

**RFID Implementation in Retail Industry:  
Current Status, Issues, and Challenges**  
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## **1. Introduction**

With the advancement of Information and Communication technologies, cost reduction in RFID readers and tags, and mandate compliances by large retailers such as Wal-Mart, Target, Albertson, and various government agencies such as Department of Defense, Department of Homeland Security and Food and Drug Administration, RFID has recently emerged as one of the emerging technologies for asset tracking, inventory management, supply chain management, payment systems, information sharing, access control and security using radio waves. Industries with the greatest opportunities to use RFID include retail, aerospace, defense, health care, logistics and pharmaceutical companies and library.

While mandates from giant retailers and various government agencies have increased awareness of RFID and have driven requirements for many organizations to implement the technology, companies that have not been affected by the mandate requirements prefer to wait until the technology matures so that they have adequate knowledge of the technology and its potential benefits (Jabjiniak and Gilbert, 2004). We believe the reason is due to the lack of thorough and clear knowledge of the technology and the benefits RFID can provide. In other words, companies are still uncertain about ROI models of RFID (Cooke, 2004).

RFID technology has been perceived to have significant development in the next decade due to the accelerated development of sophisticated technological devices and software. Determining accurate measures for RFID ROI is a critical but challenging task. Developing a comprehensive framework comprising all potential benefits that companies can achieve both in shorter and

longer terms will contribute toward the development of ROI measures. In this paper we have attempted to develop such a framework for the benefits obtained from implementing RFID in the retail supply chains. We focus on the retail industry in this work because we believe that benefits of RFID will vary from industry to industry based on their specific nature and requirements and that the retail industry is one of the most aggressive supporters of the technology. Frost & Sullivan reported that the revenue in the RFID retail market was \$400.2 million in 2004, and it expects to grow to \$4,169 million by 2011 (Bacheldor, 2006). On the other hand, according to a recent survey sponsored by NCR Corporation, 9% of the retailers who participated in the survey have an RFID implementation timeline whereas 44% of the participating manufacturers have such a timeline (National petroleum News, 2006). This raises the question why the retail industry is not adopting the RFID technology as rapidly as expected. The answer may be skepticism about the benefits obtained from implementing the technology, which will require a huge upfront investment (Michael and McCaithe, 2005).

Past research studies looked at perceived RFID benefits for businesses (Jones *et al.*, 2004; Jones *et al.*, 2005a; Jones *et al.*, 2005b; Koh, Kim, and Kim, 2006; Michael and McCathie, 2005; Vijayaraman and Osyk, 2006). Most of these studies focused only on perceived benefits that could be obtained by the adoption of RFID technology by businesses. Considering the evolving nature of the technology *perceived benefits* only cannot capture all the potentials of the technology. Also most of these studies did not look at the drivers or determinant factors and strategy that govern the adoption of the technology which has a strong correlation with the benefits.

In this study, we take a two-tiered approach and consider both general issues as well as retail-specific ones. Our work is motivated by the following research questions:

- What is the current status of RFID implementation in retail industry?
- What are the major drivers for adopting RFID in retail industry?
- Where can RFID be used in retail supply chain?
- What are the major benefits of using RFID in retail industry?
- What are the challenges faced in adopting RFID in retail industry?
- What are the issues involved in adopting RFID in retail industry?
- What are the critical factors for successfully implementing RFID in retail industry?

Our research is dedicated to follow-up the earlier research which might have overlooked significant potentials of RFID technology and thus may be incomplete. We have attempted to broaden the research horizon by including press releases and industry white papers in addition to journal or conference papers in our review. We believe that proper knowledge about the adoption drivers is very important for the successful acceptance of a technology to fully benefit from it. We have discussed the most significant challenges which are impeding the acceptance of the technology. We also observed differences in perceived RFID benefits for businesses in US and UK which inspired us to delve deeper into this issue.

## **2. History and Fundamentals of RFID**

RFID refers to a set of technologies used to identify and transmit information from tagged objects by making use of radio waves (Want, 2004; Das, 2002). This technology is primarily used for automatic data capture and has the potential to change how businesses operate today revolutionizing the business performances. Simply put it is a wireless link that has the capability to uniquely identify people or objects. It uses a tag embedded with a silicon chip and an antenna that enables it to communicate with a reader. The tags affixed to cases, pallets, or other units

transmit radio frequency signals when present in the read zone of a reader. The reader picks up the signal and decodes it. This information is then matched with record data in the host computer system and transferred to the database for storage and analysis (Jansen, 2006). So RFID system has three major components, *the tag, the reader, and the host computer system* which consists of the software also known as *middleware* that provides the core functionality of converting the data collected from the tags into useful information (Chiesa et al., 2002).

