The Likelihood of RFID (Radio Frequency Identification) Technology Initiation: The Exploratory Examination

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ABSTRACT

Firms believe that new technologies can change the way we do business similar to the way the Internet has changed commerce. Today, an emerging technology so called RFID (Radio Frequency Identification) would change the way of current business processes between firms and suppliers and customers. This study focuses on contextual variables such as environmental, organizational, and technological dimensions as major determinants of RFID investment intention and moderator effect such as trust and power with partners in the context of supply-wide. Survey was resulted in 250 out of the 90 firms which RFID is already either implemented or is willing to adopt. Uncertainty, organizational size, top management support, IT infrastructure, and tag compatibility influence positively the likelihood of RFID project initiation. In turn, while trust of trading partners moderate between competitor's competition, top management support and the likelihood of RFID project initiation, whereas power of trading partners moderate the relationship between uncertainty, size, top management support and the likelihood of RFID project initiation.

Keywords: IT investment, IT infrastructure, Radio Frequency Identification Systems (RFID), Adoption.

1. INTRODUCTION

During the last decade, the large potential impact of the Internet in firms, especially, supply chain management, was timely important and indispensable in the digital economy (Swaminathan and Tayur, 2003). Collaboration by supply chain partners over Internet can potentially save $223 billion with the reduction in transaction, production, and inventory costs (Keenan and Ante, 2002). Even though many companies adopted the new supply chain systems, each functional department of those companies still requires manual works to initialize or finalize their processes, i.e., for example, manual data entry, manual scanning barcodes, unorganized information results. It implies that firms still require huge intervention of human labor forces to create valuable information; meanwhile, it happens possibly inaccurate data or information from the semi-automatic processes (Scharfeld, 2001).

To solve this problem, a new technology introduced in industries called Radio Frequency Identification (RFID) technology, which stands for a technology that involves tags that emit radio signals and devices called readers that pick up the signal (www.epcglobalinc.org) is going to be a $3 billion market within five years as this sophisticated tracking technology gradually begins replacing its cheaper but still less powerful than the bar code system (http://en.wikipedia.org/wiki/RFID). IDC reported that the investment of RFID has already carried $91.5 million until 2003 and expect the investment to increase $1.3 billion until 2008, and record the annual growth of 70%. Firms expect that the RFID systems will significantly accelerate supply chain productivity, performance and effectiveness throughout and across trading partners (Gramling et al. 2003). In order to start RFID project, firms have to perceive the internal facilitators or barriers as well as supplier relationship. As the previous collaborating systems (i.e., Electronic Data Interchange: EDI) reflected (Son et al., 2005), the role of trading partners' trust and power in collaborating systems make a different result.

Although IT adoption has been researched in various areas, it still remains to the most emerging technology such as RFID for business and supplier relations. With the emergence of RFID, many believed that firm would wary the effect of the significance. However, a few large firms are looking for a better solution for their organizational processes to exchange their information. Numerous studies via EDI, Internet, SCM, or interorganizational value-added network systems have found the effects of adoption and use, organizations are still willing to replace their existing systems with RFID systems for various reasons. Most importantly, RFID reduce considerably human intervention during the operational transactions.

The goal of this study therefore identifies the determinant for the RFID technology and system from a firm itself and shows particularly the trading partner's considerations. Surprisingly, empirical research on RFID adoption in organization has not found positive evidence insofar but also little known about the RFID adoption with partners. We address our research questions in our paper: What are the determinants of RFID project initiation on the firm level? How partners' trust and power moderates between the determinant and RFID project initiation? We explore the determinants and moderators of RFID, offer a conceptual model, and examine the relationship between identified factors and the likelihood of RFID project and trading partners' trust and power effect. We provide literature review in section 2, research model and hypotheses in section 3, research methodology, results, and discussion in section 4, conclusions, implications, and limitation in section 5.

2. LITERATURE REVIEW

2.1 RFID Technology/Systems

Like a bar code, a Radio Frequency tag is a data carrier. While a bar code carries data in a visible symbol and is read at optical or infrared wavelengths, and RFID device (or tag) carries data programmed into a chip and operates at radio frequencies, typically 125 KHz, 13.56 MHz, 2.45GHz and around 900MHz (AIM Inc WP-98/002R2). RFID systems have two different devices, which is actively transmitted called transponder; on the other hand, tags not actively transmit signals to a reader. Radio frequency in reader detects a tag at a remote distance without a necessity of any line, for example, a car that has an authorized tag can pass the entrance parking lot simply. RFID tags have specific data related to the identification of an object. Company will identify the tag attached on an object when a sale occurs, and then the tag will be deactivated after a consumer takes it out. RFID tags consist of a semiconductor chip with memory processing capability and a transmitter connected to an antenna. The tags have a different kind of memory type such as read only, write once, read repeatedly, or write and read together. Furthermore, recent tags have not a chip-called 'chipless tags' instead, these tags have a limitation of data storage, range and data transfer compared with chip-based tags. RFID tags can be divided into chip-based tags and chipless tags. RFID tags will be used mainly for payments, identification, information collecting or a

combination of the above (Intermec, 2003). The reader comprises an antenna and a controller. The controller codes, decodes, checks and stores the data, manages communications with the tags and communicates with the management system. Reader only reads data from the tags whereas an 'interrogator' reads data from the tags and writes data to them. The management system of RFID is the nerve centre for the application and forms part of the FRID user's information technology system. It is responsible for using the data received from and sent to the RFID tags for logistics and commercial management. Readers are also capable of reading all or only relevant parts of the data depending on how the system is programmed (AIM Inc, 2000).

