AN EMPIRICAL STUDY FOR RADIO FREQUENCY IDENTIFICATION (RFID) ADOPTION BY SMEs IN THE TAIWANESE INFORMATION TECHNOLOGY (IT) INDUSTRY

Hsin Chen[1*] and Anastasia Papazafeiropoulou[2]

*[1]Department of Business System, Business School,
Bedfordshire University, United Kingdom
[2]School of Information Systems, Computing & Mathematics,
Brunel University, United Kingdom*

*Corresponding author: hsin.chen@beds.ac.uk

ABSTRACT

Radio Frequency Identification (RFID) technology represents a common standard for data storage and retrieval that could improve collaboration and data sharing between non-competing organisations. With the advent of RFID, organisations have the opportunity to rethink how their organisation will operate and integrate in the supply chain. Especially for Small to Medium Sized Enterprises (SMEs), that they have limited resources adopting such an innovative technology (i.e. RFID) the adoption decision can be daunting. Literature indicates that SMEs that decide to go on with implementation have so far only a few guidelines from either private companies or public authorities regarding awareness on specific opportunities and risks. This research is therefore trying to explore in detail the factors that affect SMEs' RFID adoption in the Taiwan Information Technology (IT) manufacturing industry. We are employing Exploratory Factor Analysis (EFA) techniques and utilising a questionnaire survey in order to collect and analyse our data. After classifying the responding SMEs into three different adopters categories named ready adopter, initiator adopter and unprepared adopter using EFA technique our results show that each category has some specific adoption factors related to their unique situation. These are for ready adopters: cost and management, for initiator adopters: competitiveness and process efficiency and unprepared adopters: IT management difficulties, IT implementation difficulties and cost of implementation. A SMEs RFID adoption model is then proposed. It is anticipated that the findings of this research will not only enhance the research in RFID adoption in SMEs, but can also act as a reference for practitioners in the industry and researchers in the academic field.

Keywords: Radio Frequency Identification (RFID), Small and Medium Enterprises (SMEs), adoption, Information Technology (IT), Exploratory Factor Analysis (EFA)

INTRODUCTION

Radio Frequency Identification (RFID) technology uses radio waves to identify objects (Lin, 2009; Srivastava, 2004). Companies use RFID in various industries in an attempt to improve their businesses, reduce their daily running costs, and increase their potential opportunities. RFID is being used in many places in many countries, for different purposes such as collecting tolls, automating parking, car theft prevention, and operations in airports (Landt, 2005, Srivastava, 2004, Chang, Yen, & Chen, 2008). Also, RFID is often being used to replace bar codes in supply chain management (SCM). Some large companies substitute RFID for bar codes because bar codes can only be used to show the same code on the same type of items, whereas RIFD can be used not only to identify various products, but also to keep track of the production process and sequence of activities (Zhang, Feng, Wu, & Yu, 2008). Lin (2009) points out that the RFID application includes immediate position tracking and monitoring procedures in the delivery service. This can assist companies to successfully manage their warehouse and supply chain by means of tracking and monitoring their trucks and products. Additionally, cost savings, supply chain visibility, and new process creation have been identified as the three key benefits of RFID adoption (Roh, Kunnathur, & Tarafdar, 2009). Wamba, Lefebvre and Lefebvre (2006) claim that RFID technlogies can be useful in the integration of the supply chain by improving the shiping and receiving processes, automatically triger specific processes, foster higher level of information sharing among supply chain partners and finally promote the use of new business processes. Also, Smith (2005) draws attention to the fact that using RFID technology can not only improve SCM but also Customer Relationship Management (CRM). This means that RFID technology can improve both business and the internal organisation. It is therefore no suprising that, in recent years, America, Japan, and developed countries in Europe have actively introduced RFID technology into their daily logistics operations and product distributions. By adopting RFID, products and inventory can be easily managed. For example, Wal-Mart, HP, Germany Metro Group, and Marks & Spencer are using RFID system to track supplies in order to increase management efficiency, and to reduce the number of human resources and man-made mistakes (Tajima, 2007; Lin, 2009). In contrast other counties seem to still lacking behind in the implementation of RFID technologies such the retail sector in South Africa where in a study that took place in 2005 many retailers had not yet adopted RFID or even contacted trials altough they had some intention to do it in the future (Brown & Rusell, 2007).