The development of RFID technology dates back to the early 1920s with the birth of radar systems and was further developed when it was used for detection of enemy air-crafts during the World War II and is only recently getting increasing attention in commercial business applications like supply chains for automatic identification purposes and is revolutionizing the way business is conducted by ensuring real time visibility (Jacob *et al.* 2004; AIM, 2001; Wyld, 2005). Interest on the RFID technology took a major leap in June 2003 with Wal-Mart's mandate to its top 100 suppliers to begin using RFID tags on shipped items at the pallet level by January 2005 (Curtin, Kauffman and Riggins, 2006). It is now being referred to as a major business rather than a technological evolution (Swedberg, 2006).

### **3. Related Work**

Despite the increasing awareness of the RFID technology among businesses there is still a lot to achieve. Similar to our work is Michael and McCathie's (2005) attempt to identify the pros and cons of RFID in supply chain management. Their work is geared toward RFID adoption in general whereas our main focus in this paper is to look at the Retail industry specifically. Larsson and Qviberg (2004) also conducted a similar research on the justification of RFID implementation. Johansson (2005) worked on the identification of factors influencing RFID

implementation in automotive and pharmaceutical industries. Jones *et al.* (2004) suggest the potential benefits and challenges of RFID throughout the supply chain for retailers in United Kingdom (UK). Koh, Kim and Kim (2006) surveyed on the issues and critical factors of RFID in Retail industry; which is related to our work but their focus is on perceived benefits which may be limiting due to the emerging nature of the RFID technology. Vijayaraman and Osyk (2006) conducted an empirical study of RFID implementation in the warehousing industry. Karkkainen (2003) did an analysis of benefits of RFID obtained by increasing the supply chain efficiency for short shelf life products. Our analysis has resulted in more categories of potential benefits which suggest that earlier works have not included all possible categories in the study instruments which might have resulted in overlooking some important benefits of the technology.

#### **4. Status of RFID Adoption in Retail Industry**

Retail industry represents one of the largest industries in the world. In the United States it is the second largest industry in terms of the number of employees as well as the number of establishments for doing business (Vargas, 2004). Retail sector is one of the most important business sectors which see potential in the use of RFID technology in order to stay at a competitive edge and to achieve profitability in short or long terms (Wamba *et al.*, 2006). With increasing globalization the retail industry is facing more and more competition which is making them struggle harder and harder to succeed through better performance (Koh, Kim, and Kim, 2006). The global RFID market is expected to reach \$ 3.0 billion by 2008 with a growth rate of 23% (Chen, 2004; Maselli, 2003).

Apart from Wal-mart other major retailers like Albertsons, ASDA, Best Buy, Home Depot, Marks and Spencer, Meatco, METRO, Sainsbury, Sears, Target, Seattle's Best Coffee, Tesco,

Woolworth's and so on are the other major players in the retail industry who have either mandated their major suppliers to tag the supplies at pallet or case level or are intending to do so in the near future (Maloni and DeWolf, 2006). According to IdTechEx (2006), the retail industry will comprise 44% of the global RFID market value for systems including tags by the year 2016. The expected growth of RFID usage in the retail industry is primarily because of the perceived benefits that could be obtained by implementing the technology. In the retail industry RFID technology is expected to replace the barcode technology as it provides much more functionalities without requiring the line of sight of the reader thus ensuring speed and process efficiency. Most importantly it provides supply chain visibility thus resulting in a tighter integrated supply chain which is more efficient and is the foundation for future profitability. This will help the retailers stay at a better competitive edge which is what all retailers are striving to achieve in the modern times of ever increasing competition. Good supply chain management is a key to achieve that. It revolves around three core elements which are availability, inventory, and cost (Accenture, 2004).

According to a recent study conducted by Koh *et al.* (2006) the most significant benefits from RFID implementation for retail industry are improved inventory management, improved in-store operation, integrated business model, and velocity of retail cycle. The initial benefits obtained from the technology for the retail sector is improved accuracy of inventory management which can very easily lead to savings. The next key benefit that is much talked about is the supply chain visibility that can be transformed into huge savings (Jones *et al.*, 2005b). We observed that most of the benefits that are talked about focus on achieving operational efficiency for businesses. But there is a lot more to this technology which is yet unexplored and deserves more attention. Many of these benefits are related to each other as well which could be of interest

to businesses and researchers. Past studies have not taken these relationships into account. This will be novel in this research domain.

