The Antecedents and Consequences of RFID Technology Adoption for China's Logistics Companies

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Abstract

With the fast growth in China's economy, the logistics industry in China is set to take off, and more and more logistics companies begin to adopt innovative logistics technologies. RFID technology has been regarded as an important innovative application in logistics operations and supply chain management. This paper aims to study the antecedents and consequences of RFID technology adoption from the perspective of technological innovation by conducting a questionnaire survey on China's logistics companies. The factors influencing RFID technology adoption consist of organizational and environmental dimensions. Research findings reveal that organizational encouragement for innovation, quality of human capital, organizational accumulation of related knowledge, perceived environmental uncertainty, and governmental support exhibit significant influences on the willingness to adopt RFID technology. Logistics companies with higher levels of willingness to adopt RFID technology will be associated with better supply chain performance.

Keywords

China, logistics companies, RFID technology adoption, supply chain performance, technological innovation

Introduction

More than two decades of economic reform and transition to market economy has brought China unprecedented economic growth. As China continues to develop into a global manufacturing factory, China's logistics industry plays an important role in the global supply chain. With the fast growth in China's economy, the demand for logistics

services has been growing significantly in China, and the logistics industry in China is set to take off. The total logistics value has grown by 29.9 percents year-on-year (Li & Fung Research Centre, 2005). New modern facilities such as logistics parks, distribution centers and warehouses are being built at a record setting pace. Many logistics companies have invested extensively in information and logistics technologies. Continuous technological advancement can assist China's logistics industry to revolutionize the way they operate and conduct their business. Therefore, this paper will study the topic about the adoption of RFID technology in China's logistics industry.

The logistics industry plays an important role in the supply chain. Logistics is a strategic factor that provides a unique competitive advantage in the supply chain. The globalization of supply chain has prompted many firms to develop logistics as a part of their corporate strategy. The purpose of logistics is the supply of services or products to the customers at the right time, with the right quantity, in the right quality, with the right cost and at the right place. Logistics is a process dealing with the flow from the primitive occurring point to the final consumption point and the storage efficiency as well as the cost benefit of raw material, half-finished product, finished product and related information, for the purpose of satisfying the customer's requirement (Bowersox & Closs, 1996). To deliver products quickly to customers, many companies seek to outsource their logistics activities to logistics companies. This reflects the trend of using logistics companies to satisfy increasing need for logistics services (Lieb & Miller, 2002).

To provide logistics services more efficiently and responsively, many logistics

companies have acknowledged that they must adopt technologies that will help manufacturers, warehouses, and retailers to communicate with each other more efficiently. A body of research has shown that the adoption of technological innovations is the most important tool for enterprises to keep their competitive advantage. Logistics companies can increase their performance by employing new technologies. The logistics industry should pay attention to innovation in logistics service, which can be implemented through technology, knowledge and relationship networks (Chapman, Soosay, & Kandampully, 2003). Among many logistics technologies, radio frequency identification (RFID) technology has been taken as an important application in logistics operations and supply chain management (Smith, 2005; Srivastava, 2004). Federal Express, Dell, Proctor and Gamble, the US Department of Defense, and the European retailer Metro Group have begun to utilize RFID technology in their supply chain systems. Moreover, much like Wal-Mart did with electronic data interchange and bar code development, Wal-Mart has been beginning to drive the adoption of RFID technology, which will mean significant changes in the way supply chains are managed. Wal-Mart announced that they would require all of their larger suppliers to implement RFID on every box and pallet shipped to Wal-Mart. RFID technology is one type of auto-identification technology that uses radio waves to identify individual physical objects. An RFID tag consists of two main components: an antenna and a chip containing an electronic product code. RFID technology is compact and robust, and has been used for in many applications including the manufacturing and distribution of products. It can help item level identification, which is useful for easily and efficiently identifying each item within the entire supply

chain (Davis & Luehlfing, 2004). Due to the application of RFID, we can interact with the product items without physical contact, and increase our handling efficiencies. RFID technology provides a tool for real-time data communication and can close the information gaps in the supply chain (Angeles, 2005; Prater, Frazier, & Reyes, 2005).

