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# RFID Adoption: An Exploratory Study of Issues and Concerns

Anand S. Kunnathur

*University of Toledo, akunnat@utnet.utoledo.edu*

Sridhar Vaithianathan

*ICFAI Institute for Management Teachers, sridhar\_we@yahoo.com*

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# RFID Adoption: An exploratory study of issues and concerns.

**Anand S. Kunnathur**  
College of Business Administration  
University of Toledo,  
Toledo, Ohio – 43607. USA.  
Phone: 419.530.5644  
Fax: 419.530.7744.  
akunnat@utnet.utoledo.edu

**Sridhar Vaithianathan**  
ICFAI Institute for Management Teachers  
Hyderabad – 500 034, India.  
Phone: +91-40-23430254  
Fax: +91-40-23430468  
sridhar\_we@yahoo.com

## ABSTRACT

Radio frequency identification (RFID) systems have received increased attention from academicians and practitioners in the past few years. By implementing RFID, companies could achieve “process freedoms” and real-time visibility. Studies have discussed about opportunities, benefits, and challenges in deploying RFID. The issues discussed and insights offered in these studies were mostly of theoretical and conceptual significance due to the emergent nature of the phenomenon and difficulty in collecting data. The purpose of this paper is to get practical insights into organizations’ strategic issues in adapting to this new technological change. It examines the firm’s decision to adopt RFID from strategic perspective and aims to understand the transition process in doing so. The findings and conclusions reported are based on the data collected from organizations that have started the deployment process or have already deployed RFID.

## Keywords

Radio Frequency Identification (RFID), Strategy, Adoption, Implementation.

## INTRODUCTION

Radio frequency identification (RFID) is a generic technology concept that refers to the use of radio waves to identify objects (Auto-ID Center, 2002). Recently there has been much attention paid to RFID because of the numerous benefits it offers in effectively managing firms’ supply chain and in achieving internal process improvements. Some of the benefits include improved speed, accuracy, efficiency and security of information sharing across the supply chain (Jones, Clarke-Hill, Shears, Comfort, and Hillier, 2004), reduced storage, handling and distribution expenses; increased sales through reduced stock outs; and improved cash flow through increased inventory turns (Kakkainen, 2003). By implementing RFID in a company, “process freedoms” and real-time visibility are achieved (Angeles, 2005).

RFID can be used for identification (E.g. access control), authentication (payment of highway tolls), prevention of shoplifting, tracking and tracing of products, people and animals. A combination of RFID tags with sensors could be used to measure temperatures and humidity, which in turn could be applied to monitor the temperature of perishable products or drugs. Thus RFID promises to unleash a revolution in the field of efficiency, comfort and security (Schermer, 2006; Huslsebosch, Strating, Teeuw, and Schaffers, 2006). These opportunities bring with them many challenges that need to be met before numerous utilities of RFID can be achieved. An online survey of more than 350 IT executives in April 2004 identified the top three business risks of using RFID as: 1).technical standards are not final; 2).business benefits or return on investment are unclear; and 3).there is a lack of industry-wide adoption (Emery, 2004). It is clear from the above that there are many issues that need to be resolved before widespread RFID deployment can occur. However, concerns such as strategy formulation and concerted implementation of RFID have barely received any attention.

While, substantial improvements have been made in the past few years in overcoming challenges such as achieving common technical standards, reducing cost of tags, fixing data management and storage problem, security and privacy problems. One issue that demands attention and has not been talked much about is how the companies are making the transition to RFID. The purpose of this research is to get insights into how the companies are adapting to this new technological change. What are their intentions to adopt? Is it out of their own choice to achieve process improvements or pressure from their supply

chain partners? Does organization deploying RFID have formal plan? Do they analyze about the benefits and risk associated with the same? Is there any resistance from employees during and after adoption? Are the organizations ready to spend huge amounts of money as the cost of implementation is very high, does the spending substantiate the expected benefits? In short, this paper examines the strategic perspective of the organization in adopting RFID, among other things. This is done by interviewing a few companies that are currently adopting RFID. This might give better perspective and realistic knowledge about what they have done or plan to do with RFID.