## **5. Research Methodology**

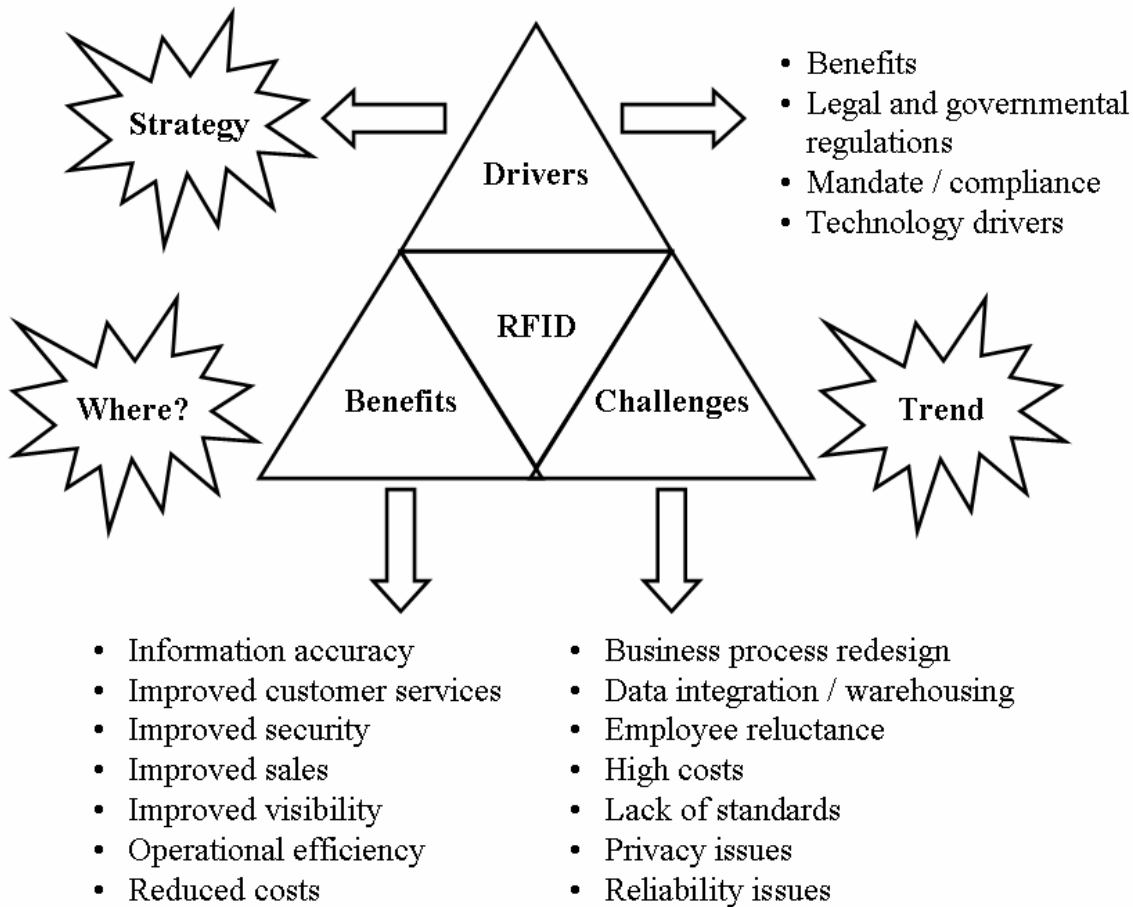
We use a popular research methodology called *content analysis* to guide our reference search, data collection and analysis. Content analysis method has been widely used in information and library science and social sciences research (Krippendorff, 1980). The methodology is exploratory in nature yet allows researchers to capture and quantify information. Our study consists of three major phases: (1) references identification and search, (2) association analysis and conceptual framework development, and (3) data analysis and interpretation.

***Phase 1: References identification and search.*** In this phase, we identify the possible sources as the targets for our extensive search for relevant references. Our search covers popular on-line sources such as AIM Global, RFID Exchange, RFID Gazette, RFID Journal, and RFID Solutions Online and major academic on-line databases such as ABI INFORM, ACM Digital library, Elsevier ScienceDirect, IEEEexplore, and Springer-Verlag Journals. We used key-words starting with “RFID” and collected all relevant articles which were pulled up. We conducted our search between October and December, 2006. A total of 362 relevant articles was found and retrieved. Majority of these articles were published anywhere between the year 2002 and 2006 December.

***Phase 2: Association analysis and conceptual framework development.*** We categorize and sort the data based upon the major themes that emerged, from which, we then develop an integrated conceptual framework to guide our in-depth analyses. Figure 1 shows the key issues that emerged from our association analyses and classification, which include drivers, benefits and challenges. Please note that the underlying assumption of this integrated framework is that none

of these elements can or should be studied independently. They are integrated to each other significantly and require to be viewed *synergistically*.

**Phase 3: Data analysis and interpretation.** Based upon the integrated framework that we developed, we then use it to organize and perform in-depth analyses. We examined and kept track of the frequency of the articles that support each aspect of the framework which acts as an important quantitative measure to support the analysis and discussion.



