Abstract

This study brings in the task interdependence as the antecedent for growing team social capital and increasing knowledge sharing among team members in IS project context in which heterogeneous members need to interact very closely. Data collected from 203 IS projects largely confirm the proposed research model. Between the task interdependence and team performance, the team social capital as well as the knowledge sharing among members fully mediates the relationship. Interestingly, direct path from task interdependence onto performance is found to be insignificant, rebutting the suggestions of the work design theory which says well designed interdependence directly increase performance in heterogeneous teams. Findings of our study signify the criticality of the mediating roles of social capital and knowledge sharing. Additionally, it is also confirmed that the social capital grows with time. Also, longer term projects revealed a bit different mechanism than shorter ones. Implications are discussed with limitations and further studies.

Keywords: Task Interdependence, Social Capital, Knowledge Sharing, Work Design Theory, IS project, Performance

Introduction

In business, knowledge is critical asset in maintaining competitive advantages and growing for the future. Knowledge possessed by organizations members is only as much useful as communicated among the members. In this regard, studies have been conducted exploring knowledge transfer, knowledge diffusion, and/or knowledge sharing (Wasko and Faraj 2005). However, in practice, as the shape and form of knowledge sharing is rather different depending upon the specifics of work context and content, efforts to share knowledge would not be easily concerted at the organizational level (Staples and Webster 2008).
Criticality of knowledge sharing is particularly eminent when the environmental uncertainty is high, such as in a large systems development projects (Sambamurthy 2005; Staples and Webster 2008; Wasko and Faraj 2005). Though knowledge sharing is important in any team based tasks and work, studies in IS project management also have demonstrated that it is also important in project teams as the tasks are not routinized and therefore highly interdependent on each other (Powell, Piccoli and Ives 2004). The significance of sharing knowledge and expertise is more critical in IS project teams because business expertise need to be tightly integrated with advanced technologies in terms of business strategy as well as operational supports in developing business information systems (Park, Lee, Lee and Truex 2012).

Previous studies used the social capital theory explaining the mechanism that creates and shares knowledge in an organization (Nahapiet and Ghoshal 1998; Wasko and Faraj 2005). Properly nurtured social capital among members of an organization motivates them (the agents of knowledge sharing) to readily transfer and acquire knowledge, allows them to recognize the value of knowledge sharing, and bolsters their capability to integrate gathered knowledge, which naturally results in the active sharing of knowledge (Nahapiet and Ghoshal 1998). In the IS development team context, it has also been studied that team social capital is critical in raising the level of knowledge sharing, thus enhancing the team performance. However, most of these studies treated the social capital as ultimate independent construct influencing knowledge sharing and performance. It seems that antecedent of social capital is largely neglected.

Also, in these studies of IS team social capital, it has been recognized that different characteristics of tasks play an important role within the nomological net of social capital, knowledge sharing and team performance (Langfred 2005; Staples and Webster 2008; Wasko and Faraj 2005). In lieu of task characteristics, the work design theory researchers have identified different characteristics of task that may predict individual performance, boost job satisfaction and curtail turnover (Kiggundu 1981; Morgeson and Humphrey 2006). Among task characteristics identified in work design theory, recent studies points out that the task interdependence – a measure of dependence on other’s expertise – is known to directly and indirectly influence the performance of teams (Langfred 2007; Staples and Webster 2008). In other words, task interdependence may impact the team social capital and the knowledge sharing level among team members, leading to good performance.

Against this backdrop, the present study theorizes the relationship between the social capital of a team and the task interdependence as the preceding mechanism of knowledge sharing in IS projects, where knowledge sharing is the key factor to success. Combining work design theory with social capital theory, a research model is developed and empirically tested for the direct and indirect effects of task interdependence on the team’s social capital, knowledge sharing and project outcomes. Results indicate that work design theory largely supports and augment the social capital theory in expanding the explanatory power of knowledge sharing mechanism in IS projects. Furthermore, from the practical perspective, it seems that well designed task interdependence among team members seems to nurture and grow team social capital necessary for knowledge sharing to impact the project performance.

Theoretical Background

Research model proposed in this study integrated the work design theory with the social capital theory, proposing knowledge sharing as a key mediator for these two theories (Humphrey, Nahrgang and Morgeson 2007; Nahapiet and Ghoshal 1998). Work design theory posits a process in which work characteristics affect the workers’ psychological states, which in turn generate positive performance. Work characteristics in work design theory are defined in three dimensions: motivational, social, and work context characteristics. Studies demonstrated how the task interdependence, one of the social characteristic variables, along with trust, influences team’s knowledge sharing and performance (Staples and Webster 2008; Kiggundu 1981; Parker, Wall and Cordery 2001).

Work Design and Task Interdependence

Work design theory originated from aspirations to establish the most effective work design for motivating workers (Hackman & Lawler, 1971). The initial theory defines five “core” work characteristics as skill variety, task identity, task significance, job feedback, and autonomy (Gallagher & Einhorn, 1976; Hackman & Oldham, 1975). The five “core” dimensions are seen as prompting three psychological states
(experienced meaningfulness of the work, experienced responsibility for the outcomes of the work, and knowledge of the results of the work activities), which, in turn, lead to beneficial personal and work outcomes.