RFID literature has many studies on benefits of RFID (Niederman, Mathieu, Morley, and Kwon, 2007; Eckfeldt, 2005; Sellitto, Burgess, and Hawking, 2007; Vijayaraman and Osyk, 2006; Prater, Frazier, and Reyes, 2005; Smaros and Holmstrom, 2000; Brewer and Sloan, 1999; Jansen and Krabs, 1999; Lapide, 2004; Karkkainen and Holmstrom, 2002; Hosaka, 2004; Srivastava, 2004). Technical issues and challenges that need to be resolved for widespread use of RFID have been examined issues in Wu, Nystrom, Lin, and Yu, 2006; Angeles, 2005. Issues related to security and privacy have been explored in Ayoade, 2006; So and Liu, 2006; Ohkubo, Suzuki, and Kinoshita, 2005; Thiesse, 2007; Freeman, 2007. There has been scant attention paid to strategic issues associated with formal adoption and implementation of RFID. It is indispensable for the firms to analyze and understand the issues linked with adoption from strategic angle to properly deploy this technology and to avoid implementation failure and future loss. Also the papers that throw light on the strategic perspective of RFID (Li, Visich, Khumawala, and Zhang, 2006; Curtin, Kauffman, and Riggins, 2007) are mainly conceptual in nature lacking empirical support. This study attempts to fill this gap in modest measure by adopting a multiple case study method to understand the practical concerns in RFID adoption from a strategic stand point as well.

## RESEARCH OBJECTIVES

The paper reports the results of an exploratory study on RFID adoption in five firms based in USA. To understand whether the benefit substantiates the risk, it is imperative that research needs to be done. This paper addresses the following research questions.

1. How the RFID adoption strategy is formulated by the organizations?
2. How the strategy is implemented in the organizations?

Hence the primary goal of the paper is to acquire practical insights into how the companies that have actually adopted RFID carried out strategy formulation and implementation, the issues involved, and the challenges faced regarding the same. The rest of the paper is structured as follows, in the next section details of research methodology are discussed, then data analysis and the results of the study are presented, followed by contribution, limitation and scope for further research.

## RESEARCH METHODOLOGY

Given the motivation for the research and the emergent nature of the problem domain, qualitative (Walsham and Waema, 1994; Klein and Myers, 1999; Guba and Lincoln, 1994; Kerlinger, 2000) approach was adopted and multiple case study based research method (Eisenhardt, 1991; Yin, 2003; Lee, 1989) was used. Issues relating to RFID deployment strategy were studied in five large firms, two from manufacturing industry, one in automotive industry, one in retail industry and one in medical industry which produces health and hygiene products. Description of the organizations participated in the study is as given in Table 1. Since the companies expect the adoption to bring them competitive position in the market, the companies requested that their names to be disguised, so the names of the companies were changed for the purpose of the study and presented.

Industry	Firm Name (for the purpose of the study)	Sales <sup>a</sup> (USD)	Number of Employees (worldwide)	Experience with technology Adoption (Years)
Manufacturing	MAN1	6.5 billion	19,000	3
Manufacturing	MAN2	119.2 million	100	11
Medical	MEDI	16.7 billion	46,000	5
Automotive	AUTO	19.4 billion	127,319	5
Retailing	RETAIL	40 billion	140,000	5

<sup>a</sup> - the figures are for the year 2005-2006.

**Table 1: Description of the Firms.**

To accurately gather information from these companies and the issues pertaining to the study, a five page questionnaire was developed and provided to each interviewee prior to the actual interview. We attempted to structure the feedback from those interviews in areas where the questions related to the literature. Some of these questions admitted of only YES/No type answers and others had a broader spectrum of possibilities. Open-ended questions were asked to get as much information about the context under study as possible. Two main sections make up the questionnaire. The first piece contains questions regarding their company's adoption approach. This section is used to collect information about how companies formulate a strategy, the potential benefits and costs of adoption, whether or not security was a concern, etc. The second piece contains questions regarding the adoption process that the company went through. Some firms were still in the process of installing RFID and others were at the very beginning stage where their focus was on strategy. This section was designed to answer questions about how RFID was implemented, how employees were trained, or any problems or legal issues that occurred, etc. Companies from different industries were interviewed because each had a different reason for looking into RFID, which gave an opportunity to have more insights into different adoption strategy, implementation issues and concerns. Data were collected through telephone interviews and through e-mail to accommodate their schedules. In addition to the interviews, company website information and data from the archives of the respective companies, press reports were also used.

