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Impact of knowledge sharing and absorptive capacity on project performance: the moderating role of social processes

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Abstract

Purpose – *This study aims to propose an integrated model to examine the impact of knowledge governance, knowledge sharing and absorptive capacity (ACAP) on project performance in the context of project-based organizations (PBOs). This study also examines the moderating role of social processes on the relationships among these variables.*

Design/methodology/approach – *To test the proposed model, cross-sectional data were collected regarding projects from 133 PBOs in Pakistan's information technology/software industry. The data were analyzed using the partial least squares – structural equation modeling (PLS-SEM) method and PRCOESS tool. Finally, this study also uses causal asymmetry analysis to check asymmetric relationship in the key constructs.*

Findings – *The results generally support the proposed model. Knowledge governance and knowledge sharing are important antecedents for improving the ACAP of the project, which in turn significantly improves project performance. Additionally, social processes positively moderate the relationship between knowledge sharing and ACAP, as well as between ACAP and project performance.*

Research limitations/implications – *The findings suggest that PBOs should invest in developing a knowledge governance system that guides and stimulates knowledge sharing within and between projects. This would boost the ACAP of projects and lead to superior project performance.*

Originality/value – *This study addresses the important issue of knowledge management in IT/software projects. It proposes a unique model that integrates the key constructs of knowledge management and describes their effect on project performance.*

Keywords *Knowledge management, Absorptive capacity, Project performance, Social processes, PLS-SEM, Predictive validity*

Paper type *Research paper*

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1. Introduction

Successful organizations continually invest in learning and acquiring new knowledge as a means for improving business performance and sustaining a competitive advantage (Jelenic, 2011). In the field of project management, effective knowledge management is particularly essential because of such inherent challenges as uncertainty, complexity and use of multidisciplinary teams (Bosch-Sijtsema and Henriksson, 2014). These challenges become especially apparent in project-based organizations (PBOs).

The Project Management Body of Knowledge (PMBOK) Guide (PMI, 2013) defines PBOs as various forms of organizations that conduct the majority of their work through projects. PBOs do not possess a standard organizational form (Pemsel and Wiewiora, 2013). They

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may take the form of stand-alone organizations or may be embedded within a larger organization (Turner and Keegan, 2000). In some cases, they may even take the form of multi-firm networks (PMI, 2013). PBOs are more prevalent in certain industries, such as telecommunications, oil and gas and consulting services (PMI, 2013; Artto *et al.*, 2011). The IT/software industry that is the focus of this study is also characterized by a prevalence of PBOs. As an emerging organizational form for managing complex products and systems (Thiry and Deguire, 2007; Hobday, 2000), it is pertinent to examine the underlying knowledge management mechanisms in PBOs and understand how they affect the performance of the projects undertaken by these organizations.

PBOs often operate under conditions of complex project management, characterized by complex problem-solving under conditions of uncertainty (Ahern *et al.*, 2013), where information identification and sharing becomes critical factors to success (Oshri *et al.*, 2005). However, PBOs face the challenges of dealing with decentralization and knowledge fragmentation during the project (Disterer, 2002). Furthermore, as projects usually take the form of temporary organizations, the retention of valuable project knowledge and avoidance of "organizational amnesia" post project closing is a central challenge for PBOs (Grabher, 2004). Under these circumstances, knowledge management models based on conventional organizations may not be adequate in capturing the complex interplay of macro- and micro-level factors that govern the knowledge management in PBOs.

The understanding of knowledge management within the project management field is still underdeveloped and requires further examination (Gasik, 2015). Historically, the PMBOK Guide has not adequately defined the meaning of knowledge or offered a systematic approach toward knowledge management in the context of projects (Gasik, 2015). It was only recently in the sixth edition of the PMBOK Guide that an attempt was made to address these gaps by introducing a new process "Manage Project Knowledge" under the project integration management knowledge area (PMI, 2017). Therein, the tacit and explicit forms of knowledge are recognized and knowledge management is positioned as one of the tools and techniques through which project knowledge is created, shared and integrated (PMI, 2017). The guide further states that knowledge management takes place at all stages of the project and that the appropriate set of practices depends on various contextual factors such as project complexity and team diversity (PMI, 2017). Likewise, the Association for Project Management (APM, 2012) in a similar guide defines knowledge and knowledge management and provides some generalized guidelines for knowledge management at the project, program and portfolio levels. While the current treatment of knowledge management in the professional project management literature is certainly an improvement but various gaps still remain. For example, neither guide addresses how knowledge goals for individual projects are set and aligned with the parent organization's objectives. Furthermore, they do not address how knowledge-based organizational competencies, such as absorptive capacity (ACAP), can be developed and leveraged to support the attainment of project goals.

On the academic side of the literature, the discussion on knowledge management in the context of projects is more nuanced and the topic has been studied using various constructs and from various theoretical perspectives. Empirically, previous studies provide evidence that knowledge management systems have a positive impact on project performance (Cohen and Levinthal, 1990; Reich *et al.*, 2013). However, the mechanisms through which knowledge management impacts project performance are not completely understood. For instance, while the success factors of effective knowledge management systems have been explored in detail (Mingers, 2008; Hautala, 2011) and generic frameworks for knowledge management have been proposed (Liebowitz and Megbolugbe, 2003), limited work exists on how these systems can be aligned with organizational objectives and strategy.

To address these gaps, the purpose of this study is to develop a holistic model to explain how knowledge is directed, created, transferred and applied to improve project performance. Specifically, this study examines the chain of relationships between knowledge governance (KG), knowledge sharing and, ACAP and project performance. Furthermore, this study investigates the moderating role of social processes in the relationships between knowledge sharing and ACAP, as well as between ACAP and project performance.

The proposed model builds upon the framework of KG in PBOs developed by Pemsel *et al.* (2014), which itself builds upon various previous studies (Coleman, 1990; Foss, 2007; Foss *et al.*, 2010). Broadly, the framework posits that knowledge process outcomes occur as a result of the interaction between macro- and micro-level factors within the PBO. Specifically, the framework posits that macro-organizational antecedents (such as organizational control and leadership) influence micro-conditions of knowledge processes (such as beliefs and expectations) which in turn influence micro-knowledge behaviors (such as knowledge sharing and recombination) that ultimately influence the achievement of desired macro-knowledge-based goals and outcomes (such as dynamic capabilities and ACAP) (Pemsel *et al.*, 2014). Our conceptual model similarly applies this theory of macro- and micro-level interactions to explain how knowledge management processes affect project performance in PBOs (Ali and Park, 2016; Ali *et al.*, 2016). We posit that an organization's macro-level KG practices, which consist of knowledge policies and strategies, as well as the incentives and control mechanisms to support these strategies, would stimulate micro-level knowledge sharing practices within projects. Consequently, this would stimulate the development of macro-level ACAP enabling projects to acquire, assimilate, transform and exploit relevant knowledge for achieving the project's objectives (Ali *et al.*, 2016; Ali *et al.*, 2017a, b). We posit that a higher level of ACAP would ultimately result in improved project performance.