However, as organizations grew in size and added on more business departments and employees, the five core work characteristics would not represent all work environments (Kiggundu 1981). In fact, team members frequently collaborate with one another and tasks in different business departments are intertwined, intensifying the significance of social relationships to produce good performance in teams. Therefore, in the expanded work design model, social factors were added such as task interdependence, feedback from others, social support, and interaction with outside of the team (Humphrey et al. 2007).

Among those social factors, the task interdependence has received the most attention (Grant et al. 2009). Because the task interdependence is considered as the defining characteristics of teams (Campion et al. 1996; Dierdorff et al. 2007) compared to other characteristics which are individual attributes or interpersonal level variables. Task interdependence is positively associated with satisfaction for workers who work in team or group (Campion et al. 1993), and more likely to promote better performance in heterogeneous than homogeneous teams. In teams has a higher level of diversity, task interdependence motivates higher performance, helping behaviors, cooperation, and sharing information. Those activities can lead to excellent decision-making and high level performance (Grant et al. 2009). Heterogeneous team members have various expertise, educational and functional backgrounds, and different skills, such as information system development project teams.

Work design theory explained how do work characteristics influence work outcomes. The earlier version of work design theory (as known as Job Characteristics Model) proposed the processes in the form of the critical psychological states focused on individual motivation (Fried et al. 1987). The work design theory has elaborated with social factors and has a team level viewpoint. The assumption is that team inputs, such as work characteristics, affect outcomes via intra-team processes (Parker et al. 2001). Some research explained the process to apply learning and development mechanisms; team members learn from each other, and this learning promotes better performance (Batt 1999). Other researches showed that increased interdependence has been reflected in increased cooperation within teams (Parker et al. 2001). However there is little empirical evidence about how work characteristics affect team interaction processes.

**Social Capital and Knowledge Sharing in Teams**

Traditionally, physical and human capital was considered the key resources of an organization’s productive economic activities, and knowledge has been acknowledged as equally valuable resources (Nahapiet and Ghoshal 1998). Social capital theory is an important theory that explains the mechanism underlying the creation and transfer of knowledge in an organization; it is defined as the embodiment of existing and potential resources that reside in social construction and relationships (Bourdieu 1986; Tansley and Newell 2007). From the team’s perspective, a common standard and trust are constructed and sharing values is promoted as team members interact, leading to the creation of social capital (Wasko and Faraj 2005).

Social capital comprises three dimensions: members of an organization connecting through networks (structural); sharing common codes, language, or background (cognitive); and constructing trust, a standard, and an identity (relational) (Chow and Chan 2008; Nahapiet and Ghoshal 1998). The benefits of social capital do not immediately arise upon composing a team; rather, they developed through time on the basis of trust among members and anticipation of prospective benefits (McCallum and O’Connell, 2009; Tansley and Newell 2007). Because project teams are relatively temporary compared to traditional teams or social relationships, studies probe PM’s leadership or trust among team members as the preceding factor of social capital (Lee et al. 2013; McCallum and O’Connell 2009; Tansley and Newell 2007).

Members of a team share knowledge with one another when they have access to other team members through which they can garner and integrate knowledge and can anticipate value through sharing. Sharing is further motivated when trust and a common language are established and members acquire the capability to productively integrate shared information and knowledge. Other empirical studies also
report that social capital, by its very nature, can directly generate constructive project outcomes (Bolino, Turnley and Bloodgood, 2002; Thompson 2005).

Social capital has been studied as the ultimate antecedent influencing knowledge integration, better performance, or user satisfaction in information systems context and IS project. For example, Wasko (2005) examined how personal motivations and social capital influence knowledge contribution in electronic networks, and Robert (2008) also showed relational and cognitive capital as sub-dimensions of social capital were strongly related to knowledge integration in digital enabled team, such as virtual team. In the organization context, social capital which is on the relationship between CIO and business unit managers, or IT and business department, was an important independent variable for higher performance (Sun et al. 2012; Wagner et al. 2014), and IT service user satisfaction, too (Sun et al. 2012).

In IS project context, there were some research in which the social capital was treated as mediators; Chua (2012) conceptualized a “clan” as a strong social capital, and focused on itself as a key success factor for IS projects. Lee (2015) explained that IS project team as a knowledge-intensive collaboration one, and social capital was affected from degree of knowledge and communication interdependence among team members. There is a research about the role of social capital as a mediator between leadership and IS project performance (Lee et al. 2013). However, still there is little research that deals with antecedents of social capital. There is a research about proactive personality, which positively affect social capital and then can get better performance (Thompson 2005) in psychology. But most of these antecedents of social capital was related to personal traits, not to something that can be designed in the organizational context.

