The Effects of New Technology Flexibility on Innovation Performance in the Post-Implementation Age

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Abstract

Increasing market competition and quickly moving globalization require companies to improve their competitive advantages through both incremental and radical innovations. The new technologies, such as enterprise resource planning (ERP) systems, radio-frequency identification (RFID), big data analysis, and internet of things (IoT), play important roles on a company's innovation performance and sustainable competitive advantages. In this paper, ERP system is chosen as a specific case representing a major category of new technologies, to illustrate our analysis on those new technologies. In the current post-implementation age, when nearly every Fortune 500 companies and many small and medium-sized enterprises (SMEs) have installed their ERP systems, this research investigates the relationship between new technology implementation, flexibility of new technology, and innovation performances. This study proposes a research framework for the decision makers to systematically improve their overall competitive advantages through flexible new technologies and strategic management on innovations. This paper also identifies several potential future research opportunities for other researchers.

Keywords: New technology, Post-implementation, ERP systems, Innovations

1. Introduction

The current competitive business environment involves increasing market competition and quickly moving globalization. In order to maintain and extend their competitive advantages, large companies and small and medium-sized enterprises (SMEs) are all putting more effort into their research and development (R&D) functions, in terms of their financial supports, top management commitment, and employee training and development (Anderson, Banker, and Ravindran, 2006; Shahmandy, Silong, and Samah, 2012; Sykes, Venkatesh, and Johnson. 2014). To allocate those value resources optimally, companies have to keep looking for both incremental and radical innovation to increase their response rate to the dynamic market and offer specialized solutions to complex problems. To facilitate these needs, companies began to emphasize the importance of new and flexible software to support their innovations (Rajagopal, 2002; Kumar, 2013; Maditinos, Chatzoudes, and Sarigiannidis, 2014).

While many companies have emphasized the implementation of new technology, such as ERP, the performance of innovation may not have been achieved as the decision makers expected (Khattak, Nasir, and Sultan, 2012; Kumar, 2013; Tian and Xu, 2015). Those cases indicate that new technology implementation could not directly relate to the success of innovation in a company. This study focuses on one of the key factors to discuss: the flexibility of the new technology. This paper proposes a research framework to identify the effect of new technology flexibility on the relationship between the extent of new technology implementation and the innovation performance in a company.

A research gap exists in the current research. While most articles studied the installation of a new technology, such as ERP systems; in the current post-implementation age, when nearly every Fortune 500 companies and many SMEs have installed their ERP systems, there are much fewer studies focusing on a firm's innovative performance and value created by a new technology, such as the ERP system, as time goes on after years of their installation (Morris and Venkatesh 2010; Kumar, 2013; Tian and Xu, 2015).

In this study, we focus on the content of the implementation and the effects of new technology flexibility on innovation performance in the post- implementation age. The ERP system is used as an illustration in the analysis, and the results can be generalized into other new technologies, which are further discussed in the last section.

This paper is structured as four sections. Following the introduction, we start with a discussion about the theory bases and a literature review in Section 2, and then develop the research model in Section 3 as the main part of this research. After the model development, we provide a conclusion and discussion of future research opportunities in Section 4.

2. Theory Bases

In this section, we discuss two related theories to support our analysis. As the theoretical bases, they will provide the rationale for our proposed framework, which is given in next section.

2.1.1. Technology-Organization-Environment Framework

Tornatzky and Fleischer (1990) initially developed the Technology-Organization-Environment (TOE) framework. This framework identifies three aspects of a firm's contexts which affect the process and performance of introducing, adopting, implementing, and using the advanced technologies. The three contexts in this framework are: technological, organizational, and environmental. According to Zhu and Kramer (2005), TOE is useful to explain the adoption and implementation of new technologies, because TOE well articulates the driving force in a comprehensive manner. Technological, organizational, and inter-organizational characteristics are regarded as the key drivers of technology diffusion. In this study, we use TOE to identify the antecedents of new technology implementation.

2.1.2. Resource-Based Theory

Resource-based theory (RBT) suggests that an organization can create its value through the resources that are valuable, rare, inimitable, and non-substitutable (VRIN) and use them as competitive advantages against competitors (Barney 1991; Barney, Wright, and Ketchen, 2001). In the literature, RBT has been used to analyze IT capabilities (Mata et al. 1995) and to explain how organization's ability to utilize the new technology is more important than in the new technology itself (Zhu and Kramer, 2005). Technology-enhanced capabilities that innovatively and creatively integrate various resources and environments cannot be easily imitated and substitutable, thus they will provide the sustainable competitive advantages (Barney, Wright, and Ketchen, 2001; Kumar, 2013; Tian and Xu, 2015).

3. Model Development

Based on the theoretical and practical insights we propose a conceptual model that studies the relationships among new technology flexibility, extent of new technology implementation, the firm's innovative performance, and the firm's financial and operational performances. The model is summarized in Figure 1 and more details and discussion are provided as follows.