**Figure 1: The Integrated Framework for RFID Implementation**

## 6. Results and Discussion

### 6.1 Major Drivers for RFID Adoption in Retail Industry

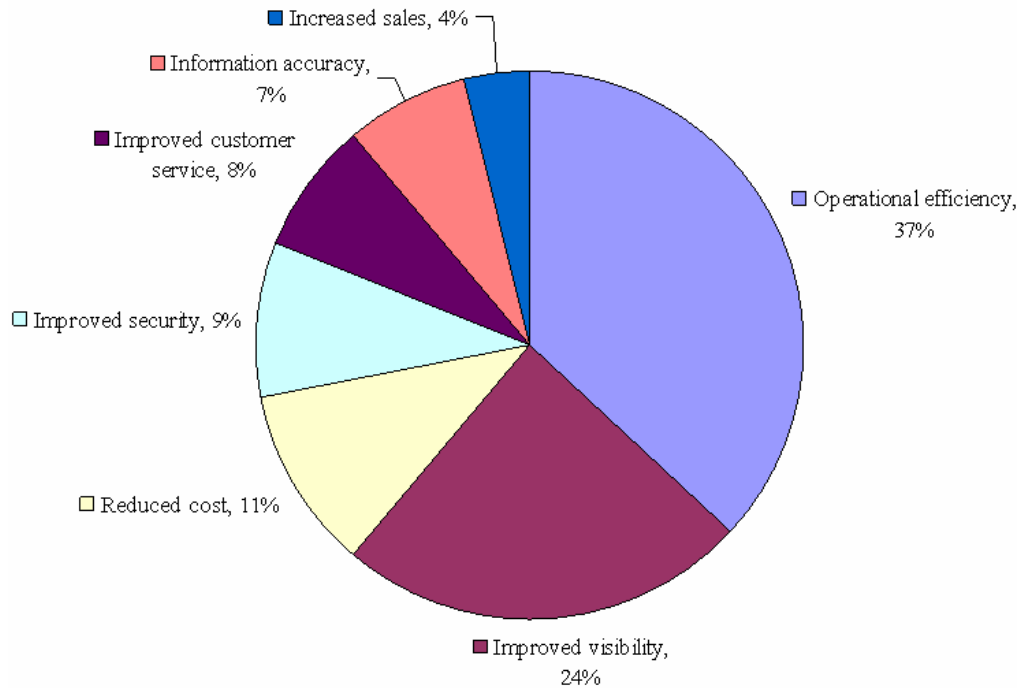
From our analysis we came up with the significant drivers of adopting RFID technology in the retail industry. The most dominant driver for adoption of RFID in Retail came out to be *benefits* obtained by implementing this technology. The next most significant driver which emerged is the Wal-mart mandate requiring its major suppliers to tag at a pallet/case level. Followed by the mandate is the technology driver which comprises of two issues. The first one is the decreasing cost of tags and readers and the second one is the EPC global initiative to achieve standardization. Anti-counterfeiting is a requirement that originates from legal and government regulations came out to be a not so significant driver for retail sector as it is mainly for the pharmaceutical industry. Table 1 shows this information along with the frequency of articles that support this analysis.

**Table 1: Drivers for RFID Adoption in Retail Industry**

Drivers	Frequency	Percentage
Benefits	228	92.68 %
Wal-Mart mandate	7	2.85 %
Decreasing cost of tags and readers	5	2.03 %
EPC Global initiatives for standardization	5	2.03 %
Anti-counterfeiting	1	0.41 %
Total	246	100.00 %

## 6.2 Benefits of RFID for Retail Industry

The expected growth of RFID usage in the retail industry is because of the perceived benefits that could be obtained by implementing the technology. RFID can provide benefits such as operational efficiency, improved visibility, reduced cost, improved security, improved customer service levels, better information accuracy and increased sales. The pie chart in Figure 2 gives the actual percentages of each of these benefit categories that was observed in our analysis.



**Figure 2: Benefits of RFID for Retail Industry**

Operational efficiency and improved visibility are the most significant benefits in comparison to the others but we want to stress the fact that many of these benefits have the potential to influence each other and thus should not be looked at independently rather an integrated approach should be taken when analyzing these issues. Table 2 given below shows the broad benefit categories along with the sub-categories they are composed of. The sub categories are close to the actual activities which contribute to the broader benefit category.

Here we observe that there are some inherent relationships between different benefit categories which might be interesting to address in more detail in follow up research. One category of benefit can be used to boost the other category. For example RFID provides improved security for the businesses but it overlooks the potential it has to improve customer service levels which directly benefits the customer in terms of savings. Similarly improved visibility has the potential to guard against out of stock incidents which directly is related to

improved customer service levels again. Better information accuracy may lead to better demand planning which can boost customer service levels. Similarly increased sales and reduced cost for retailers will ultimately accrue to the savings of the customers. In a nutshell we can say that many of the benefits which are only supposed to be retailer specific have potential to impact customer service levels positively.

