Initiation, Experimentation, Implementation of innovations: The case for Radio Frequency Identification Systems

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ABSTRACT

This research primarily examines the stages hypothesis of the process of technology adoption by management personnel of organizations in the supply chain sector involving the Initiation, Experimentation, and Implementation stages. Further, this research examines key antecedents that may influence the various stages, including top management support, external pressure, and organization size. Using responses provided by top management representatives of 210 supply chain organizations on their organizations' engagement with Radio Frequency Identification (RFID) technologies, this research finds that the stages hypothesis holds for RFID technologies. Specifically, organizations were seen to sequentially progress through the Initiation, Experimentation, and Implementation stages. Over 80% of organizations, who had reached the Implementation stage of adoption, had gone through the Initiation and Experimentation stages as well. Additionally, the data showed that the antecedents exerted varying levels of influences on the three stages. Top management support strongly influenced all three stages; external pressure influenced the Initiation and Implementation stages, and organizational size influenced Experimentation and Implementation stages. The paper discusses several implications for research and practice.

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1. Introduction

The Radio Frequency Identification (RFID) technology has been around since 1940, when it was used to identify friendly aircraft. However, it has only found mainstream application in the supply chain sector since the early 2000s (Landt, 2005). For instance, in 1999, the Uniform Code Council and EAN International came together to form an organization co-funded by Proctor and Gamble to research and develop standards for the use of RFID technology in supply chain organizations (Landt, 2005). Then in the early 2000s, more than 100 large organizations, including Wal-Mart and Proctor & Gamble, joined the Auto-ID Center at the Massachusetts Institute of Technology to pilot the technology. By 2005, several large organizations in the supply chain sector, such as Wal-Mart (Bose, Jae-Nam, & Yen, 2008), had adopted this innovative technology for various reasons.

Prior research yields considerable insights on how organizations deal with and integrate RFID technologies into their operations. For example, studies have examined the implementation of RFID technologies (Angeles, 2005; Vijayaraman & Osyk, 2006; WenJie, Yufei, Xiaofeng, & Archer, 2006; Young, 2006) as well as issues in implementing RFID technologies (WenJie et al., 2006; Young, 2006). Other studies have proposed models and agendas for the adoption of RFID technologies (Brown & Russell, 2007; Curtin, Kauffman, & Riggins, 2007; Matta & Moberg, 2006). In general, these studies have focused on the antecedents or potential consequences of the organizational adoption of RFID technologies.

Literature on innovations describe adoption as a process that happens over time and how organizations may progress through different stages of this process (e.g., Rogers, 2003). This thesis probably holds for the adoption of RFID technologies as well, since they can be potentially disruptive technologies that require organizations to consciously initiate, experiment with, and finally implement them over time (e.g., Fichman, 2001). While there has been case study research to examine and study adoption processes (Chang, Hung, Yen, & Chen, 2008; Jeyaraj, Sengupta, & Sethi, 2008; Kamoun, 2008), no studies were found to quantitatively examine the stages of adoption by organizations in the context of RFID technologies. Thus, our research asks: *Do the stages of Initiation, Experimentation, and Implementation in the Adoption process apply for RFID innovations?* Moreover, organizations may be subject to different types of pressures and considerations as they deal with the Adoption process. Some empirical studies have examined the effects of technological, organizational, and environmental factors on the adoption of innovations (e.g., Grover & Goslar, 1993; Ramamurthy, Premkumar, & Crum, 1999; Teo, Wei, & Benbasat, 2003). However, there is still a lack of information about

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understanding the antecedents of the various stages in the adoption process. Thus, our research asks: *What are the antecedents of the Initiation, Experimentation, and Implementation stages in the adoption process for RFID innovations*?

The remainder of the paper is organized as follows. The next section describes the theoretical framework, including the stage model and the antecedents. The following sections discuss the research methods and results. A discussion of the findings and implications is presented next followed by conclusions.

2. Theoretical framework

2.1. The RFID Innovation

The case for adoption of RFID technology is tempting, but unclear. The innovation outperforms other automatic identification technologies such as bar codes in many aspects. RFID tags can store more information than bar codes, and can be reprogrammed with new information. There are new capabilities in tag scanning abilities: they do not require line-of-sight, can be scanned simultaneously, faster and from a greater distance than bar codes (Lewis, 2004). However, there are several issues with implementation of an RFID system. They are technological (Spekman & Sweeney, 2006), cost-based (Katz, 2006), and involve managerial (Matta & Moberg, 2006), strategic (Lundstrom, 2004), economic (Katz, 2006) as well as social issues (Ohkubo, Suzuki, & Kinoshita, 2005). It appears that the benefits of the RFID innovation have been oversold, and adoption of RFID technology has been lagging (Fenn & Linden, 2005; Ferguson, 2007; Vijayaraman & Osyk, 2006). The case for adoption of RFID is further confounded by the fact it requires large scale reconfigurations of systems, while only providing incremental automation over what is already automated to some extent (with barcode and Electronic Data Interchange (EDI)). The socio-technological landscape of supply chain businesses has changed since examination of EDI and barcode technologies (Chwelos, Benbasat, & Dexter, 2001; Premkumar, Ramamurthy, & Crum, 1997), and can short-circuit the adoption processes. Our research therefore aims to explore the adoption processes and characteristics using the RFID innovation.