**Knowledge Sharing and Project Performance**

In an organization, various projects are undertaken to address a specific problem. Experts in different fields, appropriate for the purpose of a project, come together to work on a project. For example, an IS project demands collaboration between business experts in areas such as sales, production, logistics, and finance that undertake tasks such as business process innovation and system transformation based on work changes; and system experts specializing in system architecture or development. Such projects smoothly advance as the experts share their knowledge and prowess, thereby requiring an effective transferring process. This process is facilitated only when certain conditions are fulfilled: knowledge providers must display an intention to share, receivers must actively accept and possess an adequate capacity to do so, learners must demonstrate an aggressive learning attitude, and there must be an appropriate transfer channel for the specific type of knowledge being shared (Schultze and Leidner 2002).

The sharing of knowledge is at times difficult because the person with useful knowledge has a propensity to monopolize it, during which certain factors are demanded to facilitate knowledge sharing (Hart and Saunders 1997). Unlike traditional teams, the performance of project teams can be readily measured because they have a specific goal. In this context, several studies focus on the factors that promote the sharing of knowledge. First, there are studies on team members’ roles: the manager’s leadership is imperative to facilitate knowledge sharing (Lee et al. 2013). Xue, Bradley and Liang (2011) confirm that team environment and empowering leadership have profound effects on knowledge sharing. There are also studies confirming the effect of team members’ mindsets on the employment of knowledge and the degree of sharing (Hsu, Chang, Klein and Jiang 2011), and studies determining that project sponsors’ or stakeholders’ interest and support are important determinants of knowledge sharing (Yuan, Zhang, Chen, Vogel and Chu 2009).

Moreover, some studies focus on the flow of knowledge. Hsu et al. (2012) and Chen et al. (2013) attempt to identify the mechanism of examining team members’ dispersed knowledge based on the principles of transactive memory system. Chang et al. (2013) highlights the significance of team relationships by observing that knowledge is dispersed due to a wide distribution of experts, while another studies take the perspective of social capital, concentrating on the relationships among project participants (Bartsch, Ebers and Maurer 2013; Newell, Tansley and Huang 2004). Finally, one study confirms that the social interdependence among project participants is a decisive factor of knowledge sharing (Pee, Kankanhalli and Kim 2010), and Patnayakuni, Rai and Tiwana (2007) emphasizes that various activities (formal and informal) that promote knowledge sharing should transform the form of organizational structure, while accentuating the need to bolster diversified communication. Park and Lee (2014) provide empirical evidence that team members share their knowledge when they trust their partners and when they feel
dependent. Feelings of dependence and trust are influenced by the communication frequency, perceived similarity of the project's value, and the perceived expertise.

As follows, previous studies confirm the effect of interdependence of members of an IS project team on knowledge sharing. However, only recently have studies explored the interdependence (Pee et al. 2010), and there is a demand to investigate the mechanism of how the task interdependence reinforces social relationships among project team members and affects knowledge sharing.

**Research Model and Hypotheses**

The purpose of this study is to empirically analyze the relationship among work characteristics, social capital and knowledge sharing of team members, and project outcomes, in IS development project context. Figure 1 shows the research model for this study which combines work design theory and social capital theory. This model deals with the direct and indirect effects of interdependence (major social characteristics in work design) and teams’ social capital on knowledge sharing and project outcomes. Social capital is composed of three dimensions: network connections, trust, and shared vision, analyzed as second order factor. In addition, project type and size was measured for control purpose.

![Figure 1. Experimental Model](image)

**Task Interdependence**

Recently, there is much more attention given to social characteristics such as task interdependence (Langfred 2005). Because work became complex and knowledge intensive as business environment changed more dynamic and unpredictable. Organization structure turned to be horizontal such as project teams rather than operation parts. Workers need more information each other to do their own task and have to work together for better productivity (Grant and Parker 2009). Therefore there is need to focus on social characteristic rather than individual ones.

Three areas may demonstrate the task interdependence: scope of work, resources, and criticality (Kiggundu 1981). In terms of the scope of work, tasks are interdependent because the conclusion of a task is linked to the commencement of another. Resources are also interdependent, as different work shares materials, tools, capital, as well as manpower and information. Finally, interdependence is also exhibited in criticality because a single task has a considerable effect on its upstream tasks (Qu, Li, and Li 2009).

High task interdependence not only induces the sharing of physical resources, information, and knowledge, but also stimulates better performance outcomes by team members in learning a more effective method to perform tasks through interaction and knowledge sharing (Berman 2002; Langfred 2007). In this context, we posits the following:

**H1. Task interdependence has a positive effect on project performance.**
The underlying mechanism of how task interdependence affects social capital and knowledge sharing can be categorized into three areas. First, work design theory explains that high interdependence among team members indicates a rise in team members’ encounters and increased efforts to communicate needs and expectations among one another (Guzzo and Dickson 1996; Humphrey et al. 2007; Ilgen 1999). Such efforts lead to key aspects of social capital: sharing of value or language and establishing social relationships such as trust and standards through forming a network or communication. Therefore, we can theoretically expand the direct relationship between interdependence covered in work design theory and social capital theory. Second, a team’s task can be interrelated to the initiation or conclusion of another team member’s tasks. Resources such as tools, information and knowledge can be shared. And third, the failure or success of a task has a profound effect on another task (Kiggundu 1981). Hence, high task interdependence signifies more than a connection between different tasks; it means that there is a higher degree of knowledge sharing and that social relationships are imperative to the success of the task (Qu et al. 2009). In this context, we posit the following:

