



## IMPACT OF RADIO FREQUENCY IDENTIFICATION ON RETAIL INVENTORY MANAGEMENT

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### Abstract:

The goal of inventory management is to have products in right location, right time and right quantity, with minimum time and cost waste. Technology that promises to reduce time, cost and improve customer satisfaction is Radio Frequency Identification (RFID). This paper explores potential benefits and challenges of the application of RFID in retail operations, specially related to inventory management and out-of-stock reduction. Paper concludes that although RFID technology can significantly improve product availability and traceability, costs of item-level RFID implementation are still much larger than the costs of current identification technologies.

### Key words:

RFID technology,  
inventory management,  
out of stock.

## INTRODUCTION

Radio Frequency Identification (RFID) is more than 50 years old technology that has been increasingly used in supply chain management in recent years. This technology can identify, classify, and control the flow of goods and information throughout a supply chain. Its advanced identification and communication characteristics can improve the product traceability and the visibility among supply chains. RFID promise to increase accuracy, efficiency and speed of processes, reduce storage, handling and distribution costs and improve sales by decreasing the number of stock-outs [1].

Bagchi et al. 2007 reported the prediction of RFID growth as from \$1 billion in 2003 to \$4 billion in 2008 to \$20 billion in 2013 [2]. So far, RFID systems enabled world companies such as Wal-Mart, Gillette and Proctor & Gamble to increase their product visibility, reduce out-of-stock rates, eliminate stock errors, reduce storage costs, reduce theft and shrinkage and regularly update their inventory databases [3]. Current applications of RFID focus on inventory management, logistics, manufacturing, etc. [4]. However, some industries have more opportunity to gain profit from RFID applications, such as retail, health-care, textile, automotive and luxury goods industries [5].

Since the benefits vary from industry to industry, we have chosen the retail sector, as one of the most intense supporters of the RFID technology. NCR study showed

that only 9% of the retailers at the time had an RFID implementation timeline, as compared to 44% of the participating manufacturers [6]. This raises the question of why retailers, other than large ones, are not adopting RFID quickly. Most retailers may be doubting the benefits of RFID technology, given the need for a huge investment up front and the uncertain return on investment [7]. In this paper, we examine the potential challenges and benefits of the use of RFID in the retail inventory management.

## OVERVIEW OF RFID IN RETAIL

Radio Frequency Identification (RFID) is an automatic identification technology, composed of three elements: a tag (chip) connected attached to the product; a reader that emits radio signals and receives in return answers from tags, and software that connects RFID hardware and enterprise applications [8]. At present, the retail supply chain has primarily been interested in using passive RFID tags. Passive tags are power-driven by radio waves created by a reader and transmitted via its antennae. The passive tag will remain powered only while it is within the read field. While in the read field, the powered tag will reply to the reader by reporting the data contained within.

At the store level, the readers are restricted to the backroom area – no readers are on the sales floor (see Fig. 1). Receiving doors have read gateways similar to those found at the DC dock doors and capture reads from the



individual cases as they are unloaded from the truck. The product then moves to the sales floor (where readers are placed next to the doors going to the sales floor) or onto backroom shelving. Eventually, all products should be relocated to the sales floor and the empty boxes returned through the sales floor doors (a second read is captured at this point) and positioned into the box crusher for disposal (the last read point).

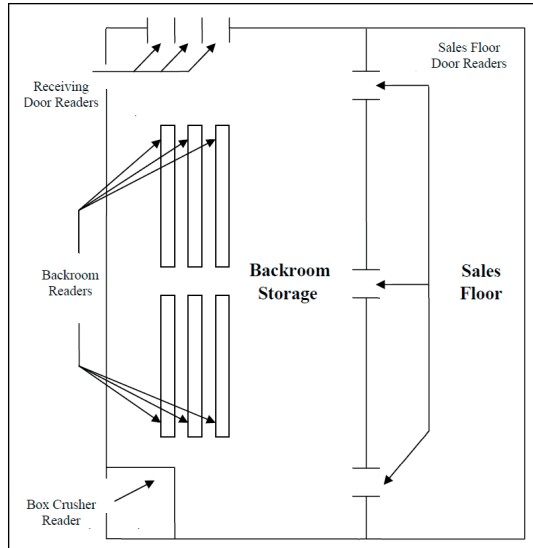


Fig. 1. Example of retail store read points

Almost 40 years retail chains have been using barcodes as the main form of product identification. Given the success of barcodes, the question arises 'Why move to RFID?' The answer lies in the numerous benefits of RFID relative to barcodes. Examples of these advantages include: (1) RFID does not require line of sight; (2) RFID allows hundreds of tags to be identified at one time; (3) RFID allows hundreds of tags to be read per second; (4) RFID tags can store more data; and (5) the data on RFID tags can be manipulated [9]. These advantages have encouraged many companies to aggressively pursue RFID as a way to improve the supply chain and consequently reduce costs and increase sales.

