

THE DETERMINATION OF RFID ADOPTION IN CHINA

by

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ABSTRAK

RFID adalah salah satu kaedah yang digunakan untuk memajukan pengurusan dan operasi dalam industri logistik , pembuatan dan informasi awam. Tujuannya adalah untuk menentukan pengurusan terbaik dalam pelaksanaan organisasi syarikat untuk meningkatkan pencapaian. Tujuan projek ini adalah mengkaji semua faktor yang mempengaruhi peralancaran sistem RFID di negara China. Penggunaan RFID telah menjadikan tumpuan untuk meningkatkan pencapaian syarikat melalui penentuan pelaksanaan, daripada keperluan penentuan, pengurusan sampai pemindahan pelaksanaan terbaik. Berdasarkan maklumat yang diambil daripada 130 orang awam, kajian ini telah melingkungi isu alam sekitar, organisasi, teknologi dan produk hasil .Kajian ini dijalankan secara kemunduran. Hasil kajian ini didapati bahawa penggunaan RFID telah menunjukkan perhubungan ketara dengan faktor persekitaran,teknologi,hasil produk and organisasi dan memberikan kesan positif terhadap alam sekitar dan teknologi. Justerusnya ,perhubungan RFID antara faktor tersebut dapat diterima secara amnya. Hasil pengajian ini, penggunaan RFID yang membekalkan maklumat yang terperinci dapat membantu mencapai kejayaan yang lebih baik dalam industri pembuatan. Selain daripada itu, kajian ini akan dijadikan sebagai panduan kepada mereka yang ingin melancarkan RFID. Implikasi dan cadangan RFID masa depan juga dibincang dalam tajuk terakhir.

ABSTRACT

RFID is a way of improving the management and operation efficiency when used in industries of logistics, manufacture and public information service. The aim is to identify best practices that can be adopted and implemented by the organization with the purpose of improve a company's performance. This project aims to study the factors that affecting the adoption of RFID systems in China. Focus has evolved from RFID as a means to improving company performance through the identification of best practice, to the need to identify, manage and transfer best practices. Base on the data collected from 130 respondents, this study examined the model involving environment characters, organizational characters, technology characters, and product characters. The analyses were done through regression method. The findings revealed that environment, technology, product and organizational characters are the most significantly related to the adoption of RFID. The adoption of RFID is positively related to environment and technology. Consequently, the hypotheses in relation to the above-mentioned variables were accepted. With the finding of this study, it is hope that it will provide a detail analysis of which areas to RFID to the manufacturing industry for improvement. In addition, this study will serve as a guideline to those that have intention to extensively used RFID all over the organization in a big way. The implication of this study and suggestions for future research are also discussed in the final chapter.

Chapter 1

INTRODUCTION

1.0 Introduction

The Radio Frequency Identification (RFID) technology is a type of non-contact automatic identification technology realized through radio frequency communication. With constant improvement and upgrading of the relevant technologies, the RFID technology will become an emerging hi-tech industry group as well as new growth point of the national economy. Accordingly, China has initially carried out research and development and industrialization of technology related to RFID and begun to apply in some areas in recent years. However, China should grasp such opportunity and concentrate efforts on research and development of RFID core technology and promote the formation of competitive industrial chain so that China can clinch its position in this area.

1.1 Background

The Radio Frequency Identification (RFID) technology is a type of non-con-contact automatic identification technology, which can substantially improve the management and operation efficiency when used in industries of logistics, manufacture and public information service. The development of RFID technology and application, which is a sophisticated systematic work, influences many areas such as economy and society,

and involves many industries and government authorities. It also needs overall planning, research and development, and coordinates enterprises and governments for the sake of complementary advantages to the maximum extent.

In recent years, the RFID technology has been applied in many social areas and worked significant influences on improving life quality of people, enhancing public security, increasing economic benefits of enterprises, and advancing the level of social information.