**H2. Task interdependence has a positive effect on social capital.**

The magnitude of interdependence is especially highlighted in teams (Guzzo and Dickson 1996; Ilgen 1999). A high interdependence facilitates communication and interactions among team members in order to pinpoint each another’s needs and expectations to determine their own prospective responsibilities (Humphrey et al. 2007). As a result, this sharing of knowledge among team members prepares and guides each employee to perform his or her tasks more effectively, engendering more successful outcomes (Berman 2002; Langfred 2007), especially in IS development project (Pee et al. 2010). The existing literature on interdependence in team organizations shows that interdependence is studied as a control variable that escalates each control effect in the analysis of the relationship between team members’ trust, knowledge sharing, and outcomes (Langfred 2005; Staples and Webster, 2008). Of note, the effect of interdependence in fostering knowledge sharing that produces better outcomes is relatively more evident in more interdependent tasks than in the less interdependent tasks. In this context, we posit the following:

**H3. Task interdependence has a positive effect on knowledge sharing.**

**Social Capital**

The formation of a network among team members facilitates communication through shared knowledge and that bond creates social capital which promotes aggressive interaction, thus producing an environment where members can create, integrate, and share knowledge (Chow and Chan 2008; Lee et al. 2013; Nahapiet and Ghoshal 1998). Social capital fosters access among team members through which they can integrate and transfer knowledge, and when they can anticipate the sharing of knowledge and its potential benefits, sharing occurs (Tansley and Newell 2007). Team members are further motivated to share knowledge through trust and a common language among themselves, which enhances their capabilities to integrate information and knowledge (Inkpen and Tsang 2005; Puttnam 1995; Wasko and Faraj 2005). Therefore, we theorize the relationship of social capital and knowledge sharing as follows:

**H4. Social capital has a positive effect on knowledge sharing.**

Moreover, several empirical studies confirm the positive effects of social capital on project outcomes (Bolino et al. 2002; Thompson 2005). In IS project team, leadership, communication and knowledge sharing between members, and social capital were critical impact on project performance (Lee et al. 2013; Lee et al. 2015; McCallum et al. 2009; Tansley et al. 2007). Therefore, we posit the relationship of social capital towards the project outcomes as follows:

**H5. Social capital has a positive effect on project performance.**

**Knowledge Sharing and Project Performance**

In an IS development project, sharing knowledge has numerous effects on project outcomes. Choi, Lee and Yoo (2010) reports that sharing knowledge creates a more effective team and buttresses the efficiency of decision making. Jewels and Ford (2006) affirm the need to operate an IS project after understanding the mechanism of knowledge sharing because the outcome is considerably dependent on it. Chen et al. (2013) underscore the significance of knowledge sharing in realizing technological achievements in a
project. In addition, Yuan et al. (2009) clearly state that interaction and knowledge sharing among team members are crucial to a successful IS project. Hence, we posit the following:

**H6:** Sharing knowledge will have a positive effect on a project performance.

**Research Method**

**Procedures and Participants**

In this study, data had been collected from the teams in five large systems integration firms in Korea. Via contact persons in each company, a list of 353 project managers was secured with contact details. For data collection, a two stage approach was used. First, 353 project managers were contacted by email or phone. In general, contacts were made by one of the researcher, but some contacts were indirectly made by previous contacts who know each other. 205 project managers agreed to participate (positive response rate 58%). As a second stage of data collection, survey packages including cover letter and questions were delivered to these 205 managers electronically. Two responses were dropped out of 205 from the analysis due to incomplete answers. 203 data points were used for final analysis. Data collection was conducted over a period of 6 months. Non-response bias was tested by comparing differences between the first wave of respondents (first quartile) and the last wave of respondents (last quartile) on key demographics and study variables. This comparison was based on the premise that the last wave of respondents were more likely to be similar to non-respondents. The comparative assessment revealed no significant differences in demographics and study variables.