2.2 Innovation and Adoption

Many innovation studies have researched in conceptual issue articles (Downs and Mohr, 1976; Ven de Ven, 1986) as well as empirical studies such as between innovation and performance (Damanpour and Evan, 1984), categorize types of innovations (Damanpour, 1987), and determinants and moderators of innovation (Damanpour, 1991). Damanpour (1991) explains the adoption of innovation that is the generation, development, and implementations of new ideas including a new product or service, a new production process technology, a new structure or administrative systems, a new plan & policy, program etc. Thong notes the Rogers(1983)'s definition of an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption (p.190)'. Innovation occurs when a new idea is exercised and used across each employees or individuals (Damanpour, 1984), which is caused by not only firms' internal interest but also environmental factors (Damanpour and Evan, 1984), and which is the level of economic and social use of product and process consisting with needs and wants (Utterback, 1971). Innovation theory encompasses adoption, diffusion, and implementation of firms, which look for a better organizational efficiency and effectiveness (Damanpour, 1991). Innovation is a way of method to change organization, which is categorized as major three dimensions: administrative and technical, product and process, and radical and incremental (Damanpour, 1991). Administrative innovation refers to the wide range of changes in administrative core such as organizational structure, administrative processes, and management whereas technical innovation entails products, services, and production process technology that are primarily work activities in organization. Secondly, process innovation, which it improves production process through the new method, machines, or production systems. IS adoption may be included in this category, whereas, production innovation, which it introduces a new product, goods, or service to consumers. Finally, innovation can be realized radically (shock or big bang) or incrementally (gradually or phased approach). The adoption of IT is closely related to technical innovation and process innovation that can bring changes of organization processes or procedures.

Damanpour (1991) introduced 13 organizational determinants of innovation: specialization, functional differentiation, professionalism, formalization, centralization, managerial attitude toward change, managerial tenure, technical knowledge resources, administrative intensity, slack resources, external communication, internal communication, vertical differentiation. Premkumar et al (1994) reveal the most frequent cited factors of innovation such as compatibility, relative advantage, complexity, cost, communicability, divisibility, profitability, social approval, trialability, and observability. Ramamurthy and Premkumar (1995) categorize three dimensional determinant for IT diffusion: innovation factors (compatibility, complexity, cost-effectiveness, relative advantage), organizational factors (top management support, task scope, IS sophistication, championing), organizational learning (elapsed time after IS adoption). Tornatzky and Fleishcer (1990) have provided a considerable underlying dimension of determinant of innovation such as the context of environment, organization, and technology. Their theoretical framework provides a parsimonious view of determinant toward innovation; therefore, many IT researchers have applied their research framework into different type of applications in the various context (Chau and Tam, 1997; Chengalur-Smith and Duchessi, 1999; Chwelos et al., 2001; Forman, 2005; Grover and Goslar, 1993; Iacovou et al., 1995; Khoumbati et al., 2006; Premkumar, Ramamurthy, and Nilakanta, 1994; Rai et al., 1997; Thong, 1999; Zhu and Kreamer, 2005).

Environmental dimension: In early work of innovation, the environment conditions affect a firm to implement or adopt innovation (Mansfield et al. 1977; Utterback, 1971). Specifically, uncertainty in the competitive environment has received considerable attentions in the strategy literature. Milliken (1987) explains that the uncertainty is caused by the lack of information and the perceived inability toward prediction. Perceptions of environmental uncertainty occur when executives are unable to predict future changes in components of the environment or possess an incomplete understanding of the relationships among components of the environment. Much of the theoretical and empirical work on uncertainty has focused on perceptions of uncertainty in the firm's industrial environment (Tosi and Slocum, 1984). Environmental conditions in market are changing constantly through competition. Competitor is a major facilitator to enable a firm to think other strategic options (for example, IT investment) (Kim and Sanders, 2002). The competitor reactions or counter reactions on IT investments may affect the revenue or cost of a firm structure in a long-term base and can justify an IT investment decision making (Garud et al., 1998). In terms of bandwagon effect, bandwagons are not because of its innovation's benefit itself but because of pressure from other firms that have already adopted the innovation (Abrahamson and Rosenkorf, 1993). Abrahamson and Rosenkorf (1993) argued that technological, administrative, or strategic innovation would be adopted with bandwagon way if a firm feels losing competitiveness against competitors. Thus, competitors' pressures a firm to adopt an innovation as good as uncertainty in environmental conditions.

Organizational dimension: Ein-Dor and Segev (1982) introduced ten organizational context variables related to the success of MIS. These variables include organizational maturity, organizational size, organizational structure, organizational time frame, the organizational physiological climate toward MIS, the extra-organizational situation, organizational resources, rank and location of the responsible executive, and the steering committee. Among the ten organizational contexts, they stressed that size is recognized as an important determinant of organizational MIS structure both directly and indirectly. They measures organizational size as three measures: size relative to the relevant industry, number or employees, and total sales. Organizational size is traditionally the most critical factor to management literature (Dewar and Dutton, 1986; Moch and Morse, 1977). However, organizational size also has some controversial points that affect positively or negatively on innovation. Damanpour (1989; 1991) found that there is a positive relationship between organizational size and innovation, however, oppositely, large organization is usually more complex and slow, which make a firm to adapt to change hard and lead implementation slowly (Baker and Cullen, 1993). Many researchers have explained the reason of positive effect as following: economies of scale (Kimberly and Evanisko, 1981), slack resources (Eveland and Tornatzky, 1990), accessible outside resources (Attewell, 1992), and the dependable adoption risks (Hannan and McDowell, 1984), decision agility and prior technology experience (Zhu and Kreamer, 2005). In addition, management in organizational aspect is a critical factor as well. Empirical researches found that top management support has positively associated with IT implementation, success, effectiveness, and diffusion (Ramamurthy and Premkumar, 1995; Thong et al., 1996). Favorable attitude of top management toward innovation affect organizational climate and lead member's behavioral change, since top management has broad view of IT and responsibility of IT strategy, planning objectives, policies, and funding (Thong et al., 1996).