RFID is an emerging technology for automatic data capturing, enabling real time information visibility. It promises great potentials in many industries to improve logistics operational efficiency, to help reduce inventory, and to automate asset/item track and trace, etc. The pace of change in China and the control its government has in stimulating economic development, especially in the areas of manufacturing and logistics, has paved the way for tremendous trade growth between Asia and the United States. The RFID adoption in China is a highly concerned topic as China has become a world manufacturing center. Facing with the fierce international competition and the giant market demand, China has applied the RFID technology in many areas, such as ticket management, railway carriage number identification, special equipment and hazard materials management, public transport and production process management.

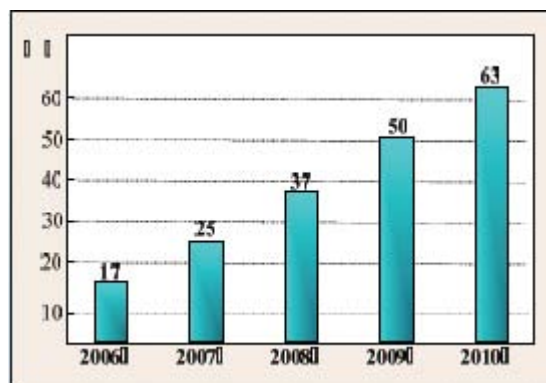
1.2 Problem Statement

RFID has shown great capabilities in uniquely identifying objects, and potentials towards many industries such as supply chain management, telemetry and patient movement detection (Yu, 2007). However, RFID adoption in the manufacturing industry in Asia is still low. There are not a lot of companies in Asia that really do know how to implement RFID correctly, and many of them are still lack of the awareness of what RFID can or cannot do. Marcus (2005) said the company is lacking an understanding of what factors influence companies' decision whether or not to start using RFID and is also interested in learning what potential customers need from an RFID solution. For 2005, some experts have predicted rapid growth of RFID in China, while others contend that the RFID market is still in its infancy and will have limited growth (China Economic Times, 2004). All RFID projects in China are relatively small and are still in a pilot test stage, especially when compared to developed countries, like the USA, where the RFID industry chain includes mature and large-scale projects from giant businesses, such as Wal-Mart and DHL (Lai, Joe and Zhang, 2005). In a survey of a hundred executives from major manufacturing and retailing companies from Asia-Pacific countries, Accenture (2004) found out that Chinese executives predicted high returns on their RFID investments. Of these executives, 18 percent anticipated implement RFID beginning in 2006, while 45 percent indicated that they would implement RFID in 2007 or later. They indicated that the greatest barriers to RFID adoption in China were the costs of overall implementation, the costs of tags, and the lack of standards (Lai, Joe and Zhang, 2005).

Since RFID tags must be attached to every product, it is costly to deploy RFID if the RFID tags are expensive (Lai, Joe and Zhang, 2005). The current cost of an RFID tag in China is about US\$0.25 to US\$0.30 (RMB ¥2.0), compared to the barcode cost of about US\$0.0024 (RMB ¥0.02) (China High-Tech Industry Herald, 2004). Although the cost of tags should decline over the next few years, the costs will likely remain prohibitive for many routine RFID applications (Lai, Joe and Zhang, 2005). It may require a long time for this large increase in global demand for RFID tags. Accordingly, the cost of RFID tags may continue to present a major hurdle for China's RFID adoptions.

As China is a big country for consumption and manufacture that RFID products shall be used and applied broadly in industries of public traffic, manufacture, postal service, logistics, propagation monitor, dangerous good backward management, railway carriage identification etc (Cao, 2007). All these applications would affect greatly national economy and living.

Figure 2
The Chinese RFID market scale



From the Figure 2 which Cao mentioned in 2007, it shows that the RFID market boosts rapidly from 2006 to 2010. The forecasting market scale of 6.3 billion RMB will bring along with correlative industries of 30 billion RMB by 2010.

Although RFID is now considered to be a new technology application with the potential for explosive long-term growth, RFID applications are still in their infancy with their contributions to enterprises still unproven (Tzeng, Chen and Pai, 2007). Global manufacturers' source product from many nations, but no nation plays a bigger role than China. The greatest barriers to RFID implementation in China were the costs of overall implementation, the costs of tags, and the lack of standards (Lai and Joe, 2005). Hao (2006) mentioned the obstacles of RFID in China are:

- No successful and integrated solutions clearly available in the market;
- No early indications of consistent priority application areas for both retailers and manufacturers;
- Inconsistencies remain among manufacturers and retailers regarding expectations and business benefits.