Furthermore, we build upon the framework of Pemsel *et al.* (2014) by examining the role of social processes, specifically familiarity, communication, proximity and trust (Akgün *et al.*, 2005), in moderating the influence of knowledge sharing on ACAP, as well as ACAP on project performance. Using the lens of social capital theory (Putnam, 2001), we posit that strong social processes within the project serve to enhance its internal social capital by ensuring that project team members and decision-makers are interconnected, willing to cooperate and aligned toward common project objectives (Pinho *et al.*, 2012). We argue that in projects with strong social processes, and thus a high level of internal social capital, knowledge sharing practices would create meaningful exchanges between participants based on a mutual understanding of project objectives and information needs. Similarly, social processes would stimulate the effective application of internal and external knowledge to overcome project challenges and improve project performance. Therefore, we posit that social processes would positively moderate the relationship between knowledge sharing practices and ACAP, as well as between ACAP and project performance.

2. Literature review

The process of knowledge management within projects is directed by, and highly dependent upon, the policies and strategic priorities of the funding PBO. This concept is embodied in the emerging research area of KG. Foss *et al.* (2010) define KG as "...choosing organizational structures and mechanisms that can influence the processes of using, sharing, integrating, and creating knowledge in preferred directions and toward preferred levels.". In the context of PBOs, Pemsel *et al.* (2014) re-conceptualized KG as "...a strategic combination of knowledge processes and their enabling formal and informal mechanisms that allows moving the organization to set knowledge-based goals.". In this context, KG serves to guide knowledge processes based upon the goals and values of the organization and implicates that policies and processes be implemented to enable such processes (Pemsel *et al.*, 2014). Hence, KG focuses on the organizational mechanisms that seek to guide the behavior of, and interactions between individuals (Pemsel *et al.*, 2016), such as knowledge-related policies and strategies, as well as the incentives and control mechanisms, to ensure the successful implementation of these strategies (Statistics Canada, 2001). The emergence of KG practices in PBOs is influenced by structural mechanisms (i.e. whether the PBO is a stand-alone unit or a subsidiary), visionary mechanisms (the goals and objectives of the PBO) and pragmatic mechanisms (the role of the executive in enabling KG practices) (Pemsel and Müller, 2012). This is indicative of a need to take a contingency approach toward KG, based on the characteristics of the PBO (Pemsel and Müller, 2012).

Knowledge sharing is the process of exchanging tacit knowledge through social and collaborative processes (Nonaka, 1994). The term implies the transfer of information framed within a specific context and subject to the interpretation of the receiver (Sharratt and Usoro, 2003). The process can take place through direct interpersonal means, such as face-to-face or telephone conversations, as well as through IT-facilitated means, such as e-mail or within online communities of practice. Knowledge sharing practices are vital for mobilizing the "flow" of knowledge within an organization (Wang *et al.*, 2008), which is an essential precursor to knowledge creation and overall organizational learning (Pinho *et al.*, 2012). These practices include the open transfer of knowledge between all organizational levels and departments, as well as within networks of organizations (Wang *et al.*, 2008).

ACAP is defined as "a dynamic capability pertaining to knowledge creation and utilization that enhances a firm's ability to gain and sustain competitive advantage" (Zahra and George, 2002). A project's ACAP refers to its ability to acquire, assimilate, transform and exploit relevant knowledge to achieve project objectives (Leal-Rodríguez *et al.*, 2014; Popaitoon and Siengthai, 2014; Zahra and George, 2002). Zahra and George (2002) and Ali *et al.* (2016) further explain each of these four processes in detail. Knowledge acquisition refers to the proactive initiatives implemented by the project to identify and collect relevant information from external sources that is critical to its operations. Knowledge assimilation is the sense-making process, whereby this information is analyzed, processed and interpreted so that it may be used toward supporting project objectives. Subsequently, knowledge transformation is the process through which the new knowledge is combined with existing knowledge and opportunities for improvements are identified. Finally, knowledge exploitation is the process of leveraging the newly acquired insights to support the achievement of project objectives.

In the following sections, we examine in greater detail the theoretical links among the concepts in our proposed model.

2.1 Knowledge governance and knowledge sharing in PBOs

The importance of KG is emphasized when considering the inherent uncertainty involved in project management. Ahern *et al.* (2013) describe complex project management as a form of complex problem-solving that typically involves incomplete pre-given information. These circumstances demand a holistic approach to creating and coordinating knowledge in the project organization (Ahern *et al.*, 2013) that takes into consideration the needs of project processes and people, and is guided by a strategic business need (Carrillo *et al.*, 2013). Effective KG can help bridge this gap by removing barriers to knowledge sharing, such as excessive departmentalization, while also developing collaborative organizational structures and providing incentives to facilitate knowledge sharing (Pinho *et al.*, 2012). Hence, KG serves to stimulate purposeful knowledge sharing through various formal mechanisms, such as organizational structures and reward systems; relational mechanisms, such as steering committees and expert panels; and informal mechanisms, such as trust and organizational culture (Pemsel *et al.*, 2016). Additionally, by defining the PBO's knowledge-based objectives, KG provides direction to the knowledge-sharing processes within individual projects and serves to align them with the broader goals of the organization (Smith and Lumba, 2008). As a result, KG would increase not only the intensity but also the effectiveness of project knowledge sharing.

In the context of conventional organizations, the results of Cao and Xiang (2012) provide empirical evidence that both formal and informal KG mechanisms have a significant and positive impact on knowledge-sharing practices. Furthermore, the findings of Zhao *et al.* (2015) indicate that KG practices also help foster cross-project knowledge transfer, thus enabling PBOs to retain valuable knowledge beyond project closing. Based on the above discussion, we formulate our first hypothesis:

H1. Higher levels of knowledge governance practices in PBOs is positively related with higher levels of knowledge sharing.

2.2 Knowledge sharing and absorptive capacity

While KG serves to stimulate and guide knowledge-sharing practices within projects undertaken by PBOs (Cao and Xiang, 2012), this in itself is not sufficient to improve project performance. To have a lasting impact, these practices must contribute to developing ACAP of a project. Knowledge-sharing processes act as a vital driving force for developing a project's ACAP in various ways. First, these processes serve as the catalyst for exchanging and externalizing the tacit knowledge possessed by individual project team members in the form of past experiences and lessons learned (Duffield and Whitty, 2016). This knowledge contributes to the project team's semantic memory (i.e. explicit and articulated knowledge) (Alavi and Leidner, 2001) and forms the bedrock for a mutual understanding of project goals and challenges. Additionally, knowledge-sharing practices grant individuals mutual access to pertinent information from their internal and external knowledge networks (Duffield and Whitty, 2016). This builds the project's ACAP by enabling project team members to identify and acquire relevant external information through active networking (Biedenbach and Müller, 2012).

In addition to developing its knowledge stock, knowledge-sharing practices develop ACAP by creating an enabling environment for knowledge transfer (Reich *et al.*, 2012). This facilitates the assimilation and transformation of relevant knowledge to address the needs of the project. Furthermore, the process of knowledge sharing increases the propensity to promote and implement new ideas for both the recipient (Nonaka and Takeuchi, 1995) and the sharer (Mura *et al.*, 2013). Therefore, project team members engaging in knowledge-sharing practices would be more likely to exploit relevant knowledge toward the achievement of project objectives. In line with the above, we formulate our second hypothesis:

H2. Higher levels of knowledge sharing in PBOs are positively related with higher levels of ACAP.

