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Abstract

Digital innovation is characterized by generativity, in which digital technologies act upon other technologies, products, services, or processes to generate innovations. Because of generativity, digital innovation should be understood as involving multiple events that could be associated with changes in the process and outcome of IS and business activities. Drawing upon Swanson's (1994) tri-core model of IS innovation, this study argues that digital innovation could entail innovative IS activities in the functional IS, business administration, and business technology areas. Since these areas rely differently upon innovative digital technologies, this study suggests that organizations should pursue IT exploitation and IT exploration simultaneously in order to improve digital innovation capability.

Keywords: Digital innovation, IT ambidexterity, tri-core model of IS innovation

Introduction

The advances in hardware, software, and networking technologies make it possible to digitize virtually all kinds of products, services and business processes nowadays. Digitization refers to the practice of transforming objects, content, or processes that used to be primarily physical into new forms that are primarily digital (Fichman et al. 2014). Because modern digital technologies possess affordances of reprogrammability, homogenization of data, and self-referentiality, digitization can make physical products, services, and processes become more programmable, addressable, sensible, communicable, memorable, traceable, and associable (Yoo et al. 2010). In turn, organizations are allowed with more opportunities to innovate by entangling physical materialities with software-based digital capabilities (Yoo et al. 2012). Such new possibilities to change are referred to as digital innovations (Fichman et al. 2014), in which digital technologies serve as operant resources that act upon other technologies, products, services, or processes to generate innovations (Nambisan 2013; Vargo and Lusch 2004). This is in contrast with traditional IT/IS innovations, in which digital technologies play the role of operand resources that organizations act upon to obtain support for generating innovations (Nambisan 2013). Such difference leads to new challenges that organizations need to address (e.g., Nylén and Holmström,2015).

Yoo et al. (2012) indicate that the affordances of digital technologies produce innovations with the characteristics of generativity. Generativity means that digital technologies and innovations are

inherently dynamic and malleable. With reprogrammability, for instance, digital technologies permit procrastinated binding of new digital capabilities to digital innovations. Besides, a digital innovation could essentially be encompassed or intertwined with multiple forms of or other digital innovations. For example, Boland et al. (2007) found that the adoption of digital 3D representations for architectural design and construction should not be understood as a singular innovation event. Instead, it involves changes in the relationships, work practices, organization structure and strategies that are stimulated by various aspects of the 3D technologies. Thus, organizations that engage in digital innovations are not merely faced with the challenge of adopting and diffusing a homogeneous and standardized ICT-enabled innovation. Furthermore, they could be involved in the adoption, assimilation or even creation of heterogeneous digitized artifacts and processes (Fichman et al. 2014). Therefore, this study argues that organizations need to adopt a more holistic view to examine digital innovations that could encompass interdependent and yet distinctive constituents (Yoo et al. 2012).

IS scholars have studied IS/IT innovations for over three decades. Earlier endeavors focus on examining the organizational impact of digital technologies adoption. Thus, a number of typologies have been proposed to describe what aspects of organizational innovation are supported or enabled by digital technologies, such as product vs. process and product/service vs. administrative vs. technical innovations. Swanson (1994) suggests a tri-core model of IS innovation, which asserts that IS innovations encompass the (functional) IS core, the (business) technology core, and the (business) administration core. The merit of the tri-core model is that it distinguishes innovations occurred at the business and the IS functional level, in which business-level IS innovations are argued to be mediated through IS product/service innovations provided by core IS function. In addition, business-level IS innovations are qualitatively distinguished into technological and administrative dimensions. Thus, the tri-core model enables a more comprehensive and precise understanding regarding the loci of occurrence of and the potential interrelationships among various IS innovations. Accordingly, this study contends that the tri-core model offers a more holistic view to examine the interdependent and yet distinctive constituents of digital innovations.

Further, the above discussions suggest that accomplishing digital innovations requires organizations to perform activities that focus on innovating both digital technologies and business technologies/administrations. March (1991) distinguishes innovation activities into exploitation and exploration. Exploitation refers to "the use and development of things already known," while exploration means "the pursuit of new knowledge" (Levinthal and March 1993: 105). Accordingly, this study proposes IT exploitation as the construct to capture that organizations engage in the use and development of existing digital technologies. Besides, IT exploration is proposed as the construct capturing that organizations engage in pursuing new digital technologies. This study argues that innovating digital technologies requires IT exploration, while IT exploitation is enough for digital technology-based business technology/administration innovations. Therefore, both IT exploitation and IT exploration are necessary for organizations to achieve digital innovations. IT ambidexterity thus is proposed to capture the simultaneousness of pursuing IT exploitation and IT exploration (e.g., Jansen et al. 2008; Lee et al. 2015). These discussions lead to our research question that: Whether IT ambidexterity positively affects digital innovation capability?