China is becoming a global manufacture center for its great population and constantly growing economy scale, and therefore RFID technology has its vast market for application. Currently the RFID technology and application develops rapidly but not mature, China should grasp such opportunity (White paper, 2006). Chinese enterprises are positive on adoption of RFID technology in both manufacturer and retailer (Hao,

2005). China is in urgent need of strengthening management via the application of RFID technology by way of improving people's life quality and constructing a harmonious society. China is a major player in RFID standards development because of its role as a world-class manufacturing center and the fact that it will create total supply chain visibility when the products are tagged at its origin (Lai, Joe and Zhang, 2005). Thereby, China should catch hold of such opportunity and concentrate efforts on research and development of RFID core technology, formulate technology standards accord with the national conditions of China, push forward the construction of self-proprietary public service system and promote the formation of competitive industrial, accordingly China can clinch its position and promote application in areas of public security, control, modern logistics, supply chain management, traffic management and production management (White paper, 2006).

1.3 Research Objectives

Research objectives of this study are:-

1. To examine the influence of environment characteristics on the adoptions of RFID in China.
2. To examine the influence of organizational characteristics on the adoptions of RFID in China.
3. To examine the influence of technology characteristics on the adoptions of RFID in China.

4. To examine the influence of product characteristics on the adoptions of RFID in China.

1.4 Research Questions

Research questions of this study are:

1. What is the influence of the environment characteristics on the adoptions of RFID in China?
2. What is the influence of the organizational characteristics on the adoptions of RFID in China?
3. What is the influence of the technology characteristics on of RFID in China?
4. What is the influence of the product characteristics on the adoptions of RFID in China?

1.5 Significant of the study

RFID has a wide and growing range of potential uses throughout industry, commerce, education and the public sector more widely. The main driver for the development of the technology is the capability to identify and track the movement of products through the supply chains. This is important to retailers because it reduces the likelihood of items being out-of-stock, estimated, in retail, to have been around 4% of annual sales in 2003 (McFarlane, 2003) and reduces 'shrinkage' (loss of stock, including through theft) which is reported to have cost American companies \$31.3

billion in 2003 (Deutsch, 2003). However, in order to maximize those benefits, industry will need to develop an appropriate strategy and undertake significant business reengineering process in many areas. The RFID technology enables management in a supply chain to capture and deliver information necessary to make a good decision (Mohsen, 2007). Acronym (2006) mentioned that there is a need to provide support and funding to actors, institutions and institution in order to overcome the obstacles and therefore it is recommended to encourage and support specific actions that increase the knowledge of RFID-technology. Mohsen (2007) also mentioned that the RFID technology enables management in a supply chain to capture and deliver information necessary to make a good decision.

Nevertheless, this does not mean an end to the RFID initiative. In particular, studies into the ways in which RFID can be fitted to business processes, and the problems it presents, are worthy of investigation.

Since China is becoming a WTO member, many foreign logistics providers have entered China (Lai, Joe & Zhang, 2005). In the standardization of RFID in China report (2005), it mentioned RFID is important to China for two main reasons. For application in the supply chain, it is ideal to incorporate the tagging process at the manufacturing level. China is the manufacturing center of world; more than 65% of non food products sold in Wal-Mart are manufactured in China.

Because of the booming economy, interest in China has soared in recent years (David, 2000). As a world-class manufacturing center, China is a major player in RFID standards development. RFID adoption in China by both commercial and academic institutions is already underway. The adoption of RFID is also being enhanced by mandates from large retailers, such as Wal-Mart (Lai, Joe & Zhang, 2005). China faces a number of challenges for RFID adoption (Lai & Joe, 2005). In China RFID Whitepaper (2006), it also mentioned that China is becoming a global manufacture center for its great population and constantly growing economy scale, and therefore RFID technology has its vast market for application. Recently, the China's RFID standards group announced that it is in the process of developing its own air interface specification but at the same time they emphasized that the specifications will be interoperable with international standards. One unnamed official noted that the purpose of the standardization is not to setup a competitive barrier against global efforts but rather for ensuring that quality requirements and performance benchmarks are met by the growing market. As with any standardization process, the specifications will evolve as the technology becomes more mature. Regardless of the intent, it is clear however that to maintain its manufacturing leadership, China must make sure that its standards are interoperable beyond its national borders and across the global supply chain. Not only are there several challenges presented for RFID adoption, such as standardization, business environment, business models and costs, but also there are a great deal number of opportunities due to the rapid growth of logistics and the rapid economic growth of China.