2.3 Absorptive capacity and project performance

Project performance refers to the extent to which project outputs and outcomes satisfy budget goals, schedule goals, operational and technical specifications, and, ultimately, the business needs of the client (Popaitoon and Siengthai, 2014). Within the project ecology, a high level of ACAP greatly enhances the project team's capacity to absorb new knowledge and combine it with existing knowledge, which translates into greater innovation capabilities (Ali and Park, 2016; Ali *et al.*, 2016; Cohen and Levinthal, 1990; Leal-Rodríguez *et al.*, 2014; Zahra and George, 2002) and, consequently, improves overall project performance (Ali *et al.*, 2016; Patel *et al.*, 2015; Tsai, 2001). As projects typically involve a great degree of uncertainty and complexity, innovative capabilities would enable the project to better deal with technical and operational challenges. Similarly, a high level of ACAP would enable projects to better identify, analyze and prioritize project risks, thereby improving performance through improved risk management (Neves *et al.*, 2014).

A high level of ACAP in PBOs also facilitates the transfer of knowledge from the project organization to other projects (Zhao *et al.*, 2015), as well as the parent organization (Bakker *et al.*, 2011). The creation of new knowledge is often an integral component of project success criteria (Khan *et al.*, 2013) and therefore directly improves project performance.

Furthermore, the findings of Popaitoon and Siengthai (2014) indicate that a high level of project ACAP leads to significantly improve project performance in project-oriented organizations. These results are corroborated by the findings of Biedenbach and Müller (2012), which indicate that ACAPs improve both short- and long-term project success, as well as overall project portfolio performance. Similarly, the findings of Stephens and Carmeli (2016) suggest that project teams with greater knowledge-creation capabilities, which enables them to respond to complex and rapid changes in the project environment, are more likely to achieve project performance outcomes. Based on the preceding discussion, we formulate our third hypothesis:

H3. Higher levels of ACAP in PBOs are positively related with higher levels of project performance.

2.4 The moderating role of social processes

The human aspect of knowledge management, in the form of social networks and interactions between individuals, is a critical component of any knowledge management system (Duffield and Whitty, 2016). Socialization is the process whereby individuals exchange and synthesize tacit knowledge (Nonaka and Takeuchi, 1995) that is eventually externalized and ultimately contributes to the semantic memory of the group (Alavi and Leidner, 2001). Social processes are therefore intricately tied to the knowledge management process. Social capital theory offers one potential theoretical lens to explain why this is the case. Adler and Kwon (2002) broadly define social capital as the "goodwill that is engendered by the fabric of social relations, and that can be mobilized to facilitate action." A high level of social capital within an organization builds trust and cooperation among individuals (Pinho *et al.*, 2012). From this perspective, knowledge can be viewed as a form of currency that is exchanged between individuals to build and reciprocate social capital within a group. In the multidisciplinary environment of projects, building social capital is especially vital for individuals to foster collaborative relationships (Putnam, 2001) and exchange specialized knowledge to achieve project objectives.

"Social processes" is a broad term that refers to various practices that can facilitate the creation of social capital within a particular group or organization. These processes can help to increase the intensity and frequency of social interactions, thereby giving individuals more opportunities to exchange knowledge (Yli-Renko *et al.*, 2001). Social processes, in one form or another, have been examined in the knowledge management literature from various viewpoints and in a wide range of contexts (Martínez-Cañas *et al.*, 2012; Mu *et al.*, 2008; Noorderhaven and Harzing, 2009). The emphasis on the social aspects of knowledge management processes is also an emerging trend in project management research (Holzmann, 2013). Based on the conceptualization of Akgün *et al.* (2005), this study focuses on four social processes, namely, familiarity, communication, proximity and trust.

Zahra and George (2002) posit that social integration mechanisms enable knowledge sharing while increasing the efficiency of knowledge assimilation and transformation. Hence, the implementation of social processes to support knowledge sharing practices should enhance a project's ACAP. Social processes also offer a more effective medium of transferring knowledge across projects, as opposed to ICT-based systems (Newell, 2004). Social interactions greatly enhance the effectiveness of knowledge-sharing practices and facilitate the flow of information between organizational units (Tsai, 2002). This view is supported by the findings of Teerajetgul *et al.* (2009), which indicate that collaborations between project team members leads to positive knowledge exchanges and increases willingness to share knowledge.

In the context of multidisciplinary teams, intense interactions between team members are vital for developing new methods of collaboration. Direct contacts between project team members also boost creativity in product development projects (Kratzer *et al.*, 2010). Also, social interactions are especially vital for creating and sharing embedded knowledge in interorganizational projects (Bosch-Sijtsema and Henriksson, 2014), and boundary-spanners especially play an important role in developing ACAP by bridging the various organizations through external and internal ties (Ebers and Maurer, 2014).

The findings of Leal-Rodríguez *et al.* (2014) provide empirical evidence that relational learning activities promote the development of realized ACAP (transformation and exploitation) in organizations. Similarly, the findings of Mura *et al.* (2013) found that higher levels of perceived social capital increase the propensity of individuals to translate knowledge sharing into an active exploitation of knowledge. Hence, we formulate the first part of our fourth hypothesis:

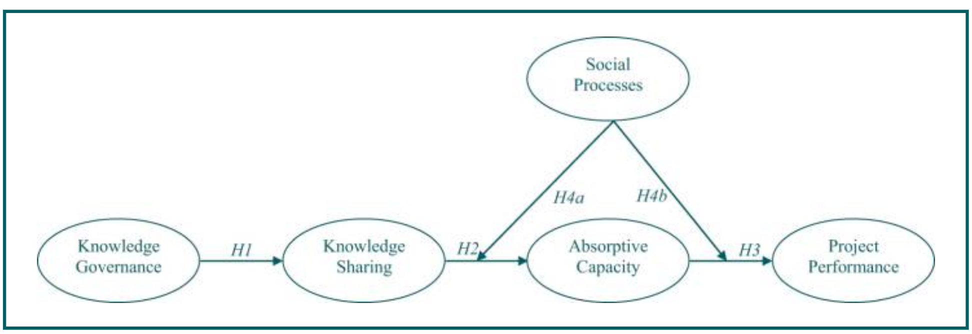
H4a. Social processes positively moderate the relationship between knowledge sharing and project ACAP.

To translate a high level of project ACAP into improved project performance, the processes of knowledge acquisition, assimilation, transformation and exploitation need to be guided toward achieving project objectives. Social processes can facilitate this process by fostering a joint understanding of project challenges and objectives among project team members (Stephens and Carmeli, 2016). Frequent interactions between project team members enable the creation of a transactive memory system, where individuals use the entire group's memory to store and retrieve relevant information (Wegner, 1995). Such arrangements significantly boost communication efficiency among team members, thereby improving project performance (Hsu *et al.*, 2012). Furthermore, the findings of Hsiao *et al.* (2011) suggest that social processes have a complementary and synergistic interaction with ACAP by invigorating individuals to acquire, exchange and apply knowledge toward improving project performance. Accordingly, we formulate the second part of our fourth hypothesis:

H4b. Social processes positively moderate the relationship between project ACAP and project performance.

