SSRG International Journal of Polymer and Textile Engineering
ISSN: 2394 – 2592 / https://doi.org/10.14445/23942592/IJPTE-V9I3P101
Volume 9 Issue 3, 1-5, Sep-Dec 2022

Original Article

The Current and Future Use of RFID by Apparel Retailers

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Received: 10 June 2022 Revised: 18 July 2022 Accepted: 30 August 2022 Published: 14 September 2022

Abstract - *Radio Frequency Identification (RFID) technology has been used for over half a century and is popularly used as a theft deterrent for clothing. This technology continues to be updated and is currently being implemented in various uses. Apparel stores were examined to determine who and how many uses some RFID technology and, if so, what form of this technology was employed. Results show that retail stores currently employ several options based on price point and brand. Positive impact and risk factors are explored in this evolving technology.*

Keywords - *RFID, RFID Yarn, Technology, IT Business Value.*

1. Introduction

Radio Frequency Identification (RFID), a contactless and short-distance wireless communication, was introduced in 1952. RFID technology has been adopted across a spectrum of merchandise, particularly since 2003, when Wal-Mart implemented requirements for their top 100 suppliers to use this technology [1]. Retail merchandisers, from the first introduction of item-level RFID and supply chain management requirements to vendors and stores at Wal-Mart, have seen the benefits and challenges of adding RFID technology.

2. RFID Used in Apparel Industry

Modern RFID sensors, for retail, are made with a memory capacity superior to a typical barcode. Retail merchandisers, supply chain managers, vendors and textile recyclers have seen the opportunities and challenges of adding RFID technology. Store level RFID has improved with newer label readers for stacks of garments, improvements of inventory outages and mapping of the stores to improve store merchandise placement [2, 3].

2.1. RFID History

RFID technology is an advanced form of radar used in World War II when it was discovered that German planes would change the radio signal reflected when returning to their base. Advances to this technology continued, and in the 1950s, one of the first electronic article surveillance tags was developed [4]. This tag, still used today, has an enclosed bit which can be either on or off. While in the store, the bit is "on", but when the article is purchased, the bit is turned off so the purchaser can leave the store. If the bit is not turned off, an alarm will go off as they try to exit [4]. RFID tags are currently used in supply chain management to track shipments and in farming to track medicine given to sick cows.

Retailers who were early adopters of the RFID chip experienced some pushback from consumers due to privacy concerns. Alternatively, RFID was used by some famous designers' brands to avoid counterfeiting. However, even with improvements, there continue to be privacy issues [5]. Primary concerns include how portable readers may scan RFID tags on clothing, credit cards and home items. Newer concerns may include how RFID could transmit information while wearing garments. In response to these RFID privacy concerns, other textile industries have created fabric for consumers to block the sensor signals [4,6,7]. However, the difference between invisible RFID-embedded clothing and non-RFID clothing cannot be detected by sight or touch.

2.2. RFID Now

RFID continues to evolve and become more widely accepted as microscopic chips are now embedded in the yarn/thread for military contractors, the healthcare industry and sportswear manufacturing [2,3,4]. New technology can be sealed inside micro resin pods within yarns, and the fabrics with embedded RFIDs can survive through washing and drying without losing their functions [4,5,7]. Similar to the RFID devices now used in bank cards for contactless payments, the tiny chips, one millimetre by 0.5 millimetres in size, can contain a lot of information usually communicated via barcode [1,7]. Smart textile innovations are changing the textile industry. This yarn/thread can be an environmentally conscious solution for the apparel industry that produces and disposes of over two billion pounds of

textiles each year [8]. Additional applications include warehouse management, hospitals, police departments, automotive industries, and even intelligent diapers for the elderly [6,7,9].

RFID has been used as a location device for consumers, such as when using a phone app to locate an item in your local Wal-Mart or Lowe's store. Trying to find an exact item can be difficult, and the location apps can be used to route the customer through the store to the exact item they are looking for. Implementing RFID for a single company showed a 4% economic savings [10,11,12,13].

Research has found that the positive impacts of applying RFID technology include increased sales due to better inventory control measures, faster inventory turnover and more efficient backroom operations, leading to increased time to assist customers in store [7]. Indeed, in the mid-2000s, many retailers were trying to solve issues with replenishment from the backroom, employee execution errors and lack of overall inventory awareness. Retailers that use RFID technology have significantly lower time in inventory and higher sales efficiency since adopting RFID technology [9]. RFID can also track what items customers buy, helping keep the needed stock out on the sales floor [10,14,15]. This technology has proven itself as an effective inventory control mechanism. Indeed, when it was revealed that the retailer Benetton planned to place RFID-enabled labels on all their Sisley branded garments in 2003 and track them through the supply chain, there was a public backlash. Privacy groups called for a boycott due to fear that Benetton would track people after purchase. Benetton responded by stating that the tags were only in a test phase and would not be immediately deployed [16].

