

RFID Adoption: Issues and Challenges

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INTRODUCTION

Radio Frequency Identification (RFID) is an emerging technology that has been increasingly used in logistics and supply chain management in recent years, particularly in the US and Europe. World's largest retailers are increasingly requiring their suppliers to be RFID compliant. Although RFID is not a new technology, the term RFID has been popular for the past couple of years. We are seeing an increasing interest in this technology by companies (Prater and Grazier, 2005).

RFID tools can identify, categorize, and manage the flow of goods and information throughout a supply chain (Ngai et al., 2005). Rapid development of RFID combined with a major push coming from mandatory RFID tagging decree by Wal-Mart and the U.S. Department of Defense and others like European companies Metro AG and Tesco, has caused companies to take a hard look at what RFID can do for them and whether they should give further consideration to adopting the technology.

RFID has been around for decades. It is one such technology that we can embed into objects to track location, monitor security, and record the status of events or even environmental conditions (Stanford, 2003). RFID systems have emerged as new forms of inter-organizational systems (IOS) and are used to improve the efficiency of the processes in a supply chain. Because of their capability for use in real-time identification and tracking over long distances, some believe that RFID systems will fundamentally change the way companies do business (Smith and Konsynski, 2003).

The following are some of the current issues and challenges facing the RFID technology adoption in industrial applications.

CURRENT ISSUES FACING RFID ADOPTION

Globally Interoperable Standardization Problem

There is lack of global standards for RFID adoption. It is no doubt that the adoption of official standards, enabling interoperability between applications or devices, can significantly accelerate the adoption of RFID technology. The RFID industry has been mainly using two different standards. One is being developed by the International Standards Organization (ISO), the world's main developer of standards that has developed several standards around RFID which are used in Europe. The other is the Electronic Product Code (EPC) system, which is being commercialized by EPCglobal, a non-profit organization set up by EAN International and the Uniform Code Council. What standard should be used is one of the most frequently asked questions from the users. It is critical that the EPC and ISO standards can co-exist in order to ensure end-to-end interoperability of RFID systems to track goods through the global supply chain Finkenzeller (2003).

Environment

Currently, the most used frequencies for RFID implementations are – 13.56 MHz (i.e. “HF” for High Frequency) and 915 MHz (i.e. “UHF” for Ultra High Frequency). At these frequencies, transmissions are impacted by two environmental factors. The first one is water and other one is liquids which are hindrance to RFID system performance. Liquids can absorb the radio energy/signals and thereby limit range or prevent tag read/write operations altogether. Label media adhesives also can be an unexpected source of liquid. Some types of adhesive or label materials that absorb moisture from the environment, which could cause performance problems. This makes “reading” tags through liquids very difficult, if not impossible. Metals are another hindrance that generally reflect radio frequency signals and deflect the radio waves, thus altering their path. This is essential source of RFID interference and should be avoided if possible. This does not necessarily mean

that metals prevent “reading” tags on objects or cartons that contain metal, but the radio waves must have a path into and out of the material.

The second technical problem is that one should watch out for the use of the other equipment of the frequency that is near the one used by the RFID solution. For example, the first generation of GSM phones transmits at 900 MHz, as do some handheld RF barcode scanners. This is near enough to 915 MHz to potentially cause interference. This problem can usually be overcome by shielding the RFID reader.

Security and Privacy

RFID technology has proven to be reliable, especially in supply chains, and is already showing tremendous advantages. But an automated supply chain mandates the necessity for data privacy, identity and non-refutability, and organizations should ensure the RFID technology they adopt supports their security requirements. Companies need to be aware of the security risks, such as profiling, eavesdropping, denial of service attacks and inventory jamming.

Education and training is the best way a business can ensure it understands the limitations and risks associated with RFID adoption. Businesses should not assume that the risks associated with RFID adoption are small because the RF footprint of current generation tags is constrained. Understanding the mean time to crack—access, alter or deny the use of—the tags is a prerequisite to ensure that tag selection embodies the objectives of the company's corporate security policy.

RFID has the potential to threaten consumers through intervention of their informational privacy, their physical privacy and security and their civil liberties (McGinity, 2004). Consumers are concerned the possible abuse of personally identifiable data (such as credit card number, security number) and sensitive data (such as prescription drugs) by the retailers when companies adopt RFID technology. A considerable driver of the fear of RFID to consumers is a lack of understanding about RFID technology. Companies should inform consumers that they use RFID tags on the products, and educating consumers of the true technological limitations of RFID.

Data Management

Many conversations about RFID inevitably end up touching on the presumed high volume of data and resulting data management issues that are expected to arise from tagging individual products. Data management is a key issue for any organization deploying RFID technology, and the robust middleware to handle that onslaught of data and route it to the right database is most concerned. To leverage this enhanced visibility of data captured, enterprises need to establish the right architecture to filter and translate RFID data into business relevant events and then to use these events to create and automate business process for providing quality service and better competitive advantages.