There is a body of research about the application of RFID technology; however, what has been missing is a discussion of the drivers or influencing factors that lead various industries to consider RFID (Prater et al., 2005). Although RFID technology has garnered a great deal of research interest, most research has primarily focused on the specifics of the technology, or its impact on general supply chain issues, such as its general promise of cost and time savings (e.g. Angeles, 2005; Kärkkäinen, 2003; Smith, 2005; Srivastava, 2004). Most studies argued that the key factor for widespread usage of RFID technology is its cost. However, it is still not clear whether other organizational and environmental context will affect the adoption of RFID technology. The implementation of RFID technology in the logistics industry is still in the initial stage of development, it is reasonable to view the adoption of RFID technology as an innovative process for a logistics company. Therefore, this study will explore the adoption of RFID technology from the perspective of technological innovation.

The main purpose of this paper is to conduct questionnaire surveys in China to study the antecedents and consequences of RFID technology adoption in the logistics industry. Based on theories related technological innovation, the factors affecting RFID technology adoption by logistics companies consist of organizational and environmental dimensions. The relationship between logistics companies' supply chain

performance and the adoption of RFID technology is also investigated. An understanding of the antecedents and consequences of RFID adoption is essential in order for practitioners to best implement a new technology, and for researchers to best understand what issues need to be addressed.

The next section introduces the theoretical foundation and research hypotheses of the factors influencing the adoption of RFID technology and the relationship between supply chain performance and RFID technology adoption. The third section gives a description of data collection and research measurements, while the fourth section focuses on the analysis and discussions of the research findings. The final section gives research conclusions and research limitations.

Theoretical Foundation and Research Hypotheses

Innovation is the use of new technical and administrative knowledge to offer a new product or service to customers. The product or service is new in that its cost is lower, its attributes are improved, it now has attributes it never had before, or it never existed in that market before. Innovation is any practices that are new to organizations, including equipments, products, services, processes, policies and projects (Damanpour, 1991; Kimberly & Evanisko, 1981). Companies can achieve competitive advantage through acts of innovation including both new technologies and new ways of doing things. Because the implementation of RFID technology is still in its infancy (Davis & Luehlefing, 2004), it is reasonable to assume that the adoption of RFID technology can be taken as an innovative process for a logistics company. Therefore, we will utilize the

concept of technological innovation as the theoretical foundation to study the adoption of RFID technology.

Antecedents of RFID Technology Adoption

An amount of researchers have studied the determinants or influencing factors on innovation (e.g. Amabile, 1988; Kimberly & Evanisko, 1981). Kimberly and Evanisko (1981) suggested that the individual factor, organizational factor, and contextual factor would influence hospital adoption of technological innovation. Tornatzky and Fleischer (1990) suggested that the adoption and implementation of technological innovation would be affected by the technological context, organizational context, and the external environmental context. Scupola (2003) used technological, organizational, and environmental characteristics to explain the adoption of Internet commerce. Among several factors influencing technological innovation, organizational and environmental factors are the most widely analyzed in research on innovation. Therefore, this paper will investigate the influence of organizational and environmental factors on the adoption of RFID technology in China's logistics industry.

(1) Organizational Factors

A body of research has argued that certain features of organizations themselves, including the structures, climates, and cultures of organizations, will influence the adoption of technological innovation (e.g. Kimberly & Evanisko, 1981; Tornatzky & Fleischer, 1990; Russell & Hoag, 2004). Amabile (1988) found that the management skills, organizational encouragement for innovation, and support of innovation resources would help the improvement of organizational innovation. The support and

encouragement of top management is considered an essential factor for the development of innovation strategies because the resources required for the implementation of new technologies will be more easily available if the major person responsible for these resources supports the plans. Moreover, many initiatives of adopting new technologies require the collaboration and coordination of different departments and divisions and this is easier to manage when such initiatives are endorsed from the top. Therefore, we would expect that support for innovation might influence the adoption of RFID technology and propose the following hypothesis:

