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2005

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### Recommended Citation

Ranganathan, C. and Jha, Sanjeev, "Adoption of RFID Technology: An Exploratory Examination from Supplier's Perspective" (2005). *AMCIS 2005 Proceedings*. 152.

<http://aisel.aisnet.org/amcis2005/152>

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# Adoption of RFID Technology: An Exploratory Examination from Supplier's Perspective

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## ABSTRACT

RFID technology has attracted the attention of several businesses and experts worldwide. Given the potential benefits of RFID such as efficient inventory, streamlined supply chain, reduced stock outs and cost reductions, several retailers such as Wal-Mart and Target have decided to adopt RFID technologies. They have also mandated their suppliers to adopt and use RFID technologies. However, anecdotal reports suggest several challenges that suppliers need to address in the process of RFID adoption. Drawing upon innovation diffusion and inter-organizational technology adoption literature, we seek to understand the RFID adoption process in supplier firms and identify key factors affecting RFID adoption by suppliers. We propose a two-stage research design involving exploratory interviews, followed by a survey. Preliminary results from our ongoing research project will be discussed at AMCIS.

## Key words and phrases

Information Technology adoption, RFID, supply chain management

## INTRODUCTION

Radio frequency identification (RFID) technology has recently attracted the attention of businesses and experts worldwide. The basic idea behind RFID originated over fifteen years ago (Business Week, 2004) and several firms have been using RFID for a few years (Angeles 2005, Ferguson, 2002). Most of these firms used RFID in closed loop systems, however, the sudden surge of interest in RFID can be attributed to the potential usage of these technologies in supply chains and inter-organizational realms. Realizing the potential benefits of RFID, major US firms such as Wal-Mart, Department of Defense, and Target have decided to implement RFID, mandating their suppliers to adopt it as well. Market research studies point to an increased adoption of RFID technologies: the \$1 billion market for RFID specific hardware, software, and services in 2004 is estimated to rise to \$3.2 billion by year 2008 (Business Week, 2004).

An early predecessor to RFID technologies is the bar-coding technology that is commonplace today. More than a decade ago, bar-coding was adopted by companies such as Wal-Mart who spearheaded their diffusion by demanding that their suppliers use it (Fortune, 2003). A parallel scenario has emerged in the case of RFID with Wal-Mart and other retailers mandating RFID adoption by their key suppliers. The potential benefits of RFID for retailers are significant. RFID could help in efficient inventory management, thereby reducing costs that could be translated in form of low prices for customers (Wailgum, 2004). Retail analysts estimate that Wal-Mart will save around \$8.35 billion annually by using RFID, especially by doing away with manual scanning of incoming products which would result in labor cost savings and will also help reduce product theft, which costs the organization about \$2 billion per annum (Fortune, 2003).

While the potential benefits of RFID for retailers is well acknowledged, considerable uncertainty exists in the case of suppliers. Suppliers face considerable barriers in the form of increased costs of RFID and inflexible IT infrastructures that cannot be immediately integrated with existing systems. Moreover, smaller and mid-sized suppliers face financial constraints to invest in RFID. Though some of the top suppliers like Gillette, Hewlett-Packard, Johnson & Johnson, Kraft Foods, Procter & Gamble, and Unilever started adopting RFID, many other suppliers are not convinced about the returns. The laggards complain that they are being forced to pay for an investment that will predominantly benefit the retailers and the technology companies (Economist 2004). In addition, suppliers also face increased investments in upgrading their current IT infrastructure (Business Week, 2004). Despite the potential benefit, suppliers face considerable challenges in adopting and implementing RFID systems.

This paper is an exploratory investigation of RFID adoption by suppliers. Our research has three motivations. First, the sheer number of retailers (and their suppliers) adopting RFID makes this an interesting area of enquiry (Business Week, 2004a; Canadian Business, 2004). Second, since this is an emerging technology, there is very little empirical documentation on RFID adoption and the issues faced by the firms (Angeles, 2005). Three, our particular interest is to examine the supplier community as considerable ambiguity exists about their adoption processes (Business Week, 2004; Business Week, 2005; Economist, 2004). On one hand, there are faced with coercive pressures and on the other hand lie the challenges they face in effective adoption and utilization of RFID. Therefore, our research objectives are:

- (a) To understand the process of RFID adoption by suppliers
- (b) To examine the critical factors that affect RFID adoption by suppliers.

## LITERATURE REVIEW

We draw upon three streams of research to build our conceptual model. The first stream is the innovation diffusion theory (Rogers, 1983) that has been widely used to understand adoption and diffusion of innovative technologies such as RFID. The second stream is the research on IT adoption with specific focus on inter-organizational technologies and EDI. Third is the emergent research on RFID technologies. Current studies on RFID have focused largely on technical issues, industry standards and anecdotal case studies of RFID applications.