Figure 1 summarizes the above hypotheses as the conceptual model of this study.

Figure 1 Conceptual model



3. Methods

3.1 Data collection and sample

The present study focuses on Pakistan's burgeoning software industry. According to the Pakistan Software Houses Association for IT and ITES (P@SHA, 2016), the industry is experiencing rapid growth and is expected to exceed the US$11bn revenue mark by 2020. However, the industry faces a wide range of "chronic" issues, including inadequate knowledge management, that ultimately lead to poor project performance (Ahsan, 2009; Jalil and Hanif, 2009; Majeed *et al.*, 2013). The software industry is primarily project-based and the scope of work is often complex, highly technical and involves a diverse range of stakeholders. It therefore offers an interesting insight into how professionals from different areas of specialization develop and share knowledge, as well as the impact of these processes on the PBO's ACAP, i.e. its ability to identify and acquire relevant external knowledge and the project's performance.

The unit of analysis for this study is the individual project. However, because of the unavailability of a sampling frame of all projects being undertaken in the IT/software industry, the sampling was instead conducted using the sampling frame of all organizations in the industry. A similar approach has been used by previous studies that focus on the individual projects (Hwang *et al.*, 2014; Srivastava and Teo, 2012; Tiwana, 2009).

The sample for the study represents the PBOs in Pakistan, both local and multinational. To this end, a list of all PBOs in Pakistan was requested from the Project Management Institute (PMI) Lahore Chapter and Pakistan Software Houses Association (P@SHA, 2016). An exhaustive list was developed from these two sources, i.e. the sampling frame, and systematic sampling technique was used. This method provides the most representative sample and consequently produces highly generalizable results. At the time this research was conducted, there were 287 members registered with Pakistan Software Houses Association and their respective contact details and websites were provided on the P@SHA website. The postal and e-mail addresses of selected members were retrieved from their respective websites. The list obtained from Project Management Institute Lahore contained 228 members with their respective postal addresses, as well as online contact numbers. There were total 515 project-based IT/software organizations registered with both these organizations. The study selected every third member from the list for data collection, starting from the second member, to avoid systematic sampling bias. The survey questionnaires were sent through surface mail and through e-mail in the form of a Google Docs link. Two soft reminders were also sent to the respondents to maximize the response rate. Overall, survey questionnaires were sent to 170 organizations, and 133 usable responses were received with a response rate of 78.23 per cent, which is quite good in this type of research.

3.2 Measurement and instrumentation

The survey questionnaire instrument has a combination of reflective and formative measure and is validated in previous studies where the items and responses appear on a five-point Likert scale, ranging from "1: strongly disagree" to "5: strongly agree". The scale for KG is adopted from Statistics Canada (2001), and it is formed as a second-order reflective construct with two first-order reflective constructs, namely, policies and strategies (four items) and incentives and control (four items) for knowledge management. The scale for knowledge sharing is formed as first-order reflective construct (ten items) and is adopted from Wang *et al.* (2008). The instrument for ACAP is adopted from Popaitoon and Siengthai (2014), and it is formed as a third-order formative construct with two second-order formative constructs that are potential ACAP (PACAP) and realized ACAP (RACAP). PACAP consists of acquisition (five items) and assimilation (two items) as first-order formative constructs.

RACAP consists of transformation (six items) and exploitation (five items) as first-order formative constructs. The instrument to measure social process is adopted from Akgün *et al.* (2005), and it is formed as a second-order construct with four first-order constructs that are communication (four items), formality (two items), proximity (two items) and trust (seven items). Finally, the project performance scale (six items) is adopted from Popaitoon and Siengthai (2014). Appendix presents the items used in the survey questionnaire.

3.3 Analytical methods

The research model in this study (Figure 1) is analyzed by using a multivariate analysis technique, i.e. a partial least squares – structural equation modeling (PLS-SEM), as implemented in SmartPLS 3 (Ringle *et al.*, 2015). SmartPLS 3 assesses the psychometric properties of the measurement model and estimates the parameters of the structural model simultaneously (for detailed reasons of why and when to use PLS-SEM, see, for example, Richter *et al.*, 2016). PLS-SEM is a widely accepted variance-based, descriptive and prediction-oriented technique to SEM (Hair *et al.*, 2017; Sarstedt *et al.*, 2017). The use of PLS-SEM is suitable when the research objective focuses on maximizing the dependent variables' variance that the independent variables can explain (Chin, 2010; Hair *et al.*, 2012; Richter *et al.*, 2016); the sample size is relatively small (Hair *et al.*, 2012); the measurement model consists of both reflective and formative constructs (Chin, 2010; Hair *et al.*, 2017); PLS-SEM latent variable scores are applied in subsequent analyses (Richter *et al.*, 2016), and/or the available data is non-normal; and if covariance-based SEM provides no, or at best questionable results (Hair *et al.*, 2017; Sarstedt *et al.*, 2017). The following reasons summarize the suitability of PLS-SEM for this study (Roldán and Sánchez-Franco, 2012):

- the sample is relatively small (n = 133);
- this study focuses on the prediction of the dependent variables;
- the constructs in this study are model both as formative and reflective;
- the constructs in this study are operationalized as higher-order models;
- this study uses latent variables' scores in the following analyses of conditional moderation, predictive validity and causal asymmetry analysis; and
- the research model involves considerable complexity with regard to the type of relationships in the hypotheses.

This study uses SmartPLS 3 statistics package (Ringle *et al.*, 2015) for estimation of both the measurement, and the structural model, and PROCESS tool (Hayes, 2013) for the conditional moderating analysis.

4. Empirical results and analysis

4.1 Model evaluation using PLS-SEM

The validation of partial least squares – structural equation modeling (PLS-SEM) requires two steps:

1. assessment of the measurement model; and
2. testing of the structural model (Anderson and Gerbing, 1982; Hair *et al.*, 1998).

The measurement model is also known as the outer model and it relates the individual items to their respective constructs. The structural model is also known as the inner model and it relates some dependent constructs to other constructs.

4.2 Measurement model

The measurement model of this study involves both formative and reflective second-order constructs. The criteria to assess the measurement model with reflective indicators are not appropriate for measurement model with formative indicators.

Factor loadings are the estimated relationships in reflective measurement models and they determine an item's absolute contribution to its assigned construct (Hair *et al.*, 2017). The results show that the measurement model for all the first-order reflective constructs and items meet all minimum requirements. The standardized factor loadings of all reflective first-order constructs are higher than 0.70 with few exceptions. A scale factor loading lower than 0.40 suggests that an item should be considered for removal, and items with a factor loading between 0.40 and 0.70 may be considered for deletion, if their removal leads to an increase in average variance extracted (AVE), composite reliability (CR) and Cronbach's alpha (α) above the threshold (Hair *et al.*, 2017). All the main constructs meet the minimum threshold of reliability. Thus, all individual reflective items with loading above 0.40 remained and confirmed the proposed relationships among research constructs.