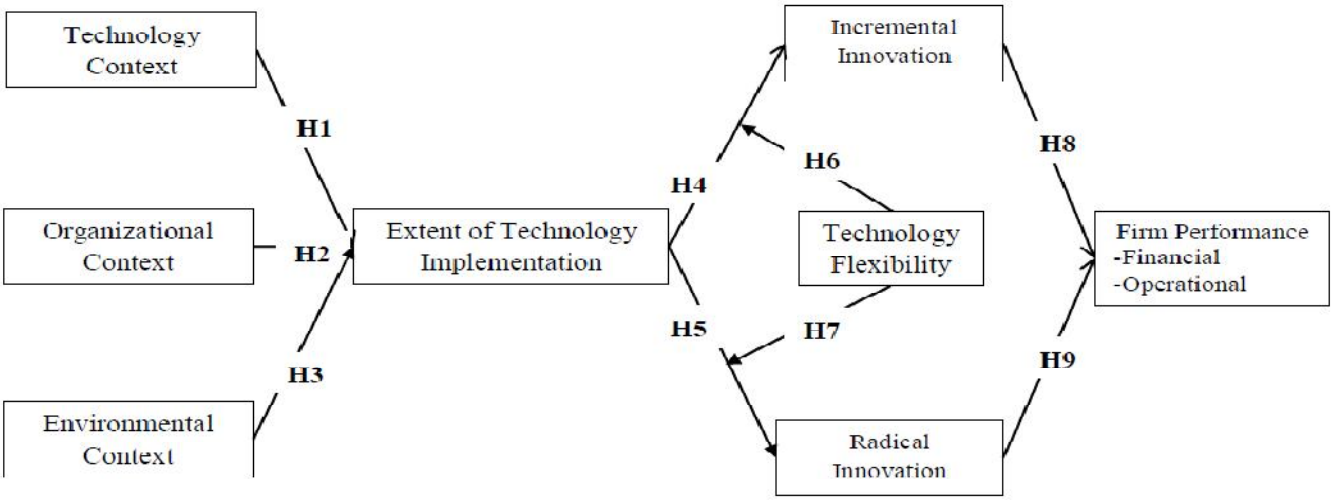

Figure 1: Proposed Research Framework

3.1. Antecedences of the Extent of ERP Implementation

The extent of new technology implementation is a unique perspective in the post-implementation age. It is a new viewpoint which focuses on the level of the implementation of a new technology system in an organization, rather than whether or not the system is installed. Technological context is the extant of the new technology relevant to the firm (Torantzky and Fleischer 1990; Zhu and Kraemer, 2005). Technological context takes into account the level of knowledge and expertise about the new technology within an organization (Chwelos et al. 2001, Iacouvou et al. 1995). More advanced and well developed technologies, such as ERP system, RFID, big data analysis and IoT, will provide higher benefits with more functional abilities, to enhance the extent of new technology implementation.

H1: Technology development is positively associated with new technology implementation.

Organizational context refers to the readiness of an organization's working culture and business process to adopt new technologies and innovative ideas. Organizational context takes into account the organizational facts that influence and affect technology adoption and implementation, such as size, scope, organizational orientation, management strategies, and the amount of slack resources (Torantzky and Fleischer 1990; Zhu et al. 2002). The literature supports that the more organizational resources an organization has, the greater value they can get from the new technologies (Brynjolfsson and Hitt 2000; Kwon and Zmud, 1987). Organizational readiness is essential for an organization to successfully implement a new technology. Thus, the more organizational resources are available, the more likely firms can extend their new technology implementation.

H2: Organizational resources are positively associated with new technology implementation.

Environmental context is the arena in which a firm conducts its business in dealing with competitors and accessing resources supplied by others (Torantzky and Fleischer 1990; Zhu and Kraemer, 2005). The environmental factors include supply chain partners' readiness, the industry trends, market competitions, government regulations, and others (Chwelos et al. 2001; Porter and Millar, 1985). Those factors can lead to innovations and encourage organizations to implement the new technologies.

H3: Environmental factors are positively associated with new technology implementation.

3.2. Innovative Performance of New Technology Implementation

Innovation has a broad definition. It could be a creative idea, a new practice, or a different way of using the existing knowledge and resources (Zaltman, et. al, 1973; Dewar and Dutton, 1986), and it can be classified as incremental and radical innovation (Abetti, 2000; Koberg et al, 2003).

Incremental innovation extends the existing resources and focuses on reducing the costs and improving the features (Miller, Miller and Dismukes, 2006). Incremental innovation encourages the managers to rethink the current use of the established technologies and resource to increase the efficiencies (Freeman, 1974). With a higher extent of new technology implementation, employees are more involved in the environment of information sharing. This information sharing can motivate coordination and cooperation between different functions and departments, and those information flows and shared ideas create more opportunities for incremental innovation.

H4: The extent of new technology implementation is positively related to incremental innovation.