Hypothesis H1a. *The more the encouragement for innovation, the more willingness that the logistics company will have to adopt RFID technology.*

Tornatzky and Fleischer (1990) suggested that informal linkages and communication among the employees, the quality of human resources, top management's leadership behavior and the amount of internal slack resources would significantly influence the adoption of technological innovation. Technologies can be viewed as one kind of knowledge (Grant, 1996). Tsai and Ghoshal (1998) found that an organization will have higher innovative capability when knowledge can be shared more easily within the organization. The transferability of knowledge will influence technology innovation. A firm with higher quality of human capital such as employees with better education or training will have higher ability in technological innovation because it is more easily to transfer or share technological knowledge within these better educated people (Grant, 1996; Teece, 1996). Therefore, we would expect that the quality of human capital might influence the adoption of RFID technology. The following hypothesis is consequently proposed:

Hypothesis H1b. *The higher the quality of human capital, the more willingness that the logistics company will have to adopt RFID technology.*

In addition, how the technology fits with the operational knowledge that a firm already possesses is another important technological characteristic (Tornatzky & Fleischer, 1990; Chau & Tam, 1997). Teece (1996) found that innovation usually follows a technological paradigm. The cumulative nature of related knowledge will influence the innovation in technologies. Grant (1996) and Simonin (1999) also concluded that an organization with rich experiences in the application or adoption of related technologies will have higher ability in technological innovation. In addition, companies with a higher level of innovation capacity innovate more frequently in a radical way (Clark & Fujimoto, 1989). The companies that have an adequately integrated innovation capacity will recognize its express purpose to solve problems, such as the adoption of RFID technology. Thereby, the most advanced and most competence-modifying technologies will emerge as a result of accumulated R&D activities (Rogers, 2003). Therefore, we would expect that organizational accumulation of related knowledge might influence the adoption of RFID technology. The following hypothesis is consequently proposed:

Hypothesis H1c. *The more the organizational accumulation of related knowledge in the firm, the more willingness that the logistics company will have to adopt RFID technology.*

(2) Environmental Factors

The external environment in which a firm conducts its business is another

important factor that influences innovative behaviors (King & Anderson, 1995). Miles and Snow (1978) found that organizations would pay more attention on innovation when they faced environments with higher instability and chaos. Kimberly and Evanisko (1981) concluded the environmental complexity and uncertainty would influence the organizational innovation for hospitals. Damanpour (1991) found that environments with high uncertainties would have positive influences on the relationship between organizational structures and organizational innovation. Zhu and Weyant (2003) suggested that demand uncertainty tends to increase firm's incentive to adopt new technologies. Therefore we would expect that environmental uncertainty might influence the adoption of RFID technology and propose the following hypothesis:

Hypothesis H2a. *The more the perceived environmental uncertainty, the more willingness that the logistics company will have to adopt RFID technology.*

Governmental support is another important environmental characteristic for technological innovation. Government through regulation can both encourage and discourage the adoption of innovation (Tornatzky & Fleischer, 1990; Scupola, 2003). Government can provide financial incentives, pilot projects, and tax breaks to stimulate technological innovation for logistics companies. Therefore we would expect that governmental support might influence the adoption of RFID technology. The following hypothesis is consequently proposed:

Hypothesis H2b. *The more the governmental support, the more willingness that the logistics company will have to adopt RFID technology.*