The internal consistency reliability refers to a reliability used to judge the consistency of results across items on the same test. Further, it determines whether the items measuring a construct are similar in their scores (i.e. if the correlations between the items are large) (Hair *et al.*, 2017). The internal consistency reliability is determined by analyzing CR and α. In terms of reliability estimates, Table I shows that all CR and α values reach the threshold level of 0.70 for significance, suggesting that all the variables in the model are reliable. AVE provides an assessment of convergent validity and refers to the degree to which a construct explains the variance of its items (Hair *et al.*, 2017). Fornell and Larcker (1981) recommend an AVE value $\geq$ 0.50. This means that 50 per cent or more of the indicator variance should be accounted for. Consistent with this suggestion, Table I also shows that all of the AVE values reach the threshold level 0.50 for significance, suggesting that each construct has an acceptable level of convergent validity. Discriminant validity describing a construct is truly distinct from other constructs in the model, in terms of how much it correlates with other constructs, as well as how much items represent only a single construct (Hair *et al.*, 2017). In this study, the confirmation of discriminant validity comes from three approaches:

1. cross loading;
2. Fornell–Larcker criterion; and
3. the heterotrait-monotrait ratio of correlations (HTMT).

Cross loading refers to an item's correlation with other constructs in the measurement model (Hair *et al.*, 2017). The results of cross loading show that all individual items are loaded higher on their respective constructs than on the other constructs. Fornell–Larcker criterion suggests that, for each construct, the square root of its AVE is appreciably greater than the correlation values below the diagonal (Table II). All of the values on the diagonal confirm this criterion as shown in Table II. HTMT refers to an estimate of what the true correlation between two constructs would be, if they were perfectly measured. It is a mean of all correlations of items across constructs measuring different constructs relative to the mean of the average correlations of items measuring the same constructs (Hair *et al.*, 2017). In all cases, the HTMT values, which lie above the diagonal in Table II, are below the threshold of 0.85 (Henseler *et al.*, 2015). Therefore, the discriminant validity of the measurement model in this study is acceptable. Finally, mean values show that most of the constructs are generally above their respective mid-point, while correlations among the independent constructs are relatively low (Table II). Further, a collinearity test is carried out to examine the potential multi-collinearity among constructs in the measurement model (Table I). Thus, multi-collinearity is not a concern in this study (Hair *et al.*, 2017).

Table I Measurement model

Factors	*SL*	*SE*	t-*value*	*CR*	α	*AVE*	*VIF*
First-order reflective constructs							
KG				0.85	0.79	0.54	1.43
Policies and strategies	0.88	0.02	43.27				
Incentives and control	0.78	0.04	21.99				
Knowledge sharing				0.93	0.91	0.56	1.75
KS1	0.80	0.03	23.02				
KS2	0.73	0.06	11.75				
KS3	0.84	0.04	23.83				
KS4	0.77	0.04	17.98				
KS5	0.85	0.03	27.99				
KS6	0.72	0.06	12.99				
KS7	0.69	0.05	12.65				
KS8	0.68	0.07	10.21				
KS9	0.69	0.07	9.39				
KS10	0.73	0.06	12.11				
Social processes				0.92	0.90	0.50	1.74
Communication	0.91	0.02	43.32				
Familiarity	0.63	0.08	8.38				
Proximity	0.84	0.03	26.75				
Trust	0.89	0.03	28.68				
Project performance				0.91	0.89	0.60	1.84
PPER1	0.66	0.05	13.22				
PPER2	0.70	0.06	11.42				
PPER3	0.50	0.12	3.93				
PPER4	0.70	0.07	10.06				
PPER5	0.60	0.09	6.95				
PPER6	0.60	0.09	6.40				
Second-order formative construct	VIF	Weight	CR	α	AVE		
ACAP	1.76		0.91	0.89	0.52		
PACAP	1.00	0.28					
RACAP	1.00	0.42					

Notes: SL = Standardized loadings; SE = standard error; CR = composite reliability; α = Cronbach's alpha; AVE = average variance extracted; and VIF = variance inflation factor

Table II Construct reliability, convergent validity and discriminant validity (Fornell–Lacker and HTMT criterion)

Constructs	*Mean*	*SD*	*1*	*2*	*3*	*4*	*5*
1. KG	4.15	0.41	*0.74*	0.54	0.60	0.59	0.71
2. Knowledge sharing	4.21	0.65	0.38***	*0.75*	0.57	0.60	0.59
3. ACAP	4.16	0.57	0.44***	0.56***	*0.72*	0.64	0.58
4. Social process	4.22	0.50	0.52***	0.69***	0.56***	*0.70*	0.71
5. Project performance	4.09	0.53	0.51***	0.59***	0.57***	0.61***	*0.78*

Notes: ***Correlation is significant at the 0.01 level (two-tailed). SD = standard deviation; Italicized values on the diagonal are the square roots of the AVE (average variance extracted). Values below the diagonal are the correlations between the constructs. Values above the diagonal are the HTMT values

This study applies a two-stage approach to evaluate the hierarchical second-order latent constructs. In the first stage, the repeated indicator approach is used to obtain the latent variable scores for all the first-order constructs, which, in the second stage, serve as manifest variables in the measurement model of second-order constructs (Becker *et al.*, 2012; Hair *et al.*, 2017).

The validity of second-order constructs with reflective dimensions (i.e. KG and social processes) requires the general acceptance criteria of measurement model, whereas in case of second-order constructs with formative dimensions (i.e. ACAP), the weights provide information regarding how each dimension contributes to the respective construct. This obviates the need for a minimum level and also for examining multi-collinearity among the formative dimensions. Table I shows that all second-order constructs fulfill the minimum requirements of their acceptability.

4.3 Structural model

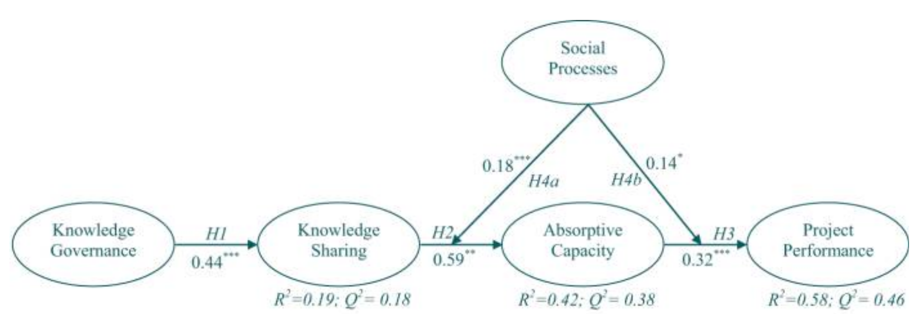
This study follows Hair *et al.* (2017) to evaluate the structural model. All the variance inflation factor (VIF) values for all possible sets of predictor constructs are less than the common threshold of 5-10. This provides confidence that the structural model results are not negatively affected by collinearity. Following the rules of thumb, Figure 2 shows that the R^2 values of knowledge sharing (0.19), ACAP (0.42) and project performance (0.58) exceed the minimum value of 0.1 recommended by Falk and Miller (1992) which shows a satisfactory level of predictability.

Figure 2 shows that the Q^2 values of all the endogenous constructs are considerably above zero, thus providing support for the model's predictive relevance regarding the endogenous latent variables.