**Table 2: Benefits from RFID implementation in Retail Industry**

Benefits	Frequency	Percentage %
<b><i>Operational Efficiency</i></b>	<b>84</b>	<b>36.84 %</b>
Reduced out of stock	37	16.23
Accuracy, speed and efficiency of process	14	6.14
Automated shipping/receiving	10	4.39
Reduced inventory	9	3.95
Improved efficiency of store operations	9	3.95
Improved labor productivity	4	1.75
Streamlined process achievement/Leaner manufacturing	1	0.44
<b><i>Improved Visibility</i></b>	<b>55</b>	<b>24.12 %</b>
Realtime visibility	14	6.14
Tracking and Tracing	14	6.14
Improved visibility of orders and inventory	11	4.82
Asset Management	6	2.63
Returns/Recall management	6	2.63
Tracking shopping behavior	3	1.32
Streamlined reverse logistics	1	0.44
<b><i>Reduced Cost</i></b>	<b>24</b>	<b>10.53 %</b>
Reduced labor requirements/costs	14	6.14
Reduced overall cost	10	4.39
<b><i>Improved Security</i></b>	<b>21</b>	<b>9.21 %</b>
Security against theft/fraud	12	5.26
Reduced shrinkage	6	2.63
Improved supply chain security	2	0.88
Eliminates return merchandise fraud	1	0.44
<b><i>Improved Customer Service Levels</i></b>	<b>18</b>	<b>7.89 %</b>
<b><i>Better Information Accuracy</i></b>	<b>17</b>	<b>7.46 %</b>
Improved packing and shipment accuracy	9	3.95
Business Intelligence	8	3.51
<b><i>Increased Sales</i></b>	<b>9</b>	<b>3.95 %</b>
<b><i>Total</i></b>	<b>228</b>	<b>100.00 %</b>

From the frequency of the articles we observe that operational efficiency and improved visibility are the two most important benefits that is expected and is most talked about in the retail domain whereas there are potentials in the other benefits categories as well and these other categories are not necessarily separate issues. They are somewhat related to each other and one can be leveraged in terms of the other like we discussed earlier.

### **6.3 Where RFID has been used in Retail Supply Chains**

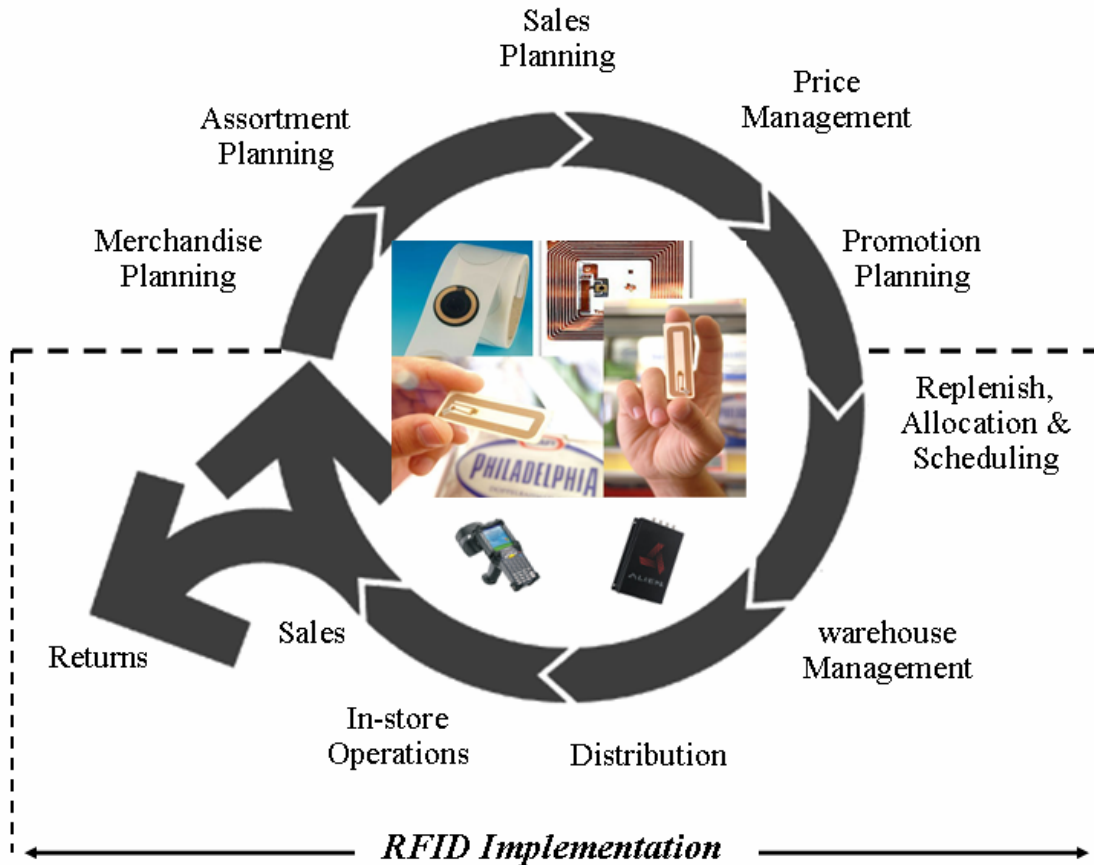
Supply chain management is the process of managing raw materials and information from the point of acquisition to the point of consumption. Most of the companies today rate supply chain management as their key priority for survival and success. The use of RFID in the retail supply chain for tracking and tracing products can lead to reduced inventory and better collaboration among different players in the supply chain (Wamba *et al.*, 2006). Most of the major retailers today see potential of the RFID technology to better integrate their supply chain and improve their efficiency by reducing error rates which can cut down overall cost of operations significantly. The benefits of RFID for Retail industry primarily revolve around allowing for improved supply chain management. *Improved visibility* which is the second most significant benefits of RFID for the retail sector helps to achieve tighter and integrated supply chain.