Consequences of RFID Technology Adoption

In the resource-based view, technology is an important resource for a firm to obtain competitive advantage. A firm should develop a viable strategy to marshal resources to produce superior performance (Grant, 1991). A body of logistics research has revealed that logistics services capabilities, such as warehousing, transportation and freight bill payment, are drivers for superior supply chain performance (Murphy & Poist, 2000). Customer-focused capabilities including responsiveness and flexibility can enhance performance (Zhao, Droge, & Stank, 2001). A logistics company with a better service capability may attain a higher service performance (Lai, 2004). As RFID technology can help item level identification, which is useful for easily and efficiently identifying each item within the entire supply chain (Davis & Luehlfing, 2004), RFID technology would improve supply chain performance for logistics industry. Moreover, adopting RFID technology in logistics service process can also be seen as an innovation for a logistics company. Innovation can reinforce competitive advantage for companies in markets where customer preferences change rapidly, where differentiation is limited, and where competition is intense (McAfee, 2002). A substantial body of research has revealed the positive link between innovation and performance for service industries (e.g. Harvey, 2000; Li & Atuahene-Gima, 2001). As the application of RFID technology in logistics processes can be seen as innovation for China's logistics companies, we would expect that China's logistics company with a higher level of willingness to adopt RFID technology will have better supply chain performance.

After China's accession into WTO, allowing foreign logistics companies to

operate in China more freely boost the growth of China's logistics industry. Industry growth can rapidly reduce the levels of risk inherent in investing in long-lived technology at its emerging point, and consequently can accelerate the maturation of a technology (Russo & Fouts, 1997). Thus logistics companies that are willing to invest in a newer logistics technology, although adding to risk, also have a higher prospective return in a high-growth industry. Firms that fail to invest in newer technologies would suffer comparatively. Moreover, use of new technologies will add complexity to production or delivery processes and requires increased skills from workers at all levels of the firm (Groenewegen & Vergragt, 1991). As a proactive technology policy takes hold in a firm, we would expect that the firm might be built with the resources of organizational commitment and learning, cross-functional integration, increased employee skills and participation, and forward-thinking management style (Hart, 1995; Shrivastava, 1995), which are emerging as prime resources in the competitive environment. Therefore, the following hypothesis is consequently proposed:

Hypothesis H3 *China's logistics company with a higher level of willingness to adopt RFID technology will have better supply chain performance.*

Research Methods

Measures

Data were collected by means of delivering questionnaires to logistics companies in China. The questionnaire consists of company's basic information, factors influencing the adoption of RFID technology, supply chain performance, and

the willingness to adopt RFID technology. Besides the company's basic information, the other items were measured using 5-point Likert scales anchored by 'strongly disagree' and 'strongly agree'. Organizational encouragement for innovation was measured according to the degrees that companies' resource supports and leaders' attitudes (Amabile, 1988; Tornatzky & Fleischer, 1990). Quality of human resources was measured according to employees' information skills and innovation capabilities (Tornatzky & Fleischer, 1990). Organizational accumulation of related knowledge was measured according to the degrees of fitness of related technologies a firm that possessed (Chau & Tam, 1997; Grant, 1996; Simonin, 1999). Customers' requirements, competitors' innovative abilities, and development of logistics technologies were used to measure the environmental uncertainty (Kimberly & Evanisko, 1981; Zhu & Weyant, 2003). Governmental support was measured from the perspective of finance, technology, law and human resources (Scupola, 2003; Tornatzky & Fleischer, 1990). Quality, time, flexibility, and cost are primary categories of performance measurements (Neely, Gregory, & Platts, 1995). Based on the available literature (e.g. Beamon, 1999; Brewer & Speh, 2000; Gunasekaran, Patel, & McGaughey, 2004; Rafele, 2004), supply chain performance measurements in this study consist of financial indices including profit margin, revenue growth, cost per order, cost per unit, and return on assets, and non-financial indices including order fill rates, order cycle time, delivery time, customer requirements met, number of faults, and flexibility. The willingness to adopt RFID technology was used as measurements of RFID technology adoption. Logistics companies will try to adopt RFID technology when they have strong willingness. The measured scales were submitted to factor analysis with varimax rotation. Factors with

eigenvalues greater than 1.0 are summarized in Table 1 and Table 2.

