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Analysis of RFID Adoption in China

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Abstract

Radio-frequency identification (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 RFID adoption in China is a highly concerned topic as China has become a world manufacturing center. In this paper, we have presented an overview for China's current RFID adoption status. Based on Rogers's DOI theory, a methodology is developed for analyzing RFID adoption in China. With this methodology, China's RFID adoption status is identified, and ways to speed up the rate of adoption are also suggested.

1. Introduction

RFID or radio frequency identification [1] is a wireless identification and tracking technology that allows a reader to activate a transponder on a radio frequency tag attached to, or embedded in, an item, allowing the reader to remotely read and/or write data to the RFID tag. As China is a global manufacture center, it is important to understand the status and drivers of the RFID adoption in China. This paper is dedicated to examine the present situation of RFID adoption in China. It applies the Roger's diffusion of innovation theories (DOI) [2] to analyze current adoption situation in China to attain an in-depth understanding of the RFID adoption status. And ways to speed up the RFID adoption in China are suggested.

2. Status of RFID adoption in china

Before applying the DOI to analyze the RFID adoption in China, we will give an overview on current RFID adoption status including technology development and RFID applications.

2.1 RFID technology

Chinese government has provided funding support to the universities and organizations on various initiatives to facilitate a wider adoption of RFID. The on-going research projects in the universities cover the topics such as RFID standards, anti-collision algorithms, RFID protocols, RFID implementation technologies, RFID infrastructures, etc…

2.1.1 RFID standards. It is said that Standardization Administration of China (SAC) would like to adopt ISO18000 as Chinese standard [3]. ISO 18000-1,2,3,4,6,7 will be studied and the suitable parts will become Chinese standard (GB). There may be some extensions in Chinese standard covering special needs for China. Reader collision problem

2.1.2 Reader collision problem. Besides the existing algorithms, such as ALOHA and slotted ALOHA, many universities in China endeavored to develop new algorithms to improve the identification efficiency and accuracy (e.g. Anti-collision Algorithm Based on Jumping and Dynamic Searching [4]).

2.1.3 RFID protocols. Universities did a lot of studies in security protocol. But so far, challenges are still there to develop protocols with high security, high efficiency while with low cost [5].

And the accomplishment of the RFID promises requires the integration of a lot of technologies in different fields, including cryptology, information theory, antenna technology, microelectronics, electromagnetic compatible technology and etc. Such integration capabilities are also studied by research organizations in China.

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2.2 Application

The most common RFID application is the entrance guard (e.g. Shanghai Pudong New Area Government). Another widely used field is RFID application in electronic bills, certificates and tickets (e.g. all-in-one cards in Beijing, Shanghai and Shenzhen). Along with the quickly developing highway network in China, RFID began to be applied in auto identification of vehicles and auto charge system on highway. The first large-scale application all over the country is Realization and Application of Railway Car Number Automatic Identification System (ATIS) which was successfully carried out by China Railway in 2001.

RFID is also lightly applied in many other fields such as manufacturing process control (e.g. Haier), product tracking (e.g. State Tobacco Monopoly Administration [6]), post package tracking (e.g. Shanghai EMS [7]), etc. There are other RFID applications in library, military, aviation, etc.

3. Adoption analysis

Great attention is paid to RFID adoption worldwide, while there are a few RFID adoption studies in China. To help businesses to evaluate RFID potentials, it is necessary to study the impact of RFID adoption on individuals, organizations and markets and its classification during the adopting process, etc…

3.1 Methodology

DOI [4] classified members of a social system into five categories to measure the innovativeness of them. S-shaped adopter distributions closely approach normality (see Fig. 1). Standard deviation is used to divide the whole social system into five adopter categories: innovators, early adopters, early majority, late majority and laggards, as shown in Figure 1.

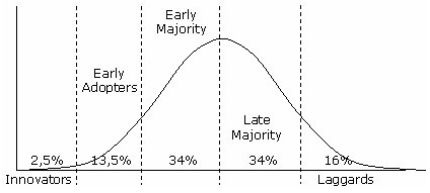

Figure 1. Rogers adoption innovation curve

In order to identify current RFID adoption status in China, we first present our method to distinguish between innovators and early adopters. We define several attributes of them, as shown in Table 1.

