

An Empirical Study of Relationships among IT Capability, Trust, and Attitude on RFID Adoption in Korea*

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ABSTRACT

Recently, many enterprises are interest in implementing Radio Frequency Identification (RFID). However, they have some difficulty in implementing RFID because of incompleteness of RFID technology and uncertainty of Return on Investment (ROI). Even though usefulness of RFID are recognized, many enterprises are just interested in planning of RFID rather than implementation of RFID. Among successful factors of RFID implementation, Information Technology (IT) capability is the most important one. If enterprises have systematic IT capability, it would make positive attitude to implement RFID. In addition, it will provide trust about RFID and promote adoption of RFID implementation. This study, therefore, empirically analyzed the relationships of trust, attitude, IT capability, and intention to RFID adoption using Partial Least Squares (PLS) approach. The result show useful guidelines and practical implication in implementing RFID.

Key words : RFID, Intention to adoption, IT capability, Trust, Attitude

1. Introduction

Since the usability of Radio Frequency Identification (RFID) has increased, many enterprises are getting interested in RFID technology[20][28][33][43]. People think that the rate of RFID adoption would be rapidly

increased[39]. However, enterprises having positive attitude to RFID adoption do not actually adopt RFID technology. The reasons are as follows: (1) risk of return on investment (ROI); (2) the lack of trust due to the incompleteness of RFID technology; and (3) lack of trust in the result of business process innovation and performance improvement by RFID adoption[27][43][59][61]. Thus, it is very important research issue to investigate critical success factors for RFID adoption.

The previous study showed that IT capability of organization is an important factor for successful IT implementation[41]. The sufficient readiness of IT capability very often leads to positive attitude toward IT, formulated trust, innovated business process, and improved organizational performance[18][41][48][53][54].

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Likewise, we might assume that the readiness of IT capability would establish positive attitude toward RFID adoption and increase trust, playing important role to RFID adoption.

According to trust and Technology Acceptance Model (TAM) of Gefen, karahanna, Straub[17], trust and positive attitude toward new technology maximize willingness to adopt technology[57]. Trust-based Decision Making Model suggested by Kim et al[30], also showed that positive attitude toward trust increase intention to use and trust affects intention to use of IT practice and e-commerce.

Therefore, it is a very important task to understand the relationship among intention to RFID adoption, trust, IT capability and attitude for successful RFID implementation[27][34][43]. The purpose of this study is to analyze the relationship among attitude, IT capability and trust, which affect intention to adopt RFID in order to provide useful RFID implementation strategies and practical guidelines.

The structure of this study is as follows. Section 1 is the introduction describing research goals and questions. Section 2 is the analysis of RFID research trends and RFID preceding researches related with theoretical background, and research hypotheses. Section 3 is the proposal of the research model and research variables. Section 4 is the suggestion of empirical results using partial least squares (PLS) for validating research hypotheses. Final section is the explanation of research implications, limitations and future research directions.

2. THEORETICAL BACKGROUND AND HYPOTHESES

2.1 RFID Research Trend

In ubiquitous environment, many enterprises are interest in adopting RFID technology because RFID technology embodies the business process innovation of enterprises. Recently, studies regarding RFID are appeared and diffused in various forms, that is, survey research and technical development study, case study,

practical research and etc[5]. Hsi and Fait[25] defined RFID researches at two phases. The phase 1 [the period of before 2000] is the RFID diffusion time for adapting organization and the phase 2 [period of after 2001] is the new diffusion time of RFID. Currently, studies regarding RFID are reported in many fields (e.g., service, machinery, manufacturing, food, IT, security, and medical industry etc). In this study, we analyzed a prior research methodology and contents, which related to RFID introduction and an implementation. Prior studies of RFID adoption with the analytical result are as a follow <Table 1>.

