

Constructs	Items	Substantive Factor Loading (R^1)	$R1^2$	Common Method Factor Loading (R^2)	$R2^2$
Project Managers' Business Knowledge	C1_1	0.898	0.806	0.069	0.005
	C1_2	0.926	0.858	0.072	0.005
	C1_3	0.898	0.807	0.067	0.005
	C1_4	0.856	0.733	0.068	0.005
	C1_5	0.953	0.909	0.074	0.005
IT Consultants' IT Skills	D2_1	0.824	0.680	0.073	0.005
	D2_2	0.898	0.807	0.067	0.004
	D2_3	0.892	0.796	0.061	0.004
	D2_4	0.876	0.768	0.056	0.003
Knowledge Transfer to Clients	F1_1	0.925	0.856	0.058	0.003
	F1_2	0.930	0.865	0.062	0.004
	F1_3	0.891	0.794	0.065	0.004
Knowledge Transfer to IT Consultants	F2_1	0.962	0.925	0.066	0.004
	F2_2	0.953	0.908	0.064	0.004
	F2_3	0.937	0.878	0.063	0.004
System Implementation Success	K1_1	0.894	0.799	0.073	0.005
	K1_2	0.877	0.769	0.069	0.005
	K1_3	0.850	0.723	0.065	0.004
	K1_4	0.877	0.768	0.067	0.004
	K1_5	0.903	0.815	0.069	0.005
Average		0.901	0.813	0.066	0.004

<Appendix E> Measurement Invariance Analysis for Group Comparison

Fit Index											
Model test	Chi-square	*df*	Chi-square/df	GFI	CFI	NFI	RMSEA	Δ GFI	ΔCFI	ΔNFI	ΔRMSEA
Baseline model	214.57	134	1.601	0.911	0.967	0.956	0.053	-	-	-	-
Constrained models between											
Model test	Chi-square	*df*	Chi-square/df	GFI	CFI	NFI	RMSEA	Δ GFI	ΔCFI	ΔNFI	ΔRMSEA
ITS and SIS	226.17	136	1.663	0.908	0.981	0.962	0.055	0.000	0.000	0.000	0.000
ITS, BIZ and SIS	226.18	136	1.663	0.908	0.981	0.961	0.055	0.000	0.000	0.001	0.000
ITS, BIZ, KIC and SIS	236.34	137	1.725	0.905	0.979	0.959	0.058	0.003	0.002	0.002	0.003
ITS, BIZ, KIC, KIC and SIS	256.27	138	1.857	0.901	0.975	0.956	0.062	0.004	0.004	0.003	0.004

Note: Legends: IT Consultants' IT Skills = ITS, Project Members' Business Knowledge = BIZ, Knowledge Transfer to Clients = KIC, Knowledge Transfer to IT Vendors = KCI, System Implementation Success = SIS

We conducted a supplementary measurement invariance analysis to determine the appropriateness of comparing path coefficients between the two groups. The measurement invariance analysis was done using AMOS 18.0. In this test, we performed configural and metric variance analyses to examine whether the measurement models are invariant across two groups (ERP vs. groupware). Configural invariance means that the patterns of item loadings are congeneric across groups. When modeling configural invariance, no restrictions are imposed on metrics across groups. A metric invariance analysis is then used to determine whether items have equal loadings between two groups. When modeling metric invariance, item loadings are constrained to be equivalent across the groups. If the change in CFI between these two nested (configural and metric) models is smaller than the suggested threshold 0.01 (Cheung and Rensvold, 2002), then metric invariance is supported, permitting path coefficient comparison between groups.

Following the above procedure, we configural invariance analysis revealed the pattern of item loadings to be congeneric across the two groups. In terms of metric invariance, the changes in CFI ranged from 0.000 to 0.004. Since these values were all less than the 0.01 level (Cheung and Rensvold, 2002), metric invariance was established, providing additional support for meaningful path coefficient comparison across groups.

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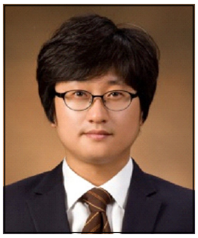

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