However, unlike large companies, many SMEs in particular in Taiwan are reluctant to adopt RFID systems as they argue that the benefits of RFID cannot

immediately be recognised (Taiwan External Trade Development Council, [TAITRA], 2010). Some SMEs are encountering many problems and difficulties when adopting RFID technologies due to their limited resources (Chang et al., 2008). According to Chang et al. (2008), at present, business enterprises and industries still lack the best model for RFID introduction. As a result, the risk of applying RFID technologies is still high including the cost of hardware and software purchase and maintenance costs. For SMEs, since their ability and resources are limited, adopting RFID technologies therefore seems to be a significant problem for them. Using such technology is harder for SMEs than it is for the large organisations due to (i) their characteristic difficulties, such as the lack of financial resources and technological knowledge and ability (Carter & Evan, 2000; Burns, 2001), and (ii) the lack of partner companies adopting RFID technologies, creating a network effect problem. Suprisingly, considering the high economic importance of SMEs in the world economy, it is interesting that the question of SME-specific requirements and potential of RFID technology has not yet received the appropriate attention in academic and political discussions (Strüker & Gille, 2008). With this in mind and to fill the research gap, this study chose Taiwan's SMEs in the IT industry as the main target of the research. This sector was considered particularly relevant to this technology as the IT manufacturing sector often needs to enhance the tracking of global products and perform immediate inventory control as a means to streamline its enterprises and increase managerial efficiency (Wamba et.al., 2006). In this paper we take the specific characteristics of of IT adoption by SME in consideration and we try to create a clear picture as to how these factors are manifesting in the case of the adoption of RFID technologies. In accordance with these, the following research question arise: "What are the factors that will influence SMEs' adoption decision for RFID technologies?" And in consequence we explore whether SMEs will be willing to invest in the adoption of such technology and why SMEs posibly resist the adopting of RFID. We agrue that there is a need to explore this area further to address the above research question.

The aim of this paper is therefore to explore and investigate the factors that influence SMEs' RFID adoption decisions based on survey data on the current progress of RFID adoption in Taiwan SMEs. In doing so, the factors obtained are analysed using EFA techniques and it is found that these factors can be classified into three different categories of adopting companies:

1. Ready adopter (factors that most likely will lead to RFID adoption)

2. Initiator adopter (factors that attract SMEs to RFID technology)

3. Unprepared adopter (factors that prevent SMEs from adopting RFID technology)

Based on the analysis, a SMEs RFID adoption model is then proposed. The present study differs from other studies because it specifically uses EFA techniques to explore and analyse the factors with respect to the adoption of RFID technology in SMEs. It is believed that the research findings reported in this paper can act as a reference for practitioners in the industry and researchers in the academic field.

The remaining paper is structured as follows. In the next section, we provide a literature review on SMEs and RFID adoption. We then proceed to present and discuss the research methodology used in this study. This leads us to the fourth section of our paper, in which we analyse the findings. Finally, discussion, conclusions and future research directions are drawn.

SMEs AND THE ADOPTION OF RFID TECHNOLOGY

More than 98% of enterprises in Taiwan are classified as SMEs according to the figure from the Taiwan Ministry of Economic Affairs 2010 (Taiwan Ministry of Economic Affairs, 2010). SMEs are vital for the global economy, as they (1) generate new jobs, (2) generate local economic activity, (3) create local wealth, (4) create new ideas, (5) introduce new products and services, (6) diversify the private sector, and (7) stabilise the private sector (Bannock & Daly, 1994; Bridge, O'Neill, & Cromie, 1998; Burns, 2001; Deakins & Freel, 2003). Thus, it is important that RFID technology will be embraced by the smaller companies, as well as it being necessary for more rigorous and relevant research into this important sector of the economy. It has been reported that smaller company size can potentially make the adoption and use of RFID easier. In reality thought SMEs take a wait-and-see approach when it comes to the adoption of the technology (Strüker & Gille, 2010).