Technological dimension: Bharadwaj (2000) claims that the importance of IT capability of a firm and a firm's IT infrastructure that composes of computer and communication technologies and the shareable technical platforms and databases. In this age, as firms' IT infrastructure span not only entire organizations but also link key supplier and customers in helping its cross-functional processes and cross-selling opportunities. Developing a RFID system may require the current IT infrastructure including enterprise database, network, and operation system would combine seamlessly for the data flow from one application to another and from one part of an organization to another. Taniverdi (2005) asserts standardized IT infrastructure enable firms to span their business processes and provide information and knowledge exchange. Another important factor in technology dimension, current systems VS. New systems should be compatible. Compatibility is conceptualized as consistent existing practices, values, past experience or norms with a new adopting of innovation (Forman, 2005). IT comprises several aspects concerning the compatibility, which should fit with the legacy system, other organizational systems or new one such as hardware, software, and infrastructure, for example, integration of data from different database systems of other organizations, or between interorganizational systems (Ein-Dor and Segev, 1982). Researchers have claimed that those three dimensions (environment, organization, technology) have been consistently found to be important.

3. RESEARCH MODEL AND HYPOTHESES

Based on the literature, we suggest the likelihood RFID project initiation model shown in Figure 1. In this model, we conceptualized as consisting of environmental, organizational, and technological dimensions toward the initiation of RFID project directly and moderating effect of trust and power between firms and trading partners for the initiation of RFID project. Accordingly, we develop and test, firstly, determinants and dependents hypotheses representing: (H1, H2, H3) and, secondly, moderating effects on between the determinants and the likelihood of RFID project initiation representing: (H4, H5).

3.1 Environment

Environmental dimension are categorized as uncertainty and competitors (Miller and Droge, 1986). Uncertainty in this study is defined as the inability to predict product and service from changes in market. As the variety of products and services offer in market, firms are hard to predict market conditions. In addition, depending on the number of competitors and action of competitors, firms tend to pursue strategic options to cope with market conditions (Kim and Saunders, 2002). Concerning the environmental factors with IT&S innovative adoptions, there still be arguments on either a positive impact or not. Grover and Goslar (1993) found significant relationships between environmental uncertainty and the usage of these technologies, vice versa, others who applied the environmental factors in their open system adoption (Chau and Tam, 1997) and CASE tool adoption (Rai and Patnayakuni. 1996) did not find the significance or negative between the market uncertainty and adoption. The findings may be resulted in differently depending on the context, type of applications. The environmental issues including uncertainty and competitors are importantly related to RFID adoption whether firm are willing to invest to preempt the RFID future market such as Wal-Mart or slow because of environment uncertainty. Thus, we suggest the following hypotheses:

H1-1: The relationship between environment uncertainty and the likelihood of RFID project initiation has significantly associated.

H1-2: The relationship between competitor's action and the likelihood of RFID project initiation has significantly associated.

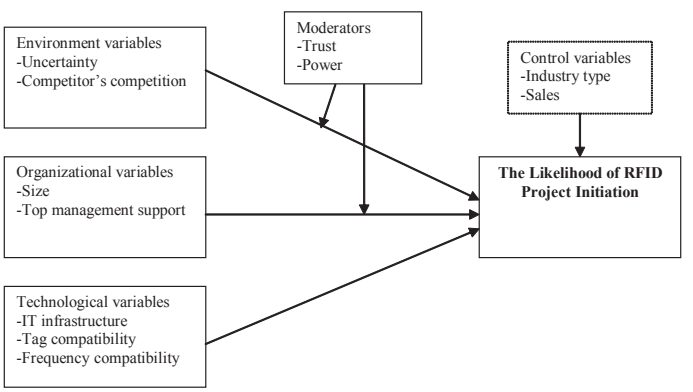
3.2 Organization

Ein-Dor and Segev (1982) posited that organization's size tend to affect organization context. They provide validity of measurement by the number of employees. Organizational size was found as strong determinant of innovation (Damanpour, 1989; 1991). Also, many empirical findings have shown the positive relationship with IT adoption ( ). In terms of RFID, many large firms such as Wal-Mart, Target, and DOD have interested in replacing Bar code systems as RFID as a strategic option. In addition, Damanpour (1991) posits that administrative intensity is one of critical determinant for innovation. Successful adoption of innovation always depends on largely on leadership, support, and coordination of manager. IT innovations always cope with risks of failure caused by the lack of financial support (Ramamurthy and Premkumar, 1995), therefore top management support is essential. In empirical research, top management support has positively associate with adoption, and diffusion (Ramamurthy and Premkumar, 1995, Thong et al., 1996; Wang et al., 2006). Given the potential of RFID to influence the firm's strategic interest and internal operational efficiency as well as its trading partner's relationships, top management will be strongly involvement necessary, need a strong support for initiating RFID project. Hence, we propose:

H2-1: The relationship between organizational size and the likelihood of RFID project initiation has significantly associated.

H2-2: The relationship between top management support and the likelihood of RFID project initiation has significantly associated.