## OBJECTIVES AND METHODS

The aim of this paper is to explore the prospective of RFID technology to improve a retail company's inventory management. To attain this main objective, we have set three specific objectives:

- ◆ Identification of the potential benefits of RFID-enabled retail inventory management;
- ◆ Exploration of potential obstacles of RFID-enabled retail inventory management;
- ◆ Investigation of potential return-on-investment (ROI) of RFID implementation.

In order to achieve these objectives, descriptive research method was chosen. By considering time and money constraints, our research is based on secondary data. Here, we have tried to study literature extensively in the areas of RFID technology and retail inventory management published in the last decade. The literature on RFID

applications in retail inventory management is limited. Most of the existing studies we can separate in two groups: practical papers (white papers and technical reports) and academic papers. Selected results are presented in following section.

## BENEFITS OF RFID ADOPTION

RFID technology can improve the traceability of products and the inventory visibility throughout the whole supply chain, and also can ensure reliable and fast tracking, shipping, checkout and counting processes, which leads to enhanced inventory flows and more precise information. Leung et al. (2007) presents the benefits of RFID in three main groups: revenue, operating margin, capital efficiency [10]. Among a number of benefits, we are particularly interested in the inventory inaccuracy as main problem of inventory management that can be improved through RFID.

Although many retail companies have automated their inventory management using information systems, inventory levels in information systems and the real physical inventory levels often do not match [11]. The difference between these inventory levels is called inaccuracy and can deeply affect the performance of firms. Dehoratius & Raman (2008) reported that 65% of the inventory records in retail stores were incorrect. The result was attained in a case study, by examining about 370,000 inventory records from 37 stores of an important retailer (Gamma) [12].

Raman et al. (2001) stated that such inaccuracies could reduce the profit of retailers by 10% due to higher inventory cost and lost sales [13]. RFID technologies provide better product traceability through its real time data capture properties that enable improvements in the supply chains against these inventory inaccuracies. It is in particular very effective to eliminate transaction errors [14]. Although RFID cannot eliminate all errors, they can be noticed quickly and by considering the presence of this problem in planning processes, they can be dealt with effectively [15]. Some of successful examples of RFID implementation in retail inventory management and out-of stock reduction are presented in the following text.

The white paper of Bitkom presents an overview of numerous applications of RFID systems in Germany. One of the results of these case studies showed that, in Metro Group, RFID technology decreased losses during transit by 11-14%, improved the availability of items in stores by about 14%, and reduced costs in merchandise distribution centers by 11% [16]. Thonemann (2002) reported that after the deployment of RFID technologies, Procter & Gamble and Wal-Mart simultaneously reduced inventory levels by 70% and improved service levels from 96% to 99% [17].

Hardgrave, Waller, and Miller (2005) reported the preliminary results of a major Wal-Mart study that examined the influence of RFID on out of stocks (OOS). Initial paper provided some preliminary surface-level analysis of the findings. Overall, when looking across all Wal-Mart store formats for a large group of RFID tagged items (4554 items), the results were positive and encour-



aging: RFID made a difference: within the test stores, out of stocks were reduced; test stores outperformed control stores; and tagged items outperformed non-tagged items within test stores [9]. Extending this study, same authors examined the influence of RFID on out of stocks effect by sales velocity (i.e., number of units sold per day). Overall, they found that for products selling between 0.1 and 15 units per day, RFID reduced out of stocks by 30 percent. This point estimate provided a robust indication of RFID's ability to reduce out of stocks [18].

RFID technology can be used to support perpetual inventory accuracy by addressing a number of root causes. Case level tagging can reduce or eliminate mislabeling cases at the retailer's DC. Corresponding automated checking when the cases (and tagged internal packs) are unloaded at the store can additionally improve the accuracy of flow data into the store. An important goal for RFID technology in the retail supply chain is to get a more accurate picture of backroom inventory versus sales floor (shelf) inventory.

Item-level tagging, which is starting to be used on high value items and time sensitive products such as clothing, video games and DVDs, brings clear inventory accuracy improvements. With the appropriate implementation there can be electronic reading, not only of the precise inventory, but also verification that the product is in the right place for a customer to find it. Item level tagging would also improve POS checkout accuracy – still this is unlikely to be widely deployed until it is economic to tag most items in a store. In the apparel and other specialized retail environments item level tagging may already be economic because of the higher unit prices and the substantial labor savings in automated inventory counting.

The automatic identification of products inside the store would increase the inventory visibility and its accuracy. This will have an influence in four fronts: shrinkage, customer service, stock outs and inventory levels. Decrease shrinkage levels, increase profits. Customer service and the shopping experience can be improved by providing complementary applications enabled by RFID. Stock out levels can be reduced as consequences of the increased inventory visibility. Reduced stock outs increase sales and eventually, increase profits. Reduced stock outs levels also increase the customer service. Finally, inventory levels can be reduced, increasing the return on investment [3].

## CHALLENGES OF RFID ADOPTION

While RFID-enabled inventory management generates a number of positive effects, yet it is faced with several technological challenges. A key challenge is the continually evolving standards in technology, application, data, firmware changes, and tracking methods. Illicit tracking of this technology related tags presents problem, like; scanning and cloning of RFID tags can potentially provide undesired access to important facilities or use for payment in commercial transactions. Implementations are supplemented by varying specifications and regulatory requirements, such as operational frequencies and power specifications vary from country to country.

