The impacts of absorptive capacity on improving software development: A preliminary study

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Abstract - Because information systems implementations depend on software development exercise, software process improvement (SPI) plays a critical role in the development of information systems. SPI is considered as an organizational learning process; it often needs external know-how and know-what that provide useful information and inspiration in implementation ad-hoc software processes. However, no research exists that focuses on a firm’s ability to increase effective external SPI knowledge acquisition and utilization. Based on the dynamic capability theory, this paper attempts to explore how a firm’s dynamic capability significantly affects SPI implementation success.

The entire research consists of the exploration of related literature, the definition of and development of hypotheses and the research model, and the empirical investigation with new knowledge inquiry. This paper serves as a preliminary study of the research that focuses on the survey of relevant literature to support the research motivation and the model. Also, in this paper, a theoretical model draft and the hypotheses are developed to guide the following research of exploring and investigating the relationships between absorptive capacity and SPI success.

Keywords: Software process improvement (SPI); Capability maturity model integration (CMMI); Dynamic capability; Potential absorptive capacity (PAC); Realized absorptive capacity (RAC)

1 Introduction

Software process improvement (SPI) is particularly important for firms or business units as it enhances and sustains their competitive advantage in the business market. SPI is a complex and continually improving software processes program. Specifically, SPI is knowledge-intensive for firms, and the implementation of SPI often requires innovation and critical thinking to supplement original knowledge of software development with external knowledge. Therefore, SPI implementation often relies on SPI knowledge [4], skills, expertise, experiences, methodologies, and technical support from external sources (e.g. external mediating institutions such as SPI consulting firms and vendors, external knowledge bodies such as Capability Maturity Model Integration (CMMI), or the International Standards Organization (ISO)) to deal with challenges that arise during SPI implementation [6].

In both practice and theory, SPI is commonly recognized as an organizational learning process [4] because SPI implementation requires significant SPI knowledge and experiences from external sources, and employees must internalize these lessons [11]. During the learning process, the gap between the acquisition and the use of the acquired SPI knowledge within a firm is an important issue [18]. The gap exists when a company receives external knowledge without the capability of using it. However, the benefit may still exist in projects, since project members who have been educated with the new knowledge are able to tailor the organization’s standard processes even though the new knowledge is not built in the standard processes. To achieve the expected SPI goals and receive the benefits due to the SPI implementation, the acquisition and utilization, be it at the project level or the organizational level, of SPI knowledge is required during SPI implementation. However, few SPI studies have focused on a firm’s ability to acquire and utilize SPI knowledge to successfully implement SPI.

In literature, the concept of dynamic capability refers to a firm’s latent abilities to renew and adapt its core competency over time [23, 26]. Further, Zahra and George [29] extend dynamic capability to include absorptive capacity (AC), which represents a firm’s dynamic ability to acquire, assimilate, and apply knowledge from external sources. Moreover, scholars have noted that AC can be considered as a specific organizational learning process for the learning, implementing, and disseminating of external knowledge internally to strengthen, complement, or refocus on the knowledge mechanisms [9, 17, 22, 26]. In other words, AC assists firms in achieving positive outcomes, such as intra-organizational knowledge transfers [3], inter-organizational learning [28], and information technology (IT) and information systems (IS) implementation [2, 14, 19, 21].

To address a firm’s ability to acquire and utilize SPI knowledge, this study focuses on the two categories of AC developed by Zahra and George [29], that is, potential absorptive capacity (PAC) and realized absorptive capacity (RAC), and investigates how these may influence SPI success. In this study, PAC refers to a firm’s ability to identify, embrace, and assimilate external knowledge. On the other
hand, RAC represents a firm’s ability to leverage newly absorbed knowledge and incorporate transformed knowledge into the development of innovation processes and operations [7]. Accordingly, insight into a firm’s PAC and RAC is required for understanding how SPI knowledge acquisition and utilization affects SPI success.

Therefore, we are to explore how AC influences the success of SPI. Specifically, we address three research questions: (1) how PAC influences the success of SPI implementation within firms, (2) how RAC influences SPI success within firms, and (3) how PAC and RAC interrelate for SPI success. To answer these questions, this study proposes a research model that links PAC, RAC, and SPI success.

2 SPI Success

SPI helps firms integrate traditional organizational functions, and sets process improvement goals and priorities that update existing process systems to improve organizational performance [20]. SPI has played a critical role in helping firms achieve various business benefits. For example, SPI improves product quality, reduces the time to market, leads to better productivity, and reduces costs. To realize these benefits, the effective implementation of SPI requires effort and time, careful scheduling, resources, and suitable and useful knowledge [11, 13]. Decisions about SPI implementation are influenced by organizational factors, and several studies have analysed the critical success factors for SPI [13, 15].

In literature, Dyba [4] validated a theoretical model of SPI success factors and proposed an operational definition of the variables of SPI success. The study suggested that SPI success is defined by two indicators: improved organizational performance and the perceived level of SPI success, which includes cost reduction, decreased cycle time, and increased customer satisfaction. Dyba’s theoretical model of SPI success factors has been applied in various studies. For example, Winter and Ronkko [28] investigated product usability metrics by adopting Dyba’s SPI success factors. Egorova et al. [5] evaluated the effect of software engineering practices for industrial projects based on Dyba’s work. In this study, we adopt Dyba’s definition of SPI success as the dependent variable in the proposed model.