<Table 1> Prior Studies of RFID Adoption

Researcher	Methodology	Research Issue
Lai et al. (2005)	interview	suggest of risk factors and opportunity factors in China
Jones et al.(2004)	literature review	implementation factor of RFID in U.K.
Wu et al.(2006)	literature review	problem of implementing RFID and their solution
Ngai et al.(2007)	case study	providing guidelines for container management using RFID technology
Kim, Yoon (2007)	case study	RFID implementation case of electronic business in South Korea
Brown, Russel (2007)	literature review	analyzing of RFID risk management factor in retails areas
Sebastian et al., (2006)	literature review	evaluating model of RFID implementation
Miller (2007)	literature review	evaluation model of RFID solution
Lim(2008)	empirical study	suggestion of risk factors in implementing RFID
Shen, Shi (2005)	literature review	core technology and strategy of RFID Implementation

2.2 Technology Acceptance Model (TAM) and Application

Today, a new technology acceptance in an enterprise is still a very important issue[26]. According to many researchers appeared in <Table 2>, they have used and applied TAM in explaining the accommodation and acceptance of new information technology because TAM is able to explain the technology adoption process of the organization and consumer. Also TAM enables to propose the strategic implications in promoting the

technology acceptance. The studies using TAM are showed in the <Table 2>.

<Table 2> Application Studies of TAM

Researcher	Applied Studies of TAM
Lai, Honglei (2005)	Adoption of Internet banking
Kwasi, Salam (2003)	Adoption of ERP systems
Gefen et al., (2003)	Adoption of On-line shopping
Davis, Venkatech (1996)	Adoption of usage personal computer
Oh, Ang, Kim (2003)	Adoption of broadband Internet service
Cheng et al. (2006)	Adoption of Internet banking
Gefen et al.,(2003)	Adoption of online shopping using trust
Venkatesh et al., (2002)	Adoption of online shopping in decision making process
Gefen (2004)	Adoption of ERP systems and role of trust
Pavlou (2003)	Adoption of e-commerce regarding trust and risk
Dishaw, Strong (1999)	TAM and technology fit
Featherman, Pavlou (2003)	Adoption of e-service
Huang, Lu, Wong (2003)	Adoption of electronic mail service
Hulland, Vandenbosch (2001)	Adoption of electronic payment systems
Davis, Venkatesh (2004)	Adoption of new technology in IT project management
Horton et al. (2001)	Adoption of Intranet
Moon, Kim (2001)	Adoption of World Wide Web context
Hong et al. (2006)	Adoption of mobile Internet service

2.3 Research Hypotheses

RFID is one of core technologies in implementing Supply Chain Management (SCM). So enterprises have developed numerous industry initiatives such as Quick Response (QR), Efficient Consumer Response (ECR), Vendor Management Inventory (VMI), and Collaborative Planning, Forecasting and Replenishment (CPFR). The core of SCM strategy is building a trust in the supply chain network because SCM strategy mainly focus on collaborative work, information sharing, and partnership construction[1][7][8][21][51][56][60]. Therefore, one way to reinforce IT capability in organizations is building an affirmative trust about RFID.

As we mentioned above, IT capability with a trust is closely related in pursuing the SCM. IT capability consists of: (1) information system usage ability; (2)

information system application ability; and (3) information system management ability of the enterprise[42][44]. Marchand et al[44], asserted that IT capability area consists of IT practice, IT management, and IT value. They also asserted that IT capability influenced IT performance. Lee[41] suggested that the IT capability affected the improvement of business performance in their study focusing the change management of ERP system. Hence, reinforcing IT capability by implementing RFID would affect improvement of business performance. Some studies revealed that IT capability in implementing RFID affected attitude and intention to adoption of RFID[6][18][54]. Therefore, this study assumed that increased IT capability in implementing RFID would affect trust and intention to adoption of RFID.

[Hypotheses 1] IT capability is associated with RFID trust.

[Hypotheses 2] IT capability is associated with an affirmative attitude toward RFID.

[Hypotheses 3] IT capability is associated with intention to adopt RFID.

Fishbein and Ajzen[19] established the theoretical frameworks regarding belief, attitude, intention and behavior of individuals. Davis[11] explained adoption process of information technology using an extended theory of Fishbein and Ajzen[19]. Davis's TAM has been applied in various research areas, such as adoption of electronic mail services[11][16], word-process and spreadsheet[4][60], computer and Internet adoption[3], Internet banking adoption[7], electronic library acceptance[22][23], wireless Internet service acceptance[31], and on-line electronic commerce[17].