RFIDS tags allow customers to pay for purchases using RFID-sensitive tables and iPads [17,18,19]. Tags on garments could also be made to "talk" to smart washing machines, which would automatically know how to wash the garment [18] best. Dressing rooms can now identify what item is brought in, and a screen in the room lets the customer know what sizes and colors are available. At Burberry, RFID tags tell the story behind their garments as their tags communicate with consumers' phones and give information about where the products were produced or recommend wearing options [20, 21]. With this wide variety of uses, increased information and ease of shopping, consumers may be more willing to embrace RFID technology in the future.

RFID technology can be difficult for small to medium-sized companies to implement due to the initial upfront costs [22]. While it is difficult to determine a straight ROI for this technology, the benefits are evident in the numerous ways outlined here. Additional evidence of value includes Walmart's estimate of saving $6.7 billion in labor costs alone or Walgreens sales increasing 400% after RFID implementation [23,24]. Currently, five different types of RFID are used in the apparel industry. These include sensor keys, cards, chips, stickers, and embedded yarn [7,9].

3. Method

This study aimed to explore the current use of RFID in retail stores. National retail chains, department stores, speciality stores, and discount stores were explored to examine RFID types in use. This research is twofold: explore RFID in retail stores to analyze the type of RFID used an interview RFID yarn producer's representatives. A total of 100 RFID labels were collected from five retail stores. Five categories of RFID devices were divided into tags, yarn, cards, keys, chips, and stickers. Researchers visited and observed the retail stores to collect all information. Retail stores conducted informal interviews to identify RFID impacts and risk factors. Also, information found in the company reports was used to analyze the final results. An invisible RFID yarn manufacturer provided a catalogue to understand the functions of the clothing and provided yarns for inspection.

As the RFID-embedded yarn is invisible, a manufacturer of luxury items was contacted. This discussion stated that many luxury items currently use invisible RFID technology [5]. This technology has been instituted to reduce theft issues and maintain a high-end appearance for luxury items [11,25,26]. While we cannot ascertain all the luxury brands precisely using this technology, the lack of identifiable RFID tags on the higher-end items was noted in our study.

4. Results and Discussion

Data were collected from store observations and individual interviews. Positive impacts and risk factors were both identified. This section discusses our findings.

4.1. Visited Retail Stores

All retail stores visited had at least one of five RFID categories, including tags, cards, keys, chips, and stickers. No yarn-embedded devices were identified in the retail stores. National retail chain stores and department stores were found to have standard RFID cards and chips. Speciality stores were likelier to create decorative hang tags to give the RFID a more luxurious appearance. Perfumes and aroma items adopted packages with chips inside of the box. For some luxury items, brands had adopted double keys or a combination of card and key.

ALL RFID found are shown in Table 1.

Table 1. RFID Used in the Retailers

						Total
	Sensor key	**Card**	**Sticker**	**Chip**	**Yarn**	
	35	20	3	40	2	100
	RFID Used in the stores					
Speciality store	10	4	3	10	2	
Department store	15	8	0	10	0	
Discount store	10	8	0	20	0	
TOTAL	35	20	3	40	2	100

4.2. Positive Impacts

The following summarizes four positive impact factors: improved inventory, integrated business model, effectiveness and efficiency of store operations, and rapidity of retail cycle.

4.2.1. Improved inventory management.

In the retail environment, RFID is used to improve inventory management in the following ways: a. Increased accuracy in inventory data collection; b. Reduced shrinkage; c. Simplified inventory and reduced complexity in inventory control; d. Faster customer checkouts, improved inventory verifications and control, e. Enhanced integration of orders and warehouse management; and f. Real-time inventory data bank.

Unique identification through RFID tags identifies each item in the supply chain, making it possible to track items individually. Speed is the key for retailers in adopting this technology, as RFID readers can count several items per second. Location is important in inventory management for retailers, and with RFID technology, items can be located quickly and relocated elsewhere in the store to increase sales. Employees also need not be near the item for the RFID reader to locate it.

While barcodes help track inventory, RFID technology improves the data collected more than barcodes. RFID can track the actual movement of the item when it is attached to items in transit to the warehouse or on a forklift within a warehouse. The RFID tags can be read from anywhere in the warehouse so that employees know exactly how many items there are and the exact location of each item.