Prior studies have provided insight into identifying critical success factors for SPI. In spite of this, there is little or no research that focuses on how a firm’s learning ability are placed to increase effective external SPI knowledge acquisition and acquired SPI knowledge utilization. To close this SPI knowledge gap, a firm’s SPI knowledge activities in the context of SPI success should be investigated further. Therefore, this study adopts absorptive capacity (i.e. PAC and RAC) as the explanatory knowledge mechanism to investigate how organizational learning impacts SPI success.

3 Absorptive capacity

In literature, AC has played a critical role in ad-hoc investigation of IT and IS implementations [17]. According to the literature, AC was originally defined as a firm’s ability to recognize the value of new, external information, assimilate it, and apply it to commercial ends [3]. AC also implies learning and acting in discovering scientific and technological activities outside the organization’s limits [8]. It enables firms to gain superior organizational performance, innovation capability, and competitive advantage [9, 10].

Recently, Roberts et al. (2012) suggested several assumptions that underlie AC. First, AC depends on prior related knowledge. With some prior related knowledge, a firm can correctly select valuable and useful external knowledge. Second, an organization’s AC depends on the AC of its individual members, which form a mosaic of individual capabilities. AC is firm-specific and embedded in the knowledge structures of a particular firm; hence, AC cannot easily be purchased. Third, accumulating AC is essential for efficiently utilizing the knowledge needed to face technological and market turbulence. In literature, AC is treated as a dynamic capability and a firm’s AC affects its ability to reconfigure its existing substantive capabilities (Zahra and George, 2002; Jansen et al., 2005). According to the dynamic capability theory (Teece et al., 1997), Van den Bosch et al. [25] deemed AC as a high-level organizational ability. Zahra and George [29] further divided AC into PAC and RAC and distinguished the four dimensions of AC as being acquisition, assimilation, transformation, and exploitation.

Specifically, each of the dimensions is considered a capability that together produce AC, a dynamic capability of the organization [22], and these dimensions explain how AC influences a firm’s knowledge mechanisms. Acquisition refers to a firm’s ability to identify, acquire, and value external knowledge that is critical to operations. Assimilation refers to a firm’s ability to analyse, process, interpret, and understand external knowledge. PAC enables a firm to be receptive to external knowledge and focus on the acquisition and assimilation of new external knowledge [29]. Transformation is a firm’s ability to combine existing knowledge and the newly acquired and assimilated knowledge for future use. Exploitation refers to a firm’s ability to integrate acquired, assimilated, and transformed knowledge into its operations to develop new processes, routines, operations, and systems. RAC enables a firm to transform and exploit the knowledge that has been absorbed [29].

As mentioned earlier, PAC and RAC can be performed as two separate, yet complementary, roles of AC in facilitating the use of new external knowledge [26, 29]. PAC is regarded critical because it enables a firm to make sense of and respond to its external business environments and challenges, enabling firms to adjust to change, explore new methods, and reshape
their knowledge base. Conversely, RAC is an essential foundation for forming and performing innovation [7]. From the organizational point of view, firms cannot exploit and apply knowledge without first acquiring it. Likewise, firms may have the capacity to acquire and assimilate external knowledge, but may not have the capacity to transform and exploit it into operations that enhance performance [29]. Besides the traditional concept that considering PAC and RAC as a whole, in this research, we are also to explore the possibility if PAC and RAC contributes to SPI success individually.

In literature, the effect of AC on organization’s technological adoption and implementation has been an important subject. Many reports have demonstrated the importance of AC in IT and IS deployment and implementation. For example, Harrington and Guimaraes [8] indicated that AC establishes an external communication channel to gather useful knowledge that influences the implementation of new technologies. Srivardhana and Pawlowski [21] developed a theoretical framework to analyse AC that enables organizations to build new capabilities in creating and deploying enterprise resource planning (ERP) knowledge. Also, Saraf et al. [19] investigated the relationship between PAC and RAC in the assimilation of ERP systems and found that both PAC and RAC positively and directly impact ERP assimilation.

Although AC has been used in the IS/IT domain, it has not been addressed for the field of SPI, which is a critical and challenging task that enables the success of the aforementioned IT/IS development. Some previous studies have highlighted that the concept that SPI implementation depends on external prerequisites and essential SPI knowledge [12]. Therefore, this study considers that the role of AC is more pronounced when examining successful SPI implementation. Thus, we expect that AC as a firm’s dynamic capability is relatively critical for SPI success. In the following section, we further review more literature to derive and develop the research hypotheses.