Kim et al[31], suggested a trust-based decision making model. Their model had been developed based on the application of Theory of Reasoned Action (TRA), and TAM. They asserted that customer trust influenced a consumer's risk perception in e-commerce and that risk affects intention to purchase e-commerce. They also[31] asserted that trust affected risk and shopping intention. Therefore, we adopted both the

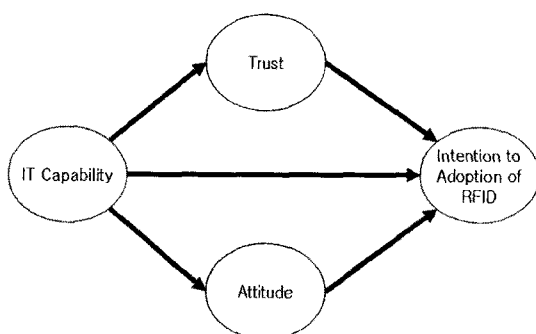
theoretical background of TAM, TRA, and the trust-based decision making model. We posited that attitude of RFID affects intention to RFID adoption.

[Hypotheses 4] RFID trust influences intention to RFID adoption.

[Hypotheses 5] The affirmative attitude on RFID influences intention to RFID adoption.

3. RESEARCH MODELS AND VARIABLES

3.1 Research Model



<Figure 1> Research Model

This research proposes and validates the study model presented in Figure 1. Drawing on the prior literature[2][12][13][19][30], we propose our research model and five hypotheses. Our research model focuses on the relationship between IT capability, trust, attitude, and intention to adoption of RFID.

3.2 Research Variables

In this study, we adapted relevant prior studies in identifying our research variables. For examples, we modified items measuring RFID intention by adapting from Gefen[15], Kim et al[31], and Jarvenpaa et al[36], Items measuring RFID attitude adapted form Jarvenpaa et al[36], Jarvenpaa, Tractinsky[37], and Taylor, Todd[55]. Also, Items measuring RFID trust adapted form Gefen[15], Jarvenpaa et al[36], Jarvenpaa, Tractinsky[37], Doney, Cannon[14]. Items measuring IT capability adapted form Marchand et al[44], Lim[43], and Straman, Roth[54]. We measured the research items of the variables on a seven point Likert type scale (1 = strongly disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neither Agree Nor Disagree, 5 = Some what Agree, 6 = Agree, 7 = strongly agree). The group of research variables used in this study are showed in the <Table 3>.

<Table 3> Research Variables

Variables	Measurement Items	Prior Research
Attitude (A)	[a1] The RFID adoption would improve the performance of business transaction. [a2] The RFID adoption would be useful to the business process reengineering. [a3] The RFID adoption would enable the business process reengineering.	Jarvenpaa et al., (2000), Jarvenpaa, Tractinsky (1999), Taylor, Todd (2005)
Trust (T)	[t1] The RFID adoption would contribute to the business process reengineering. [t2] The RFID adoption would provide the reliable and useful information. [t3] The RFID adoption would enhance the collaboration between companies (business to business) more strongly than expected.	Gefen (2000), Jarvenpaa et al., (2000), Jarvenpaa, Tractinsky (1999), Doney, Cannon (1997), Macintosh, Lockshin (1977)
Intention to adoption of RFID (IA)	[ia1] Our company, both employer and employee, wants to adopt RFID. [ia2] Our company, both employer and employee, would be very cooperative for RFID adoption. [ia3] Our company, both employer and employee, has a great concern on RFID and studies RFID related area. [ia4] The more budget would be allocated for seminars and studies about RFID next year.	Gefen (2000), Kim et al., (2008), Jarvenpaa et al., (2000)
IT Capability (ITC)	[itc1] Our company has full of IT capability to use and utilize RFID systems. [itc2] Our company employees fully understand RFID system functions and processes. [itc3] Our company employees have enough ability to communicate with IT managers about RFID system implementation when its implementation matters occur.	Straman, Roth (2002), Marchand et al. (2002), Lim (2008)

3.3 Survey

In this work, data were collected from enterprises that had a plan to implement RFID in South Korea. We employed surveyors for collecting a set of data. We trained those surveyors regarding RFID practice case and technology to make them properly understand the study purpose. The survey was conducted from September 2008 through November 2008. We obtained 96 usable responses excluding unusable responses at the end of the survey period. We analyzed a set of 96 using SPSS 12.0 and Visual PLS 1.04b software.