## DATA ANALYSIS

In this section each of the companies' strategy formulation and strategy implementation regarding RFID adoption is discussed in detail. "Adoption" here refers to the firm's decision to implement RFID for its process improvements."Strategy formulation and Strategy implementation" refer to how the company went about adoption and actual implementation of RFID starting from a well designed plan to actual implementation steps/processes carried out.

### Strategy Formulation

This section reports the strategies used by the five companies under study in deploying RFID, some of the questions addressed includes, when did the adoption began, what's the expected length of time for the adoption process to complete, whether there was formal strategy in place to go about implementing RFID, whether the initiation was taken from top-down or bottom-up or both, does the top-management supported the adoption, whether the adoption is targeted for specific application or for the company as whole, have they considered the costs and benefits of RFID adoption from the beginning, what are the potential costs of RFID that has been considered, how security concerns were dealt with and what was the budget allocated for the adoption. Table 2 gives the summary of important issues in strategy adoption which are discussed with the participated firms and their responses regarding the same.

MAN1 and MAN2 are two companies in the manufacturing industry but at different stages of RFID adoption. MAN1 has already been in the adoption process for 3 years now but MAN2 is still in the planning phase. MAN1's form of RFID adoption is much more complex than MAN2's plan because there is not an expected time to finish. MAN2 expects their process to be complete within a couple months. Both companies did agree that a formal strategy was created before the adoption began. Both companies also had a budget set within their adoption strategy. MAN2 budget was less than \$50,000. And for MAN1, its pilot project alone costs around \$250,000. Further implementation added on \$125,000 per assembly line.

S.No	Strategy Formulation Issues	MAN1	MAN2	MEDI	AUTO	RETAIL
1 <sup>a</sup>	There was a Formal Strategy used for RFID Adoption	3	4	5	5	5
2	Feedback was provided from employees	5	4	5	3	4
3	Top Management Supported the adoption	3 (supported later)	4	5	5	3
4	RFID security was a concern from the beginning of Adoption process	1	2	5	4	2
5	RFID Pitfalls were expected from start	3	4	5	5	4
6 <sup>b</sup>	Adoption benefits considered from beginning?	YES	YES	YES	YES	YES

7	Was the cost of RFID adoption considered?	YES	YES	YES	YES	YES
8	Was there a budget for RFID adoption?	YES	YES	YES	YES	YES

<sup>a</sup> Questions 1 to 5 were asked on five point scale. Scale Used: 1- Strongly Disagree. 3- N/A (Not Applicable or Information Not Provided). 5 – Strongly Agree.

<sup>b</sup> Questions 6 to 8 were Yes or No answer type.

**Table 2: Summary of Important Issues in Strategy Formulation**

MAN1's strategy was formulated from the bottom up, where the idea of RFID adoption was initiated by the group and a person who was in charge of the group formulated a strategy. Then the team's idea was conveyed to senior managers before actions could take place. On the other hand, in MAN2, the RFID adoption strategy was formulated top-down. Managers developed a strategy that would allow the company to save the most money. MAN1's strategy was to look at RFID and experiment to see how it would work with their manufacturing application. The reason for the adoption was to help track their products in the supply chain. Unlike MAN2, it was more of a struggle to get top management to support the adoption process. MAN2 and MAN1 both had expectations regarding the benefits and costs of implementing RFID into their processes. MAN1 expected some benefits such as being able to perform tasks better than before but not all were apparent from the start. In case of MAN2, they didn't consider the benefits of RFID from the beginning but eventually started seeing benefits like reducing the manpower to 2,000 hours a year as the strategy formulation continued.

Both the manufacturing companies did think about potential costs at the beginning of the adoption strategy. In MAN1, the group which initiated the adoption came up with the calculated costs to make sure the RFID project would benefit the company financially and apprised top management. Similar adoption strategy questions were asked of the retail company. RFID adoption at RETAIL began in 2002. The amount given to budget the project was not public information. The adoption strategy was formulated from the top down. The "higher-ups" at RETAIL wanted to get on the fast track by adopting RFID technology within their supply chain and lead in the item level store selling floor applications area within the electronics industry. Most retail stores used RFID back in the warehouse of the store. RETAIL also have plans to test the effects of RFID in check-out section of the store.