Figure 1. The likelihood of RFID project initiation model



3.3 Technology

IS research has posited that IT infrastructure, IT maturity, and IS sophistication such as IT resource, skill, and expertise is positively associated with IT success, adoption, diffusion, and performance (Grover and Goslar, 1993; Ramamurthy and Premkumar, 1995, Tippins and Sohi, 2003; Taniverdi, 2005). Zhu and Kreamer (2005) show that EDI and Electronic Fund Transfer infrastructure make a firm easy to do Internet business. RFID is essentially necessary from the current IT infrastructure support so that data transactions can be seamlessly overall internal organization as well as external trading partners. In addition, IT compatibility refers to the degree of consistency with the existing legacy systems, procedures, and new systems (Forman, 2005). The more IT innovation compatibility exists, the more likely firms will adopt the new systems (Premkumar et al., 1994). Current state of RFID has lack of standards, which various applications and industries not only pursue different vendors' competing frequencies and protocol but also not even exist yet open systems (AIM inc, 2001). The key components of an RFID system are tag (Asif, 2005) and frequency (AIM Inc, 2001). Choice of tag and frequency wave is also primary importance in determining data transfer rates (AIM Inc, 2001). Thus, type of tag and frequency compatibility would be primary concerns for firms that are likely to adopt the RFID. Here, we propose the following hypotheses:

H3-1: The relationship between IT infrastructure and the likelihood of RFID project initiation has significantly associated.

H3-2: The relationship between types of RFID tag and the likelihood of RFID project initiation has significantly associated.

H3-3: The relationship between types of RFID frequency and the likelihood of RFID project initiation has significantly associated.

3.4 Moderator Effects

Some studies have shown evidence of a positive relationship between trust and power and EDI use and adoption (Hart and Saunders 1997;1998; Son et al., 2005). However, these findings have not discussed major determinants of innovation in theoretical basis that might affect innovation. We assume that the possibility of a moderating effect that affects the effectiveness of innovation adoption and use is consistent with traditional variables for the innovation theory. On the basis of Hart and Saunders (1997)'s study, we induce trust and power possible moderator effects of major innovation determinants on IT adoption. We will examine that trust and power could affect the relationship environmental and organizational dimensions and IT adoption. If these moderating effects exist, firms should focus on possible considerations for the adoption through adjusting the degree of trust and power with trading partners. For example, a new technology in the early stages of a market is influenced by uncertainty as well as by competitors' behavior. Also, it is important to remember that organizational factors are important element of innovation and thus both organizational size and its management support would be crucial to strengthen or weaken the relationship of determinant and IT adoption.

Trust: Hart and Saunders (1997) posit that trust is vital factor in interorganizational relationship. Its trustful relationship facilitate firms to invest their shareable resources rather that behave opportunistic action among other alternatives. Trust explained by Hart and Saunders (1997) is "the behavior of another will confirm to one's expectation and goodwill of another" (p.24) without exploring vulnerability. In terms of firm's trust, which one firms can make another firm perform better and would not make negative result for the firm (Son et al., 2005). Trust may not be build by artificial relation or just long-term trading but "fair dealing" between buyer and supplier in a reciprocal transaction (Hart and Saunders, 1997). In terms of IT systems, IT encourages firms to share information with their partners. Once firms and their partners make a co-investment on IT, its benefit arises from not just coordination but the reduction of uncertainty for the future. Son et al (2005) stress that reciprocal investment draws one party desires to stay relationship firmly into the future. To improve their collaboration through IT, firms first build trustful relationships with their partners. The collaboration based IT and trust enables the

firms to span their business processes and enrich their information sharing with partners. Thus, trust makes a strong relationship to bring co-IT investment and sharing assets and accomplish their strategic and operational outcomes through IT. RFID also needs to share information with between buyer and supplier more enhanced method, even individual customers. The main benefits of RFID exists transaction with suppliers and buyers having accurate information, visible stock data, physical inventory counts such as receiving, picking and shipping, and so on. To achieve this objective, firms need to build RFID into the entire supply chain of transaction and planning systems—of its own plans as well as those of its suppliers and customers. It is strongly necessary of firms to share RFID project plan based on partner's trust. Recently, Zhu et al (2006) study that a moderating variable affects between independent variables and dependent variable, which they incorporate a firm's prior experience of EDI the relationship between the adoption costs and the open-standard EDI adoption. They found that firms that have experienced EDI made a different response toward the Internet based Inter Organizational Systems (IOS). Based on the notion of moderating effect, we infer that the likelihood of RFID project initiation will be differently depending on trust. In this study, we assume that trust would moderate the relationship between environmental factors and organizational factor and RFID project initiation. Hence, we provide the following hypothesis:

H4-1: Trust with trading partners will moderate the relationship between environmental uncertainty and the likelihood of RFID project initiation.

H4-2: Trust with trading partners will moderate the relationship between competitors' competition and the likelihood of RFID project initiation.

H4-3: Trust with trading partners will moderate the relationship between organizational size and the likelihood of RFID project initiation.

H4-4: Trust with trading partners will moderate the relationship between top management support and the likelihood of RFID project initiation.