4. EMPIRICAL RESULTS

4.1 Demographic Information

The descriptive statistical analysis of responses was as follows. Out of the 96 respondents, the industry distribution of sample is machinery (3 respondents = 3.1%), services (4 respondents = 4.2%), information technology (2 respondents = 2.1%), logistics (14 respondents = 14.6%), banking (9 respondents = 9.4%), metal (2 respondents = 2.1%), electronics (23 respondents = 24%), textiles (2 respondents = 2.1%), chemistry (9 respondents = 9.4%), food (10 respondents = 10.4%), retail and distribution (10 respondents = 10.4%), miscellaneous (1 respondents = 1%), and etc (7 respondents = 7.3%). The size of employee consists of 50-100 (52.1%), 100-500 (24%), 500-1000 (6.3%), and 1000-5000 (17.7%). The total sales amount per year distribution shows 1-5 billion Won (13.5%), 5-10 billion Won (13.5%), 10-50 billion Won (12.5%), 50-100 billion (12.5%), over 100 billion (24%), and no response (6.3%)

4.2 Basic Statistics

In this study, we employed Partial Least Squares (PLS) technique, which is one of data analysis methods. PLS have a good advantage because it simultaneously analyzes both formative indicators and reflective indicators. Therefore, it is very useful to develop a theory for an exploratory research. In this

research, we used to Visual PLS version 1.04b for testing the proposed model.

<Table 4> Basic Information

Construct	Indicator	Mean	Stdev	Loading	Residual	Weight
ITC	itc1	4.479	1.765	0.903	0.184	0.474
	itc2	3.927	1.687	0.889	0.210	0.386
	itc3	4.792	3.064	0.751	0.436	0.305
T	t1	5.177	1.629	0.938	0.121	0.405
	t2	5.063	1.555	0.946	0.105	0.351
	t3	4.917	1.427	0.907	0.177	0.318
A	ra1	4.854	1.622	0.948	0.101	0.337
	ra2	4.625	1.564	0.968	0.062	0.351
	ra3	4.500	1.603	0.957	0.085	0.357
IA	i1	4.146	1.783	0.904	0.183	0.330
	i2	4.000	1.806	0.917	0.159	0.329
	i3	3.479	1.795	0.841	0.293	0.258
	i4	3.448	1.770	0.781	0.391	10.235

<Table 5> Composite Reliability and AVE

Construct	Composite Reliability	AVE	Cronbach Alpha
ITC	0.886	0.723	0.748
T	0.951	0.866	0.922
A	0.971	0.917	0.955
IA	0.920	0.744	0.885

Convergent validity of variables in this study was measured based on the composite reliability and average variance extract (AVE). The acceptability level of composite reliability value for a reliable construct is 0.7. As showed <Figure 5>, composite reliability of our research variables ranged from 0.88 to 0.97. The acceptability level of AVE values for a reliable construct is 0.5. In this study, AVE range shows from 0.72 to 0.91. Therefore, AVE value of research variables is above the acceptable value.