### Overview of RFID Systems

RFID is a generic technology that is used to identify objects using radio waves. It is similar to barcodes, smart cards, biometrics, machine vision, magnetic stripe, optical card readers, voice recognition, etc. that are used for automated data collection (Angeles, 2005). A RFID system essentially has two components. First, is the tag consisting of an antenna and a chip with the electronic product code (EPC). These tags can be active, passive or semi-passive depending on whether they have a battery or not. At present, the cost of tags has been rated to pose as the highest barrier to RFID adoption, followed by concerns about stability of the market, complexity of integration, data synchronization, and initial decrease in productivity (eWeek, 2004; Angeles, 2005). Second, are the readers, that communicate with tags through inductive coupling mechanism. Tag's antenna draws energy from the magnetic field created with the reader's antenna and uses this energy to transmit digital information (EPC) back to the reader.

Initially, RFID may be applied to cases and pallets in the warehouse, but soon, as tags become cheaper, every item could have tags. As the shelves get replenished, they sense the change in state and alert the automated system to demand refills from the supplier. This takes the burden of maintaining inventory off from retailers and puts the onus on suppliers to keep the shelves full (Wailgum, 2004). In addition, RFID also promises to track every single piece of item in the entire supply chain from factory to warehouse, and from warehouse to shelf. (Wailgum, 2004).

### Adoption of Inter-organizational Systems

Innovation diffusion theory has been widely used to understand technology adoption in organizations. Most studies have emphasized a three-stage model of IT diffusion that consists of initiation, adoption and diffusion. This model is based on the classic innovation diffusion model proposed by Rogers (1983) that has subsequently been adapted to several areas of organizational theory, organizational design, and individual, functional and firm-level studies on innovation. However, in IS research, the three-stage model has been refined to provide a broader conceptualization of the diffusion process, with sub-stages of adaptation, acceptance, routinization and infusion (Cooper & Zmud, 1990). In this research, our primary interest lies in adoption of RFID technologies. Consistent with literature, we define adoption as a decision made by a firm on the use of a particular technology followed by the commitment of adequate resources.

With the evolution of advanced telecommunication technologies, organizations have strategically co-opted suppliers, customers, and other stakeholders into their information systems to gain strategic benefits in the form of enhanced buyer supplier relationship, information integration, and collaborative process. Such inter-organizational systems (IOS) are IT based, which essentially help in creation, storage, transformation, and transmission of data and information. Rather than operating within a firm's internal domain, inter-organizational technologies cross firm boundaries and cover multiple organizations. As mentioned earlier, our focus is on RFID adoption by suppliers of other larger clients who tend to operate in an open loop system, wherein information gets transmitted to suppliers, retailers, and other stakeholders. Given these similarities between RFID and IOS, we draw upon prior IOS research to frame a preliminary foundation for our study.

## KEY FACTORS INFLUENCING RFID ADOPTION BY SUPPLIERS

We reviewed literature on buyer-supplier relationships, supply chain management, inter-organizational systems and EDI to identify potential factors affecting RFID adoption by suppliers. We group these factors under three broad categories namely - institutional factors, supply chain factors, and firm specific IT resources. Institutional factors refer to those in the institutional, competitive environment in which a firm operates. Supply chain factors relate to the external supply chain environment of the firm. Firm-specific IT resources are the internal factors that pertain to the information-technology environment within the firm.

### Institutional Factors

The institutional approach believes in the predominance of institutional environments in influencing organizational actions (Teo et al., 2003). The underlying argument is based on institutional theories, which suggests that organizations choose populist actions and conform to social norm to continue securing resources and support. Hence, organizations respond to an environment that consists of other organizations (Teo et al., 2003). We believe that RFID adoption by suppliers will be influenced by two institutional factors: retailer pressure and competitive pressure from other organizations.

Retailer pressure is evident from the business press coverage on Wal-Mart's demands on its suppliers to adopt RFID (e.g. Wailgum, 2004). Anecdotal evidence in business press as well as our preliminary discussions with suppliers suggest that the suppliers do not see immediate ROI from RFID adoption. Despite this, they are under coercive pressure to adopt RFID. Coercive pressure refers to formal or informal pressures exerted by an organization on its dependent firms (Teo et al., 2003; Hart and Saunders, 1998). For non compliance would not only make them lose on the possible benefits of RFID adoption, but also to competitors who adopt and prosper with RFID. This is why the second factor of competitive pressure (similar to mimetic pressures) may push organizations to adopt RFID (Teo et al., 2003).

### Supply Chain Factors

This group has two factors. First factor is information intensity in the supply chain. The more information intensive the supply chain, the more suitable it is for strategic enhancement through IT (Grover, 1993; Porter and Miller, 1985). RFID system derives its rationale from its capabilities for seamless information integration from suppliers to retailers. Highly information-intensive environments imply greater need for information exchange and information processing between buyers and suppliers. Therefore, decision to adopt RFID by a supplier is likely to be influenced by the degree of information intensity in the supply chain.

Supply chain complexity is the other external factor that is likely to influence RFID adoption by suppliers. Prior researches have attributed system complexity to have a significant inhibiting influence on its adoption (Grover, 1993; Premkumar et al, 1994; Teo et al., 2003). Extending this logic, the more complex the proposed RFID system, the more the supplies will be dissuaded from adopting it.