Table 1. Attributes of innovators and early adopters

Innovators	Early Adopters
● Be able to understand and apply complex technical knowledge. ● Control substantial financial resources which are helpful to absorb the possible losses from an unprofitable innovation. ● Be able to cope with higher levels of uncertainty about the innovation.	● Help to trigger the critical mass when they adopt an innovation. ● Serve as a role model for other members of the social system. ● Decrease uncertainty about a new idea by adopting the innovation. ● Convey a subjective evaluation of the innovation.

In DOI, rate of adoption is the relative speed with which an innovation is adopted by members of a social system. We have used the following two types of variables that determine RFID adoption rate: One type includes perceived attributes of innovations (including relative advantage, compatibility, complexity, trialability, and observability); another type includes incentives and mandates.

3.2 The stage of the RFID adoption in China

With the data in section 2, we identify the adoption stage in China by looking into the current situation in China and the characteristic of RFID technology.

3.2.1 Immaturity of RFID technology. The RFID technology is not quite ready. Tags are less than completely reliable. Solutions still need to be developed to handle the huge volume of data from RFID systems. As the situation described in section 2.1, the RFID standards in China are still on their way and low cost protocols with high security and efficiency are not available yet. And also, integrating RFID with the existing application systems can be quite complex. The immaturity of standards decelerates large scale adoption of RFID. Not many players within the supply chain are able to fully understand the technology and apply RFID in their daily operation.

3.2.2 High investment. First of all, cost of the tags is still quite high. Although the tag price is said to be dropped, it is not trivial for those low-profit product manufacturers in China to join this RFID business. And an RFID label printer costs about $4,000, a little more than twice the price of standard bar-code printers.

Furthermore, companies in China cannot always outsource RFID tagging to third-party logistics to avoid setup cost as its counterparts do. In China, only 21 percent of large corporations (including multinational corporations) outsource logistics to third-party logistics providers [8]. The third-party logistics in China cannot afford tremendous outsourcing yet.

The third-party logistics themselves are reluctant to take the potential financial risk.

Only a few minorities of the manufacturers, such as Haier and some state owned enterprises can control substantial financial resource which helps to absorb the possible losses from an unprofitable RFID adoption, and they become the innovators of RFID.

3.2.3 Lack of successful cases. Pilots of adopting RFID are mainly those state owned enterprises or government-owned organizations. Even among these applications, it is hard to say they are matured and can be widely deployed. ATIS is a closed system, which cannot connect to other systems yet. State Tobacco Monopoly Administration only tries RFID tags in a few of its branch factories [6].There are few cost-effective models in each industry as benchmarks to follow. It is common sense that only when all the parties along the supply chain adopt RFID, will the return reach the highest. At present, most enterprises are adopting a wait-and-see policy and some of them are well-prepared to be early-adopters to reap the benefits of RFID as soon as it is more mature.

According to differences between innovators and early adopters listed in Table I, a conclusion can now be drawn that RFID adoption in China is expanding past the innovator stage. Only a few pioneers in the industries, who can understand the technology and are able to tackle with the financial risks, are served as innovators in RFID diffusion.

3.3 How to speed up the rate of diffusion?

The attributes that influence the rate of RFID adoption in China are first examined in this section. We will look into the impact of five perceived attributes of innovations and then the impact of incentives and mandates.

3.3.1 Perceived Attributes of Innovations

- Relative advantage

Relative advantage is a ratio of the expected benefits and the costs of adoption of an innovation. Sub-dimensions of relative advantage include economic profitability, low initial cost, a decrease in discomfort, social prestige, saving of time and effort, and immediacy of reward.

In the scenario of RFID adoption, the value proposition of RFID are observable as accountability, improved safety, a deterrent to counterfeiting, less risk from the cost of product recalls, and the opportunity for proactive field service. In other words, RFID enables supply chain operations to be more effectively coupled with marketing, accounting and finance-related processes, and thereby allows increasing levels of business process outsourcing.

However, RFID does not expect a low initial cost and immediate reward. The cost for RFID system is relatively expensive while the reward is slow and hard to observe. The more time spent on making the innovation decision, the slower the rate of adoption. Thus either a lower setup cost has to be realized or incentives and mandates have to be introduced to speed up the adoption (see section 3.3.2).