Table 1 Results of Factor Analysis for Organizational Factors

Items	Factor loading		
	Factor 1	**Factor 2**	**Factor 3**
Encouragement for innovation (Factor 1)			
Company's leaders encourage employees to learn new information.	0.839	0.083	0.089
Our company provides supports for employees to learn new information.	0.817	0.095	0.102
Company's leaders can help employees when they face new problems.	0.782	0.110	0.106
Our Company provides rewards for innovative employees.	0.751	0.143	0.115
Quality of human capital (Factor 2)			
Employees can learn new technologies easily.	0.100	0.829	0.093
Employees can share knowledge with each others.	0.124	0.803	0.107
Employees possess abilities to use computer to solve problems.	0.137	0.756	0.183
Employees usually provide new ideas for companies.	0.204	0.728	0.041
Accumulation of technology (Factor 3)			
It is easy to integrate that technology with company's current logistics system.	0.112	0.108	0.814
Our company has implemented many related technologies.	0.127	0.145	0.793
It is necessary to have experiences in using related technologies.	0.144	0.201	0.749
Eigenvalue	4.122	2.983	2.011
Variance explained	32.182 %	24.879 %	20.136 %
Accumulated variance explained	32.182 %	57.061 %	77.197 %
Cronbach's α *for each dimension*	0.8863	0.8541	0.8617
Cronbach's α		0.8689	

Table 2 Results of Factor Analysis for Environmental Factors

Items	Factor loading	
	Factor 1	**Factor 2**
Governmental support (Factor 1)		
Government provides financial support for the development of logistics technologies	0.858	0.083
Government encourages companies to propose projects of logistics technologies	0.833	0.091
Government help training manpower with logistics skills	0.789	0.118
Government relieves the regulation for the logistics industry	0.761	0.194
Environmental uncertainty (Factor 2)		
The advance in new logistics technologies is quickly	0.091	0.828
Competitors usually provide new logistics services	0.086	0.801
Customers' requirements are diversified	0.109	0.762
Customers' requirements vary quickly	0.127	0.748
Eigenvalue	4.195	2.379
Variance explained	37.457 %	32.066 %
Accumulated variance explained	37.457 %	69.523 %
Cronbach's α for each dimension	0.8312	0.7798
Cronbach's α	0.8108	

The organizational factors consist of "organizational encouragement for innovation," "quality of human capital" and "organizational accumulation of related knowledge". Environmental factors consist of "environmental uncertainty" and "governmental support." From the results of factor analysis, we can confirm the construct validity of this study. Results of the reliability analysis are also illustrated in these tables. The overall reliability is 0.8451. As the smallest value of Cronbach's alpha for this study is 0.7798, the sampling results are reliable (Nunnally, 1978).

Data Collection and Sample Description

Logistics companies carry out logistics activities for their customers, which include warehousing, transportation, inventory management, order processing, and packaging (Delfmann, Albers, & Gehring, 2002; Sink, Langley, & Gibson, 1996). The sample frame was drawn from members of the logistics councils in Shanghai region because the development of logistics industry in this region is more mature than other regions in China. The Shanghai Municipal Government has been giving priority to the development of three large-scale logistics parks during its tenth five-year plan period. Six hundred questionnaires were mailed or delivered directly to the sampled companies in Shanghai region. In order to get a higher rate of response, we also personally deliver questionnaires to some logistics companies in each area. As a result, 219 questionnaires were returned. Of these respondents, 13 uncompleted or unconfident questionnaires were excluded. The overall response rate is 34.3 percents. The basic information of these companies is shown in Table 3.

Table 3 reveals that most logistics companies belong to small and medium size enterprises in China. Because RFID technology has been seen as a product data identification technology to replace bar code, we also surveyed the experience of using bar code for logistics companies. We can find that about sixty percents of logistics companies in China have the experience of using bar code in their logistics service processes. According to the survey results, we also found that about fifty percents of logistics companies are interested in RFID technology, but only about nine percents of logistics companies have the experiences of using RFID technology.