### Firm Specific IT Resources

IT expertise, IT infrastructure, and perceived return on investment (ROI) are the three variables that form this group. Prior studies on IOS and EDI have found relative advantage of a system to be associated with better adaptation (Premkumar et al., 2003). Similarly, anticipated advantage or ROI has also been found to significantly influence EDI adoption (Chwelos et al, 2001). Business press has been reporting lack of perceived benefits to be one of the important factors discouraging suppliers to adopt RFID (e.g. Wailgum, 2004). Therefore, perceived benefits of RFID in relation to its costs are likely to influence RFID adoption by suppliers. This view is also consistent with the technology acceptance model that postulates perceived value to be an important determinant of IT adoption.

Grover (1993) found proactive technological orientation to be the most important factor influencing adoption of customer based inter-organizational system. Similarly, Chwelos et al. (2001) found IT readiness to be significantly associated with the intent to adopt EDI. Further, Teo et al., (2003) studied the possible association between IT department size and adoption of IOS. Ranganathan, Dhaliwal and Teo (2004) found a significant relationship between managerial IT knowledge and assimilation of web technologies in SCM. Based on the above literature, we derived two variables, IT expertise (knowledge) and IT infrastructure, and we expect that these two would have a significant association with RFID adoption by suppliers.

## Proposed Conceptual Model

The above discussion is summarized in our conceptual model shown in Figure.1.

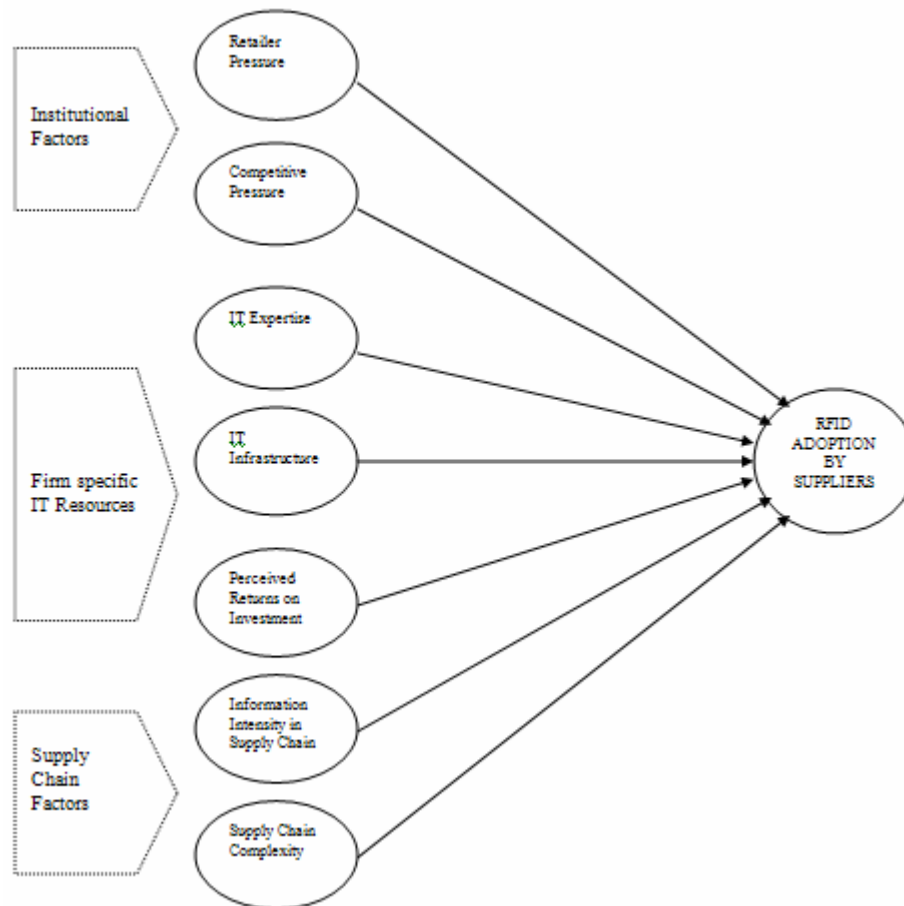


Figure 1. Conceptual Model

## PROPOSED RESEARCH METHODOLOGY

To actualize our research goals, we propose a two-stage research design. Given the exploratory nature of our study and a lack of prior empirical research on RFID, we intend to conduct semi-structured interviews with selected suppliers in mid-western USA. The interviews are intended to provide in-depth qualitative data on the decision making processes concerning RFID adoption by these suppliers, and the key factors that influenced the RFID adoption process in these supplier firms. We plan to interview IT and supply chain executives from large, mid-sized as well as small supplier firms in order to understand the range of challenges facing supplier firms of all sizes. We hope to validate the factors derived from literature review, as well as unearth any additional factors from the interview data. In the second stage, we propose to do a survey, collecting data from a larger group of suppliers.

## CURRENT STATUS OF THE PROJECT

We have completed pilot interviews with two suppliers and are in the process of analyzing the data obtained from these interviews. We hope to have at-least ten interviews completed by Summer 2005. We plan to present the results from our first stage of the research at AMCIS2005.

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