1.6 Definition of Terms

The following definitions were referred to this study specifically.

- RFID – a technology for transferring data between an RFID reader and a transponder or tag through the use of radio waves. The tag includes a memory chip where a unique identification number or additional information about the object it is attached to can be stored (Marcus, 2005).

- Environment characters – including competitive pressure, consumer readiness, regulations, etc.

- Organizational characters – including workforce changes, process changes, and infrastructure required.

- Technology characters – including unreliable performance, continually changing hardware/software, and cost/difficulty in adopting RFID.

- Product characters – including the product satisfaction, effectiveness and the application.

1.7 Organization of the Remaining Chapters

There are 5 Chapters during the whole study. For the rest of the study,

Chapter 2 will introduce the literature review on elements related to this research, importance, the adoption of RFID and variables with definitions, theoretical framework and hypothesis.

Chapter 3 will expound the proposed methodology that includes the sample and unit of analysis, data collection method, variables and measurement, and data analysis.

Chapter 4 will present in detail the profile of the respondents, descriptive analysis and the results of statistical data analysis.

This study will conclude in Chapter 5, discussing the recapitulation of the study findings, results of the research. Implications, limitations will be covered due limitations will be reviewed with recommendations for the future research.

Chapter 2

LITERATURE REVIEW

2.0 Introduction

This section will review the findings from previous studies. Based on the literature review, theoretical framework and hypotheses are developed. This chapter was organized to give an overview of literature, underlying theory, literature review, theoretical framework and the hypothesis testing.

2.1 Importance of RFID

RFID is causing a whirlwind of activity and spending in manufacturing (Fataneh & Betty, 2005). Therefore, it is considered one of today's hottest technologies in respect that Linda and Samuel (2007) mentioned its specialized capacity to track and trace objects across the extended supply chain in real time. Since then, this technology has been used for various niche applications such as antitheft systems, luggage tracking systems in airport, electronic toll collection systems, etc(Linda & Samuel, 2007). Many business enterprises and the health industry are applying the advantages of RFID to experimental projects to improve operational efficiency and to gain a competitive advantage (Chao, Yang & Jen, 2007).

Many approaches to technology adoption and implementation can be found in recent academic and practitioner literature (Angeles, 2005). China has reached initial results in terms of RFID application promotion architecture, public service system, middleware, system integration and information integration and testing work, and has applied the RFID technology in many areas e.g. railway carriage number identification, ID card and ticket management, animal identification, special equipment and hazard materials management, public transport and production process management. However, despite the numerous opportunities for RFID, it seems that there is still a long way to go before its extensive global application is achieved (Ngai, Karen, Frederick & Candace, 2007). Both academics and practitioners are keenly aware how organizations can extract business value from RFID. Pedro (2007) said that to determine whether adopting RFID will be beneficial to an organization or one of its processing applications, a manager must follow a procedure that is conducive to the organization's business plan and objectives. Hou and Huang (2006) also mentioned that in the near future, taking advantage of RFID features to facilitate enterprise operation and management efficiency will be one of the essential topics of RFID technology development. Therefore, RFID could indeed create whole new ways of doing business, new conveniences, and vast, multi-billion dollar opportunities if such generally accepted market projections are even halfway correct (David, 2006). Accordingly, it is a priority for manufacturers to implement technologies that improve the management of materials and the efficiency of the production process within their facilities (Linda & Samuel, 2007). According to Lu (2006), the unique capabilities of

RFID have the potential to:

- Facilitate the dynamic planning of production activities
- Improve the tracking of materials, tools or spare parts
- Ensure the efficiency of the maintenance process
- Enhance the management of reusable assets
- Reduce labor cost
- Minimize human related errors, etc.