The values of path coefficients and weights for the structural model are obtained. The significance levels of the path coefficients and weights are obtained using a bootstrap procedure with a number of 5,000 subsamples and 133 bootstrap cases. Table III provides the path coefficients, *t*-statistics, significance level and *p*-values, as well as the accompanying 95 per cent bias-corrected and accelerated (BCa) bootstrap confidence intervals. An analysis of the direct path coefficients and levels of significance shows that *H1* (β = 0.44***; t = 6.29), *H2* (β = 0.59**; t = 2.69) and *H3* (β = 0.32***; t = 3.90) are accepted.

The moderation hypotheses of the social processes in the path between knowledge sharing and ACAP (*H4a*) and ACAP and project performance (*H4b*) are tested using the two-stage technique (Hair *et al.*, 2017). This approach uses the latent variable scores of the latent predictor and latent moderator variable from the main effects model (without the interaction term) in the first stage. These latent variable scores are saved and used to calculate the product indicator for the second-stage analysis that involves the interaction term in addition to the predictor and moderator variable (Hair *et al.*, 2017). The moderation analysis shows

Figure 2 PLS-SEM results



Note: * $|t| \geq 1.96$ at p 0.05 level; ** $|t| \geq 2.58$ at p 0.01 level; and *** $|t| \geq 3.29$ at p 0.001 level

Table III Significant testing results of the structural model path coefficients

Structural path	*Path coefficient*	t-*value*	*Significance level*	p-*values*	*95% BCa confidence interval*	*Conclusion*
KG → knowledge sharing	0.44	6.29	***	0.00	(0.33, 0.60)	*H1* supported
Knowledge sharing → ACAP	0.59	2.69	**	0.01	(0.15, 0.99)	*H2* supported
ACAP → project performance	0.32	3.90	***	0.00	(0.17, 0.49)	*H3* supported
Social processes → ACAP	0.12	0.87	n.s	0.38	(0.03, 0.62)	
Social processes → project performance	0.43	5.46	***	0.00	(0.28, 0.59)	
Knowledge sharing × social processes → ACAP	0.18	3.89	***	0.00	(0.12, 0.30)	*H4a* supported
ACAP × social processes → project performance	0.14	1.95	*	0.05	(0.01, 0.26)	*H4b* supported

Notes: n.s = not significant; BCa = bias corrected confidence interval; *I t I ≥ 1.96 at *p* 0.05 level; **I t I ≥ 2.58 at *p* 0.01 level; and ***I t I ≥ 3.29 at *p* 0.001 level

that interaction term knowledge sharing by social processes have a significant effect on ACAP, also the term ACAP by social processes have a significant effect on project performance. Therefore, both *H4a* (β = 0.18***; t = 3.89) and *H4b* (β = 0.14*; t = 1.95) are accepted.

To analyze the conditional moderating effects of independent variable on dependent variables at different values of moderating variables, this study uses an inferential test using the PROCESS macro (Hayes, 2013). Taking latent variables scores from SmartPLS 3 as an input, this analysis produces estimates and bias-correlated 95 per cent bootstrap confidence internals for indirect effect as different values of social processes as moderating construct.

After confirming the moderating effect of social processes on the relationship between knowledge sharing and ACAP and ACAP and project performance, this study examines social processes at three levels to determine whether the relationships between knowledge sharing and ACAP and project performance varies at different levels of social processes [Table IV(A)]. These three levels are as follows: the mean (M = 4.22; SD = 0.50), which is equivalent to the average levels of social processes among the sample; the mean minus one standard deviation (−1 SD; i.e. 3.22), which is equivalent to low levels of social processes; and the mean plus one standard deviation (+1 SD; i.e. 5.22), which is equivalent to high levels of social processes. Consistent with *H4a*, Table IV(A) shows that when social processes is low (−1 SD), the conditional effect of knowledge sharing on ACAP is positive but weak and non-significant (β = 0.44, boot SE = 0.31). However, when corporate reputation is high (+1 SD), the conditional effect is both positive and significant (β = 0.77, boot SE = 0.31). These findings support *H4a* such that the positive effect of knowledge sharing on ACAP is moderated by social processes. The effect is stronger when social processes are favorable and weaker when social processes are unfavorable.

Table IV Conditional process analysis

	Path coefficient	*Boot SE*	t-*value (bootstrap)*	*95% Confidence interval*
(A) Conditional effect of knowledge sharing on ACAP at the values of social processes				
Low; M – 1.0038 SD (3.22)	0.44	0.31	1.41	(−0.18, 1.06)
Moderate; M (4.22)	0.61	0.30	1.97	(−0.00, 1.21)
High; M + 1.0038 SD (5.22)	0.77	0.31	2.45	(0.15, 1.40)
(B) Conditional effect of ACAP on project performance at the values of social processes				
Low; M – 1.0038 SD (3.22)	0.22	0.17	1.26	(−0.12, 0.56)
Moderate; M (4.22)	0.32	0.10	3.29	(0.13, 0.51)
High; M + 1.0038 SD (5.22)	0.42	0.11	3.96	(0.21, 0.62)

Note: Values for social processes (moderator) are the mean and plus/minus one standard deviation (SD) from mean

Similarly, applying the same procedures, the findings in Table IV(B) are consistent with *H4b*, which suggest that the positive effect of ACAP on project performance is moderated by social processes. The effect is stronger when social processes are favorable and weaker when social processes are unfavorable. The implications of these results are discussed in the "discussion and conclusion".

4.4 Predictive validity analysis

Understanding that the fit is not a good way of assessing predictive validity (Armstrong, 2012), this study conducts a test for predictive validity of the model. The PLS-SEM analysis demonstrates how well the proposed structural model fits the data. Yet, the model is not indicative of how independent variables predict dependent variables (outcome of interest). In line with previous research (Ali *et al.*, 2016, Ali *et al.*, 2017; Felipe *et al.*, 2017; Salam *et al.*, 2017), this study evaluates the predictive validity through cross-validations tests with holdout samples. Thus, following the approach suggested in Cepeda-Carrión *et al.* (2016), a predictive analysis is performed in this study (Gigerenzer and Brighton, 2009; Woodside, 2013). The predictive validity of the PLS-SEM findings is performed as follows: first, two-thirds of the sample is randomly chosen which is composed of 89 samples as the training set; the remaining 44 samples represent the holdout sample. The training set is used to estimate the parameters in the model. Using the holdout sample, each indicator is standardized, and the construct scores are formed as linear combinations of the respective indicators using the weights obtained from the training sample. The construct scores are standardized. For the project performance of the endogenous construct in the holdout sample, the predictive scores are created by using the path coefficients obtained from the training sample. The correlation between the predictive scores and construct scores is 0.61 ($p < 0.01$), which suggests that the PLS-SEM model has acceptable predictive validity.