POWER: Hart and Saunders (1997) posit that power can affect change of a trading partner. A buyer-supplier relationship for adopting a new technology is resistant, hesitant, disobedient, or refuses from the trading partners. In those cases, firms that are more powerful use their power to less powerful partners to listen, and act for their proposal. Hart and Saunders (1997) define power as "the capability of a firm to exert influence on another firm to act in a prescribed manner" (p.24). Thus, using power for partners is a very useful method that adopts EDI (Chwelos et al., 2001). Generally, power depends on a firm's revenue, if a certain buyer generates a supplier's revenue with a large portion, the buyer can have power against the supplier under the condition of other alternatives to be options (Hart and Saunders, 1997). In case, the buyer pushes the supplier to accept its proposal. Vice versus, if the numbers of suppliers are small, unique (Williamson, 1985) or not any alternatives, then, buyers relatively more depend on suppliers, which oppositely decrease the control power for the supplier (Hart and Saunders, 1997). They explain potential power and exercised power, which potential power is a type of influence that is not yet exercised that most likely to influence in EDI adoption when a less powerful firm has already adopted EDI. On the other hand, exercised power is a type of influence in EDI adoption when a less powerful firm has not any EDI with any other trading partners (Hart and Saunders, 1997). Power can be exercised two ways: persuasive and coercive. Persuasive method is that firms that are more powerful give rewards or benefits to their partners in response to their request. Vice versus, coercive method is that firms that are more powerful threat verbally they would stop doing business or actual punishment to the firms that are less powerful unless they don't listen. Power allegedly frequently exercises in industries such as automobile, large retailers like Wal-Mart, Sears etc. (Hart and Saunders, 1997). However, there are not many researches on the moderating effect of power between determinants and dependent variables. Thus, we exploratory test that power will moderate the relationship between environmental factors and organizational factors and RFID project initiation. We suggest the following hypotheses:

H5-1: Power with trading partners will moderate the relationship between environmental uncertainty and the likelihood of RFID project initiation.

H5-2: Power with trading partners will moderate the relationship between competitors' competition and the likelihood of RFID project initiation.

H5-3: Power with trading partners will moderate the relationship between organizational size and the likelihood of RFID project initiation.

H5-4: Power with trading partners will moderate the relationship between top management support and the likelihood of RFID project initiation.

3.5 Control Variables

We consider two control variables to affect our results: Industry type and sales. First, industry type may significantly affect innovation adoption (Zhu et al., 2006), since industry-specific type may specially have interested in RFID adoption such as retailing and logistics, manufacturing, and IT&S software industries, which those industries would expect to achieve a major benefit from the automatic value chain activities. Second, firm size may significantly affect innovation adoption, because large firms may have more slack resource. Douma et al. (2006) assert that sales are a proxy for the size of a firm. Fiss (2006) used an alternative measure such as sales for firm size. Thus, our study set two control variables in our analysis, which variables are various industry type and broad range of sales, may affect our results.

4. RESEARCH METHODOLOGY

4.1 Data Collection

We collected data using survey questionnaire for a wide range of firms and industries from South Korea, in which RFID has either already implemented or being implemented or is plan to adopt RFID. The names and address of ninety firms that have interested in RFID is obtained from LGCNS Company, which is one of biggest IT service companies in South Korea. LGCNS provided the list of potential firms that are planning to adopt RFID for its potential RFID project. We made survey instruments based on IS literature and pretest them for 40 MBA students to ensure the validity of our data. Over two months from early October through late November of 2004, we conducted 250 survey by visit, mail, email, and fax for two or three people simultaneously at a same company (project manager, consulting partner, IS senior executives, task employee, middle managers), who are involved in RFID TFT(Task Force Team) out of 90 firms. They are all involved in RFID project. Before we contact each respondent, we call everyone and explain the purpose of this study, on the other hand, when we visit, we also explain to the respondents about the goal of this study. We collected totally 195 out of 250 surveys from the 90 companies. The response rate is 78%, unusable data is 24, then, 171 used for analysis (response rate: 68.4%). We collected data from various industries such but mainly retail & logistics (40.0%), manufacturer (26.7%) and sales range from over 50 million U.S dollar (15.5%), 1-5 million (30.0%), and 0.5-1 million (32.3%). The plan of RFID adoption will be within one year (42.1%), and 6 month (20.0%), being implemented (7.8%), and already implemented (8.9 %). See Table 1.

4.2 Data Analysis

Instrument Development: To develop the survey instrument, generally accepted instrument development guidelines were followed. Scale items are shown in

Table 1. Statistics of demographic

		Frequency	Percent
Industry	Manufacturing	24	26.7
	Plant & Constructing	7	7.8
	Retail & Logistics	36	40.0
	IS & IT, Software	21	23.3
	Non-profit org	2	2.2
Sales	Less than 0.5 mill	6	6.7
	0.5-1 mill	29	32.3
	1-5 mill	27	30.0
	5-10 mill	9	10.0
	10 -50 mill	5	5.5
	More than 50 mill	14	15.5
Employee	Less than 50	27	30.0
	51-100	33	37.0
	101-300	7	7.8
	301-500	5	5.5
	501-1000	5	5.5
	Over 1,000	13	14.2
Plan of RFID adoption	No plan	4	4.5
	Within 3 years	15	16.7
	Within 1 year	38	42.1
	Within 6 months	18	20.0
	Being implemented	7	7.8
	Already implemented	8	8.9

Table 2. Correlation matrix for likelihood of RFID initiation

Variables	AVE	S.D	ENV_U	CORTR_C	ORG_SZ	TMS	ITINFRA	TG_C	FRE_C	T_TRT	T_PWR	RFID_AD	***Industry***	***Sales***
ENV_U	4.67	.663	1.000											
COPTR_C	5.22	.600	.278**	1.000										
ORG_SZ	2.38	1.68	.087	.302**	1.000									
TMS	4.94	.967	.070	.213**	.088	1.000								
ITINFRA	2.66	.783	-.099	.094	.323**	.193**	1.000							
TG_C	5.22	.783	.118	.004	.090	-.073	-.277**	1.000						
FRE_C	5.29	.627	.124	.040	.032	-.042	-.047	.095	1.000					
T_TRT	5.15	.734	-.140*	.087	.230**	.162*	.039	-.094	-.028	1.000				
T_PWR	4.77	.897	-.024	.197**	.175**	.154*	.127	.043	.007	.037	1.000			
RFID_AD	3.31	1.32	.150**	-.089	.102**	.038	.033	.005	.272**	-.119	.156**	1.000		
Industry	3.45	1.57	-.147*	.080	.155**	-.152*	.226**	-.060	-.069	-.076	-.144*	-.435**	1.000	
Sales	3.12	1.39	.036	.243**	.928**	.150*	.305**	.059	.023	.230**	-.004	.263**		1.000