Literature Review

The Tri-core Model of IS Innovation

The tri-core model identifies three types of IS innovation that capture innovation activities occurred in the functional IS core (Type I) as well as in the business administration (Type II) and technology cores (Type III) via IS products and services (Swanson 1994; Grover et al. 1997). Type I innovation constitutes an IS process innovation, while Type II and III innovations involve IS products in the service of business administrative process and core business products and processes. Type I IS innovations refer to process innovations restricted to the IS function, including innovations in administrative support (i.e. IS administrative process innovation) and in technical aspects (i.e. IS technological process innovation) of IS activities. Type II IS innovations involve applying IS products and services to the organization's business administration activities (i.e. IS product and business administrative process innovation). Type III IS innovations entail the integration of IS products and services with the organization's core business technology. There are three subtypes, including IS product and business technological process innovation, IS product and business product innovation, and IS product and business integration innovation.

The merit of the tri-core model is that it incorporates both the pull-side and push-side IS innovations (Lyytinen and Rose 2003). Specifically, earlier scholars focused primarily on studying pull-side IS innovations. IS innovation was conceptualized as innovation in the application of digital technologies (Swanson 1994). The viewpoint of innovation diffusion thus was drawn upon by past IS innovation research, assuming that a pull-side demand drives adopters' IS innovation behaviors. Accordingly, the "organizational dimension" of IS innovation, such as new forms of work, business processes or administration procedures that attract the application of digital technologies, was the major concern of early researchers. This bias can be found in early typologies of IS innovation. However, IS innovation may cover additional activities such as using new technologies or methods to producing or delivering IS products and services. Such innovation activities focus on reshaping the content, scope, and organization of IS tasks, which are more associated with digital technologies or processes. Moreover, innovations in new digital technologies or processes could be the forces pushing the realization of certain ICT-based organizational innovations (e.g., Lyytinen and Rose 2003). As such, the functional IS core proposed by Swanson (1994) fills the void of push-side IS innovation in the literature.

The inclusion of push-side IS innovation also allows for examining potential interrelationships among distinctive IS innovations, because pull-side and push-side are often adopted in ensembles in cascading way (Lyytinen and Rose 2003). For instance, Fishman et al. (2014) indicate that, in order to make digitally animated feature films come alive (i.e., IS product and business product innovation), Pixar developed a technology called Renderman to help create 3D images (i.e., IS technological process innovation) and has constantly pushed the envelope on the production process of those films (i.e., IS product and business technological process innovation). This example illustrates that an individual IS innovation type could be intertwined with others in important ways. Similar possibilities have been suggested by Swanson (1994), which posits that strong-order and weak-order effects exist among IS administration/technology process, business administration/technology process, business product, and business integration. Carlo et al. (2011) also find the strong-order effects that base innovation (i.e., IS technological process innovation) affects service innovation and process innovation as well as that service innovation partially mediates the impact of base innovation on process innovation. Therefore, it is possible that the same firm can engage in all three cores of IS innovation. Because the tri-core model allows us to identify interdependent IS innovation types in a more comprehensive way, this study determines to adopt it as the foundation to conceptualize the notion of digital innovation.