4.5 Causal asymmetry analysis

A causal symmetrical relationship in variables means that low values of independent variable *X* associate with low values of dependent variable *Y*, and high values of independent variable *X* associate with high values of dependent variables *Y* (Woodside, 2013). While, asymmetric relationship indicates that high values of independent variable *X* are both necessary and sufficient for high values of dependent variable *Y* to occur and that low values of dependent variable *Y* occur with low values of independent variable *X*. Causal asymmetric relationships imply that different paths lead to outcome of interest, which is not necessary, with the same configuration explaining the non-outcome (Ragin, 2008). Failure to meet causal asymmetric relationships may result in incomplete or even incorrect causal understanding of phenomena under study. Causal asymmetric relationship offers a more detailed picture and allows for rich insights that increase understanding of the complex causal relationships and the effects of causal recipes of high project performance (Ren *et al.*, 2016; Woodside, 2013). One of the ways of testing causal asymmetrical relationships is to analyze the heteroscedasticity (Cepeda-Carrión *et al.*, 2016). Following Wang *et al.* (2016), Table V shows that all the tests for heteroscedasticity are not significant and do not reject the null hypothesis for the project performance. These findings suggest that causal asymmetrical relationship is less of a concern for this study.

Table V Tests for heteroscedasticity (causal asymmetry)

Dependent variable	*Test*	$\chi^2_{(4)}$	p-*value*
Project performance	White's test	3.97	0.86
	Breusch-Pagan test	3.30	0.80
	Koenker test	2.06	0.73

5. Discussion and conclusion

The purpose of this study was to develop and empirically test a conceptual model that seeks to explain how knowledge is directed, created, transferred and applied to improve project performance in PBOs. Broadly, the model posits that the knowledge management process begins with the setting of knowledge-based goals at the PBO level. KG supports the attainment of these goals through policies and incentives designed to promote collaboration and induce a culture of knowledge sharing at all levels within the organization. This, in turn, leads to the development of a project's ACAP, i.e. its ability to acquire, assimilate, transform and exploit relevant internal and external knowledge. A high level of ACAP allows projects to anticipate potential opportunities and challenges. Such projects proactively seek, obtain and use relevant knowledge to exploit opportunities and address challenges, thereby improving project performance. Furthermore, the model emphasizes the role of social processes in:

- facilitating the translation of knowledge sharing practices into ACAP; and
- enabling the project organization to leverage its ACAP to improve project performance.

KG was found to be a significant predictor of knowledge sharing practices within projects, thereby supporting the findings of Cao and Xiang (2012) and Pemsel and Müller (2012). The results shed light on the crucial role of KG in steering the knowledge management efforts at the project level and, more broadly, at the PBO level (Pemsel *et al.*, 2016). KG practices are both functional, in that they help break down barriers to collaboration while enabling and incentivizing knowledge sharing, and symbolic, in that they signify the top management's commitment to a culture of open knowledge exchange within the organization. Hence, effective KG is a vital pre-requisite for effective knowledge sharing.

Knowledge sharing was found to have a significant positive effect on ACAP, which supports the findings of Bosch-Sijtsema and Henriksson (2014) and Krstić and Petrović (2012). Furthermore, the results strongly suggest that an increase in ACAP leads to an improvement in bottom-line project performance, which support the findings of Popaitoon and Siengthai (2014), Biedenbach and Müller (2012), and Tsai (2001). Because of the complexity and dynamism that is inherent to software projects, a high level of ACAP enables project management to anticipate and adapt to changes in the external environment.

While knowledge sharing is a process, ACAP may be viewed as an organizational competency that enables it to identify, acquire and leverage relevant knowledge to support the attainment of organizational objectives. Projects with mature knowledge-sharing practices and processes would be more conscious of potential opportunities and challenges and, therefore, would be more likely to proactively seek new knowledge to fill any existing knowledge gaps. Hence, knowledge-sharing practices lead to the development of an organization's ACAP (Krstić and Petrović, 2012). The findings support the notion that knowledge sharing in itself does not directly lead to improved project performance but rather serves to build the project's ACAP. This, in turn, leads to improved project performance (Bakker *et al.*, 2011; Biedenbach and Müller, 2012).

Furthermore, the results indicate that projects wherein teams are engaged in a high level of social processes are more likely to develop a higher level of ACAP through knowledge sharing. In this study, social processes refer to the level of familiarity, communication, proximity and trust between project team members (Akgün *et al.*, 2005). While formal, IT-based knowledge-sharing systems are useful for collecting and disseminating relevant information; social processes are more effective in generating social capital among project team members, thereby greatly improving the intensity and efficacy of knowledge-sharing practice (Tsai, 2002). Social processes are also a more practical means of knowledge sharing, as the hectic and time-constrained environment of projects makes it tedious for team members to sift through large databases. Additionally, social interactions between project team members help to create a "shared reality" (Jackson and Klobas, 2008) where members are better able to understand and absorb communicated knowledge (Yli-Renko *et al.*, 2001). As a result, team members may be more likely to achieve a consensus on which external knowledge is worth pursuing and how this knowledge may be exploited to benefit the project.

Additionally, the findings indicate that social processes do not have a direct impact on ACAP but they significantly increase the likelihood of translating high levels of ACAP into high levels of project performance. This is interesting for two reasons. First, it suggests that the effect of social processes on ACAP is indirect and occurs only by intensifying the effect of knowledge sharing on ACAP. If project team members do not engage in knowledge-sharing practices, social processes have no effect on ACAP. Second, in line with our theoretical arguments, it suggests that social processes enable the translation of higher ACAP into improved project performance. Therefore, it is argued that social processes are a vital component of the knowledge management model. This is further evidenced by the significant positive effect of social processes on project performance.

5.1 Implications for practice and theory

The findings of this study have various practical implications for PBOs in the IT/software sector. First, the findings make the case for PBOs to adopt a proactive approach of identifying and targeting relevant knowledge areas and developing a set of strategically aligned objectives for knowledge creation. These objectives should be supported by an appropriate KG strategy that facilitates their achievement through formal mechanisms, such as policies and incentives, as well as informal mechanisms, such as access to knowledge sources and fostering trust through team-building exercises (Pemsel *et al.*, 2014). Furthermore, an effective KG strategy should strive to create a supportive organizational culture that encourages and rewards knowledge sharing. This may be achieved through an affirmation of top management commitment to continuous learning and the adoption of open, receptive and transformational leadership practices by project managers (Pinho *et al.*, 2012). Beyond these general guidelines, the appropriate form of KG strategy depends on the contextual factors of the PBO. The typology of KG strategies developed by Pemsel *et al.* (2016) presents some guidelines for formulating an effective strategy.

Second, the findings suggest that project team members should not only share their own knowledge but also facilitate access to their informal knowledge networks and communities of practice. Essentially, this view of knowledge sharing adopts a proactive, outward-facing approach that constantly reevaluates internal knowledge in light of external knowledge with the aim of improving the project organization's knowledge stock, in accordance with its knowledge-based goals. Such an approach would facilitate the development of the project's ACAP and enable it to steer through the obstacles inherent in the dynamic project environment.

Finally, this study advocates the facilitation of social processes between project team members as a means of boosting the intensity and efficacy of project knowledge management processes. This can be achieved by encouraging interactions, enabling formal and informal communications, positioning the team members in close proximity to one another and encouraging team members to participate in trust-building exercises. Additionally, the development of "knowledge communities" can help facilitate knowledge exchange. These communities are designed to "...share knowledge interactively, often in non-routine, personal, and unstructured ways" to improve business performance (Earl, 2001). An added benefit is the possibility of extending these communities beyond the boundaries of the PBO to form mutually beneficial links with subcontractors, specialist groups and possibly even the client.