Note: N=171

*Significant at *p<.05; **p<.01*

ENV_U=Environmental Uncertainty, COPTR_C=Competitor's Competition, FRM_SZ=Firm Size, TMS=Top Management Support, ITINFRA=IT Infrastructure, TG_C=Tag Compatibility, FRE_C=Frequency Compatibility, T_TRT=Trading Partners' Trust, T_PWR=Trading Partners' Power, RFID_AD=Likelihood RFID Adoption, IND=Industry

Appendix A. Many items were derived from earlier work and adapted them to this study. However, scale items for tag and frequency compatibility were newly development. Although many scholars have developed compatibility, there is few for RFID tag and frequency. To measure used in this study is a 7 Likert scale (Strongly disagree =1 or Strongly agree =7) measure of detailed aspects of adoption determinants in IT&S implementation that researchers is likely to adopt. The development of the compatibility of tag and frequency was grounded in the work of ABI Research (2003).

Descriptive Statistics and Correlations: The Pearson Correlation Matrix for the likelihood of RFID initiation was analyzed. The correlation among the independent variables were conducted by the aggregated measure of each variables in Table 2.

Data Reliability and Validity: Table 3 shows the result of reliability test. The reliability analysis is conducted on the 24 items that measured the components for this study. Cronbach's alpha value is showed over 0.6, which the value is recommended as threshold for the exploratory research (Nonnally, 1978). All constructs had higher than 0.60 cutoff alpha values, ranging from 0.6213 to 0.8968.

For convergent validity, items having item-to-total correlation scores lower than 0.4 were dropped from further analysis in Table 4. Factor analysis is used to check discriminant validity. Because each variable was measured by multi-item constructs, factor analysis with Varimax method is conducted to check the unidimensionality among items. Items with factor loading values lower than 0.5 are deleted.

Table 3. Reliability

Variables	Items	Cronbach's Alpha
Environment Uncertainty	2	0.6328
Competitor's competition	3	0.6425
Organizational size		N/A
Top management support	3	0.8851
IT Infrastructure	5	0.8968
Tag compatibility	2	0.7555
Frequency compatibility	3	0.6213
Trust	3	0.8569
Power	3	0.8140

4.3 Regression Analysis

A hierarchical regression analysis tests our hypothesis. For each hypothesis, each dimension of independent variables is run for the dependent variable separately and control variables (industry type and sales) are included in each regression analysis as shown in Table 5. Our model is considered as an aggregated variable, and its correlation is computed. To meet the assumptions of regression analysis, we examined the linearity, constant variance, and normality (Hair et al., 1995). Our model includes industry type and sales as a control variable shown significant positive relationships between two control variables and the likelihood of RFID initiation. Table 5 presents the regression analysis results. In this study, we used a hierarchical regression analysis the following equation model.

Equation:

The Likelihood RFID Adoption =f(Independent variables, Control variables)

$Model1=\alpha_0+\beta_1 ENV\_U+\beta_2\ COPTR\_C+\beta_3 Industry+\beta_4 Sales+\varepsilon$

$Model2=\alpha_0+\beta_1 OS+\beta_2\ TMS+\beta_3 Industry+\beta_4 Sales+\varepsilon$

$Model3=\alpha_0+\beta_1 ITINFRA+\beta_2\ TG\_C+\beta_3 FRE\_C+\beta_4 Industry+\beta_5 Sales+\varepsilon$

The results supported hypotheses 1-1, 2-1, 2-2, 3-1, and 3-2. The likelihood of RFID project initiation is significantly associated with environmental characteristics (uncertainty), organizational characteristics (size, top management support), and technological characteristics (IT infrastructure, tag compatibility), and two control variables (industry type, sales) are also associated positively with the likelihood of RFID project initiation. One environmental characteristics (competitor's competition), and technological characteristics (frequency compatibility) are not significantly related to the likelihood of RFID initiation in Table 5.

Moderating effect is explained as the impact of a predictor variable that has on a criterion variable is rest on the level of a third variable called the moderator (Venkatraman, 1989). It will affect the direction of strength of relationship between independent variables and dependent variables.

Y = f(X, Z, X*Z), X, Z are independent variables, Y is dependent variable, and X*Z is represented as a joint effect. Moderating effect equation set into following way:

$Y=\alpha_0+\alpha_1 X+\alpha_2 Z+\varepsilon$

$Y=\alpha_0+\alpha_1 X+\alpha_2 Z+\alpha_3 X*Z+\varepsilon,$

Table 4. Rotated factor matrixes with Varimax rotation

	Factor1	Factors	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8
ITINFRA1	0.805							
ITINFRA2	0.906							
ITINFRA3	0.835							
ITINFRA4	0.840							
ITINFRA5	0.788							
TMS1		0.891						
TMS2		0.892						
TMS3		0.843						
T_TRT1			0.913					
T_TRT2			0.883					
T_TRT3			0.812					
T_PWR1				0.862				
T_PWR2				0.889				
T_PWR4				0.748				
TG_C 3					0.867			
TG_C4					0.862			
ENV_U1						0.838		
ENV_U2						0.768		
COPTR_C1							0.745	
COPTR_C2							0.726	
COPTR_C3							0.628	
FRE_C2								0.740
FRE_C3								0.629
FRE_C4								0.744
I-gan Value	4.325	2.954	2.545	2.144	1.827	1.500	1.364	1.057
% of Variance	18.022	12.309	10.606	8.935	7.617	6.251	5.682	4.405
Cumulative Variance	18.022	30.332	40.938	49.873	57.486	63.738	69.420	73.825