<Table 6> Correlation Results

	ITC	T	A	IA
ITC	1.000			
T	0.676	1.000		
A	0.721	0.787	1.000	
IA	0.797	0.702	0.737	1.000

Finally, we verified discriminant validity using correlation analysis. The correlation value was blower than 0.8[29]. Therefore, the correlation results of research variables showed discriminant validity. It was

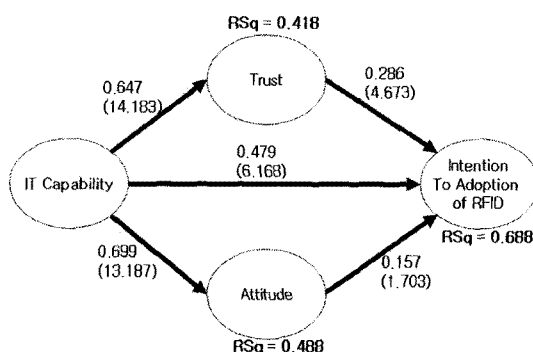
also showed that the multicollinearity was checked among research variables <Table 7> presents the factor loading of the research variables. Providing strong convergent and discriminant validity, all items exhibited high loadings (loading values > 0.7) on their all constructs.

<Table 7> Factor Structure Matrix and Factor Loading

Scale Items	ITC	T	A	IA
itc1	0.913	0.691	0.711	0.778
itc2	0.898	0.524	0.572	0.672
itc3	0.759	0.408	0.487	0.505
t1	0.695	0.948	0.777	0.748
t2	0.554	0.956	0.764	0.689
t3	0.560	0.917	0.663	0.572
a1	0.655	0.742	0.958	0.668
a2	0.679	0.749	0.979	0.700
a3	0.693	0.788	0.967	0.711
ia1	0.746	0.717	0.730	0.913
ia2	0.717	0.752	0.745	0.926
ia3	0.626	0.531	0.497	0.850
ia4	0.587	0.450	0.467	0.789

<Table 8> Empirical Results

Hypotheses	Entire Sample estimate	Mean of Sub-samples	Standard error	T-Statistic
ITC → T	0.647	0.650	0.046	14.183
ITC → IA	0.479	0.472	0.078	6.168
ITC → A	0.699	0.696	0.053	13.187
T → IA	0.286	0.290	0.061	4.673
A → IA	0.157	0.157	0.092	1.703



<Figure 2> Empirical Result

We tested our structural model using a PLS approach in <Figure 2> by reviewing the R Square

explanation in <Table 8>. The R Squares of trust, attitude, and intention to adoption RFID is 0.418, 0.488, and 0.688. The R squares explanation indicated acceptable level.

[Hypothesis 1] predicted that a high degree of IT capability leads to their RFID trust. As showed <Figure 2>, RFID trust significantly predicted intention to adopting RFID (estimate = 0.647, t-statistic = 14.183), supporting [Hypothesis 1]. [Hypothesis 2] predicted that a high degree of IT capability of organization lead to the intention to adopting RFID. As showed <Figure 2>, RFID trust significantly predicted intention to adoption RFID (estimate = 0.479, t-statistic = 6.168), supporting [Hypothesis 2]. [Hypothesis 3] predicted that a high degree of IT capability of organization lead to the positive attitude. As showed <Figure 2>, RFID trust significantly predicted intention to adoption RFID (estimate = 0.699, t-statistic = 13.187), supporting [Hypothesis 3]. [Hypothesis 4] predicted that a high degree of RFID trust lead to their intention to adoption RFID. As showed <Figure 2>, RFID trust significantly predicted intention to adoption RFID (estimate = 0.286, t-statistic = 4.673), supporting [Hypothesis 4]. [Hypothesis 5] predicted that a high degree of positive attitude regarding RFID lead to their intention to adoption RFID. As showed <Figure 2>, RFID trust significantly predicted intention to adoption RFID (estimate = 0.157, t-statistic = 1.703), supporting [Hypothesis 5]. The empirical results provided that the coefficients of our research variables of IT capability, attitude, and RFID trust affected intention to adopt of RFID.

5. Conclusion

5.1 Summary and Research Implication

The actual RFID adoptions and practices of enterprise have not been increased, though interests regarding RFID have been increased. Therefore, we analyzed the relationship between IT capability, trust, and attitude, which influences company's intention to adopt RFID because RFID adoption researches in the

firm-level provide an useful guideline for a successful RFID implementation.