Generally speaking, RFID data management issues fall into several categories: RFID data collection and storage, data integration, data synchronization, data ownership and privacy, data interpretation and analytics, and execution of end-user business processes to sense and respond to RFID data. Companies need to address a couple of questions, for example: what RFID data should be collected and stored? How this RFID data is different from that is currently collected and stored? Who owns the RFID data, and what elements are subject to privacy or security considerations? What is the best way to visualize this RFID data collection and act upon key events? And most important, what business processes need to be changed to enable people to act upon this information?

Tag Failure Rate

As pointed out by the report of Deavours (2005) in the “UHF EPC Tag Performance Evaluation” – “Even tags of the same make and model vary significantly in their performance as this excerpt from the RFID Alliance Lab’s report (<http://www.rfidjournal.com/labreports>). The tests showed that the range of under-or nonperforming tags can range from 0 percent up to 19 percent. Companies should screen out under or nonperforming tags. Even if tag producers will reimburse you for bad tags, you still need to do the screening yourself.

Focus on the worst case performance tags, not average or best case because your system will have to be designed to accommodate the worst performance. Currently, there is a high rate of first pass write failure, anything up to ~10%. Clearly, this failure rate is not the one that one could sensibly sustain in live operations. A Root Cause Analysis has thrown up two probably causes of this high failure rate:

1. A tag was mounted on a plastic base and multiple tags were then mounted on a plastic backing roll. Separating the two quickly set up an electrostatic discharge which damaged the chip.
2. When pulling the tag off the reel for manual application, the operators had a tendency to pull the tag across the centerline thus causing the antenna strip to separate from the chip.

Quality Assurance

An important part of the user’s requirement is that the tags on all goods must be intact and readable. Considering the Wal-Mart as an example, pallet tags must be 100% readable at the receiving dock and case tags must be 100% readable on a conveyor moving at the speed of 600 feet per minute with a minimum spacing of 8 inches between cases (Deavours, 2005).

One should ensure that there are sufficient processes, checks and balances in place to guarantee that all RFID tags on pallets and cases have been written correctly and are intact at the point of shipment to the next location, be that a customer location or another distribution center. One should also ensure that all reasonable steps have been taken to prevent the damage or removal of the tag in transit.

RFID Expertise for Deployment

A recent survey by the Computing Technology Industry Association revealed that 80 per cent of the responding companies said there were not sufficient numbers of skilled RFID professionals. Two-thirds of them said training and educating their employees on RFID technology is one of the biggest challenges they face in order to succeed in the RFID market (Morrison, 2005). We believe that the problem is more serious in Asian countries. Like Hong Kong, there is a lack of strong expertise in RFID technology deployment. Local large-scale deployments are usually made by foreign companies. It is difficult to find local experts in the RFID field with large-scale deployment experience. Certainly, education through short course like an RFID certification program and a coordinated crash training program may be the best hope to fill the work force urgently need but for long time, the knowledge and skills related to RFID technology should be education in higher education.

CURRENT CHALLENGES FACING RFID ADOPTION

Along with the potential offered by RFID come the inevitable challenges that must be understood and overcome before companies can reap the benefits.

Management Commitment

Gaining management commitment is one of the biggest challenges in implementing RFID. Despite it can result in savings, it is always difficult to get senior management commitment because it is new to them. Return on investment (ROI) is an important consideration for management consider in assessing RFID investments before RFID project commitment. Gillette is using the RFID tags in one of the biggest EPC project, tagging all pallets and cases of its Venus women’s razors that his vice president, Mr. Cantwell championed RFID technology internally at Gillette (Roberti, 2004).

Dual Systems

With RFID, not all partners will use it, and those who do may require it for only their RFID-ready distribution centers. Furthermore, not all the items or packages will be tagged. Another need for dual systems arises when you deal with small

and medium businesses that can not afford RFID systems. You should assume that exceptions to the “all or nothing” ideal will always exist and be prepared to deal with this challenge from a technical and operational standpoint.

Cost Challenges

The biggest challenge companies faced with RFID is that it is the high cost of implementation. One of the challenges a company faces with the introduction of RFID technology is whether the business really needs the technology and how to justify the investment in the implementation. Cost-benefit analysis is critical to the successful adoption of an RFID project. At present, the cost of RFID adoption is the major investment in hardware, application software, middleware, tags and the cost of integrating RFID-based system with the legacy systems, consultancy fees and employee training.

Legal and Patent Challenges

Most of the companies overlook the importance of having a legally binding master agreement before adopting RFID. As most of us know that in the end there are no real winners in a trading relationship that ends up in litigation. RFID technology, should carefully discuss with vendor, each trading partner about the liability limitations that pertain to the data contained on tags (because it can mistakenly be overwritten). The intellectual properties (IPs) of some RFID technology is still not clear. Like in 2004, Symbol Technologies has filed a counter patent-infringement lawsuit against Intermec Technologies (<http://www.rfidjournal.com/article/articleview/1443/1/58>).