Retail supply chain may consist of one or more of each of these entities- suppliers, manufacturer, distributor, retailer and consumer (Sikander, 2005). A typical integrated retail supply chain has the following major elements as shown in Figure 3. Each of the elements is briefly explained below (Vargus, 2007):

1. *Merchandise planning*: It is an approach aimed at maximizing ROI through proper planning of *sales and inventory*. This approach is all about maintaining a balance between sales and inventory in order to increase profitability.

2. *Assortment Planning*: It is the retailers' planning for selection of merchandise both in terms of depth and breadth (e.g., what and how much).
3. *Sales planning*: It is a business process to plan the routes to reach the target customers.
4. *Price management*: It is the process of understanding, managing, and improving pricing processes based on predictions and forecast data. It has direct impacts on profit.
5. *Promotion planning*: It is the process of planning and managing promotions that drives demand and profit. It also depends on forecast data.
6. *Replenish, allocation and scheduling*: It is the process to replenish products to avoid out-of-stock situation. It has the potential to reduce inventory and influence improved customer services.
7. *Warehouse management*: It is the process to achieve improved distribution of products across diverse facilities. It has the potential to reduce inventory.
8. *Distribution*: It is the process of distribution of products accurately to the correct destination.
9. *In-store operation*: Management of various store operations like receiving, shelf stocking, product ordering for store replenishment so on and so forth
10. *Sales*: Managing the 'sales' process which is directly associated with revenue generation.
11. *Return*: Managing return merchandise. The idea is to make reverse logistics streamlined.

Looking at the Figure 3 below, we can see that most of the dominant RFID benefits concentrate at the lower end of the supply chain. The potential it has on the other aspects of the supply chain are somewhat neglected. Since the benefits are not standalone they can leverage from one another to their own advantage. Also if the benefits are well dispersed across all the entities of the supply chain it will meet the incentives of a wider range of stakeholders (suppliers, manufacturers, retailers, and consumers).