<Table 5> The Likelihood of RFID Project Initiation

Explanatory variables	Model1 (Environment)	Model2 (Organization)	Model3 (Technology)
ENV_U COPTR_C	.116(2.827**) -.051(-.797)		
OS TMS		.888(5.680**) .265(3.107**)	
ITINFRA TG_C FRE_C			.218(3.464**) .256(4.513**) .030(.505)
Industry Sales	-.374(-5.980**) .164(2.594**)	-.374(-5.980**) .164(2.594**)	-.407(-6.892**) .239(3.911**)
R^2 Adjusted R^2 F-Value	.228 .112 1.710**	.564 .216 16.133**	.563 .101 10.606**

**P<.05, **p<.01*

The moderation effect is supported if the unstandardized coefficient, α3, differs significantly from zero.

Moderating effect equation:

The Likelihood RFID Adoption =f(Independent variables X Moderating variables)

$Model4=\alpha_0+\beta_1 ENV\_U\ \Xi\ Trust+\beta_2\ COPTR\_C\ X\ Trust+\varepsilon$

$Model5=\alpha_0+\beta_1 OS\ \Xi\ Trust+\beta_2\ TMS\ X\ Trust+\varepsilon$

$Model6=\alpha_0+\beta_1 ENV\_U\ X\ Power+\beta_2\ COPTR\_C\ X\ Power+\varepsilon$

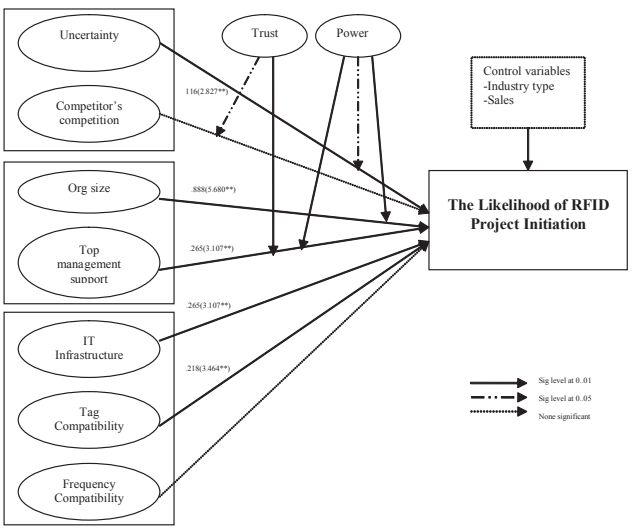
$Model7=\alpha_0+\beta_1 OS\ X\ Power+\beta_2\ TMS\ X\ Power+\varepsilon$

We show the result of our hypotheses in Figure 2.

Table 6. The moderating effects

	Trust	β	R^2	ΔR^2	ΔF	p
Model4	ENV_U COPTR_C	.417 -.509	.237 .242	.002 .013	.459 3.751	.499 .044
Model5	OS TMS	-.643 -2.256	.216 .261	.007 .032	2.213 9.210	.138 .003
	Power	β	R^2	ΔR^2	ΔF	p
Model6	ENV_U COPTR_C	1.233 -1.127	.263 .247	.015 .009	4.476 2.561	.036 .111
Model7	OS TMS	-2.960 -2.252	.473 .304	.154 .068	62.979 21.041	.000 .000

Figure 2. The estimated model



4.4 Result and Discussion

We investigate two-dimensional sides for the likelihood of RFID project initiation. One hand is the determinant effects, on the other hand is the moderating effect on the relationship between determinants and the likelihood of RFID project initiation. The data analysis shows that environmental uncertainty has a major effect on the likelihood of RFID project initiation, whereas competitor's competition is not significantly related. Organizational size and top management support, both, are strongly effect on the likelihood of RFID project initiation, and IT infrastructure and tag compatibility influence positively the likelihood of RFID project initiation, except frequency compatibility is not related. As RFID technology emerges in market, many firms expect the benefits and predict their RFID potential impact on business, then, shows more positive attitude toward the RFID adoption under uncertainty. This result provides support for Grover and Goslar (1993)'s findings which uncertainty is positively related to telecommunication adoption. But, inconsistently, competitor's competition (competitive intensity) does not show a significant relation as good as Grover and Goslar (1993)'s. Organizational size and top management support are consistent with the IS literature. A firm that is a large size is likely to a chance to invest a new IT with enough slack resources (Forman, 2005, Teo et al. 2003; Zhu and Kreamer, 2005). Top management support is always critical factor for adoption innovation in a firm. If the innovation is viewed as a better solution for the firm than the existing system, it is paid attention by top management. Another major determinant affecting of the decision to adopt RFID is IT infrastructure, since the RFID technology should heavily depend on the existing systems. Compatibility of tag and frequency is a peculiar issue for RFID system that should carefully concern not likely other systems. RFID consists of the tag and frequency. Practically, the rate of data transfer is affected by the frequency of the carrier wave. The higher the frequency the higher the data transfer. Depends on the type of tags (passive or active tag), the passive tags are less expensive and unlimited operational lifetime but shorter read ranges, whereas the active tags is higher data transmissions rates, which has the ability to perform well in electromagnetically noisy environments (AIM Inc. White Paper, 2001). Depends on the type of tag and frequency, firms' RFID investment cost and overall organizational effectiveness would be different. RFID is a technological innovation that demands a large portion of IT budget of firms. Most of all, the tag and frequency will affect the future projects that would be extended based on the prior type of tag and frequency. In the context of RFID adoption by firms, the capacity of tag and frequency should be compatible with not only the current organizational process but also current using systems.