Iacovou, Benbasat and Dexter (1995) claimed that smaller organisations have been shown to have different technological adoption patterns than larger ones. Small organisations have long been found to be different from large organisations in the Information System (IS) context, as they are not a simple scaled-down model of large organisations (Raymond, 1985). In general, small businesses face greater risks in the use of IT than larger businesses because of inadequate resources, limited knowledge, a lack of "know-how" about IT, and several other constraints (Cragg & King, 1993; Iacovou et al., 1995). Managers in SMEs have also been characterised as having reservations about the adoption and use of IS or IT (Chang & Powell, 1998; Thong, 2001). Due to these characteristics, it can be expected that RFID usage among SMEs and large enterprises will be different

(Strüker & Gille, 2008). SMEs are likely to be less prepared and less able to change. Gao, Zhou and Wang (2007) pointed out that, because of cost and technical obstruction considerations, electronic identification and RFID have not been widely used by many SMEs.

The existing literature has documented some factors that affect RFID adoption by organisations. Many earlier studies (Acharyulu, 2007; Wicks, Visich, & Li, 2006; Glabman, 2004; Hosaka, 2004) on the application of RFID technology are on the evaluation of its managerial benefits and implementation challenges. Carr, Zhang, Kloppig and Min (2010) examined the contextual variables that affect the adoption of RFID in a healthcare organisation. Lee and Shim (2007) explored the adoption of RFID technology in healthcare using the theory of technology-push and demand-pull. They specifically examined the role of organisational readiness in the organisational adoption context. Using data from a survey among 146 German companies Strüker and Gille (2008) measured how the type and sophistication of benefit and performance analyses conducted before and after RFID introduction impact upon the productivity gains achieved by RFID. They found that the frequent use of particular measurement methods is strongly correlated to the improvement of target variables such as lead time and labour cost. In another paper, the same authors addressed specific aspects of small and medium sized companies (Strüker & Gille, 2008). They found that RFID adoption is easer in smaller enterprises. Moreover, Chang et al. (2008) draw attention to the fact that three features will influence SMEs to adopt RFID, namely, the environment of the industry, the organisation, and the characteristics of RFID. Tang and Tsai (2009) proposed a conceptual model of RFID adoption based on multiple case studies to explore the related factors of RFID application. They found that the major factors of RFID adoption include technology (including complexity, compatibility, and cost), organisation (including organisation size and readiness, procedure flexibility, and top management support), and environment characteristics (including industry competition, external support and technology policy).

The review of literature shows that only a small amount of theoretical and empirical analyses have so far focused on RFID usage especially aimed at SMEs (Strüker & Gille, 2008). Based on the literature review, RFID adoption factors are summarised in Table 1.

Table 1
Summary of potential adoption factors affecting RFID adoption in SMEs (from literature)

Factors	Details
Characteristics	Store huge information about product's details
	Read multiple items at the same time
	Track products effectively
	Track long distance
Increased Data Visibility	Show real-time
	Increase data accuracy
Accurate Product Tracking	Identify the amount, items and electronic codes of products
	Show a container's history
Inventory Improvement	Handle right time of delivery
	Reduce stock and out of stock problem
	Reduce man-made mistakes
Labour Reduction	Track products and record data automatically
Cost Savings	Reduce human resources
	Manage inventory effectively
	Reuse tags and readers
	Save working and tracking time
	Effective data management
Sharing Data Between Enterprises	Communicate with partners much more effectively
	Improve businesses
	Increase competitiveness
Technical Problems	Creating huge amounts of unnecessary data
	Cause food deterioration or spoiling
Privacy and Security Problems	Illegal tracking
	Stealing of personal information
	Counterfeit RFID
Lack of Investment	High cost
	Upgrade software and equipment
	Hard to achieve short term

In our research this list of factors was used as a guide when designing the questions for the questionnaire. Using this factors as a starting point we explored using a deductive approach the reasons behind the adoption decisions in the IT manufacturing sector in Taiwan.

RESEARCH METHOD

In this section we present the rationale behind our research design and data analysis process that took place during the study.