Research results are as followings. Firstly, IT capability of organization about RFID affects to trust. Secondly, IT capability of organization affects intentions to adoption RFID. Thirdly, IT capability of organization regarding RFID affects positive attitude of the enterprise employee. Fourthly, RFID trust affects intention to adoption RFID. Finally, RFID attitude will affect in intention to adoption RFID. In summary, research [Hypotheses 1], [Hypotheses 2], [Hypotheses 3], [Hypotheses 4], and [Hypotheses 5] were adopted. Consequently, an intention to adopt RFID implementation has a importance role to reinforce IT capability, positive attitude and the trust diffusion effort regarding RFID.

This study contributes to RFID implementation in the following ways. Firstly, currently the RFID research is staying to the exploratory level. This research analyzes IT capability trust, and attitude affects in intention to adoption RFID. This research presented the theoretical base of implementing RFID. Secondly, in implementing RFID, IT capability of organization is very important. IT capability affect to RFID trust, attitude of employee and intention to adoption RFID. Therefore, the enterprise of planning to implementation RFID will be tried to effort for reinforcing IT capability of organization. Namely, the enterprises conduct the effort for strengthens of management capability in information system and network. The effort makes help in building trust and embodiment positive attitude, and reinforces intention to adoption RFID. Thirdly, in a successful RFID implementation, RFID trust and attitude is very important. RFID trusts and positive attitude affects to intention to adoption RFID. Therefore, To diffusions intention to adopting RFID, the enterprises need to strengthen a RFID trust and formulating positive attitude, RFID education, organizational support of chief executive officers (CEOs) and members.

5.2 limitations and Future Research Direction

This research has several limitations. Firstly, this

research limitation is to a sampling process. Actually, RFID business process and industry types are various. The data collection process of this research didn't consider business process and industry types. Therefore, these result have the limitation of the generalization in all industries. Future research consider in various industry and business process and will do to collect and analyze sufficient data of various industry.

Secondly, in this research, we examined in intention to adoption RFID of enterprises of planning to RFID implementation. Actually, the contingency characteristics of the enterprises affect the intention to adoption of RFID. Hence, the enterprises of planning to RFID implementation reflect contingency factor, that is informatization level, expense, applied process and etc. This research didn't reflect various context of organization. Therefore, future research is needed to expand the contingency factors regarding RFID implementation.

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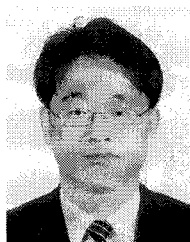
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[Appendix A] Standardized Items Loading and Dropped Items

Scale Items	Wording	All Items	After Dropping Items
itc1	Our company has full of IT capability to use and utilize RFID systems.	0.9040	0.9128
itc2	Our company employees fully understand RFID system functions and processes.	0.8949	0.8984
itc3	Our company employees have enough ability to communicate with IT managers about RFID system implementation when its implementation matters occur.	0.7759	0.7592
t1	The adoption of RFID would contribute to the business process reengineering.	0.9481	0.9477
t2	The adoption of RFID would provide the reliable and useful information.	0.9079	0.9558
t3	The adoption of RFID would enhance the collaboration between companies (business to business) more strongly than expected.	0.9091	0.9166
t4	The adoption of RFID would improve the business performance in the end.	0.5091	Dropped
ra1	The adoption of RFID would improve the performance of business transaction.	0.9558	0.9581
ra2	The adoption of RFID would be useful to the business process reengineering.	0.9752	0.9786
ra3	The adoption of RFID would enable the business process reengineering.	0.9517	0.9668
ra4	I have a positive feeling about RFID technology.	0.5430	Dropped
i1	Our company, both employer and employee, wants to adopt RFID.	0.8928	0.9134
i2	Our company, both employer and employee, would be very cooperative for adoption of RFID.	0.8806	0.9262
i3	Our company, both employer and employee, has a great concern on RFID and studies RFID related area.	0.8286	0.8499
i4	The more budget would be allocated for seminars and studies about RFID next year.	0.8378	0.7894
i5	There would be a great concern for business innovation using RFID next year.	0.6887	Dropped



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