Diffusion of RFID in Organizations: A Perspective Based on Risk Perception

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ABSTRACT

There are very well known advantages of implementing RFID technology in many industries. For example, if RFID tags are embedded within drugs it becomes very difficult for counterfeit drug makers who will have to replicate the RFID tag as well. However, there are several reasons for lack of adoption, including: rapidly changing technology, high costs, and poor reliability of tags. Even required mandates from partners and senior management may not be sufficient drivers to ensure penetration of RFID technology in other organizations. The "Diffusion of Innovation Theory" or DoI is used to explain the delay in the adoption of the technology in businesses. There has been significant work on computing the ROI for RFID based on technology risks and the cost of technology. The focus in this paper is on the significance of atypical risks in the adoption of RFID technology. This research is using the survey method to reject two suggested hypotheses. The innovative approach is in expanding the DoI in the organization into the process of planning the adoption of RFID technology and to continue using DoI during the implementation process.

INTRODUCTION

Radio Frequency Identifiers (RFIDs) are computer chips that can be tracked from a distance. They are slated to become one of the most significant business innovations in this century with far reaching implications in supply chain management, real-time location monitoring, and asset management. Since RFID allows a product to be tracked without line of sight, a greater level of automation in business processes is possible leading to reduction in labor costs and improved efficiency. In addition, RFID enables improved accuracy and closer integration with business partners. RFID tags are typically affixed onto the goods that they are supposed to track, however, they can also be embedded within the product thereby preventing proliferation of counterfeit goods with fake RFID tags or at least making it much more difficult. For instance, if the RFID tag is embedded within drugs counterfeit drug makers will also have to replicate the RFID tags. There are limitless possibilities for use of RFID tags, however despite all these advantages, their adoption remains painfully slow. There are several reasons for this lack of adoption, including: rapidly changing technology, high costs, and poor reliability of the tags. The infrastructure supported by different vendors is also often incompatible due to conflicting standards, incompatible frequencies, and different power levels for RFID tags and readers. Even required mandates from partners and senior management may not be sufficient drivers to ensure penetration of RFID technology in other organizations. In addition, there are other risks that have not been explored adequately which can skew the ROI equation for the adoption of RFIDs. We examine the risk perception of adopters to determine its impact on the penetration of the technology in organizations. The diffusion of innovation theory is used to explain the delay in the adoption of the technology in businesses. This work builds up on the initial work on RFID risks (Goel & Crnkovic, 2005). There has been significant work on computing the ROI for RFID based on technology risks and the cost of technology. However, there are several factors that have been ignored in this equation which we believe will be the key to the adoption of this technology, including, health, environment, security, privacy, and business uncertainty. The focus if this paper is on the significance of atypical risks in the adoption of RFID technology. Our hypothesis is as follows:

H1: Non-technology perceived risks are a significant factor in adoption decision on the RFID technology in organizations.

H2: Organizations are still mired in the first two stages (relative advantage and compatibility) of the Roger's Diffusion of Innovation Theory (DoI) in RFID adoption.

We use DoI to explain our hypothesis. In addition, we conduct a survey to collect the data to examine the hypothesis. The rest of the paper is organized as follows: Section 2 provides the theoretical foundations of this work; Section 3 presents the data collection methodology and preliminary results, and Section 4 presents conclusions and directions for future work