From a theoretical standpoint, the findings of this study emphasize the pivotal role of KG practices, which both directly and indirectly influence an organization's knowledge management processes and outcomes. However, research on this topic is limited and various gaps exist in the literature, especially in the context of projects and PBOs (Pemsel *et al.*, 2016). Hence, KG offers a rich and important avenue of research that can reveal potentially profound insights that are relevant across multiple disciplines, such as strategic management, organizational learning and organizational behavior. Furthermore, we posit that KG is of particular importance to the project management discipline, where increasing levels of uncertainty, complexity and a rapid pace of change demand a disciplined and structured approach to direct knowledge management practices.

A second theoretical implication of this study is that knowledge-sharing practices do not directly impact project performance but rather lead to the development of the project's ACAP by facilitating the free-flow of information within and between organizations. This, in turn, allows the project to be more responsive to opportunities and challenges, hence improving project performance. The results suggest a need to look beyond knowledge processes and toward organizational knowledge capabilities, particularly how such capabilities are developed and how they mature over time.

Finally, the findings of this study shed light on the important role played by the social processes of familiarity, communication, proximity and trust in translating knowledge-sharing practices into ACAP and, subsequently, into improved project performance. This implies that a mechanistic approach to knowledge sharing is not sufficient in developing and leveraging a project's ACAP. Social interactions and the development of social capital between organization members are important considerations in developing an effective knowledge management system.

5.2 Limitations and future research directions

A fundamental limitation of this study arises from the use of a quantitative research design, thereby limiting its ability to explore in greater detail the complex interrelationships between the constructs under study. Second, the use of a self-reported questionnaire also presents various opportunities for bias in the data. To minimize this, multiple approaches were used including explicitly assuring respondent anonymity, providing explanations of key concepts in the questionnaire cover page and using standard data screening practices to remove unengaged and unusable responses. Furthermore, the scales used in this study were sourced from existing publications in reputable journals. Third, as the sample used in this study consists exclusively of IT/software organizations in Pakistan, the results may have limited generalizability in other organizational and geographical contexts. However, an effort was made to develop a theoretically grounded model and it is hoped that the proposed relationships should be stable in other contexts as well.

Future research may examine in greater detail the concept of KG in the context of PBOs. Specifically, how KG strategies are implemented and how they vary based on project characteristics, such as level of complexity and duration of the project. Additionally, it may be fruitful to investigate the interplay of ACAP at the project level, the PBO level and, if applicable, the parent organization level. Also, while this study examined the role of social processes in the relatively collectivistic culture of Pakistan, future studies may compare these findings with those from more individualistic national cultures to see if similar conclusions are reached. Furthermore, because of the complexity of the concepts under study, qualitative research designs would be useful to explore the intricacies of each of the proposed relationships in the model. Finally, future studies may test the proposed model of knowledge management in different project industries and different countries, with an emphasis on how the role of social processes varies according to these contexts.

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Appendix. Questionnaire items used

Questionnaire items (five-point Likert scale: 1 "strongly disagree"; 5 "strongly agree")

Knowledge governance (Statistics Canada, 2001)

Policies and strategies

1. My organization has a written knowledge management policy or strategy.
2. My organization has a values system or culture intended to promote knowledge sharing.
3. My organization has policies or programs intended to improve worker retention.
4. My organization uses partnerships or strategic alliances to acquire knowledge.

Incentives and control

5. My organization rewards knowledge sharing with monetary incentives.
6. My organization rewards knowledge sharing with non-monetary incentives.
7. In my organization, knowledge management practices are a responsibility of the team members.
8. In my organization, knowledge management practices are explicit criteria for assessing team members' performance.

Knowledge sharing (Wang et al., *2008*)

1. We have systems and venues for people to share knowledge and learn from each other in the company.
2. We share information and knowledge with our superiors.
3. We share information and knowledge with our subordinates.
4. We often share ideas with other people of similar interest, even if they are based in different departments.
5. There is a great deal of face-to-face communications in our company.
6. We use information technology to facilitate communications effectively when face-to-face communications are not convenient.
7. We use information technology to access a wide range of external information and knowledge on competitors and market changes, etc.
8. Through sharing information and knowledge, we often come up with new ideas that can be used to improve our business.
9. We have networks of sharing knowledge with other organizations on a regular basis.
10. People are encouraged to access and use information and knowledge saved in our company systems.

Absorptive capacity (Popaitoon and Siengthai, 2014)

Potential ACAP – acquisition

1. Our project has frequent interactions with corporate headquarters to acquire new knowledge.
2. Members of our project regularly visit other units/departments.
3. We collect industry information through informal means (e.g. lunch with industry friends, talks with trade partners).
4. Our project periodically organizes special meetings with users/customers or third parties to acquire new knowledge.
5. Project members regularly approach third parties such as accountants, consultants, or tax consultants.

Potential ACAP – assimilation

6. New opportunities to serve our clients are quickly understood.
7. We quickly analyze and interpret changing market demands.

Realized ACAP – transformation

8. Our project regularly considers the consequences of changing market demands in terms of new products and services
9. Project members record and store newly acquired knowledge for future reference
10. Our project team quickly recognizes the usefulness of new external knowledge to existing knowledge.
11. Project members hardly share practical experiences.
12. We laboriously grasp the opportunities for our project from external knowledge.
13. Our project periodically meets to discuss consequences of market trends and new product development

Realized ACAP – exploitation

14. It is clearly known how activities within our project should be performed.
15. Users complaints fall on deaf ears in our project
16. Our project has a clear division of roles and responsibilities.
17. We constantly consider how to better exploit knowledge.
18. Project team has a common language regarding our products and services.

Social processes (Akgün *et al.*, 2005)

Familiarity

1. I knew the other members of my team (on average), at the time our project team was formed.
2. I had interaction with the other members of my team (on average), at the time our project team was formed.

Communication

3. Team members conducted frequent formal communications through team meetings with fellow project team members.
4. Team members conducted frequent formal communications through memos with fellow project team members.
5. Team members conducted frequent informal communications at water cooler/tea table with fellow project team members.
6. Team members conducted frequent informal communications at launch or after work with fellow project team members.

Proximity

7. The core team members were located within a short walk of each other.
8. The core team members were located so close to each other that they could talk to one another without using a telephone.

Trust

9. Most of my teammates approach his/her job with professionalism and dedication.
10. I see no reason to doubt my teammates' competence and preparation for the job.

11. I can rely on other teammates not to make my job more difficult by careless work.
12. Most of my teammates can be relied upon to do as they will to do.
13. I can talk freely to my team about difficulties I am having at work and know that my team will want to listen.
14. If I share my problems with my team, I know she/he would respond constructively and caringly.
15. I would have to say that we (my team) have made considerable emotional investments in our working relationship.

Project performance (Popaitoon and Siengthai, 2014)

1. Our project is meeting operational specifications.
2. Our project is meeting technical specifications.
3. Our project is meeting time goals.
4. Our project is meeting budget goals.
5. Our project is fulfilling client needs.
6. Our client is satisfied with the project's performance.