As for the types of projects, enterprise resource planning was the highest at 39.9% (81 projects), followed by data analysis and decision making at 19.7% (40 projects), and web/mobile development at 15.8% (32 projects). The duration of projects varied, with 78 projects (38.4%) in the 13-24 months category, followed by 71 projects (35.0%) under 6 months. The number of project participants also varied, with 102 projects (50.2%) under 10 participants. These project characteristics are outlined in Table 1.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Categories</th>
<th>Sample N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Type</td>
<td>Data Analysis and Decision Making</td>
<td>40</td>
<td>19.7%</td>
</tr>
<tr>
<td></td>
<td>Enterprise Resource Planning</td>
<td>81</td>
<td>39.9%</td>
</tr>
<tr>
<td></td>
<td>Supply Chain Management</td>
<td>9</td>
<td>4.4%</td>
</tr>
<tr>
<td></td>
<td>Knowledge Management</td>
<td>16</td>
<td>7.9%</td>
</tr>
<tr>
<td></td>
<td>Human Resources Management</td>
<td>11</td>
<td>5.4%</td>
</tr>
<tr>
<td></td>
<td>Customer Relations Management</td>
<td>7</td>
<td>3.4%</td>
</tr>
<tr>
<td></td>
<td>Manufacture Execution Systems</td>
<td>5</td>
<td>2.5%</td>
</tr>
<tr>
<td></td>
<td>Finance and Accounting Systems</td>
<td>2</td>
<td>1.0%</td>
</tr>
<tr>
<td></td>
<td>Web/Mobile Development</td>
<td>32</td>
<td>15.8%</td>
</tr>
<tr>
<td>Project Duration</td>
<td>Under 6 months</td>
<td>71</td>
<td>35.0%</td>
</tr>
<tr>
<td></td>
<td>7-12 months</td>
<td>43</td>
<td>21.2%</td>
</tr>
<tr>
<td></td>
<td>13-24 months</td>
<td>78</td>
<td>38.4%</td>
</tr>
<tr>
<td></td>
<td>Longer than 25 months</td>
<td>11</td>
<td>5.4%</td>
</tr>
<tr>
<td>Project Size</td>
<td>Under 10 people</td>
<td>102</td>
<td>50.2%</td>
</tr>
<tr>
<td></td>
<td>11-20 people</td>
<td>40</td>
<td>19.7%</td>
</tr>
<tr>
<td></td>
<td>21-30 people</td>
<td>18</td>
<td>8.9%</td>
</tr>
<tr>
<td></td>
<td>31-40 people</td>
<td>14</td>
<td>6.9%</td>
</tr>
<tr>
<td></td>
<td>More than 41 people</td>
<td>29</td>
<td>14.3%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>203</td>
<td>100</td>
</tr>
</tbody>
</table>
Measurements

Questionnaire items were adopted from previous studies. There were a total of 24 question items measured on a 7-point Likert scale. We defined and divided a team’s social capital into network connections, trust, and shared vision (Chow & Chan, 2008), with a total of 11 items on the questionnaire.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement Item</th>
<th>Confirmatory Factor Analysis</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Social Capital</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Ties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NET1</td>
<td>A close social relationship was formed among the members of the project team.</td>
<td>5.429</td>
<td>1.078</td>
</tr>
<tr>
<td>NET2</td>
<td>There was active communication among the members of the project team.</td>
<td>5.502</td>
<td>1.009</td>
</tr>
<tr>
<td>NET3</td>
<td>There occasionally were personal group activities among the members of the project team.</td>
<td>5.438</td>
<td>1.127</td>
</tr>
<tr>
<td>NET4</td>
<td>There was intimate cooperation among the members of the project team.</td>
<td>4.635</td>
<td>1.461</td>
</tr>
<tr>
<td>Shared Vision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SVC1</td>
<td>Members of the project team shared a vision to address the problems of the project.</td>
<td>5.300</td>
<td>0.859</td>
</tr>
<tr>
<td>SVC2</td>
<td>Members of the project team shared a goal.</td>
<td>5.170</td>
<td>0.897</td>
</tr>
<tr>
<td>SVC3</td>
<td>Members of the project team shared values to help one another.</td>
<td>5.204</td>
<td>0.976</td>
</tr>
<tr>
<td>Trust</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRT1</td>
<td>Members of the project team trusted one another.</td>
<td>5.244</td>
<td>0.899</td>
</tr>
<tr>
<td>TRT2</td>
<td>Members of the project team trusted one another’s capabilities.</td>
<td>5.261</td>
<td>0.887</td>
</tr>
<tr>
<td>TRT3</td>
<td>Members of the project team trusted one another’s product/outcomes.</td>
<td>5.347</td>
<td>0.982</td>
</tr>
<tr>
<td>TRT4</td>
<td>Members of the project team trusted one another’s behaviors.</td>
<td>5.468</td>
<td>0.871</td>
</tr>
<tr>
<td>Interdependence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT1</td>
<td>Members of the project team must perform tasks together.</td>
<td>5.845</td>
<td>0.784</td>
</tr>
<tr>
<td>INT2</td>
<td>A member of the project team cannot perform a task independently.</td>
<td>5.456</td>
<td>0.870</td>
</tr>
<tr>
<td>INT3</td>
<td>A member of the project team can perform a task only after another’s task is completed.</td>
<td>5.796</td>
<td>0.873</td>
</tr>
<tr>
<td>INT4</td>
<td>The tasks of members of the project team are interdependent.</td>
<td>5.855</td>
<td>0.721</td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KWS1</td>
<td>Members of the project team actively shared knowledge among one another.</td>
<td>5.212</td>
<td>0.809</td>
</tr>
<tr>
<td>KWS2</td>
<td>Members of the project team provided one another tasks and technological insights.</td>
<td>5.325</td>
<td>0.775</td>
</tr>
<tr>
<td>KWS3</td>
<td>Members of the project team actively shared experiences and know-how.</td>
<td>5.108</td>
<td>0.860</td>
</tr>
<tr>
<td>KWS4</td>
<td>Members of the project team took the initiative to share knowledge among one another.</td>
<td>4.901</td>
<td>0.936</td>
</tr>
<tr>
<td>Project Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEF1</td>
<td>The project’s technological requirement goals were accomplished.</td>
<td>4.993</td>
<td>0.894</td>
</tr>
<tr>
<td>PEF2</td>
<td>The project’s work-related requirement goals were accomplished.</td>
<td>5.047</td>
<td>0.961</td>
</tr>
<tr>
<td>PEF3</td>
<td>The project was completed within the target budget.</td>
<td>5.094</td>
<td>1.063</td>
</tr>
<tr>
<td>PEF4</td>
<td>The project was completed within the target plan.</td>
<td>5.049</td>
<td>0.918</td>
</tr>
<tr>
<td>PEF5</td>
<td>The project was successful.</td>
<td>5.259</td>
<td>0.880</td>
</tr>
</tbody>
</table>