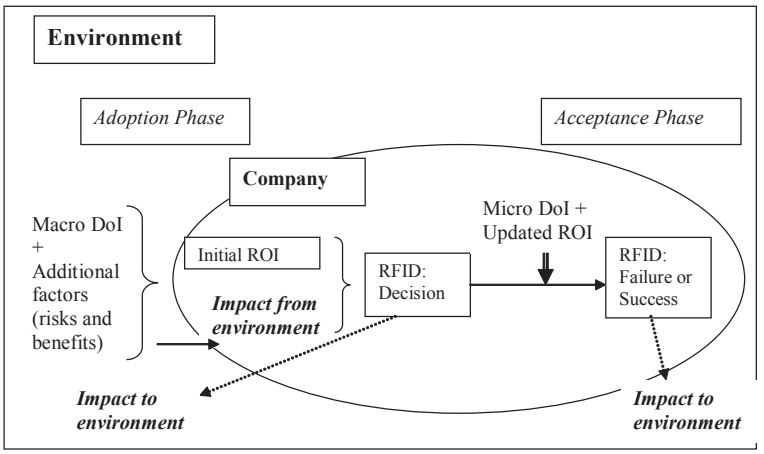
2.0 THEORETICAL FOUNDATIONS

There is often inertia in adoption of innovations by organizations for a variety of reasons such as: lack of clear understanding, aversion to risk, and general apathy to create changes in the organization. In the past, problems of diffusion and adoption of new ideas, processes, and technologies have been studied under the rubric of DoI. Rogers and Shoemaker (1971) have defined diffusion as the process of communication of a new idea to a person, group, or organization. Rogers and Shoemaker (1971) defined the adoption as the process of acceptance of an idea or technology after initially learning about it. The basic tenet of DoI is that innovation is communicated through certain channels over time within an organizational context. Individuals have different degrees of willingness to adopt new ideas or technology and the percentage of individuals adopting innovation is distributed normally over time (Rogers, 1995). The rate of adoption of innovations is impacted by five factors: 1) relative advantage, 2) compatibility, 3) trialability, 4) observability, and 5) complexity. The first four factors are generally positively correlated with rate of adoption while the last factor, complexity, is generally negatively correlated (Rogers, 1995). Mustonen-Ollila & Kalle Lyytinen (2003) in a recent study show that several DOI factors strongly influence adoption of innovations in organizations, however, innovation adoptions follow no discernable pattern.

The rate of adoption is governed by both the rate at which an innovation takes off and the rate of later growth. Low cost innovations may have a rapid take-off provide a quicker breakeven point for investment, while high cost innovations require a larger time to amortize the initial costs. RFID falls in the latter category where the initial investment is very high and the amortization time is fairly long. Given the high degree of uncertainty in the current business environment companies are reluctant to make the huge investments in an unproven technology (Collins, 2004; Schrieber, 2005).

Innovation adoption rates can also be impacted by other phenomena such as civic, social, and ethical concerns of the adopters. Some of the risks are real while others are based on paranoia emanating from lack of knowledge and understanding. The key factors influencing management decisions include health, security, privacy, environment, and business ethics. The key health issue is the possibility of radio frequency waves having carcinogenic effects. However, recent research by the cell phone industry refutes these claims. Current emission levels of WLAN and RFID tags are below RF emission levels from cell phones (CISCO, 2005). In addition, RFID uses low-end of electromagnetic spectrum from which the waves are not dangerous for general public (ILO, 2006). The other areas of legitimate concerns are security (Goel & Crnkovic, 2005) and privacy (EPIC, 2005), are currently being addressed through encryption and other security technologies. There are significant environmental concerns primarily related to disposal of millions of tags including batteries for active RFID tags. However on the other

Figure 1. Model for exploring acceptance of RFID using the DOI model



hand, RFID tags also allow trash to be tagged and tracked, which provides some ecological advantages (Thomas, 2003). A growing concern about adoption of RFID technologies will have huge labor implications (Gonsalves, 2004; Jaques, 2004; ILO, 2006).

This study examines the impact of the factors suggested in the DoI model as well as the civic, social, and ethical concerns of decision makers.

In this research, we are expanding DoI outside from simply organizational settings to discuss the planning of implementing this new technology. There is a very strong network externality associated with the adoption of the new technology since the supply chain can only be automated if all vendors and suppliers in the chain have adopted the technology. However lack of standardization in the technology and protocols associated with RFID mitigates the impact of network externality. Nevertheless, in the current network environment where company supply chains are intricately linked, a group of companies operate as a single organization with adoption decision made at the level organizations in the supply chain. Typically DoI is applied to individual companies where adoption is considered as an individual level. In view of a network environment we extend the DoI theory to a group of firms linked together via a supply chain. We consider the adoption within the organization as micro level diffusion and the adoption by the firm as the macro level diffusion.

Our research model is presented in Figure 1 which shows that DoI is applicable at two levels: 1) the macro level (adoption by multiple companies in a supply chain), and 2) the micro level (acceptance of RFID within a single organization). Our focus in this paper is the adoption of RFID among companies in a supply chain or in other words, at the macro level. To obtain the reasons for adoption it is important to understand the perspectives of the management and we choose to employ the survey methodology as described in Section 3. We attempt to determine the factors preventing the implementation of the technology and to identify the stage of diffusion that organizations are by evaluating their perceptions of the technology.