Table 3 Basic Information of the Sample

	Category	Number	Percentage (%)
Company history (Years)	0~5	139	67.5
	6~10	49	23.8
	11~20	12	5.8
	Above 20	6	2.9
Number of employee	Below 50	73	35.4
	51~100	71	34.5
	101~300	38	18.4
	301~500	17	8.3
	Above 501	7	3.4
Capital (Million, RMB Yuan)	Below 1	46	22.3
	1~5	65	31.6
	5~10	46	22.3
	10~50	28	13.6
	Above 50	21	10.2
Bar Code experience	Yes	128	62.1
	No	78	37.9

Research Results and Discussions

Antecedents of RFID Technology Adoption

The method of multiple regression analysis was used to determine the influences of organizational and environmental factors on the adoption of RFID technology. Based on the above results obtained by the method of factor analysis, the organizational factors include organizational encouragement for innovation, quality of human capital, and organizational accumulation of related knowledge; environmental factors consist of environmental uncertainty, and governmental support. This paper took these five factors as independent variables and the willingness to adopt RFID

technology as the dependent variable, and then, employed the method of regression analysis to determine their relationship. Because firm size and history (Spencer, 2003) and past experiences or related technologies (Grant, 1996; Simonin, 1999) might influences the adoption of technological innovation, company history, number of employee, capital size, and bar code experience are taken as the control variables in the regression analysis. Table 4 shows the standardized results of regression analysis.

Table 4 Regression Results for the Antecedents of RFID Technology Adoption

Dependent variables: Adoption of RFID technology				
Predictors	**Model 1**		**Model 2**	
	Coefficient β	*t*	Coefficient β	*t*
Control variables				
Company history	0.011	0.579	0.006	0.610
Number of employee	0.043	0.883	0.025	0.739
Capital size	0.058	1.536^{+}	0.032	1.067
Bar code experience	0.062	1.672^{+}	0.051	1.613^{+}
Organizational factors				
Encouragement			0.161	4.012**
Human capital			0.189	3.997**
Accumulation			0.173	3.925**
Environmental factors				
Uncertainty			0.133	2.016*
Government			0.195	4.357**
R^2	0.094		0.563	
adj R^2	0.074		0.509	
F	1.013		7.497**	
Durbin-Watson value	1.691		1.703	

$^{+}$ $p<0.1$ * $p<0.05$ ** $p<0.01$

Table 4 reveals that all the proposed organizational and environmental factors have positive influences on the adoption of RFID technology. Organizational

encouragement for innovation, quality of human capital, organizational accumulation of related knowledge, environmental uncertainty, and governmental support all exhibit significantly positive influences on the willingness to adopt RFID technology for China's logistics companies. This means that all the proposed research hypotheses, *H1a*, *H1b*, *H1c*, *H2a*, and *H2b* are supported.

We can conclude that organizational encouragement for innovation can give employees motivation and support to adopt new logistics technologies, such as RFID technology. High quality of human resources means that employees are capable of learn and use innovative logistics technology like RFID technology. More accumulation of related knowledge within the firm can make logistics companies have more abilities to adopt RFID technology. Actually, the positive relationship between the experience of using bar code and the willingness to adopt RFID technology also reveals the positive influences of accumulation of technology. Environmental uncertainty did have significant influences on the willingness to adopt RFID technology. Governmental support can encourage and guide logistics companies to adopt RFID technology.

Consequences of RFID Technology Adoption

To determine the relation between supply chain performance and RFID adoption, the method of regression analysis was also used. The willingness to adopt RFID technology is taken as the independent variable and supply chain performance is taken as the dependent variable. As the firm size and history might influence organizational performance (Capon, Farley, & Hoenig, 1990), company history, number of employee, and capital size are taken as the control variables in the regression

analysis. Table 5 shows the standardized results of the regression analysis.