2.2. Stages of the IT innovation adoption process

The adoption process can be defined as a sequence of stages through which an organization passes through before initiating a new technology within an organization (Rogers, 2003). As noted by Kamal (2006), existing research is replete with frameworks and models theorizing stages of the process of adoption, ranging from as few as a two-stage to a more granular model of six or more stages (Lindič, Baloh, Ribière, & Desouza, 2011; Rogers, 2003). In most cases however, the adoption processes hold parallels, typically differing in the level of generalization. For instance, the two-stage process of adoption comprises Initiation and Implementation (Gopalkrishnan & Damanour, 1997). In their model, Initiation can hold parallels to three stages of Frambach and Schillewaert's six stage model (2002): Awareness of the innovation, its Trial and its Evaluation, while the Implementation stage is analogous with the Decision for adoption of the innovation, as well as its Assimilation and Routinization.

Prior research has attempted to reconcile the models on IT innovation organizational adoption process by grouping them into three main stages: pre-adoption, adoption and post-adoption (Agarwal & Prasad, 1998; Cooper & Zmud, 1990; Damanpour & Schneider, 2006; Gallivan, 2001; Kamal, 2006; Karahanna, Straub, & Chervany, 1999), consistent with Lewin's model of the change process (Lewin, 1952). According to Lewin's model, the change process is a sequence of three core stages: unfreezing, changing, and freezing. Unfreezing prepares the system for a change, changing explores and assimilates the consequences of the changes, and refreezing makes the innovation a permanent part of the system (Lewin, 1952). We perceive the three adoption stages as follows. The pre-adoption stage is one in which an organization accepts the possibility of the change (unfreezing), and initiates the adoption. The second stage (change), corresponds to arriving at the decision based on trials and Experimentation with the innovation. The third stage involves Implementation of the innovation which includes user acceptance of the innovation idea, and actual use of the innovation (Kamal, 2006). Pierce and Delbecq (1977) also support that most adoption process begin with a cognitive stage, followed by an ideation stage and decision phase, and end with implementation, institutionalization or routinization. These stages are discussed in more detail below and depicted in Table 1 below.

The *Initiation* stage involves activities relating to the interest, research and discovery of issues, opportunities, and solutions, leading eventually to the intention to adopt an innovation. Organizational members, typically top management (Gallivan, 2001) learn about the innovation, its capabilities, advantages, and disadvantages, and examine the compatibility and suitability of the innovation for the organization (Rogers, 2003). Research shows this stage as resulting in creation of an overall but initial attitude towards the innovation, leading to the conception, Initiation of a plan for the adoption of the innovation (Agarwal & Prasad, 1998; Kamal, 2006). Since the RFID innovation is especially relevant to supply chain organizations (Angeles, 2005), such activities relating to the Initiation stage are abound.

The *Experimentation* stage generally involves trials and pilots (i.e., an evaluation) of the innovation (Fichman, 2001) from practical, strategic, financial, and/or technological perspectives (Damanpour & Schneider, 2006). Agarwal and Prasad (1998) suggest that potential adopters engage in evaluative behaviors in this stage. The evaluation of an innovation, therefore, allows the

Table 1
Prior models of the process of organizational adoption of innovations.

	Initiation	Experimentation	Implementation
The change model (Cooper & Zmud, 1990; Lewin, 1952)	Unfreezing	Changing	Refreezing
User perceptions in IT adoption (Agarwal & Prasad, 1998)	Awareness: information about existence of innovation	Perception, information seeking, evaluative behavior	Decision to accept or reject innovation
Organizational adoption and assimilation of complex technical innovation (Gallivan, 2001)	Primary authority is involved in adoption	Secondary authority organizational assimilation	Organizational acceptance
Phases of adoption of innovation in organizations (Damanpour & Schneider, 2006)	Knowledge-awareness	Evaluation-choice	Adoption-implementation
Organization structure, individual attitudes and innovation (Pierce & Delbecq, 1977)	Initiation, cognitive component, awareness	Activities leading to adoption decision	Implementation, adoption, routinization, institutionalization
Determinants impacting the adoption and implementation of RFID technology in South Korea (Kim & Garrison, 2010)	Agenda setting, matching	Refining, restructuring	Clarifying, routinization