We defined interdependence as the necessity and the degree of significance of relying on project partners to complete each stage of the project. The questionnaire included four items borrowed from the studies of Qu et al. (2009) and Park and Lee (2014). We defined knowledge sharing as the degree of attitude...
displayed by project partners to share their knowledge and skills, measured by four items borrowed from the study of Bock, Zmud, Kim and Lee (2005). Finally, we defined project outcomes as the achievement of project goals, measured by five items from the study of Lee et al. (2013). Table 2 delineates more detailed measurement items and references from existing literature.

Questions were translated into Korean and administered. Three step approaches was used in translating into Korea. Initial translation was made by one of the author independently, and translated questions were reviewed by other two authors. As a second step, five project managers were contacted in person and they have reviewed for understandability. In consultation with these project managers in different companies, questions were revised. As a last step, three researchers with two independent observers trained in English speaking countries compared the English version with Korean version in order to identify misinterpretations.

Analysis and Results

This study employed Partial Least Square (PLS) analysis based on a structural equation to verify the hypotheses. PLS is a statistical analysis tool that can be applied in small samples because it does not have stringent requirements on sample sizes and residual distribution (Gefen 2000). Moreover, both the theoretical structural model and measurement model can be analyzed simultaneously (Chin 1998). Therefore, PLS is the most appropriate method of analysis for investigative research that attempts to verify several new theories, as in the present study.

Measurement Model Analysis

PLS analysis requires confirmatory factor analysis before the verification of the structural model in order to confirm that each variable is properly composed and measured. Confirmatory factor analysis is a method of confirming construct validity, and we performed verifications of reliability, convergent validity and discriminant validity (Spanos and Lioukas 2001).

Through confirmatory factor analysis, we first analyzed the factor loading values for each measurement item against related variables. If the loading value between the measurement items and variables was higher than 0.7, we deemed construct validity as established (Chin 1998). As shown in Table 2, all loading values were higher than 0.7. Reliability indicates the internal consistency in measuring the construct. In general, it can be evaluated by reviewing the composite reliability and Cronbach’s α. A reliability of 0.5 is usually seen as an acceptable internal consistency and a value above 0.7 indicates a very high internal consistency. As can be seen in Table 3, the minimum value of composite reliability and Cronbach’s α of this study is 0.8.

<table>
<thead>
<tr>
<th>Construct</th>
<th>CR</th>
<th>Cronbach’s α</th>
<th>AVE</th>
<th>Correlation Analysis</th>
</tr>
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<tr>
<td></td>
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<td></td>
<td>NET</td>
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<tr>
<td>Network Ties</td>
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<td>0.336</td>
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</tr>
<tr>
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<td>0.036</td>
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<tr>
<td>Project Type</td>
<td>1</td>
<td>1</td>
<td>1.000</td>
<td>-0.029</td>
</tr>
</tbody>
</table>
Convergent validity signifies a statistically significant correlation between two theoretically intimate constructs. Moreover, it means that measured variables for each potential construct should be loaded with significant t values. We reviewed convergent validity by calculating the average variance extracted (AVE), which shows the amount of construct variance in relation to measurement of error (Bagozzi and Yi 1988). As shown in Table 3, all AVE values are above the measurement standard of 0.5.

Discriminant validity represents a very low correlation between two constructs. The correlation coefficient of the latent variable must indicate an appropriate pattern of loading values, and the measured variable should be loaded higher on its associated factor. In a PLS analysis, the discriminant validity can be deemed sufficient when the square root value of AVE is larger than the correlation coefficient PLS (Fornell and Larcker 1981). The right matrix of Table 3 shows the correlation coefficient values of each variable, and the diagonal matrix illustrates the square root of AVE. The square root value of AVE is much larger than other correlation coefficients, satisfying the requirement of establishing discriminant validity. Thus, the reviews of reliability, convergent validity, and discriminant validity for establishing construct validity of this study’s measurement model seem valid.

Threats of common methods bias were assessed using Harman’s one-factor test. All of variables were put into an exploratory factor analysis in order to test the common method bias. Dataset would have a common methods bias problem if a single factor emerges that account for a large percentage of the variance in the resulting factors. However, a single factor did not emerge in our analyses, and the first factor accounted for 42.6% of the total variance. So, it seems that no common method bias exists.

