

RFID Adoption by Supply Chain Organizations in Malaysia

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Abstract. In today's competitive environment, effective supply chain management is very necessary. Appropriate IT integration has been used to boost the effectiveness of operations and to unravel novel products to the market, and to increase the firm's profitability. For the field of supply chain management, RFID is considered as one of the most thrilling technologies developed to date (Scott, 2005). The purpose of this paper is to examine the critical factors of RFID technology adoption from technological perspective in supply chain organizations in Malaysia. Research hypotheses were developed, questionnaires distributed among IT professionals, General Manager, chief executive officer or chief technology officer inside three main supply chain industries in Malaysia (manufacturing, retail, and logistics) in medium and large scales. The result shows Perceived cost has the highest significant negative impact on their adoption decision. Besides complexity, Perceived benefits and compatibility influence considerably on RFID adoption decision by organizations.

Keywords: RFID, Adoption Decision, Supply Chain, Technological Factors and Malaysia.

1. Introduction

Supply chain is a network connecting manufacturers, suppliers, distributors, and customers (Talluri, 2000). It is important to consider the exchange of operational and strategic information across functions inside of the firms and between all firms when implementing supply chain management (Moberg et al., 2004). For the field of supply chain management, utilization of radio frequency identification is considered as one of the most thrilling technologies developed to date (Scott, 2005). The RFID technology supports supply chain information sharing by providing unique features in collecting data within and between organizations, which ultimately enhance the performance of the supply chain firms (Zelbst et al., 2010). RFID is a form of technology, which is used to identify physical objects like palettes, industrial containers, or sales units, automatically by using radio waves. There are transponders placed inside or on the surface of the particular objects, which allow the objects to be identified without physical touch (Attaran, 2007).

Nowadays, RFID technology is gaining interests in businesses, academic environments and the media (Balloco et al., 2011). Even with the growing knowledge about the implementation of RFIDs, there is still not enough information about the elements driving this technology adoption. Currently, few empirical studies regarding the use of RFID and its influential steering elements have been conducted (Madlberger, 2009). This research focuses on gathering information about the key elements from technological perspective, which drives the decision by supply chain organization to adopt RFID technology in Malaysia.

1.1. Problem Statement

However, RFID has not been adopted as much as anticipated (Luo, 2007). There has been an inadequate theoretical study on the adoption of RFID in both areas of supply chain and technology adoption as compared to numerous publications about RFID technology (Wu et al., 2009). Moreover, the unique condition in each country may impact on adoption drivers; for example Madlberge (2009) carried out a research on the adoption of RFID in Taiwan. He reports that key driving factors on RFID adoption are different from industrialized nations in the west.

Most of the previous literature on RFID conducted in the developed countries (Kinsella, 2003; Loebbecke & Palmer, 2006). There are very few numbers of empirical published studies regarding RFID adoption in developed countries.

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1.2. Research Questions

- What are the critical factors that contribute towards the adoption decision of RFID technology by supply chain organizations of Malaysia?
- How does technology infrastructure of organization affect on RFID adoption?

2. Literature Review

It is widely believed that firms' efficiency and productivity rely on Information Technology noticeably (Oliveira, 2011). RFID is different and more advanced than the previous control systems. Many studies have shown that this technology by providing right information at the right time provides the potential to improve supply chain efficiencies and effectiveness dramatically, it gives much more control and flexibility on managing products as they move through supply chain (Pamela J. Zelbst et al., 2012; Jabjiniak and Gilbert, 2004). The deployment and use of RFID technology enables the supply chain to capture related customer information without human intervention and directly into their database, and also make it possible to access that information by all members of the supply chain.

2.1. Technology-Organization-Environment (TOE) Framework

Tornatzky and Fleischer (1990) came up with a TOE framework in order to examine the adoption of technological innovations in an organization. The "technology-organization-environment" context has recently turned into an extensive theoretic standpoint on adoption of IT and has been tested in various technologies in previous studies (Zhu et al., 2004). The overall structure of this research model indicates the technological concept of TOE framework.

2.2. Technological Factor and Hypotheses Development

Complexity -The difficulties in understanding, implementing and using of an innovation depends on how complicated and complex is the technology (Rogers, 2003; Seymour et al., 2007). Regarding RFID, the criteria needed to efficiently adopt and use the technology are proficiencies related to the physical features of RFID communications, RFID components to be merged and installed within the IT infrastructure of an organization. Moreover, the business processes may be altered in such a way to employ the new system and the data gained. Negative impact of perceived complexity on RFID adoption by organizations has been confirmed in prior works (e.g. Wanga et al., 2010; Tsai et al., 2010; Premkumar & Roberts, 1999; Brown and Russel, 2007). However in empirical study of Thiesse et al. (2011), which conducted from 167 EPC global subscribers, didn't support the negative impact of perceived complexity. According to above literatures, the hypothesis proposed to test is:

H1: The adoption in of RFID is negatively affected by perceived complexity of the technology.