IT Ambidexterity

Ambidexterity is defined by March (1991) as the capacity to exploit and explore simultaneously. Originally, exploitation refers to using and refining existing knowledge and exploration refers to pursuing new knowledge (Levinthal and March, 1993). Then, the concepts are extended to areas other than organizational learning. For example, Lavie et al. (2010) contend that to the extent that an organization persists within an existing technological trajectory and leverages its existing skills and capabilities, its operations are geared toward exploitation; on the other hand, they assert that exploration entails a shift away from an organization's current technological or product-market trajectories. In essence, exploration is associated with search, discovery, and embracing variance while exploitation is related to efficiency, increasing productivity, and variance reduction (O'Reilly and Tushman 2008). Since exploitation is oriented toward enhancing an organization's adaptability to current environment, it is expected to generate predictable benefits in the short run (March 1991). By contrast, exploration has been shown to contribute to a firm's long-term performance, as it aims to enhance an organization's future adaptability (Auh and Menguc 2005). Due to their differential performance effects, it is advocated that organizations need to engage in sufficient exploitation and exploration in order to achieve superior and sustained performance. Otherwise, stressing exclusively exploitation or exploration may cause firms to be caught by the competence traps or endless downward cycles of search, failure, and unrewarding change (Levinthal and March 1993). Accordingly, the notion of ambidexterity is proposed, capturing the ability of balancing exploitation and exploration (March, 1991; Gupta et al., 2006).

Based on the above literature, IT ambidexterity is defined as simultaneousness of IT exploitation and IT exploration. IT exploitation refers to the utilization of digital technologies and processes that have been adopted by the organization to develop information systems (Lee et al., 2015). Because existing digital technologies and processes are proven and more reliable, they can improve the efficiency of IS development. IT exploitation thus permits developing information systems more rapidly due to the benefits of reusing developed digital artifacts. IT exploration refers to acquiring or experimenting new

digital technologies and processes to develop information systems (Lee et al., 2015). New digital technologies and processes introduce novelty and flexibility in IS development. Therefore, the activities to diffusing new digital artifacts and methods could facilitate developing more varied IS products and services (Fichman, 2004). Like organizational ambidexterity that is posited to have positive impact on various performance outcomes (Raisch and Birkinshaw, 2008), recent research suggest that IT ambidexterity improves organizational agility by facilitating greater operational ambidexterity (Lee et al., 2015). The finding also corroborates the idea that the balance between exploitative and exploratory IT activities is helpful to produce desired performance outcomes of the IT activities.

Research Model

According to Swanson' (1994) tri-core model, digital innovation capability is conceptualized as the capacity of an organization to conduct three areas of innovative IS activities: functional IS, business administration, and business technology. Functional IS Innovation involves changes in technological and administrative processes of IS development (Carlo et al. 2010; Grover et al. 1997; Lyytinen and Rose 2003). It covers changes in technologies, tools, techniques, methodologies, or administrative principles that are deployed to analyze, design, and implement information systems. Examples include the adoption of new IT platforms, system analysis and development methods/tools, or CIO. Business administrative IS innovation refers to changes in the organization's administrative functions by means of adopting new IS products or services (Carlo et al. 2010; Grover et al. 1997; Lyytinen and Rose 2003). Examples include the adoption of accounting systems, EIS, or business intelligence applications. Business technological IS innovation entails changes in the processes, products, and organization of a firm's primary business functions through introducing new IS products or services (Carlo et al. 2010; Grover et al. 1997; Lyytinen and Rose 2003). Examples include the adoption of enterprise systems (e.g., ERP/CRM/SCM), remote customer order entry, and IOIS.

Besides, this study contends that digital innovation capability would "reflect in" rather than "is formed by" the three IS innovation cores. This is supported by several reasons. First, business administrative and business technological IS innovations are based upon IS products or services (Swanson 1994). When functional IS innovations are ready for use, it is rarely possible that business administrative or business technological IS innovations are not "pushed"; alternatively, the needs created by business administrative and business technological IS innovations also can "pull" innovations in the IS functional area (Lyytinen and Rose 2003). As such, Swanson (1994) identifies strong-order and weak-order effects that may exist among IS innovations. Carlo et al. (2010) also corroborate and examine the order effects exerted by IT platform innovation (i.e., Internet computing). Second, due to its generativity, distinct digital innovations rarely are accomplished in isolation (Fishman et al. 2014; Yoo et al. 2012). For example, the adoption of a new IT platform (i.e., an instance of functional IS innovation) may allow the organization to access to digital artifacts developed by its third-party partners. In turn, the organization could be facilitated to innovate its business technological or business administrative processes since it becomes more economically or technologically feasible to develop information systems for supporting these innovations. Besides, the phenomenon of "wakes of innovation" indicated by Boland et al. (2007) suggest that functional IS innovations might trigger business technological or business administrative innovations. As a result, the cascading effects support our contention that digital innovation capability would reflect in the three cores of IS innovations (Damanpour et al. 2009).