2.2 RFID Adoption

As the adoption of RFID technology is moving more and more from mandatory to voluntary, firms are looking for tools, frameworks and methodologies to enable them to evaluate the real impact of RFID technology on their business processes (Linda & Samuel, 2007). Nonetheless, the biggest potential lies in RFID can be used for item tracking, especially useful for global supply chain. Once all goods are attached with RFID tags, their whereabouts can be tracked automatically by radio readers, which give complete inventory visibility and supply chain management efficiency (Wu, Nystrom, Lin & Yu, 2006).

As RFID technology progresses in its development and application over the next decade, there will be vast opportunities for management researchers to not only study the advancement of this technology, but also to examine its implications from a wide

variety of perspectives. Indeed, this represents a tremendous Greenfield opportunity for research, for rarely have we had such advance notice that a technology was coming down the pipe that has the distinct potential to so radically reshape our organizations and our economy over at least a decade and beyond (David, 2006). In the academic community too, there is rising interest, leading to the publication of several RFID-related research articles in areas such as innovation management (Sheffi, 2004), product life cycle management (Harrison,2005), project management (Bendavid & Bourgault, 2005), decision support systems (Ngai,2005), supply chain management and warehousing (Bendavid, 2007) and e-commerce (Lefebvre,2006). Furthermore, management researchers could pay their attention to the impact of how RFID-enabled business processes affect organizations. RFID can and will have on the big picture of organizations, both in the private and public sectors (David, 2006). Research could address areas including:

- Business intelligence;
- Management information systems;
- Strategic management;
- Management of technology;
- Financial management; and
- Knowledge management.

Nowadays, we can agree with Reyes and Frazier (2007), where it is not reasonable to believe RFID will fit all industries. However, with the cost of technology on the

decline coupled with increased awareness of potential application, Reyes and Patrick (2007) believes that RFID will some day be applied in almost all industries. The RFID technology will determine the operating parameters for any RFID implementation (Stuart & Liu, 2006). Certainly, much of the research is being conducted by individual organizations, and hopefully, companies and governmental agencies will continue to be open in sharing both their best practices and lessons learned with the wider RFID community, both through presentations and written reports/case studies as they have been in the formative stages of the RFID revolution (David, 2006). Organizational needs have to be considered before implementation. Also, managers have to keep security and privacy issue in mind as they adopt and implement RFID. The benefits of RFID far outweigh the negative effects of the technology. With appropriate safeguards in place, RFID can be an efficiency and effectiveness solution for any organization (Reyes & Patrick, 2007).

2.3 Determinants of RFID Adoption

The global industry for RFID technology has been growing steadily since past few years and is expected to grow rapidly before stabilizing and settling on a steady growth path. Sharma (2007) analyze the literature of adoption and diffusion of innovation and extract a number of factors which are grouped to organizational readiness factors, technology factors, external environment factors and inter-organizational pressure factors. The factors are then used as key words and

respectively variables in semi-structured interviews with industry experts and numerous news reports and tested for significance to RFID technology adoption and diffusion. The most mentioned factors are the perceived benefit of the technology, costs the existence of a dominant supply chain partner, intellectual property and ownership standards adoption, data and software standards, diffusion champion presence, and top management support. In addition, RFID adoption is moderating via supply chain. Today, retailers and manufacturers are using RFID technologies to manage the supply chains (Huber, Michael & McCathie, 2007). In a sense, pervasive standards across the supply chain are necessary to encourage adoption, while adoption is stunted by the lack of standards (Asif & Mandviwalla, 2005), and so most supply chain organizations are reluctant to adopt.

2.3.1 Environment

In much the same way that an innovative organizational culture encourages adoption of new technologies, thus, whether they are from within or outside of the organization, demands will always help to encourage adoption. This is because a technology can add to value by reducing costs or enhancing quality (Asif & Mandviwalla, 2005), and so environmental conditions can have the impact on adoption. However, ‘innovation attributes’ make RFID a suitable technology to meet the demands of the supply chain; real advantage can only be gained in the supply chain when suppliers and customers are collaborating. This implies that willingness of both parties to improve their business processes might facilitate the adoption of a technology that will bring

benefits to both of them (Fawcett, Ogden, Magnan and Cooper, 2006).