**Structural Model Analysis**

After obtaining reliability and validity of the measurement model from performing confirmatory factor analysis, we proceeded to verify the theories for the structural model. A structural model represents a dependent relationship between the selected latent variables. Thus, it is used to demonstrate the relationship among the variables being studied. In order to measure the degree of relation among variables, we needed to determine the standard error and t value for each variable in addition to the relational coefficients.

Our results indicate that H1, which attempts to identify a direct relationship between interdependence and project performance, is not statistically significant ($\beta=0.025$, $t=0.273$). On the other hand, H2($\beta=0.723$, $t=20.313$), stating the relationship between interdependence and social capital, and H3($\beta=0.285$, $t=2.934$), stating the relationship between interdependence and knowledge sharing, are statistically significant. Furthermore, H4($\beta=0.222$, $t=2.325$) and H5 ($\beta=0.238$, $t=2.551$) are statistically significant confirming the relationships between social capital and knowledge sharing, and between social capital and project performance. H6 ($\beta=0.462$, $t=7.016$) is also supported as the relationship between
knowledge sharing and project performance were found to be significant. The control variable—project type ($\beta=0.061$, $t=1.090$)—did not have an effect on project outcomes. Figure 2 outlines the above results.

Initial analysis confirms the importance of interdependence among team members as a critical antecedent for the team social capital and knowledge sharing in IS project context. To nurture and grow the social capital, interdependence seems to play a critical role (0.723) while the direct influence of interdependence on knowledge sharing is relatively smaller (0.285). In other words, the social capital is a critical mediator augmenting the work design theory in which interdependence was posited to directly influence team performance.

Additionally, mediation analyses were conducted testing for full or partial mediation effects of knowledge sharing and social capital. These mediation analyses would reveal the strength of knowledge sharing or social capital in terms of impacting the project performance. We used Sobel test ($z$ value) to confirm the relationships. $Z$ value of Knowledge sharing turned out to be 3.02 and social capital to be 2.34, signifying full mediation. Statistically, the task interdependence may impact only through these two variables but not directly.

**Further Analysis by Project Duration**

As the social capital supposedly grow by time (Pfeffer 1992; Tansley and Newell 2007), further analysis seems to be required. Additional analysis was conducted to find out whether the project durations cause any differences in terms of our research model (Lee et al. 2013). Samples were grouped by the project duration and these two groups were analyzed separately: 114 data points in shorter-term projects less than twelve months (56.2%) and 89 longer-term projects lasting more than twelve months (43.8%).

**Cases of Short-term Projects**

The proposed model was then tested using the data collected from IS projects for twelve months, as shown in Figure 3. Out of the six proposed hypotheses, four paths were supported. The effect of interdependence was insignificantly related to project performance, but it had a significant effect on social capital. Thus, H1 was not supported while H2 was. Interdependence was found to be positively associated with knowledge sharing ($\beta=0.271$, $p<0.05$). Hence, H3 was supported. Social capital was found to be significantly related to knowledge sharing ($\beta=0.318$, $p<0.01$) but did not significantly impact project performance. As a result, H4 was supported while H5 was not. Finally, the level of the achievement of project performance is significantly affected by the degrees of knowledge sharing ($\beta=0.477$, $p<0.001$). Thus, H6 was supported. The interdependence and social capital explain 30.4 percent of the variance in knowledge sharing and it accounts for 46.0 percent of the variance in project performance.

![Figure 3. Results of Short-term Model Analysis](image)

In shorter term projects, it seems that the social capital is still growing and impacts performance only through extensive knowledge sharing. Direct impact of social capital on performance is not found in
shorter terms projects while, in longer term projects, this direct effect is found to be significantly large (0.265). It seems like that when the social capital grows beyond some threshold level, its effect goes beyond knowledge sharing and relates itself with other factors of collaboration.

**Cases of Long-term Projects**

Figure 4 shows the results in cases of longer term IS projects. It includes the path loadings, t-values of the paths, and R-square values. Three out of six hypothesized paths were found to be significant at different levels.

Interdependence was found to be not associated with project performance, but it did significantly impact team social capital ($\beta = 0.536$, $p<0.001$). Hence, H1 was not supported while H2 was supported. Interdependence was not related to knowledge sharing but social capital had insignificant effect on knowledge sharing. As a result, H3 and H4 were not supported. Social capital was significantly associated with project performance ($\beta = 0.265$, $p<0.05$). Thus, the results did support H5. Finally, our results showed that knowledge sharing has a significant effect on project performance ($\beta= 0.581$, $p<0.001$), as expected. Hence H6 was supported.

Interestingly, in longer term projects in which the social capital has grown strong enough, the path from interdependence to performance goes through the social capital but not the knowledge sharing. The mechanism of knowledge sharing seems to be segregated from the path of interdependence and social capital, but strongly impacts performance. Knowledge sharing by itself operates without the help of social capital among team members or the designed interdependence among team members. In longer term projects in which the social capital is high enough, knowledge sharing may happen irrespective of social capital and interdependence. There must be some other mechanisms.