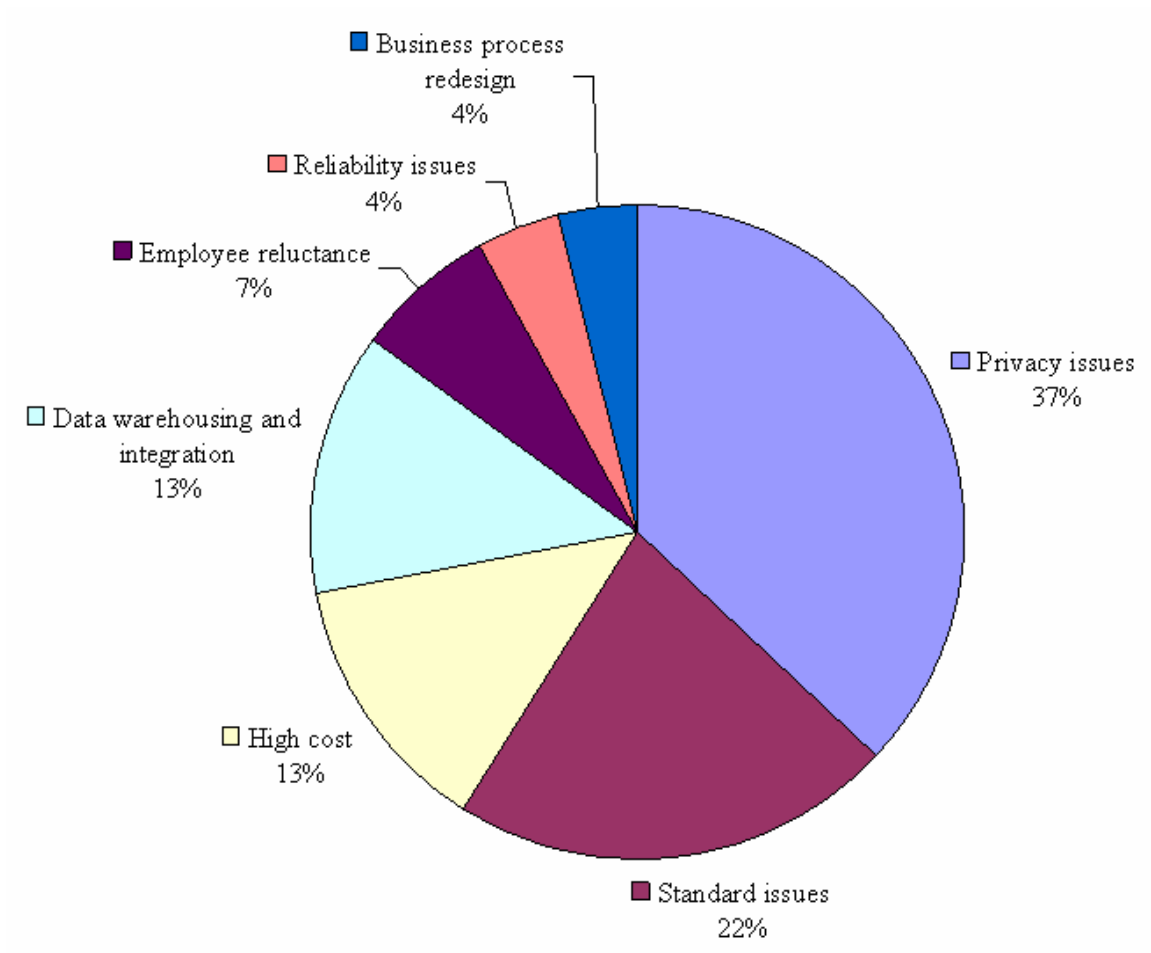
**Figure 3: Integrated Retail Supply Chains (Adapted from Callana, 2006)**

#### 6.4 Challenges of RFID for Retail Industry

The major categories of challenges impeding RFID implementation are privacy issues, lack of standards, high cost, data integration issues, employee reluctance to change, reliability issues of the technology, and business process redesign required. Figure 4 shows the different challenges that came up to be significant in our analysis.

Privacy issues are the most dominant challenge that needs to be addressed before RFID can penetrate deeper into business world, more specifically in the retail sector. Data integration issues are also daunting as the amount of data generated by the typical RFID system is enormous and business processes need to be redesigned to generate information from the data. We can see

like benefits, the challenges are also somewhat related to each other. With technological advancements most of these challenges can be overcome sooner or later. But the privacy issues being a societal issue needs more than technological advancement. A balance between the benefits consumers can get in terms of better service and savings and the impingement of privacy must be achieved and awareness about such balance should be in the top priority of the retail industry.



**Figure 4: Challenges of RFID Implementation in Retail Industry**

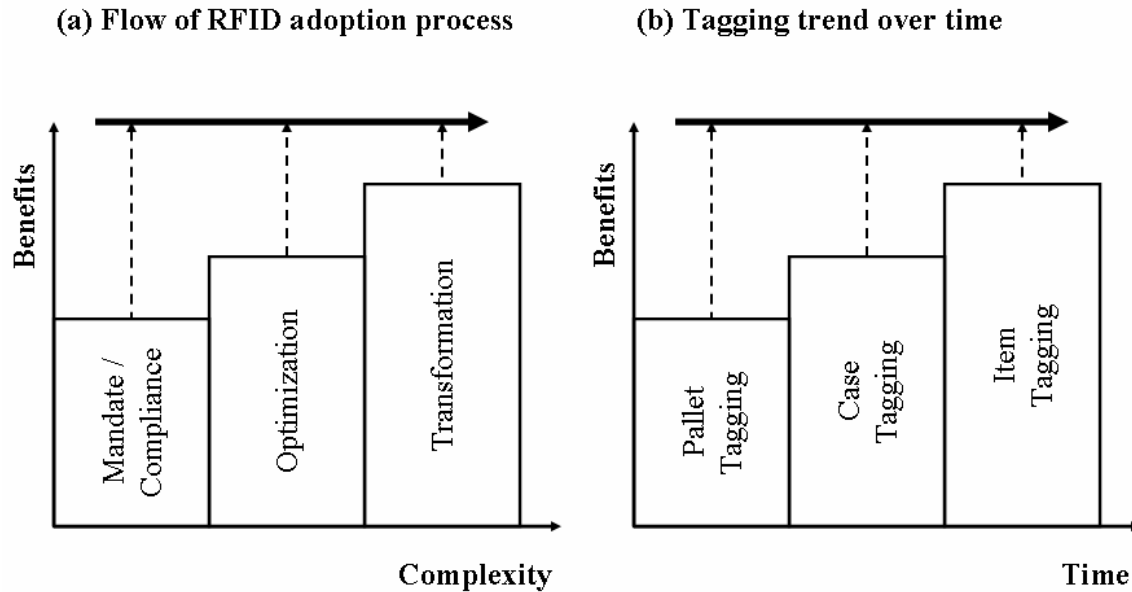
We observed from our analysis that most of the challenges for RFID implementation are generic in nature and are not specific to any industry. This is reflected from the small number of articles that are specific to challenges for the retail industry. A detailed cost benefit analysis to

justify the expenses of implementing the technology ensuring ROI is the forthcoming challenge for the Retail industry as a whole. This is equivalent to the challenge of transforming the benefits into profitability.