2.3.2 Organization

Organizations are increasingly required to incorporate new technology into business practices to improve competitiveness (Shan, Gary & Paul, 2008). Thus, organization-wide readiness is also an important factor for adoption of RFID (Asif & Mandviwalla, 2005). An organization that is logistically innovative in its use of technology, using, for instance, EDI to streamline its document processing, is usually more willing to adopt RFID (Asif & Mandviwalla, 2005), as it is within its nature and organizational culture to do so. Following by this idea, Patterson, Grimm and Corsi (2003), consider organization size to be a significant consideration in organizational technology adoption. They have found that larger organizations generally have extra capacity to devote to finding new technologies and generating economies of scale from them. Grover and Goslar (1993) hold the theory that larger organizations are generally more willing to adopt new technologies, because they have the financial resources to back the change.

2.3.3 Technology

Although there are compelling reasons to adopt RFID to replace barcodes, a few core issues exist: technology, standards, cost and privacy (Vic, 2006). Technological implementations rarely go exactly as planned since new technology brings new challenges. RFID systems are still developing common standards and protocols for

use in the supply chain (Vic, 2006). While costs for readers and tags are becoming more affordable, the software development, integration and implementations, and supporting infrastructure costs are very high. The risk of being outdated due to rapidly evolving standards makes the adoption less attractive. In Schmitt's Opinion (2006), the current trend does not necessarily allow for extrapolations of future developments since technology adoption can hardly be regarded as a linear process.