4 Hypotheses Development

Based on the dynamic capability theory [23] and considering the definition of AC, AC can facilitate organizations to focus on mechanisms of external knowledge. Vega-Jurado et al. [26] highlighted two important aspects that differentiate PAC and RAC. First, it is difficult to define a global measurement system because of the complex nature of AC and the organization’s functional structure and arrangement. For example, PAC may be mastered by some educational units in an organization, while RAC is often performed by the (software) process group (EPG or SEPG) (SEI, 2010), since the group’s job is to design and maintain organization’s standard processes, in which new knowledge is applied. Based on such an organization’s functional design, PAC and RAC may be performed and reviewed separately. Second, even though PAC and RAC are interrelated, their distinct effects should be examined separately. In other words, PAC emphasizes what we have learned; while RAC focuses on how the organization is improved by the learned knowledge. Therefore, our work focuses on the effects of PAC and RAC on SPI success, respectively. In the next paragraphs, the operational mechanisms of PAC and RAC are further elaborated respectively as follows.

In the context of SPI implementation, PAC begins with gathering the idiosyncratic SPI knowledge from external sources (i.e. SPI consulting firms and vendors). This facilitates identifying, acquiring, and evaluating external knowledge to determine what is compatible, suitable [29], and critical to the needs of SPI. Additionally, the question of how the acquired SPI knowledge is to coordinate with a firm’s specific characteristics (e.g. technology, business strategy, people, and process) should be considered. In the next stage of PAC, assimilation enables a firm to analyse, interpret, and comprehend externally acquired SPI knowledge, and then disseminate the useful knowledge through the organisation. PAC exposes a firm to the external valuable SPI knowledge [26] used to stimulate improvement opportunities for software processes, routines, and operations. When learning from external sources, firms must be able to obtain and identify the external knowledge and translate it into ‘local language’. PAC enables a firm to renew the knowledge base which is necessary for SPI, and increase the SPI knowledge acquisition required to implement improvements. Therefore, PAC likely leads to SPI success. Thus, we hypothesize that:

Hypothesis 1: PAC has a positive influence on SPI success.

In the entire learning operation of AC, RAC refers to the knowledge internalization by transforming and exploiting the acquired external SPI knowledge [29]. Transformation is regarded as the synthesis and integration of a firm’s existing knowledge with the newly acquired and assimilated SPI knowledge. The internal SPI knowledge may be synthesized by the addition or elimination of knowledge, or by the conversion of external knowledge, with consideration of the firm’s specific characteristics. Transformation also ensures that the synthesized knowledge is effectively and extensively transferred across the firm [8]. In the next stage, exploitation facilitates the transformed SPI knowledge to be incorporated into a firm’s internal processes, operations, and routines for aligning and articulating the firm’s SPI goals [1]. For example, a company may transfer the how-to-do from other company’s implementation into its software process. Without RAC, organization may not receive a holistic benefit since the newly acquired knowledge is not able to be built into the company’s processes and routines. Therefore, RAC seems critical to SPI success. Thus, we hypothesize that:

Hypothesis 2: RAC has a positive influence on SPI success.
Zahra and George [29] argued that external knowledge may not be transformed and exploited until it has been acquired and assimilated. Further, SPI is often aided by external knowledge [16]. As discussed, the development of AC might enhance SPI knowledge acquisition and utilization, and the implementation of SPI first requires effective acquisition of external knowledge (i.e. PAC). However, external knowledge cannot affect SPI success if the mechanism to transform and embed the absorbed knowledge into the firm’s real processes, operations, and routines is not established (i.e. RAC). Thus, PAC is the first step to acquiring external SPI knowledge and RAC is the next logical step to exploit the new SPI knowledge. We therefore assume that RAC would mediate the relationship between PAC and SPI success. Thus, we hypothesize that:

Hypothesis 3: RAC mediates the relationship between PAC and SPI success.

Based on the aforementioned literature review and hypotheses, we are proposing a theoretical model that integrates PAC, RAC, and SPI success, as shown in Figure 1. Based upon this model foundation, we are then to further explore the variables that significantly impact the model to comprehend the entire model, as well as to conduct an empirical investigation to test the proposed research model and hypotheses accordingly.

Figure 1. The proposed theoretical model.

5 Conclusions: what is next?

As the business environment becomes increasingly dynamic, many organizations have adopted SPI to achieve superior organizational performance. The pursuit of organizational performance relies on the organization’s learning ability to acquire, process, and comprehend knowledge. In this paper, we have highlighted the importance of potential and realized absorptive capacity and have developed a draft of the theoretical research model to understand how organizational learning and its mechanisms, in terms of PAC and RAC, facilitate SPI success. It is hoped that through the discussion venue of this prestigious conference, valuable comments and suggestions can be obtained for helping the development of the model in the next research stage.

In the next stage of research, we are to complete the development of the proposed research model, and to test and verify the model. An empirical investigation will be conducted in the following study. We will further use a survey method for data collection in SPI-certified Taiwanese firms and examine the hypotheses using the statistical technique of partial least squares (PLS). PLS has commonly used in the IS literature. PLS is supposed to be distribution-free (i.e., the estimation is not affected by the complexity of the model, small sample size, or nonnormality of the data). Furthermore, PLS is also orthogonal and overcomes multicollinearity problems [24].

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6 References