An issue involving supply chain companions is the absence of integration, for example, when the manufacturers' resource planning systems are not linked in real time to retail systems. Another issue is the partners' resistance to information sharing, which is necessary to achieve maximum benefit from RFID technology. In the past, many companies implemented RFID for technology's sake, without establishing a valid business case to support their investment decision. In these instances, the cost often tends to be a problem with the price of a tag being too high in comparison to the price of the product to be identified or traced. This makes the use of RFID completely irrelevant.

Due to technological and financial reasons, most radio frequency identification (RFID) applications have been limited to tags on pallets and cases and have not descended to the individual item level, where RFID shows great promise to address shelf OOS. However, at the case and pallet level, RFID applications can track when the cases are delivered to the store's backroom, and when they move from the backroom to the store floor and vice versa. As a result, RFID has been shown to reduce shelf OOS for high velocity items that require that the store hold large levels of back stock [19].

## RETURN ON INVESTMENT (ROI)

As stated before, RFID technologies can provide several benefits on supply chains: cost reduction such as labor cost, inventory cost, process automation, or efficiency improvements and value creation such as increase in revenue, or increase in customer satisfaction [20]. However, the cost of RFID is still larger than current identification technologies [21], and companies must decide whether to invest or not to acquire RFID technologies. Therefore, return of investment (ROI) analyzes can be useful to support decisions on the feasibility of RFID utilizations. The literature on this subject is still limited [22].

A positive ROI depends on the technology costs; price of tags, readers and middleware, implementation costs, maintenance service cost, etc. The level of RFID tagging is an important cost factor. Case/pallet level tagging cost is lower than item level tagging cost which can provide more benefits. Gaukler and Seifert report that there is no positive ROI of item level tagging for manufacturers while a positive ROI can be attained for retailers [4]. Tag cost is also less important in a closed loop because tags can be used many times while, in an open loop, tags are used one time [23].

A positive ROI also depends on the benefits that RFID can provide [24]. Classical ROI analyzes concentrate on direct benefits, while new RFID analyzes investigate indirect benefits. Direct benefits of RFID technologies include increase of sales and/or decrease of lost products that can be observed and quantified. Indirect benefits consider non-financial benefits such as improved customer satisfaction and shortened customer response times, etc. These improvements cannot be quantified by a direct economical calculation but they can increase direct benefits later [10].





Implementation of RFID technologies in entire supply chains is another important factor. If all the members of a supply chain share the cost of RFID, implementation becomes easier and cheaper for each of them. In their paper, Gaukler et al. indicate that sharing the cost of RFID between a manufacturer and retailer can maximize the total supply chain profit [25]. For example, Wal-Mart requested that its 100 largest suppliers use RFID at the pallet and case levels in 2005. Wal-Mart shared the RFID implementation cost with their suppliers [26].

The process of calculating a Return on Investment (ROI) for RFID implementation needs to be observed within an organization's business context. PwC Consulting has sketched out preliminary cost/benefit figures for a "typical" retailer that maintains 800 stores. The required investment for this retailer in the amount of \$50 million to support an RFID system on a pallet/case level is expected to yield \$55 million in savings on labor costs and generate about \$43 million in additional sales from decreased out-of-stock incidences [27]. Logically, the calculations of costs and benefits resulting from RFID implementation can vary across different pilot implementation experiences of forerunner users. Even though these firms may have to finally replace a significant portion of their internal IT infrastructure when RFID technology is implemented, they highly value the learning experiences they have gained from having started early. The Auto-ID Center posted an electronic ROI calculator developed by IBM and Accenture on its Web site. Twenty-five firms that were among the corporate sponsors of the Auto-ID Center tested and validated the ROI calculator [28].

The calculator takes into account the nature of the business of the inquiring company (i.e., manufacturer, distributor, retailer, etc.); the level of tracking required (i.e., pallets, cases, or items); the expected benefits (e.g., savings in labor costs, lowered inventory levels, decreased theft or shrinkage, etc.); and more detailed information about the company's operations, among other factors. The user can change the nature and number of variables it would like to include in its "what-if" scenarios [15]. Pilot projects help companies calculate the major intangible benefits from RFID within the firm's business environment. Peter Abell of AMR Research estimates that it takes most companies a year before they acquire funding for a pilot project [29]. This can be too long for those companies that need immediate RFID readiness in response to trading partner mandates.

## CONCLUSION

We can conclude that RFID technology can provide tangible benefits in retail inventory management through better traceability and improved visibility of products. Increase of efficiency and speed of processes, improvement on information accuracy and reduction out-of-stock rate, are just some of these advantages. However, real applications of RFID technologies are still limited because the costs of RFID are still often much larger than the costs of current ID technologies. RFID technologies have been attractive in numerous contexts and companies, but most

of them still prefer to start with pilot projects and evaluate the cost and potential profits. Choosing the right implementation option (such as cooperative implementation with suppliers) and right business environment is a critical decision for any retail company to gain the most out of expensive technology such as RFID.

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