The actual strategy formulated by RETAIL committed \$150mn in costs for \$500 million ROI over a span of 5 years. The strategy was a detailed plan that would be implemented in 2 Distribution Centers and 5 stores. 50 vendors associated with RETAIL would participate as well. After this first phase of implementation, RETAIL would expand their RFID installation to more warehouses and retail stores. The main cost of implementing RFID at RETAIL would be the large financial outlay that it would take over 5 years with benefits in labor and inventory savings. Also tags used have the ability to be locked to prevent so fraudulent rewrites.

AUTO is an automotive company that manufactures tires. The person, who is in charge of the RFID adoption within AUTO company, was interviewed. AUTO started the adoption process in 2003. Their testing process took 18 months. The whole goal of the testing was to help eliminate as many as 12 labels that specified which tires would fit on which vehicle. There was a budget for the testing and RFID process as a whole but the numbers were not available to the public. The adoption strategy was formulated from the top down. Management wanted to standardize RFID tags for the tire industry. They wanted to create a universal tag that all tire manufacturing companies could use.

AUTO's strategy for implementing RFID was to embed tags into the tires in order to help identify and track their product along the supply chain and also let them know which tires belong to which vehicle. The adoption strategy is target specific where RFID would be focused on the shipping department of the company. Both benefits and costs were considered from the start. One benefit that AUTO saw in RFID was the ability to set a standard for the whole industry. This would help put AUTO at the head of the automotive business. The second benefit was that AUTO would be able to track their product all the way to the corresponding vehicle. This was a problem before where 12 tags were used for identifying which component will suit which machine and mistakes were made. They saw tag hackers as a potential threat to RFID as a whole but they only placed certain product information on their tags. Even if a hacker found a way to get information from the tags imbedded into their product, the data would be of no use to them.

MEDI is a company within the medical industry that produces health and hygiene products. They are one of many companies who have chosen to move forward and use RFID technology. MEDI's RFID adoption began back in 2002. Like AUTO, they were unwilling to give any information about their budget for the project. The formulation of the adoption strategy was done both from the top down perspective and bottom up as this was the usual procedure followed within the company. "Senior

leadership set the vision and other layers in the organization developed the strategy to support our vision". MEDI's strategy plan was to touch all areas of their value chain. The company would use their capabilities to help engineer the technical and process issues. The benefit that the company expected is that RFID would help them reduce working capital. They also wanted to see their sales grow as a result. They figured there would be a lot of financial costs because they had to purchase the hardware and software in order to implement RFID. The cost of reengineering their business processes was considered to be a big cost.

## **Strategy Implementation**

### *Implementation Plan*

The process that goes into action after the strategy has been formulated is just as important as the strategy itself. Companies have taken a lot of time to come up with a plan that would stretch out over years to get it implemented correctly. The purpose of the second half of the questionnaire was to gain information on how companies go about their RFID implementation process. From what other companies were used as guidance to how employees were trained, it is important to see how different companies went about putting their strategies into play. Table 3 gives the summary of important issues in strategy implementation which are discussed with the participating firms and their responses regarding the same.

MAN1 used help from consultants for implementing their RFID strategy but MAN2 did not. The reason for this was because MAN2 was in the beginning phase of their RFID adoption and had not actually started implementing their strategy. Since MAN1 is well into their implementation process, they have looked for help where needed. They relied on guidance from two renowned consulting companies.

MAN1 had better idea about the actions to be performed for RFID implementation. Once the strategy was formulated and approved by management above, the RFID tags and hardware that would be used was selected. And have planned to use an engineering firm to help install the equipment and build the databases where information would be stored. One of the two consulting companies would monitor and make sure the RFID system was working properly after completion. Since MAN2 was still in the planning phase of their RFID adoption, the person-in-charge for adoption process mentioned his thoughts of how the implementation process would go about. He had a good idea of how the process would work since he had experience with RFID in the past. He explained that his company would use a reusable tag for packages. Each company involved would have a database that contains information about these packages.

RETAIL was well into their third year of their RFID adoption implementation phase. Like many other companies working with RFID, RETAIL did employ a renowned consulting company. RFID installation was done the way it was planned during the strategy formulation phase. RFID readers were installed on warehouse doors. Products on the pallet level had RFID tags slapped on them. The implementation on the check-out lanes area of the retail store is still being tested on.