## **6.5 Future Implementation Trends**

Figure 5 shows two trends emerged toward future RFID implementation: (a) flow of RFID adoption process and (b) tagging trend over time. The RFID adoption is currently at the stage of mandate compliance from larger retailers. The smaller retailers are also influenced by the mandates issued by the giant retailers because of increasing competition among businesses. With time and more maturity of the technology complexity will increase and the benefits obtained will also increase at the same time. Benefits and complexity will be positively increased related to each other. The second stage will be of optimization when the benefits of the technology will be realized and utilized to achieve operational efficiency by businesses. The third and final stage that can be foreseen is the transformational stage which will revolutionize the way business is conducted by providing complete visibility across the supply chain both internal as well as external to any organization.

In terms of tagging the retail industry is moving from pallet level to the case level. Item level tagging is where the future is and businesses are striving toward it. Benefits and pallet through item level tagging are also positively increased related meaning benefits will increase from pallet to item level tagging and it will be achieved over time.



**Figure 5: Current Trend in RFID Implementation**

## 6.6 RFID Diffusion Strategy

According to Rogers (Rogers, 1986; Rogers, 1995) there are two different technology diffusion models. The traditional model is a 'top down' process in which administrative mandates introduce the technology and administrative decisions and perceptions drive adoption and diffusion as for example the 'Internet' technology. The other approach called 'bottom up' is the one in which the diffusion of the technology is primarily dependent on the perceptions and decisions of individual users as in the case of 'wireless technology'. The process of RFID technology diffusion in organizations currently appears to be top down in nature as it is mandated and pushed by top managers and executives. The decision of implementation and usage of the technology depends upon the perceptions of the top management. This is similar to the Internet and personal computer (PC) adoption trends back in 1980's. Considering the similarity it would be interesting to see if RFID also follows the *bubble, burst, boom* model of adoption like that of PC. Another interesting issue related to RFID technology adoption/diffusion

model is whether it will follow the common technology (innovation) decision process – knowledge, persuasion, decision, and confirmation (Rogers, 1995). Though the technology is still in its infancy it would be interesting to see what path or course it will follow in the longer run. RFID is an emerging wireless technology in which its benefits grow with adoption as in Internet technology. Most early RFID adopters spent high costs in their RFID implementation; however, with growing and more adoption, the costs of RFID devices will quickly reduced, that will lead to more benefits and further adoption (Au and Kauffman, 2005).

## **7. Conclusion**

In this paper we study the current status, drivers, benefits, challenges, and strategy to adopt RFID in retail industry via content analysis. We develop an integrated framework of RFID adoption to lead our analyses and interpretation.

We concluded that four major drivers contributed to the adoption of RFID in Retail industry. Benefits being the most dominant one followed by mandate compliance, technology drivers, and anti-counterfeiting. Anti-counterfeiting came out to be not so significant for the retail world because it is mainly for the pharmaceutical industry. The major benefits that emerged in our study are operational efficiency, improved visibility, reduced cost, improved security, improved customer service levels, better information accuracy, and increased sales. Many of these categories are also strongly correlated with each other which needs to be considered when quantifying the ROI expected from implementing this new technology. The major challenges impeding diffusion of the technology by businesses are privacy issues, lack of standards, data integration issues, high cost, employee reluctance to change, business process redesign, and reliability issues. Clearly these issues are also tied up with each other and many of them can be

overcome with technological advancement. But privacy issue is a major challenge in front of the businesses.

We have also identified the places in the retail supply chain where most of the expected benefits are concentrated on the later end of the chain such as replenishment, warehouse management, distribution, in-store operations, sales, and return handling. The other possible areas may have big potential but that needs to be further explored. This research study is a contributing step toward clarifying some of the misconceptions regarding the RFID technology which is impeding its progress and acceptance in the retail world despite its immense potentials.

We intend to carry this work in future and validate or revise our model by putting it to test in the real world. We will develop a study instrument based on our analysis and framework to test in subsequent research. If we can validate it will be a true success and if we cannot we can revise and rectify our model which will be useful as well. We also intend to conduct a cross-industry study of the benefits and drivers of the technology to enhance our understanding in RFID implementation.

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