- Compatibility

Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past values, and needs of potential adopters. Compatibility is critical to a successful adoption of an innovation. In the context of manufacturing process, we primarily consider RFID compatibility in four aspects:

1. Compatibility between the RFID solution and existing Manufacturing Execution System (MES), Advanced Planning & Scheduling (APS) or Enterprise resource planning (ERP) systems;
2. Compatible with the manufacturing process, the nature of the materials and the regulatory of the industry, etc.;
3. Compatibility between the RFID solution and the manufacturer's primary objectives with respect to performance improvement;
4. Building compatible data exchange platform for easy, secure, real-time communication between manufacturing, logistics and trading partners.

To solve those problems relies on not only the improvement of the technology, but also an innovative management group, who are determined to update their existing infrastructure and adopt new technology.

- Complexity

Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use. The complexity of RFID could be split into two sections: the complexity of the RFID deployment and the complexity of operating RFID system. We merely care about the complexity of operating RFID system since users are not required to understand how RFID works. Therefore a user friendly interface of RFID system can help the diffusion.

- Trialability

Trialability is the degree to which an innovation may be experimented with on a limited basis. Because of high initial cost of RFID system, the trial of applying RFID in potential adopter's enterprise is infeasible. Thus how to give potential adopters an intuitive sense of applying RFID in their enterprise is a problem. An analysis framework [9] is proposed for evaluation over the RFID adoption and deployment based on value integration.

- Observability

Observability is the degree to which the results of an innovation are visible to others. RFID can shorten lead time, reduce safety stock and improve service level, etc.. However, to calculate the benefits from adopting RFID is difficult to some extent. Thus, there are few solid figures or concrete evidences to persuade potential adopters. To figure out persuasive performance indicators to measure performance enhancement can also help the diffusion of RFID.

3.3.2 Incentives and Mandates

- Incentives

Providing incentives is one means through which a higher level of social organization, such as a government, community, or a commercial company, can exert its influence on the behavior of individual members of the system to speed up the rate of adoption. In 2006, The Ministry of Science and Technology of China launched a scheme of "RFID Technology and Application" within the Hi-tech Research and Development Program of China (863 Program)[10]. The Chinese government is spending great efforts to encourage industries to adopt RFID.

- Mandates

Besides incentives, mandates of government can also speed up the rate of adoption. The China National Tobacco Monopoly Administration requires every of its 37.5 billion cigarette packages to be identified with brand, type, and origin. Government acts as an important and powerful propellent in RFID adoption in China. It takes charge of developing RFID standards and mandate RFID regulations all over the country.

The incentives and mandates issued by Chinese government contribute a lot to the diffusion of RFID. There is no doubt that government mandates can speed up the diffusion of RFID. But it cannot bring it from innovator stage to early adopter stage on its own.

4. Conclusion

RFID adoption in China is expanding past the innovator stage. It would eventually develop from current innovators dominating stage into mass adoption of RFID. Before that, we observe the following obstacles have to be overcome, 1) cheaper and reliable tags, 2) compatible infrastructure, 3) uniform or generally agreed standards, and 4) security mechanisms protecting privacy. In the near future, the RFID adoption would be develop into a status with 1) a penetration more than three percent, 2) visible pilot cases in industries, and 3) objective of RFID incentives shifting to self-improvement of businesses.

We predict that the RFID adoption in China will follow the following roadmap before a mass adoption :

- The prime concern of enterprises will shift from tag costs and reader costs to data integration, since the cost of tags and readers keep on decreasing as the technology improves;
- More RFID initiatives will begin with their own interests rather than mandate compliance;
- Manufacturers will take the leadership of this revolution from retailers and government;
- The focus of the RFID system will switch from performance to compatibility.

We believe that more RFID initiatives will appear to satisfy other needs other than government or customer mandates. Manufacturers will possibly lead this diffusion in China, in four steps: 1) mandate compliance; 2) information visibility; 3) process optimization; and 4) competitive differentiation. Along with the quantity of successful RFID adoption increasing, manufacturers will realize the benefit from RFID and adopt it individually. This will trigger the take off of the rate of adoption.

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