We believe that to make sure RFID technologies are widely adopted, RFID needs to be royalty-free. As some vendors are concerned about paying high royalty cost to develop RFID systems which is another barrier for widely development of RFID systems.

Operational Automation

Companies should evaluate their own needs and determine which processes can benefit from automation with the use of RFID and associated technologies. To aid in their operational evaluation, they must study the business operations processes in their company and determine the volume of information exchange. Which if your items are suitable for tagging? What are the types of tags will they need today and how quickly will those needs change in the future. Whether they need to combine that RFID tag with a bar code when they realize that the RFID system fails them too often and leaving them. Evaluate company’s operations and determine how, where and when best to apply one or a combination of these technologies to benefit the organization, its customers and the entire supply chain. Those questions are the most frequencies asked questions by the users.

Selection of Hardware and Software

The challenges here include the choice of RFID solution including the hardware and software required. The choice of tag types in terms of read range, read/write capability, reader type, and middleware. The performance of hardware products in the market varies and a lot of efforts need to be devoted to hardware evaluation and testing. Also, the performance of RFID system varies in different environments. The solution is to tightly integrate the hardware equipment with the software system. The software system should be able to correct any problems due to the unreliable data captured via RFID.

Another consideration is whether to use the RFID tag alone or to tag it in addition to a bar code label. The advantage of the dual technology is, of course, that should one fail, and the other can serve as a backup. However, they can be sure about their implementation and maintenance costs will be higher as a result.

Technology Support for Adoption

At present, both RFID hardware and software in Asian markets are mainly from the US. Although RFID solutions are from foreign vendors with support of local distributors, which provide limited technical support, as most of their staff are marketing oriented. We have found that most RFID hardware providers in Asian markets lack technical support staff, and their RFID teams mainly consist of salesmen and marketing staff. This is due to the fact that RFID is just an emerging technology in most Asian countries.

CONCLUSIONS

Besides, the costs and technical challenges, we believe, the value of RFID, and how companies can implement this technology to enhance the quality of service, their production and eventually corporate earnings are crucial in RFID adoption. It is hoped that this paper will provide the readers to have a better understanding of the current issues and challenges facing the RFID adoption and be in a position to further investigate each issue and challenge discussed here best understand it before the implementation.

Technology researchers find out the ways to increase the range of RFID signals and reduce the radio frequency interference, standards organizations like ISO and EPCglobal unravel the standardization problem and make an open and compatible standard while stores determine how to make customers desire RFID in their lives (McGinity, 2004). However, as with other emerging technology, RFID technology is still not fully development. We see that the more research effort and development put into RFID study, the more successful RFID adoption we can see.

The following points out some research topics that are of interest for further research for RFID adoption:

- Social and economic impacts of RFID impacts of RFID adoption;
- Privacy, security, legal and cultural challenges of RFID adoption;
- Antecedents of RFID success adoption;
- Evaluation metrics and implementation of methodologies for RFID adoption;
- Barriers and critical success factors for RFID adoption; and
- Educational requirements and curriculum implications of RFID technology.

Finally, we quote a comment originally made by Mark Roberti, editor of RFID Journal that "Companies will have no choice but to use RFID, just as they have no choice but to use the Internet today".

REFERENCES

1. Deavours, D., EPC Tag Performance Evaluation, *RFID Alliance Lab*, May, 2005
2. Fao, A. and Gershman, A. The future of business services in the age of ubiquitous computing, *Communications of the ACM*, 2002, Vol.45, No. 12, 83 – 87.
3. Finkenzeller K., RFID Handbook Radio-Frequency Identification Fundamentals and Applications, *John Wiley & Sons, Ltd.*, England, 2003.
4. Morrison, J. (2005), "Help Wanted", *RFID Journal*, March/April, pp. 13 – 20.
5. McGinity, M. RFID: Is this game of tag fair play? *Communication of ACM*, 2004, Vol. 47, No. 1, 15 – 18.
6. Ngai, E.W.T., Cheng, T.C.E. Au, S., and K. H. Lai, Mobile commerce integrated with RFID technology in a container depot, *Decision Support Systems*, 2005 (Forthcoming).
7. Prater, E. and Grazier, G. Future impacts of RFID on e-supply chains in grocery retailing, *Supply Chain Management: An International Journal*, Vol. 19, No. 2, 134 – 142.
8. Roberti, M., Gillette sharpens its edge, *RFID Journal*, 2004, 12 – 16.
9. Smith, H. and Konsynski, Developments in practice X: RFID – An Internet for Physical Objects, *Communications of the Association for Information Systems*, 2003, Vol. 12, No. 19, 301-311.
10. Stanford, V., Pervasive computing goes the last hundred feet with RFID systems", *IEEE pervasive Computing*, 2003, Vol.2, No. 2, 9-14.

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