![Figure 4. Results of Long-term Model Analysis](image)

**Conclusion**

In IS project environment, a number of business experts and IS experts collaborate to achieve the same goal, and therefore sharing knowledge with team members is especially important. The objective of this study was to analyze IS project environments from a social capital and work design perspective to understand interactions among team members and the mechanism of knowledge sharing leading to performance. To this end, we developed a research model based on work design theory and social capital theory and empirically analyzed the survey data collected from 203 IS development project teams.

To summarize the analysis results, there was no direct relationship between interdependence, a measure proposed by work design theory as a social characteristic of work among team members and project outcomes. However, there is a strong indirect effect through social capital and knowledge sharing. Social capital seems to maintain strong impacts on performance through knowledge sharing according to social
capital theory. It has a significant effect on both knowledge sharing and project performance. Moreover, knowledge sharing also enhances project performance.

This study attempts to expand existing theories by combining work design theory and social capital theory. Previous studies only differentiate work characteristics suggested by work design theory by their intensities, or understand them only as playing a controlling role in promoting or interfering with the relationship between knowledge sharing and performance. In this study, however, we stress the significance of interdependence as an antecedent in the knowledge sharing mechanism, rather than merely as a moderator.

Work design theory must be interpreted within the social structure or relationship of an organization. The objectives of this study indicate that when work characteristics not only grant workers meaning in their work per se, but also offer psychological experiences such as responsibility and sharing of knowledge within social relationships, their behaviors and performance may improve. Interpreting our study results, members of a project team form interdependent relationships among themselves to perform their tasks.

IS project teams, in particular, demand business experts and IS experts to share expertise and knowledge within the team. Performing interdependent tasks that require members to share information and knowledge with one another and that affect other members’ tasks naturally increases interaction among members, promoting social capital that ultimately develops an environment that facilitates further sharing of knowledge. This mechanism was confirmed by our hypotheses 2 and 3. Particularly, interdependence was shown to have a powerful effect on social capital development, with a path coefficient of 0.723.

Griffin (1991) shows the effects of work characteristic were changed over an extended time period. Although new work environment or innovative task can affect worker’s perception or behavior, soon people adjust their new task or work environment, and the effects would change over time. Also the benefits of social capital do not immediately arise upon composing a team; rather, they developed through time (McCallum and O’Connell, 2009; Tansley and Newell 2007). Therefore work characteristics and social capital both need to be considered by project duration.

In this paper, we got some significant results on process perspective. Interdependence and social capital only can affect high performance through knowledge sharing in short-term projects. In contrast, after 1 year or more IS project team can get a high performance through their good social capital directly. On the other hand, there is no significant relationship among their interdependence, social capital and knowledge sharing in longer term projects. What is that mean? When new IS project team members start to work together, they need to share lot of information and each other’s knowledge. At that moment, the motivation of knowledge sharing is not only interdependent task itself but also their good relationship. But 1 year old or older teams have different situation. Team members already know each other, and they might have more social capital than early period of the team. Therefore social capital solely and directly can affect project performance. At that moment, we must remember that knowledge sharing also affect project performance. There are several other factors that may work with knowledge sharing mechanism, such as expertise of team members, service quality of technical service provider, or leadership etc. (Park et al. 2012; Park and Lee 2014). In this regard, the research model needs to be expanded accommodating these variables.

The key real-world implication for practice is that for IS projects, the team’s social capital and sharing of knowledge play an intermediary role in boosting outcomes. Indeed, numerous studies have already confirmed that knowledge sharing is a crucial preceding factor in project outcomes. Then, the question would be, what other variables have the potential to ameliorate knowledge sharing and project outcomes?

This study theorized and successfully confirmed that social capital is such a variable. Moreover, it was found that interdependence among members of a team is a key preceding factor in forming the team’s social capital, which also affects knowledge sharing. A demand for knowledge workers is on the rise along the rapid advancement of information communication technology; and interdependence is a major aspect of these types of jobs. Especially for IT projects, which comprises experts from a wide array of fields, interdependence is gradually taking root as technology advances and business volatility increases.

Members of a team do somewhat recognize the intensified interdependent characteristic of their tasks and are compelled by responsibility to share knowledge and resources. However, it is imperative to further
instill a sense of interdependence in these workers and ensure to design systems and tasks in a way that precisely reveals their interdependent nature. In addition, if project teams give proper attention to and effectively manage social capital, such interdependence could be channeled towards greasing knowledge sharing and bettering project outcomes. There are also several ways to strengthen the effect of interdependence on social capital and knowledge sharing. For example, communication channels can be diversified to encourage more and better communication, as well as employing information communication technology such as developing applications to support communication.

This study was a cross-sectional study performed through administering questionnaires to prove the effect of work characteristics in forming social capital and promoting sharing of knowledge. It takes some time for social capital to be formed and knowledge sharing to occur. Thus, achieving more quality results would be possible with a time-series analysis, collecting data at different time frames or performing a long-term observation. Additionally, this study was only concentrated only on one particular characteristic (interdependence) among other work characteristics. Hence, future studies should develop more variables that can measure multiple aspects of social characteristics or expand the social-perspective model for a more comprehensive analysis.

References