Research Design

The research aims to investigate and analyse RFID adoption in SMEs. The definition of SMEs may vary among countries or institutions, based on the differences in economic levels or the wealth of the countries (Gibson, 2001; Storey, 1994). Since this study was carried out in Taiwan, the SME definition given by Taiwan Economy Affair is adopted. This classifies SMEs as having sales turnover less than US$5 million and a headcount of 11 to 150. A survey was carried out to investigate and explore RFID adoption in Taiwanese SMEs in the IT industry and to study the perspectives of the SMEs who adopt RFID technology. The questionnaire has been designed with two types of questions, namely, open and closed questions (Coolican, 2009). In this study, open-ended questions are used in the questionnaire to invite suggestions from the SMEs, and closed questions are used to investigate possible factors affecting SMEs' RFID adoption decisions.

The questionnaire was sent to the randomly selected SMEs in the IT manufacturing industry – 150 questionnaires in total were sent. Only the online version of questionnaire was designed. This paper focuses on the IT manufacturing industry because the IT industry is a high-priced technology industry, in which tracking is of value for companies, and these companies may use RFID to support their bu sinesses. Also, the IT manufacturing sector had the second largest number of SMEs, at 10.64% of all SMEs (around 1,244,000) in Taiwan (Small and Medium Enterprise Administration, Ministry of Economic Affairs, 2006). The online questionnaire link was sent out to IT managers and general managers in the IT manufacturing industry via emails. IT and general managers were selected as appropriate to provide useful information to support this research because these participants have a high level of knowledge of their organisations and needs. Then the second emailing took place after two weeks. The emailing served as a reminder of the aim of the survey and the deadline for receipt of responses. The questionnaire contains 15 questions and was divided into two parts (Part A and B). In part A, the questionnaire was structured to collect the basic company details, basic knowledge of IT, and the level of satisfaction with the IT system currently used. In part B, in order to reflect the study aim, the questionnaire was structured to collect the following data: (1) the advantages and disadvantages of RFID, (2) factors related to RFID adoption, (3)

motivation and drivers for RFID adoption, (4) factors related to RFID non-adoption, and (5) problems encountered when integrating RFID technology.

Of the overall 500 sent questionnaires, 65 useable replies were received within the specified periods, which implies that a response rate of 13% was obtained. The reason for such a low return rate is that many small companies have not yet integrated RFID technology into their businesses. As such, these SMEs were not able to answer many of the survey questions.

The descriptive analysis was then carried out which provided the participants' basic knowledge and information about RFID. In addition to the descriptive analysis, other *data reduction* statistical analysis techniques were considered such as Performance Component Analysis (PCA), EFA and Confirmatory Factor Analysis (CFA). Data reduction is typically performed when a researcher does not want to include all of the original measures in analyses but still wants to work with the information that they contain (DeCoster, 1998). In this study, EFA analysis was considered to be the most suitable technique to explore the factors for each category (i.e. stage) as we are interested in not only data reduction but also in making statements about the factors that are responsible for a set of observed responses. Traditionally, EFA can be described as orderly simplification of interrelated measures and has been used to explore the possible underlying factor structure of a set of measured variables without imposing any preconceived structure on the outcome (Child, 1990). EFA is a variable reduction technique which identifies the number of latent constrcts and the underlying factor structure of a set of variables. By performing EFA, the number of constructs and the underlying factor structure can be identified (Child, 1990). EFA is used to determine the number of common factors influencing a set of measures and the strength of the relationship between each factor and each observed measure (DeCoster, 1998). DeCoster (1998) suggests that EFA is often used to determine what features are most important when classifying a group of items as well as when a researcher does not want to include all of the original measures in analyses but still wants to work with the information they contain. According to the common factor model proposed by DeCoster (1998) that each observed response (measure 1 through measure 5) is influenced partially by underlying common factors (factor 1 and factor 2) and partially by underlying unique factor (E1 through E5) (see Figure 1). EFA is used in this study to explore the adoption factors as the primary purpose of this study is to understand a set of measured variables by determining the number and nature of common factors needed to account for the pattern of correlations among the measured variables.
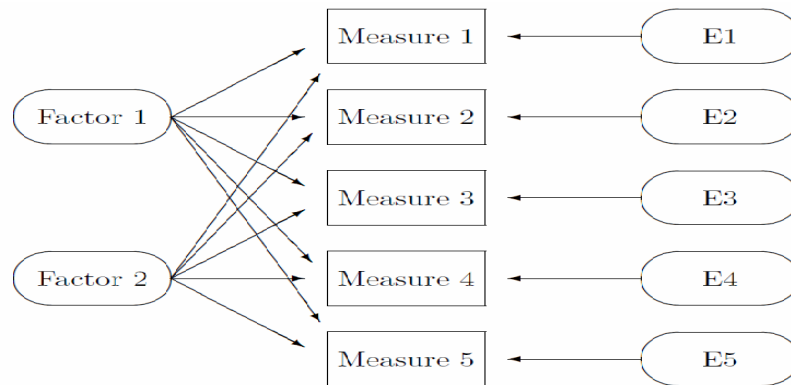
Figure 1. The Common Factor Model (DeCoster, 1998)