The moderating effects are also examined. When trust with trading partners is involved in the relationship between competitor's competition and the likelihood of RFID project initiation, the result changes statistically significance but negatively moderate on the relationship (β: -.509; $p<0.05$). Top management support also is negatively moderated by trading partner's trust (β: -2.256; $p<0.01$). In terms of the trading partner's power, the power moderates positively the relationship between environmental uncertainty and the likelihood of RFID project initiation (β: 1.233; $p<0.05$), whereas the power moderate negatively both relationship between organizational size and top management support (β: -2.960; $p<0.01$; β: -2.252; $p<0.01$). In addition, we show more specific further analysis about power, which a firm has higher power or lower power toward the trading partners. Figure 3 presents the moderating effects of power through graph. The high power group is relatively showing the higher moderating effect than the low power group does. In sum, uncertain business environment, organizational size, and top management support shows that there is moderating effect by firm's power. The moderating effect of trust is negatively engage in competitor's competition and top management support.

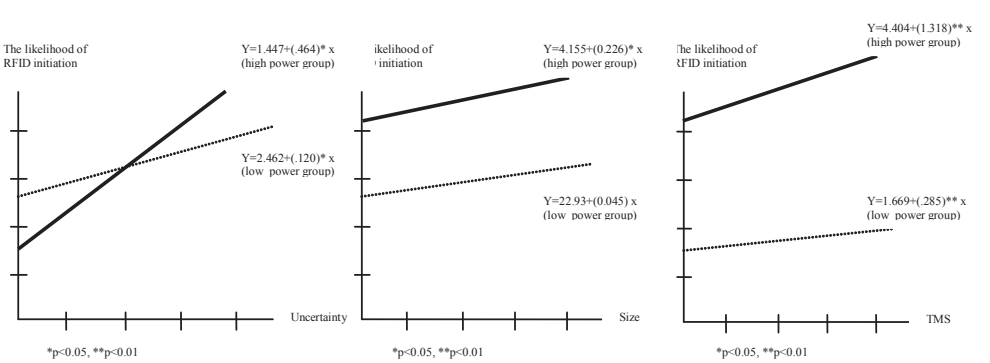
5. CONCLUSIONS

Technology adoption has widely been researching in IT&S areas with innovation theory. This study developed and tested an exploratory model of RFID adoption in early RFID stages. The results support the almost of all hypotheses that are suggested. Three deterministic variables and two moderating variables are important factors in explaining the consideration of RFID project initiation. Environmental uncertainty, organizational size, top management support, IT infrastructure, and tag compatibility have a direct impact on the likelihood of RFID project initiation, whereas the competitor's competition and frequency compatibility have no direct impact on the likelihood of RFID project initiation. In case of moderating effects, trust and power of trading partners show different results on the relationship between determinants and the likelihood of RFID project initiation. Trust moderates the competitor's competition and top management support on the likelihood of RFID project initiation, whereas power moderates the uncertainty, organizational size, and top management support on the likelihood of RFID project initiation. Therefore, the moderating effect supports partially our model.

There is a question why the degree of competition and top management support should be influenced by trust moderator. According to Premkumar and Ramamurthy (1994)'s findings, they found competitive pressure is related to reactive adoption of EDI, whereas top management support is related to proactive adoption of EDI. Those two factors are found evidence of a close relation with their trading partners (Hart and Saunders, 1998). Therefore, we assume trading partner' trust may strength or weaken the determinant and RFID adoption. Indeed, a substantially IT adoption should find more opportunities with trading partners than any other conditions. On the other hand, uncertainty, firm size, and top management support why should be influenced by power moderator. Power is the firm's ability to influence change in another firm that trade. We assume that large firm has more power to their partner than small firms do and top management support would be different depend on its partner's power under the uncertainty. For example, large firm can threaten to quit trading with partners unless the firm adopts RFID. This is why trust and power is as important and is supported as moderator. In sum, the trust and power play an important role for RFID adoption in interorganzaitonal IS system implementation.

The study provides some implications for both practitioners and researchers. In response to practical implications, the study explores the determinants and RFID adoption in early stage of RFID systems. Firms understand not only the benefits of RFID adoption but also the important factors that can facilitate to invest the RFID systems with trading partners. When RFID systems implement, trust and power of trading partners may influence. If the RFID system is not perceived as beneficial to the trading partners, there is no reason for partners to adopt it. The RFID must also be compatible with trading partners' benefits; otherwise, it would be conflict for both firms and trading partners to understand mutual interests. In terms of research implication, although this study is one of the empirical IT&S adoption researches, we explored RFID systems adoption in an early stage with a technological innovation theory.

Figure 3. Power effect between higher power group and lower power group



5. 1 Limitations and Future Research

This study has also some limitations that should be recognized. This study is the perception base of the employees who are involved in RFID task force team, so the results can be showed in a bias way from the side of a firm that has interest in RFID. Therefore, the results of this study should be carefully translated with caution. Second, there exists many other innovation characteristics to IT&S adoptions; we did not include the complete innovative variables that can affect the RFID adoption. Future research can examine other potential variables with other context.

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