Table 5 Regression Result for the Relationship between RDID Technology Adoption and Supply Chain Performance

Dependent variables: Supply chain performance		
	Coefficient β	*t*
Control variables		
Company history	0.013	0.086
Number of employee	0.042	1.573^{+}
Capital size	0.049	1.631^{+}
Adoption of RFID technology	0.131	1.967*
R^2	0.236	
adj R^2	0.195	
F	1.762	

$^{+}$ $p<0.1$ * $p<0.05$ ** $p<0.01$

According to the results shown in Table 5, it can be found that supply chain performance is positively associated with the willingness to adopt RFID technology though the overall regression model is not significant. This means that the hypothesis *H3* is supported. China's logistics companies with a stronger attitude toward adopting innovative logistics technologies will attain better supply chain performance. Those companies will require increased skills from workers at all levels of the firm because of using new technologies will add complexity to production or delivery processes. They might be built with the resources of organizational commitment and learning, cross-functional integration, increased employee skills and participation, and forward-thinking management style, which are emerging as prime resources in the competitive environment. Therefore, logistics companies that are willing to invest in a newer

logistics technology such as RFID technology have a higher prospective return.

Conclusions

Technological innovation plays a critical role in expediting further growth of the logistics industry in China. To improve their logistics services, many logistics companies in China begin to adopt innovative logistics technologies. However, much remains to be learned on the adoption of innovative logistics technologies in China. As RFID technology is one of the innovative logistics technologies, this paper investigates the factors influencing the adoption of RFID technology in China's logistics industry and the relationship between supply chain performance and RFID technology adoption. According to the research results that a significantly positive relationship exists between the willingness to adopt RFID technology and the supply chain performance, China's logistics companies with the intention to adopt technological innovations will have better performance. Logistics companies play an important role in the supply chain systems. As logistics companies must pay much attention to improve their supply chain performance to provide better services for their customers, they should begin to utilize many innovative logistics technologies to improve their performance and reinforce their competitive advantages.

According to the research results, organizational encouragement for innovation, quality of human capital, organizational accumulation of related knowledge, environmental uncertainty, and governmental support all exhibit significantly positive influences on the willingness to adopt RFID technology for China's logistics

companies.. Therefore, we can conclude that logistics companies can increase their ability to adopt RFID technology by encouraging or supporting their employees to learn new technology, by training and educating their employees to become knowledge workers, and by accumulating more related technologies within the firm. Therefore, based on these conclusions, logistics companies can plan better strategies to improve the development and application of RFID technology in China's logistics industry. In addition, under normal condition, the viability of technologies that are on the cutting edge as well as the economic consequences of using these technologies could be largely unknown. An investment in replacing and redesigning existing technologies and processes in a competitive environment is financially significant and involves substantial risk. Without governmental support, many innovative technologies will not be able to be implemented successfully. It would be even more risky to make the decision to adopt new technologies and processes (Kemp, 1993). Therefore, the government also plays an important role in the adoption of RFID technology in China's logistics industry. The willingness to adopt RFID technology will be reinforced for logistics companies if the government can provide various supports of resources and continuous encouragement policies. The China's government should provide financial incentives, pilot projects, and tax breaks to stimulate technological innovation for logistics industry.

Some limitations of this study should be recognized. First, because the research design is cross-sectional, the present study does not shed light on changes In RFID technology adoption over time. The second limitation is that the research results might

suffer from the potential respondent bias because the questionnaire survey is conducted in the study. Thirdly, there might be different effects of organizational and environmental factors on the adoption of RFID technology for different logistics service types because logistics companies cover a wide range of service types. In this study, we did not take the influences of service types of logistics companies on the adoption of RFID technology. It is worthwhile to make a further study on the moderating effect of logistics service types on the adoption of RFID technology. The fourth limitation is that this paper only studies the antecedents and consequences of RFID technology adoption for logistics companies located in Shanghai in China, which may limit the generalizability of our results because of the differences in economic development among cities in China. Moreover, there are differences between China and other countries in political structures, cultural background, historical perspective, social value, and so on. Logistics companies in different cities and countries may have different views on the influences of organizational and environmental factors on the adoption of RFID technology. It will be worthwhile to advance an International study on the adoption of RFID technology in the logistics industry.

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