March (1991) argues that there are benefits for organizations to balance exploitation and exploration when pursuing innovation. When a firm focuses solely on exploitation, it is likely to suffer from lacking of novel ideas. On the contrary, when a firm is too oriented toward exploration, it will expend significant experimentation costs without obtaining immediate benefits derived from near-term opportunities. Therefore, successful innovation demands that a firm exploits its existing competencies while trying to avoid dysfunctional rigidity by renewing them. In this study, we argue that IT exploration is not necessarily required by all kinds of digital innovation. For example, a firm can develop new information systems based on existing technology assets and IS development skills to support its business technology and business administration IS innovations. Similarly, pursuing only IT exploitation might not be enough for accomplishing all kinds of digital innovation. For instance, embracing Internet computing could be disruptive, which requires the firm to renew its technology bases, IS development processes, or business products or technological processes (Lyytinen and Rose 2003). Accordingly, this study argues that firms need to balance both IT exploration and IT exploitation in order to improve its digital innovation capability.

The notion of balance between exploration and exploitation has been interpreted in various ways (Gupta et al. 2006). Some scholars suggest that such balance implies that firms need to combine high exploitation with high exploration in order to achieve superior performance, which is considered as an ambidexterity approach to balancing exploration and exploitation (Benner and Tushman 2003). Others argue that the notion of balance could imply that a high (low) exploitation needs to be coupled with a low (high) exploration to enhance performance, which is thought to be a punctuated equilibrium approach (Levinthal and March 1993). Gupta et al. (2006) indicate that when exploration and exploitation are analyzed within a single domain (e.g., an individual), then the problem of resource scarcity and competition could be a problem. When this is the case, exploration and exploitation should be conceptualized as mutually exclusive ends of a continuum. And, the punctuated equilibrium should be an appropriate approach to balance exploration and exploitation. On the other hand, if one is analyzing exploration and exploitation in multiple, loosely coupled domains (e.g., an organization), the two becomes orthogonal tasks. In turn, pursuing ambidexterity becomes feasible and desirable to balance exploration and exploitation. In our study, the unit of analysis is the organization, where IT exploitative activities and IT explorative activities can be carried out in multiple, loosely-coupled subunits. Thus, the balance of IT exploration and IT exploitation meaning that organizations need to pursue both of them simultaneously in order to maximize the desired performance outcomes. As a result, this study defines IT ambidexterity as simultaneousness of IT exploitation and IT exploration (e.g., Lee et al. 2015). Furthermore, this study adopts the combined dimension approach to represent ambidexterity (Cao et al. 2009; He and Wong 2004). That is, IT ambidexterity represents combined magnitude of IT exploitation and IT exploration rather than the maintenance of a close relative balance between the two dimensions (Gupta et al. 2006).

According to the above discussions, this study proposes the following hypothesis:

H1: IT ambidexterity positively affects digital innovation capability.

Expected Contributions

This paper is expected to generate the following contributions.

First, this study adopts Swanson's tri-core model to conceptualize the notion of digital innovation capability. To the authors' knowledge, except for Grover et al. (1997), there is scarce empirical research that builds upon Swanson's ideas. Given that previous research primarily studies an individual IS/IT innovation at a time, there is a pressing need to investigate how and why organizations are capable of pursuing multiple types of IS innovations (e.g., frequently appear in the context of digital innovation). In this regard, this study apparently fills the research gap in the IS/IT innovation literature.

In addition to pointing out the roles of IT exploitation and IT exploration play in digital innovation, this study further argues that both activities should be pursued simultaneously (i.e., IT ambidexterity) in order to improve digital innovation capability. As mentioned previously, prior studies have controversial and distinct opinions on the manners of achieving ambidexterity. The empirical findings of this study are expected to be helpful in the accumulation of new evidence on this issue. More importantly, our research results could inform managers regarding the more appropriate way of resource allocation when pursuing digital innovation.

Future Research Directions

Future research can study the antecedents of IT ambidexterity. Prior research has identified various approaches for achieving ambidexterity, e.g., the structural, temporal, or leadership arrangements (cf. Raisch and Birkinshaw 2008). As such, a nature extension of this study would to examine whether those arrangements are applicable to enhancing IT ambidexterity. Moreover, researchers should try to identify relevant antecedents to IT ambidexterity in order to provide more actionable suggestions to managers.

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