For AUTO, the person, who is in-charge for the RFID implementation gave insight into the adoption process that took place at AUTO. Services from RFID consultant companies were also used on occasion. He had experience as an industry consultant for RFID implementation projects in the past and hence was hired by AUTO. It was found that labels made from cloth or duct tape held on to the product better than the ones made from plastic. SOP (small outline package) transponders were attached to the antenna of the RFID tag. SOP transponders were used to help protect the chip inside the tag and secure the device. Similar products of other companies were used as part of the testing process.

MEDI's interview about their adoption process was specific and a lot less detailed than the other interviews. The company did not turn to any consulting company to help out with the RFID installation. When asked on how the adoption process was implemented, the answer given was that they used "dedicated internal resources that have the experience and background to work RFID". Also it was mentioned that both internal and external resources were used to help train employees but nothing further than that.

### *Change Management Process*

During the implementation stage, it is vital to keep employees and managers up to date on what is going on. A few questions on the questionnaire had to do with employee training and if resistance was seen during the adoption process. MAN1 did verify that employees were trained; a project manager gave onsite training and taught employees how to use reports, install tags onto products, and replace antennas if needed. When asked if resistance was visible, it was mentioned that not everyone was excited about RFID. As mentioned before, top management wasn't sure how things would work out. Some employees didn't see the benefit of RFID technology. Operators of assembly lines didn't understand much about RFID and showed resistance by unplugging cables on RFID hardware. This was done by a very small number of employees but most was

willing to learn how the new technology worked. Feedback was sought from employees and was obtained throughout the whole process since employees were included in the adoption process from the start. For MAN2, onsite training were given and the only training that was considered important was to teach the employees how to identify if a shipment driving through an RFID station and to check whether the RFID tags has been read properly or not. There hasn't been any real resistance towards the idea of RFID adoption but some employees have been concerned if their jobs are at stake. The only feedback that was concerned about was information from employees on how RFID would increase or decrease their workload

S.No	Strategy Implementation Issues	MAN1	MAN2	MEDI	AUTO	RETAIL
1 <sup>a</sup>	Was an RFID consulting company was used for implementation?	YES	NO	NO	YES	YES
2	Were employees/managers given Training?	YES	YES	YES	YES	YES
3	Did any major problem occur with the adoption process?	YES	NO	NO	YES	YES
4	Did any legal issues come up during the whole process?	NO	NO	NO	NO	YES
5 <sup>b</sup>	There was employees resistance to the changes from the adoption	1	3	1	3	2

<sup>a</sup> - Questions 1 to 4 were Yes or No answer type. <sup>b</sup> - for Question 5: Scale Used: 1- Strongly Disagree. 3- N/A (Not Applicable or Information Not Provided). 5 – Strongly Agree.

**Table 3: Summary of Important Issues in Strategy Implementation.**

In RETAIL, Employees and managers were trained. Employees were sent to RFID “boot camps” to learn all about how to use the new technology. Managers were sent to conferences to learn and get feedback from other managers going through the same process. Little to no resistance was seen from employees. In AUTO, not much information was obtained about how employees were trained to work with the RFID technology. The team worked more on slapping tags on the product and less on the utilization portion. In MEDI employee feedback was encouraged. It was mentioned that feedback isn't a static process and employees are continually providing input on RFID.

#### *Problem Handling*

Both the manufacturing companies were asked if any major problem or issues occurred during RFID implementation. Major problems have been seen at MAN2 since they haven't begun their installation process. MAN1 however did mention some problems that arose with RFID system. It was explained that the RFID system worked well at first but then as time went on, the reading accuracy of the hardware decreased. At times RFID tags fell off and became missing. The tagging process sometimes failed to slap tags with products coming out without tags on it. Also, the company noticed that the water and moisture ruined some of the tags that were applied on the products. In order to fix the reading problem, the company had to switch to another brand of RFID readers, like tags were switched to dual antennas to get a better signal. Also the materials of the tags were switched to ones that were water resistant so that the tags wouldn't get ruined.

For RETAIL, some of their suppliers weren't updated on RFID technology and were requested to start the learning process in order to continue to do business. The company realized that cost, scalability, and flexibility of RFID solutions were still the issues that require attention. Getting all suppliers and vendors to adopt RFID has been a struggle since some smaller companies cannot afford it. Access to money to continue with the adoption has been a struggle since there are other competing projects within the company that look for financial help from corporate. The number of tagged products was still very low. In order to deal with these problems, the company has continued to drive requirements into the RFID industry and work with suppliers and retailers to set standards. To address legislatures issues, the company has been using their retail associates to lobby the state government and communicate the benefits to their customers.