3.0 DATA COLLECTION METHODOLOGY & PRELIMINARY RESULTS

3.1 Participants

The participants in the study are executives of companies that work full time and attend the Part-time MBA program at the University at Albany, State University of New York. These employees have a diverse background in areas such as engineering, finance, sales, accounting, medicine, and manufacturing. They all have a good understanding of the technology, but differing levels of interest in RFID deployment.

3.2 Procedures, Analysis, and Results

The survey questions were developed for the elements of DoI (relative advantage, compatibility, trialability, observability, and complexity) as well as ethical considerations (health, security, privacy, environment, and business ethics). The initial set of questions was created based on review of previous relevant literature in risk (Armitage et al., 1999; Goodhue & Straub, 1991) and refined via pretest interviews. An initial set of respondents was solicited to further demonstrate content validity and clarify the wording for each item. A pilot study will be conducted with a set of graduate students to ensure the initial reliability of the scales and the general mechanics of the questionnaire, such as instructions, completion time, and wording. The revised questionnaire will be used with the primary pool of respondents that are industry executives participating in the Part-time MBA Program. A small set of demographic questions (Appendix 3) will be used at the aggregated level. One of the authors administeres each of the surveys in person. Participants will be briefed of the study, and informed that participation was voluntary and had nothing to do with their normal MBA course work. In lieu of financial incentives as suggested by Dillman (2000), participants were promised a summary of the study. Data gathered from the pilot study and from completed survey will be examined using traditional statistical methodology. All results from the pilot study will be presented at the conference.

REFERENCES

[1] Rogers, E. M. (1995). Diffusion of Innovations. New York, NY: The Free Press.

[2] Rogers, E. M. & Shoemaker, F. F. (1971). Communication of Innovations: A Cross-Cultural Approach. New York, NY: Free Press.

[3] Moore, G. C. & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. Information Systems Research, 2(3), 173-191.

[4] Goel, S. & Crnkovic, J. (2005). RFID: Risks to the Supply Chain. Information Resources Management Association (IRMA) 2005 Conference Proceedings, Washington, D.C. IDEA Publishing, Hershey, PA.

[5] EPIC. Radio Frequency Identification (RFID) Systems. Electronic Privacy Information Center (EPIC). Retrieved on November 1, 2006 from http://www.epic.org/privacy/rfid/

[6] Erja Musstonen-Ollila, Kalle Lyytinen (2003). Why organizations adopt IS process innovations: a longitudinal study using DoI theory, Information Systems Journal, 2003, 13, 275-297

[7] Armitage, C. J., M. Conner, J. Loach, D. Willerts. 1999. Different perceptions of control: Applying an extended theory of planned behavior to legal and illegal drug use. Basic and Applied Social Psychology 21 301–316.

[8] Goodhue,D.L.and Straub,D.W,1991.Security concerns of system users: A study of perceptions of the adequacy of security. Information and Management, Vol.20, No.1, 13-27.

[9] Collins, J. (2004). RFID'S ROI Tops User Concerns. RFID Journal, October 2004, www.rfidjournal.com/article
[10] Schrieber, J. (2005). The Analytic Value of RFID. Teradata (NCR), EB-4556, 0905, www.ncr.com/en/solutions
[11] CISCO. (2005). Wireless Systems and RF Safety Issues. Cisco, Aironet 1100 Series, www.cisco.com/en/US/products/hw/wireless/
[12] Thomas, V. (2003). Product Self-Management: Evolution in Recycling and Reuse. Environ. Sci. Technol. 2003, 37, 5297-5302
[13] Dillman, D.A. (2000). Mail and Internet survey: The tailored design method. 2000, New York, NY: John Wiley & Sons
[14] Gonsalves, A. (2004). RFID saves money, displaces workers. EE Times Online, at http://www.eetimes.com
[15] Jaques, R. (2004). RFID to affect four million jobs. At http://www.vnunet.com
[16] ILO (International Labor Organization, 2006). Social and labor implications of the increased use of advanced retail technologies. Geneva, Switzerland, at http://www.ilo.org/public/english/standards/relm/gb/docs/gb297