Sample

Of the 65 respondents surveyed, 40% were defined as "small enterprise" and 60% were "medium-sized enterprise". Also, of the 65 respondents surveyed, only 13.85% of the companies have adopted RFID technology. 86.15% of the respondents are still using traditional bar codes and other technologies such as Electronic Data Interchange (EDI) to manage their supply chain (see Figure 2). Only 9 out of the 65 companies investigated have actually adopted RFID technology.
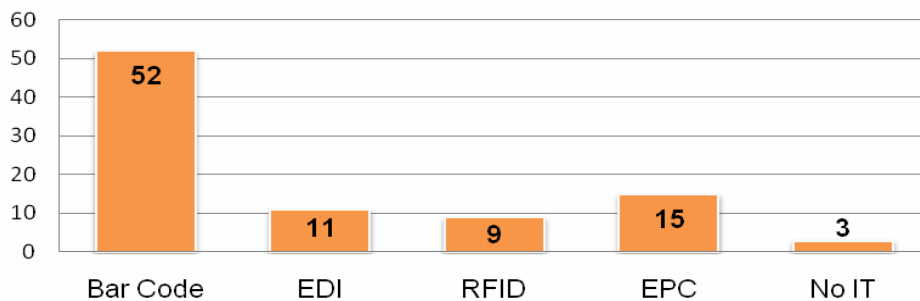

Figure 2. IT used by the respondents to support logistics/SCM

DATA ANALYSIS AND RESULTS

The descriptive statistics of the sample is analysed using SPSS and is shown in Table 2. Table 2 suggests that 83% of the companies investigated have some

basic knowledge about RFID technology, and only 17% of them have no knowledge of RFID technology. The results also indicate that 14% of the companies investigated are aware of the Taiwan government's policy on and involvement in promoting RFID adoption in SMEs. About 86% of the SMEs have not heard of the RFID promotion from the government. The data also suggests that most companies are still using traditional bar codes to integrate their supply chain, and only 13.85% of the companies have adopted RFID technology (see Table 2).

Table 2
Participants' descriptive statistics

Item	Results	
Participants have knowledge about RFID technology	Yes (83%)	No (17%)
Participants aware of the Taiwan government promotion on RFID adoption	Yes (14%)	No (86%)
Adoption of RFID technology to support logistics/delivery in SCM	RFID technology adoption (13.85%)	RFID technology non-adoption (86.15%)

In order to further explore factors that influence the adoption of RFID, an analysis was carried out on the 13.85% companies who have already adopted RFID technology in their businesses. We then used descriptive statistics and EFA to analyse our research results. Table 3 shows the descriptive statistics on factors that influence the adoption of RFID in SMEs.

In Table 3, the majority of the participants (18%) claimed that the most important factor for RFID adoption is high efficiency. Conversely, the popularity trend has the least influence on companies' RFID adoption decisions. The data also reveals that business growth, improved work efficiency and reduced management time are the main reasons that attract these companies to adopt RFID technology. The data also indicates that the high cost of RFID technology is an obstacle that stops SMEs from using such technology. Lack of communication standards is another problem which leads to RFID non-adoption.