For AUTO, the only problems that were seen with the adoption were product improvement challenges that occurred throughout the installation process. To solve these improvement problems, more testing was done to find answers. And for MEDI, there wasn't any mention of major problems that hindered the adoption process but it was explained that if there was a problem, it would be further explored and solutions would be created to address it.

## RESULTS OF THE STUDY

All the five mostly had formal plan and strategy in RFID adoption, it is understandable that the companies interviewed were large firms and hence expected to have formal structure to formulate adoption strategies and of course, later they employed consultants to successfully implement the strategy formulated. Of these five companies, two companies (MAN2&AUTO) have followed top-down approach in strategy formulation and hence do had top-management support from the start of strategy formulation, two companies have adopted both top-down and bottom-up strategy hence both top-management and employees were very positive about the adoption and benefits to the company and in case of MAN1, the strategy was formulated bottom-up, where the championing was taken by a group and later won top management support.

It was found that feedback from the employees was sought and used in all the companies during the strategy formulation. All the companies have targeted their adoption either for specific application or for specific product category and do have plans to expand further after the initial success unlike MEDI, whose adoption was targeted for applications across the value chain. All the companies have implemented or in the process of implementing RFID out of their own choice and are quite clear about the benefits. While MAN1 and RETAIL have adopted RFID mainly for internal process improvements, MAN2, AUTO and MEDI have plans to implement RFID across their supply chain. Hence it can be inferred that firms that mainly implement RFID to improve their internal processes do so without any external pressure from the partners unlike the firms which implement to achieve process improvement in the supply chain. In the latter case, it is found from the interviews that most of the companies at the bottom of the supply chain hierarchy adopt RFID due to pressure from their supply chain partners at the top of the hierarchy. Companies were quite clear about the RFID pitfalls from the start, some of the pitfalls that they were worried about are lack of global standards, cost of technology, adoption rate, advantages of RFID are quite unclear in comparison with usage of bar codes, and resistance from suppliers to adopt RFID. Except MAN2 and MEDI, all the companies have sought for consultants for RFID implementation. For MAN2 and MEDI, they managed with the dedicated internal resources that have enough experience with the technology implementation like RFID. All the companies have employee training program to cope with the process the change due to RFID implementation. In most of the companies training was provided using their internal resources, while some of them are trained by attending conference and camps, others were given onsite training. The employee resistance to change was indeed felt in some of the companies. For example, some did not see benefits, operators did not understand its role (even unplugged RFID cable), worried about loss of job, but employees then eventually appreciated the process improvements and started liking the change, the companies stated.

Companies did encounter many problems – missing tags, missed tag reading, tags ruined by the nature of product (say moisture, water, chemical composition of the product and package), cost of implementation, flexibility and scalability of RFID solutions, completing projects within budgets, getting suppliers to adopt during the implementation. Many of the problems related with tags were effectively tackled; say by changing the readers, using water resistant tags, but the issues related with cost, scalability and mass adoption by suppliers may take some time to resolve.

## CONTRIBUTIONS, LIMITATIONS, AND SCOPE FOR FUTURE RESEARCH.

This paper provides practical insights into how the companies that have actually adopted RFID carried out strategy formulation and implementation, the issues involved, and challenges faced regarding the same. The literature is filled with studies on technological issues, security issues, privacy concerns, benefits and applications of RFID adoption, but not enough studies deal with strategy implementation issues in adopting. In that sense, it could be appreciated that the study has contributed in revealing interesting insights into issues that demand immediate attention. The specific contributions are:

1. The paper explains how strategy formulation, implementation process were carried out by the organization across different industry sectors in deploying RFID.
2. Also discussed were interplay of organizational characteristics like top management support, formal task plan, employee training, resistance to change as important determinants to adopt RFID which not many studies have explored.
3. Privacy is more a concern is the issue that needs attention for many applications adopting RFID rather than security.
4. Cost and scalability associated with RFID adoption were believed to be hurdles that need to be overcome for mass adoption, as many of the suppliers lack financial clout needed for implementation.



5. The study also reveals that issues like completing projects within budgets, getting suppliers to adopt RFID, lack of global standards, and cost of technology are the issues of demanding genuine attention.

A limitation of this study is that the conclusions are based on exploratory findings from a few case studies, while important in establishing a baseline, future research is needed to validate the observations made herein.

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