Compatibility- If the information technology innovations are compatible with existing hardware and software of an organization, adoption and integration to new technology is much easier. If the requirements for integration are not met, the adoption process will be delayed or prevented (Brown & Russel, 2007). Thus, the decisions to adopt RFID technologies tend to be affected in a positive way by the high compatibility level of particular organization (e.g. Wanga et al., 2010; Brown & Russel, 2007; Premkumar & Roberts, 1999; Premkumar et al., 1997). On the other hand, study of Thiesse et al., (2011) indicates no support for positive impact of perceived compatibility on RFID adoption. A possible explanation can be, as EPC members had made a decision in favor of RFID standards, compatibility issues may lose their importance. By taking consideration of supply chain industry of Malaysia and newness of RFID in that area, the hypothesis proposed to test is:

H2: The adoption of RFID is positively affected by perceived compatibility of technology.

Perceived Benefits-The anticipated benefits of a technology innovation cause an organization consider it as a valuable technology and decide to adopt it (Brown & Russell, 2007; Premkumar et al., 1997; Rogers, 2003; Tornatzky & Klein, 1982). Some studies also shows that, awareness regarding how RFID technology benefits to the organization should be very important and has a critical driving influence on adoption decision (Tsai et al., 2010; Leimeistra et al., 2009; Sharma & Citurs, 2009; Brown & Russel, 2007; Sharma et al., 2007).

In contrast, there are also studies, which indicate that perceived benefits are not a significant driver toward RFID adoption (e.g. Li et al., 2010; Wanga et al., 2010). Besides, study of (Thiesse et al., 2011) indicates negative impact of perceived benefits on adoption decision, it can be explained that the adopters' expectation about RFID benefits were not met and consequently adaptors feedback were negative to RFID benefits.

Based on importance of perceived advantages of RFID by many prior studies, the proposed hypotheses to test is:

H3: The adoption of RFID is effected positively by perceived benefits of technology.

Perceived costs- The expenses of the adoption of IT consist of the setting up the required hardware and software and deploying the required infrastructure between partner organizations. In RFID adoption, the most noticeable expenses are equipping products with transponder labels, placing reader devices at important locations across the supply chain, and altering these components to match the current systems (Brown & Russell, 2007; Sharma et al., 2008). Extra expenses are due to the training of employees and changing the design of working procedures (Papastathopoulou et al., 2007; Premkumar et al., 1997; Tornatzky & Klein, 1982). Additionally, how to deal with sharing the expenses and benefits between the partners of the supply chain has been one of the main issues obstructing RFIDs to be adopted very quickly. The suppliers of leading international retailers are specifically the ones who raise their concerns about spending on RFIDs, where the benefits will only be of the customers (Seymour et al., 2007). Negative impact of perceived cost has been stated in some studies (e.g. Thiesse et al., 2011; Sharma & Citrus, 2009; Brown & Russel, 2007). In contrast, for example in the study of Wanga et al., (2010) stated that perceived costs do not have a notable impact on RFID adoption. Generally, it can be stated if organizations fully understand the advantages of RFID technology and perceive the gap between RFID and substitute information technology system, perceived costs would not affect notably. In this study, according to newness of RFID technology in supply chain industry of Malaysia and lack of practical awareness to RFID features along with extensive use of conventional barcode system, perceived cost may impact negatively on organizations' adoption decision. There fore the proposed hypothesis is:

H4: RFID adoption is negatively affected by perceived costs.

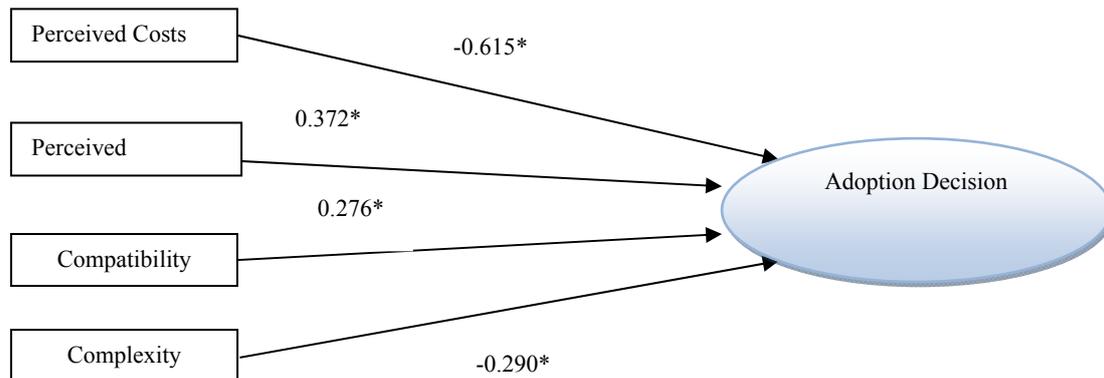
3. Research Design

3.1. Population of Study, Sampling Method, Data Collection

Target population has been selected inside three main supply chain industries in Iran (manufacturing, retail, and logistics). Qualified respondents to participate in the survey are IT professionals, General Manager, chief executive officer or chief technology officer.