Based on the results shown in Table 3, the authors then used EFA to conduct further analysis. We found that the RFID adoption factors shown in Table 3 can be classified into different categories: unprepared adopter (i.e. non-adoption), ready adopter (adoption), and initiator adopter (will likely to adopt RFID/ motivation). This confirms the research carried out by Tang and Tsai (2009). According to Tang and Tsai (2009) the characteristics in the adoption stages and the enterprise's attributes, classify the RFID adopters into three categories: unprepared adopter, ready adopter, and initiator adopter. Thus, in this study, we

also classified the factors for RFID adoption into these three categories. The authors then tested the reliability of these categories using an SPSS factor analysis module. It was found that the reliability of the ready adopter is 0.7817, initiator adopter 0.7164, and unprepared adopter 0.7214. All the values are greater than 0.7. Test results indicated that the reliability for three stages exceeds 0.7, so the reliability test results shown in Table 4 are acceptable.

Table 3

Descriptive statistics of adoption factors

Category	Results	
The factors that influence companies' RFID adoption decisions (Ready Adopter)	High efficiency	18%
	Increased profit	16%
	Easy management	16%
	Increased data collection efficiency	15%
	Lower labour costs	15%
	Ease of integration	12%
	Reduced costs	7%
	Popularity trend	1%
The factors that attract companies to integrate RFID into their businesses (Initiator Adopter)	Business growth	15%
	Improved work efficiency	15%
	Reduced management time	15%
	Increased competitiveness	14%
	Reduce labour costs	14%
	Increased product tracking efficiency	13%
	Increased data management efficiency	13%
	Integrate suppliers up and down stream	1%
Reasons why companies are unprepared to incorporate RFID into their businesses (Unprepared Adopter)	High cost	16%
	Lack of communication standards	15%
	Need staff training	14%
	Long term integration needed	14%
	Data management problems	14%
	Product quality	12%
	Signal problems	12%
	Other	3%

Table 4
Reliability result

Category (Stage)	Reliability
Ready Adopter	0.7817
Initiator Adopter	0.7164
Unprepared Adopter	0.7214

Next, the factors in the ready adopter category are further divided into two latent constructs which are *cost* and *management* constructs. The cost construct consists of two measured variables which are: reduced costs and increased profit. The management construct consists of five measured variables, which are high efficiency, ease of management, increased data collection efficiency, ease of integration and lower the labour costs. Through the shrinking of the construct task, we have an explainable variance of 62.897%. See Table 5.

Table 5
Ready adopter category

Ready Adopter Category	
Latent Constructs	Measured Variables
Cost	Reduced costs
	Increased profit
Management	High efficiency
	Ease of management
	Increased data collection efficiency
	Ease of integration
	Lower labour costs

In the initiator adopter category, there are two latent constructs: competitiveness and process efficiency constructs. Competitive ability construct consists of four measured variables which are business growth, increase competitiveness, reduce management time, and increase product tracking efficiency. The process efficiency construct includes two measured variables which are improving work efficiency and increase data management efficiency. Through the shrinking of the construct task, we have an explainable variance of 77.714%. See Table 6.

Table 6
Initiator adopter category

Initiator Adopter Category	
Latent Constructs	Measured Variables
Competitiveness	Business growth
	Increased competitiveness
	Reduced management time
	Increased product tracking efficiency
Process efficiency	Improved work efficiency
	Increased data management efficiency

In the unprepared adopter category, there are three latent constructs which are IT management difficulty, IT implementation difficulty and cost of implementation constructs. The IT management difficulty construct consists of three measured variables which are need staff training, lack of communication standards and long term integration needed. The IT implementation difficulty construct includes two measured variables which are signal problems and data management problems. The cost of implementation construct includes two measured variables: high cost and product quality. Through the shrinking of construct task, we have an explainable variance of 77.520%. See Table 7.