Radical innovation dramatically changes technology, business processes, market positions, products, a
nd strategies (Miller et al., 2006). Radical innovation requires the managers to think in different patterns, equip new technical and managerial trainings, and attempt to reform the existing business models (Freeman, 1974). In the post-implementation age, radical innovation is more difficult to process, due to the nature of radical innovation and the pre-fixed functions of the ERP systems. Radical innovation needs a dramatic change, which affects many departments and personnel, and may focus on future potential customers rather than serving current customers. The pre-decided parameters in an ERP system leave the users limited ability to dramatically modify the functions. Furthermore, the ERP systems limited the communications between different departments and individuals, who are the sources of innovation in an organization. As a result, the changing cost is very high in terms of technology changing, business reforming, and personnel training. Thus, we propose the following statement:

H5: The extent of new technology implementation is negatively related to radical innovation.

3.3. New Technology Flexibility as the Moderator

New technology flexibility refers to the ease of modifying a new technology system for some special application environments. New technology flexibility will give the organization more room and ability to respond quickly to unpredicted changes. New technology flexibility will limit the standardization, and encourage the information sharing, which is a most important factor influencing innovation. Because of the nature of radical innovation and the pre-designed ERP functions, the extent of an ERP system limits dramatic changes in an established company with an installed ERP system. However, this relationship could be different under the different degrees of ERP flexibility. An ERP system with high flexibility will motivate more radical innovations than a fixed ERP system with less flexibility. Thus, we hypothesize that new technology flexibility can moderate the relationships between the extent of new technology implementation and the innovation performance.

H6: New technology flexibility will moderate the relationship between the extent of new technology implementation and incremental innovation.

H7: New technology flexibility will moderate the relationship between the extent of new technology implementation and radical innovations.

3.4. Performance

We hypothesize that the higher the level of innovation, both incremental and radical, the better the firm performance (Frohlich& Westbrook, 2001; Ahmad & Schroeder, 2001). In this paper, the performance measures consist of the following: 1) financial measures (return on investment, sales growth, and market share), and 2) operational measures (production cycle time, new products time to market, and percentage of suppliers getting a forecast) (Kaplan and Norton, 1996).

H8: Incremental innovation is positively related to firm performance.
H9: Radical innovation is positively related to firm performance.

4. Conclusion and Discussion

Using ERP system as an illustration, this study investigates the effects of new technologies flexibility on innovation performance in the post-implementation age. The framework proposed in this study provides a systematic mechanism for decision makers to use when they evaluate their current or future new technology investment. In the post- implementation age, the new technology could affect the different types of innovation and other performances in an organization and those relationships are influenced by the flexibility of the new technology. Thus, with various strategic positions and business contexts, companies should choose the most fitted way to implement a new technology. At the same time, this study leads to more research opportunities for extending the proposed framework into a more practical decision-making process. Some examples of future research opportunities are discussed as follows.

One research opportunity consists of considering national culture as a contingent factor. This extended research would be extremely interesting to the management of multinational companies, which have to face multicultural obstacles. Some studies have discussed the diverse external factors that influence firms to use new technologies (Delpechitre, 2013; Abraham, 2013). When the management of a multinational company uses the proposed framework, they have to identify national cultural differences as environmental factors. National cultural differences are the unwritten rules of the business game. They refer to the way most people in a particular society think, feel, and act. Geert Hofstede has defined them as “the collective programming of the mind distinguishing the members of one group or category of people from another” (Hofstede 1997, p. 5). With the consideration of national culture, more interesting observations might be found from different countries and regions. The future research can treat the cultural difference as a contingent factor affecting the proposed framework. The understanding of these cultural differences is important for making the right investment and application decisions in the post-implementation age (Xue, et.al., 2005; Lin, & Rohm, 2009).

Another research opportunity would involve discussing different types of innovation that follow the “4P” model. Francisa and Bessantb (2005) introduced four types of innovation, which are summarized as “4P.”

Product innovation (P1) refers to the innovation to introduce or improve products; process innovation (P2) refers to the innovation to introduce or improve processes; position innovation (P3) refers to the innovation to define or re-define the positioning of the firm or products; and paradigm innovation (P4) refers to the innovation to define or re-define the dominant paradigm of the firm (Francisa and Bessantb, 2005).

The other research opportunity is extending the discussion into more updated new technologies. Kumar (2013) has studied the importance of software customization for a business performance. Based on Kumar (2013) and this study, the future researchers can continue to develop the research on the new technologies, such as 3D printers, Business Analytics, Big Data, Cloud Computing, the Internet of Things, and Marketing 2.0 among others (Myers, 2011; Aldhaheri and Bach, 2013).

This study proposes a framework that illustrates the relationships among new technology implementation, new technology flexibility, and innovation performance. Considering both incremental and radical innovation, we suggest that the flexibility of a new technology affects the relationship between the extent of the new technology implementation and the firm's innovation performance and outcomes. Furthermore, this study provides several potential research opportunities in this area.

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