4.2.2. Integrated business model.

RFID used to be an integrated business model which successfully implemented the following: a. creation of new business models, b. competitive differentiation, c. streamlined transaction processing, d. potential to merge the online and offline channels and e. closer connection between retailers and suppliers.

4.2.3. Effectiveness and efficiency of the store operation.

The effectiveness and efficiency of adopting RFID in business and industry are manifold. The operation has been proven to: a. decrease time spent on employee stock management, b. move merchandise faster to the sales floor from stock rooms, c. improve store operation efficiency, and d. improve visibility of stock item orders.

The use of RFID can also enhance employee productivity. RFID technology eliminates many manual procedures, such as individually scanning barcodes to get an inventory count. If an inventory is low on the sales floor, backroom stock can be quickly located and moved to the front of the house. Accurate tracking of merchandise also reduces error, misdistribution and losses.

4.2.4. The rapidity of the retail cycle.

RFID can move inventory faster, increase pricing accuracy, increase sales, and obtain improved information. RFID technology has also shown to be an effective tool in logistics, creating a closer connection to the supplier [8]. This technology has been credited with improving supply chain management through its ability to increase efficiency in handling materials, managing assets more effectively, improving the availability of products and the automatic tracking of products. The tracking of items, individually or in multiples within a container, became automated about 15 years ago, giving companies a competitive advantage.

The fashion industry is unique due to the large numbers of individual items which are time-sensitive. The advent of fast fashion requires speeding up the product lifecycle from design through manufacturing and transport to the retailer. Adopting this technology has allowed for a faster turnaround, increasing the speed to market.

4.3. Risk factors

The use of RFID can still be of concern to retailers. The interviewees' viewed the uncertainty and lack of standards as the most serious risks of implementing RFID.

4.3.1. Lack of expertise, lack of training time, lack of experts, cost of employee training, management reluctance to new technology, and lack of information about RFID.

4.3.2. The complexity of the technology, increased manageability required immaturity of RFID technology, lack of reliability, and poor interoperability.

4.3.3. Uncertainty of the technology, uncertainty about lack of standards, no clear Return on Investment (ROI), and inaccurate data reader.

4.3.4. Privacy concerns on the part of the consumer were mentioned and are also valid. Researchers discussed that if a tag is not disabled at the point of sale, it would be possible to track the customer every time they wear the tagged garment [12,13].

4.4. Discussion

RFID has the potential to change the retail, textile, health and sportswear industries by using it to track items throughout the sourcing chain until final disposal. Also, some luxury brands could use RFID to reduce theft, fight off counterfeiting, and analyze where garments are purchased.

Luxury and sports brands have created garments to control phones and music and can also be used as a guidance system. Additional brands have collaborated with sports companies to create bras, boots and yoga pants with embedded waterproof sensors containing health information for consumers. Sensors in athletic shoes can transmit information previously utilized only for professional athletes in a closely monitored, climate-controlled and wired environment and make this information available to the amateur athlete.

RFID has many new possibilities and is changing rapidly as technology and inventions are being developed daily. With invisible RFID buried inside the product and not detectable, it may be used in reducing store loss and helping improve the supply chain through tracking and recycling the billions of fabrics produced each year. The increased need for retailers and consumers to improve the environment by using RFID yarn, tags, labels and stickers led researchers to hypothesize that RFID yarn technology could provide data throughout the supply chain.

Knowledge of this innovative textile and uses of the RFID tags/labels and yarns are imperative for advanced research on textile, supply chain management and disposal/recycling of textile waste. Quick and accurate informational communication technology will majorly contribute to improved inventory management, payment systems, traceability of orders, and communication with customers and employees, all of which have key roles in retailer supply chain operations [28, 29].

5. Conclusion

This study found the adoption of RFID, including both larger technology models and smaller/micro models, and from visible to invisible. RFID tags or labels are easy to find at various merchants regardless of the size of the RFID device. RFID has gained the trust of retail stores and has successfully lowered shrinkage for retailers. As previously noted, using RFID is one of the solutions to reduce theft and counterfeit issues for luxury products. The trend for adopting RFID has spread to many industries, such as footwear, the oil industry, health care, hospital, food industry, warehouse management, textile/fabric production pipeline, and recycled textile management. However, customer acceptance and trust are still lacking. Future research is needed to apply open innovation strategies in the framework of the current study.

Funding Statement

This research was supported, in part, by the College of Tropical Agriculture and Human Resources, the University of Hawaii at Manoa, and other funding sources (CTAHR start-up fund).

Acknowledgements

This research was supported, in part, by the College of Tropical Agriculture and Human Resources, the University of Hawaii at Manoa (Hatch, Multi-State Project), and other funding sources (CTAHR start-up fund).

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