Table 7
Unprepared adopter category

Unprepared Adopter Category	
Latent Constructs	Measured Variables
IT management difficulty	Need staff training
	Lack of communication standards
	Long term integration needed
IT implementation difficulty	Signal problems
	Data management problems
Cost of implementation	High cost
	Product quality

Based on the analysis in this section, an adoption framework and a research model are proposed in Figures 1 and 2, respectively. In Figure 3, the far left column represents RFID adoption stages and is classified into three categories which are *ready adopter*, *initiator adopter* and *unprepared adopter*. The far right column represents the measured variables used to measure latent constructs (factors). The latent constructs are presented in the middle column.

Based on the analysis of the data we can clearly differentiate among the SME population we surveyed that the reasons for adoption of RFID technology are very much related to each other, while different groups have different views about the implementation effort/difficulties, managerial implications and benefits. For example initiator adopters seem to have a forward attitude to using this technology to gain process efficiency and subsequently competitiveness. They act as first movers in the marketplace and they are ready to face implementation difficulties in order to achieve competitiveness in their market. When it comes to ready adopters they are looking for more mundane and every-day-running of the business practices. Having failed to be the pioneers in their market they are creating the necessary conditions to follow up existing practices in order to reduce cost and increased profit. Finally, unprepared adopters use potential difficulties in the management and implementation process as well as implementation cost as a defence for not adopting the technology. These difficulties might rightly be in place but these companies seem to be reluctant to go beyond them in order to achieve related benefits. This group of companies seem to lack the awareness of the technology and its benefits in order to be able to make an informed decision. Figure 4 summarises the most important found in each adopter's category after the EFA analysis.

	Category (Stage)	Factors (Latent Constructs)	Variables (Measured Variables)
RFID Adoption in SMEs	Ready Adopter	Cost	• Reduced cost • Increased profit
		Management	• Ease of integration • Increased data collection efficiency • Ease of management • Reduced labour costs • Improved efficiency
	Initiator Adopter	Competitiveness	• Increased competitiveness • Business growth • Reduced management time • Increased product tracking efficiency
		Process efficiency	• Improved work efficiency • Increased data management efficiency
	Unprepared Adopter	IT Management Difficulty	• Staff training • Lack of communication standards • Long term integration needed
		IT Implementation Difficulty	• Signal problems • Data management problems • Lack of standards
		Cost of Implementation	• High cost • Product quality

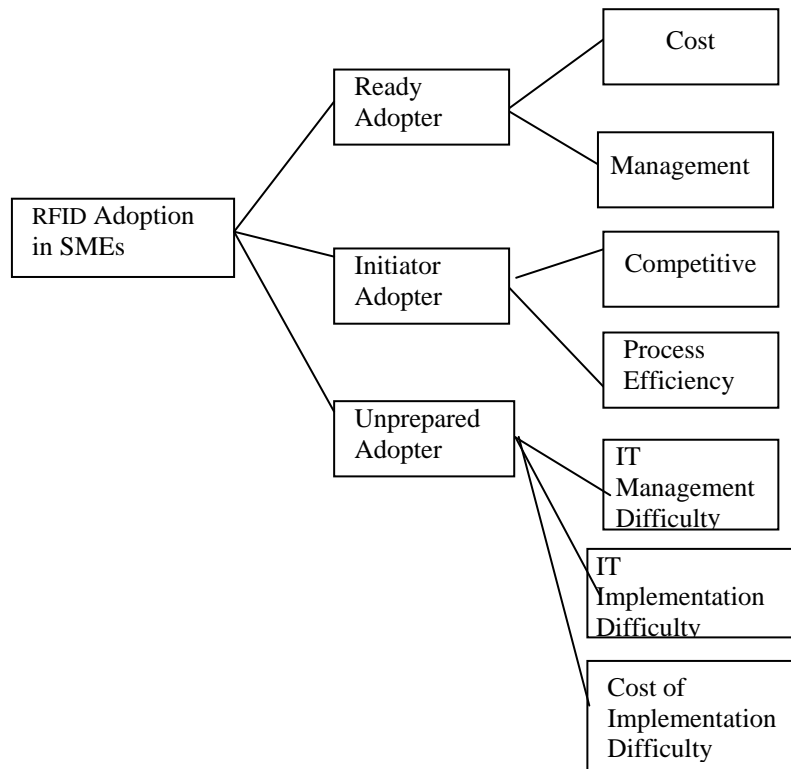*Figure 3*. A framework for RFID adoption in SMEs

Figure 4. A research model for RFID adoption in SMEs

The figure clearly shows that initiators look for first mover's competitive advantage, ready adopters interested in achieving basic cost reductions, while unprepared adopters are still debating about the difficulties involved in the application of the technology.