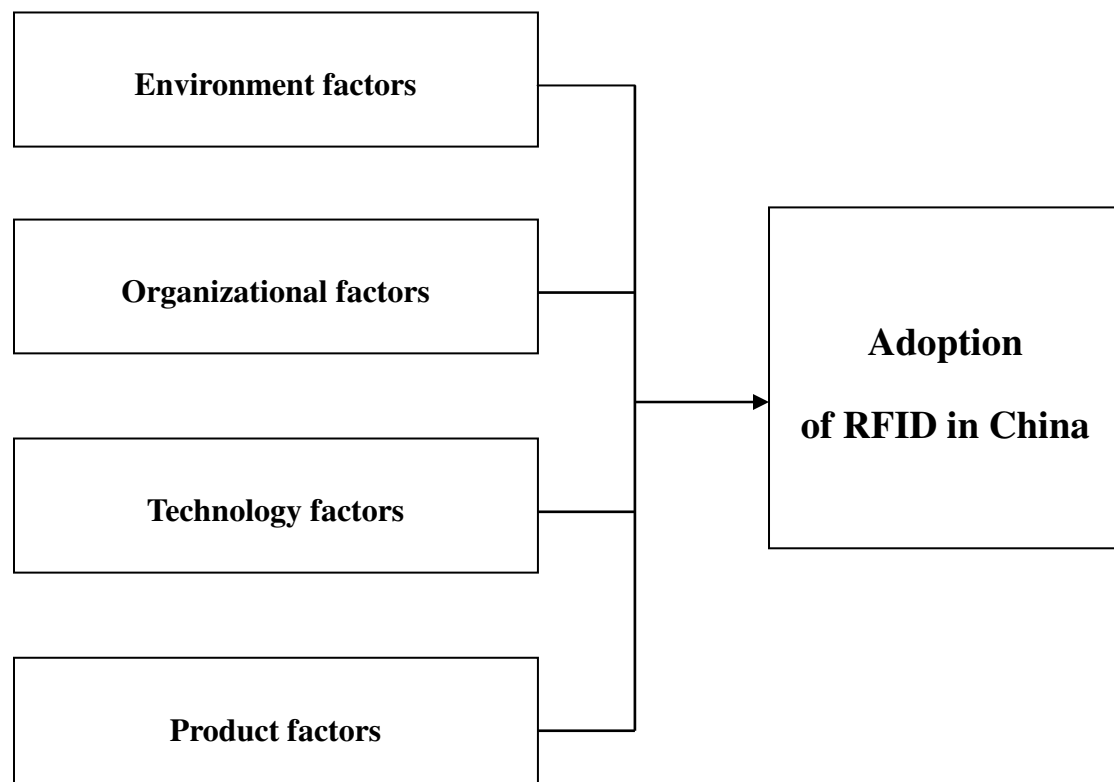
2.3.4 Product

RFID has made significant strides in the past three years. We are still in the early stages of extracting its maximum benefits. The advanced data capture capabilities of RFID technology coupled with unique product identification and real-time digital information coming from different data sources, such as environmental sensors, define a new and rich information environment that opens up new horizons for efficient decision-making activities (George, 2007). For suppliers to benefit from RFID, they need to share RFID information with their partners and exploit this information in order to streamline enterprise collaboration and gain new market knowledge (Subramani, 2004).

2.4 Theoretical Framework

From the review, it is noted that although many factors related to TQM adoption have been widely examined, RFID adoption, in consideration of top management commit, internal assessment, employee participation, have not been taken considerable attention from the researchers. Therefore this theoretical framework is served to investigate the influential factors (independent variables) that may contribute to the RFID adoption (dependent variable).

Figure 2.1
The Framework of Adoption of RFID in China



2.5 Hypothesis Testing

Base on the above framework, the following hypotheses are drawn:

H1: Adoption of RFID in China is influenced by environment factors.

H2: Adoption of RFID in China is influenced by organizational factors.

H3: Adoption of RFID in China is influenced by technology factors.

H4: Adoption of RFID in China is influenced by product factors.

Chapter 3

METHODOLOGY

3.0 Introduction

The present study was designed to investigate the factors affect the adoption of RFID in China. The methodology described in this research encompasses the research design, sampling design and a systematic framework on the administration of the research.

3.1 Sample and unit of analysis

3.1.1 Population and Sample

The population of this study comprises of all the manufacturing companies in China that are registered under Federation of China Manufacturers. Sekaran (2003) suggested that the analysis samples should be at least 10 times the number of variables in a study. Thus, 50 respondents are targeted in this study, as there are a total of 5 variables

3.1.2 Unit of Analysis

Due to the aim of the study an organization is used as the unit of analysis, which is to identify the influential factors that affect a company to adopt RFID.

3.2 Data collection method

Data collection was conducted based on personally administered questionnaire. The respondents for this study were targeted to be the people as they would have the knowledge and influence towards the RFID adoption. In order to obtain sufficient samples for analysis, 200 sets of the questionnaires were distributed to representatives who worked in agriculture, manufacturing, logistics/supply chains, banking, chemical, civil/construction, electrical and electronic, industrial and engineering, IT/ computer, sales, trading and so on industry that could personally reached their managers.

Questionnaire was developed in consideration of the examples from previous literatures (Antony et. al., 2002) and consultation from related field lecturers. The questionnaire was designed to build understanding of the follow sections:

Section A: Company background

Section B: RFID project general information (if any)

Section C: Factors influencing RFID adoption

Section D: Demographic and Profile

For all independent variables in this study, a 5-points Likert scale, which is ranging from strongly disagree to strongly agree, was used to measure the level of perception of the respondent towards the RFID adoption.

3.3 Variables and Measurement

3.3.1 Independent Variables

Environment Characteristics

Environment Characteristics (Question 1-4) was measured by customers' pressure and competitive edge. Customers' pressure was measured by people's demanding for adoption of RFID and the adaptation. These five-point scale measurements for customers pressure were adopted from the study by Premkumar and Roberts (1999). Competitive edge was measured by two items in terms of the adoption of RFID to be aware, to compete with other firms, emphasize on competitors. Five-point scale measurements for the competitive edge were adopted from the study by Banerjee and Golhar (1994).

Organizational Characteristics

Organizational characteristics (Question 5-8) were measured by the employee's information system knowledge and company support. Top management support was measured by two items in terms of sufficient funding and resources for RFID development and effective management control for RFID development. Five-point scale measurements for the organization characteristics were adopted from the study by Premkumar and Roberts (1999). Besides, employee's RFID knowledge was measured by two items in terms of employees have an understanding of RFID system based applications. Five-point scale measurements for the employee's information system were adopted from the study by Cragg and King (1993).