The Questionnaire of this study was developed by adapting and combining measures from several sources (Thessie et al., 2011; Baek and Lee, 2001; Premkumar and Roberts, 1999 ; Teo et al., 2004). Using five point Likert scales scaled all responses. Besides, probability sampling method was used for this research. The result of the reliability statistics for the pilot study indicates that Cronbach's Alpha is equal to 0.0805. Questionnaires were distributed in 40 organizations; to avoid bias five feedbacks were collected from each organization. . In order to measure the impact of predictor variables on adoption decision, multiple regressions was required. Other methods such as ANOVA and correlation applied too for further understanding and greater information by means of SPSS software.

4. Findings and Discussion



* Significant correlations coefficient at 0.05 errors.

Fig. 1: Research framework: key technological factors affecting RFID adoption decision

The regression equation:

Adoption decision = 0.276 (compatibility) - 0.290 (complexity) + 0.372 (Perceived benefits) - 0.615 (perceived costs)

- Interpretation of equation:
- For every unit increase in compatibility, adoption will go up by 0.276 units, provided other variables remain unchanged.
 - For every unit increase in complexity, adoption will go down by 0.290 units while other variables remain unaffected.
 - For every unit increase in perceived benefits, adoption will go up by 0.372 units, provided other variables remain unchanged.
 - For every unit increase in perceived costs, adoption will go down by 0.615 units while other variables stay unchanged.

Perceived costs of RFID technology have the highest negative impact on RFID adoption. This study confirms the negative impact of perceived costs in adoption decision, which is in line with previous works (e.g. Thiesse et al., 2011; Madlberger, 2009; Sharma & Citurs, 2009; Sharma et al., 2008).

Perceived benefits proved to have a significant positive impact on RFID adoption decision. Positive perception about RFID benefits and having awareness of its unique features in managing supply chain provide motives for organizations to adopt it. It is reasonable that organizations would adopt RFID technology when they understand the perceived gaps between RFID system and their conventional system. This finding emphasizes on awareness about RFID system benefits and confirms its great impact on adoption decision. Moreover this finding is in line with former works (e.g. Tsai et al., 2010; Wanga et al., 2010; Sharma & Citurs, 2009; Leimeister et al., 2009).

Perceived complexity was proved that has a significant negative impact on RFID adoption by organizations. Perceived complexity mainly goes back to changes in business process that RFID adoption would demand; also managing huge amounts of data, which are generated by RFID, system is another issue for organizations. Therefore, perceived complexity is an important hindrance of RFID adoption, which is in line with prior works (e.g. Wanga et al., 2010; Tsai et al., 2010, Brown & Russel, 2007).

Perceived compatibility has a significant positive influence on RFID adoption. A possible explanation for importance of perceived compatibility can be, the probability of adoption by potential organizations will go up if the organization's previous system is compatible with RFID system. Managers often worry of residual value of their previous investment; therefore it can have great impact on faster adoption. Besides, RFID is an emerging technology and has not been matured yet and there is not a unified standard for that, managers may think of future changes of technology and wasting of their investments. This finding is in line with some prior works such as Wanga et al. (2010), Brown and Russel (2007).

5. Limitations and Future Implications

Even though, the effort has been made to guarantee the validity of research findings, however the present study comes with some limitations, some limitations are general and some are specific to this study.

The sample size is relatively small and future study should be replicated with a larger sample size. Comparison studies also could produce valuable information on this topic. Data was collected through a survey in this research, which is limited to some pre-confirmed questions; however combination with qualitative data through interviews could provide researcher with higher quality of data for analysis. Here, I can also refer to the inherent limitation of survey research; many factors may influence on respondents' answers such as taking into consideration their situations in the organization or having a view of socially acceptable answers. Data was collected through a survey in this research, which is limited to some pre-confirmed questions; however combination with qualitative data through interviews could provide researcher with higher quality of data for analysis. Some driving factors were included in the model, however they incorporated some portion of changes in the dependent variable, future studies might consider factors that were absent in this model as well.

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