DISCUSSION

The objective of this study is to empirically identify various factors that affect RFID adoption in SMEs, and to test whether the identified factors can influence SMEs' RFID adoption decisions. Through the test result we can infer which factors make more significant contributions. Using questionnaires completed by randomly selected SMEs from the IT industry in Taiwan, we have generated a set of data for analysis. In this study, we classified the factors into three different categories (i.e. stages) named ready adopter, initiator adopter and unprepared adopter and then using EFA techniques tested which factors (i.e. latent

constructs) are most significant under each category, i.e. which are the most influential factors in explaining SMEs' RFID adoption decisions. In doing so, a novel RFID adoption model for SMEs was proposed. The findings show that cost savings and easy management are the two factors that influence SMEs' RFID adoption i.e. these two factors are the reasons that often lead to RFID adoption. For SMEs who are considering adopting RFID, increased competitiveness and process efficiency are the two factors that attract them to integrate RFID into their businesses. As for the majority of the participants (86.15%) who are unprepared for RFID adoption, IT implementation difficulty, IT management difficulty and the cost of implementation are their major concerns (i.e. factors).

Existing literature for example (Roh, Kunnathur, & Tarafdar, 2009; Brown & Rusell, 2007) has already highlighted the fact that the cost of RFID is the biggest problem companies encountered when adopting RFID technology, which supports our findings. The results indicate that high cost is indeed a critical factor as to why many SMEs have not yet integrated RFID into their businesses. Other reasons such as supply chain visibility and new process creation (Roh et al., 2009) did not seems to have significance in our study and did not come up during the interview stage with the company managers. This could be explained by the lack of awareness about the benefits of the technologies to small companies.

Furthermore, our results show that technological factors such as high efficiency seems to play an important role in the SMEs' decision to adopt such technology. Using RFID can bring not only benefits but also problems especially of a technical nature to companies as the technology is not matured in some countries/industries and there is also lack of standards affecting negatively the adoption of the technology by SMEs. This finding is in accordance with a similar study that took place in South Africa (Brown & Rusell, 2007) and can be related to the lack of government support for standard making.

CONCLUSION

In this study, the authors classify the responding SMEs into three different adopters categories named ready adopter, initiator adopter and unprepared adopter using EFA technique. Our results show that each category has some specific adoption factors related to their unique situation. (1) For ready adopters: *cost and management*; (2) for initiator adopters: *competitiveness and process efficiency;* and (3) for unprepared adopters: *IT management difficulties, IT implementation difficulties* and *cost of implementation*. A novel framework for RFID adoption in SMEs was proposed in this research.

This study has explored the factors that affect RFID adoption in SMEs, and we suggest that for future research, researchers can move on from our findings to further explore this area by carrying out interviews to generate more qualitative contextual data, which are associated with human and organisational issues. Based on the results, we also recognise the fact that government promotion/support might play an important role in SMEs' RFID adoption as mentioned by the participants. Therefore, we recommend that in-depth exploration into the relationship between government and RFID adoption in SMEs can also be the direction for further research.

As this study was exploratory in the area of RFID adoption by SMEs this work can be expanded by getting in depth understanding of SMEs' attitude to RFID technologies especially companies which are currently reluctant to use it. Problems with awareness creation for SMEs related to government policies as well as vendors strategies will certainly shed more light of into the reasons behind SMEs behaviour. Additionally, adoption push by large supply chain partners which is a common phenomenon in IT adoption by small companies could be studied in the area of RFID adoption and contrast similarities and differences with other technologies. Studying the same subject area in other geographical settings will also be interesting as the Taiwanese IT manufacturing sector is a rather advanced IT user community. Thus it will be interesting to see how similar sectors view RFID technologies in less IT developed nations. Another possible further study could be to test the validity of the proposed model and to find out how this model would be different for other industries.

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