



Solutions to the Challenges of Implementing RFID Technology in Apparel Retail Industry

Intiaz Hossain

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Hossain, Imtiaz Hossain, Imtiaz

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Abstract

Apparel retail brands experienced multifaceted landscape of RFID (radio frequency identification) technology, which reduced stockouts, labor costs, inventory costs, visibility, and customer satisfaction through self-checkout. However, RFID technology in apparel retail faces several challenges, including cost barriers, integration complexities, technological limitations, employee resistance, and privacy concerns. This study aimed to provide solutions to RFID implementation for apparel retailers and achieve overall business excellence through a value-added customer-centric approach by overcoming all prevailing barriers. Throughout this journey, this study identified the significance of RFID's omni-channel fulfillment capabilities in addressing critical issues such as inventory inaccuracies, supply chain inefficiencies, and customer satisfaction. To address and overcome these challenges in the implementation process of RFID technology in apparel retail sector, a wide literature review and empirical research were conducted to propose comprehensive insights to overcome these challenges. For apparel retailers, the best item to select for RFID deployment is a passive UHF RFID tag, which is best suited to price tickets or hangtags. Recommendations included technological advancements, managerial strategies, best practices, and cost-effective measures to facilitate the integration and ideal utilization of RFID technology. An RFID-standardized ecosystem has a significant role in guaranteeing the interoperability of items irrespective of the manufacturer or user involved. These standards provided a foundation for enterprises to build supplemental items, including tags, readers, software, and accessories.

Keywords/tags (subjects)

RFID Adoption, Inventory management, Operational efficiency, Challenges of RFID technology, RFID Implementation solutions.

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1 INTRODUCTION

The emergence of Radio-frequency Identification (RFID) technology marks a transformative era for industries, offering integrated solutions that streamline operations, enhance productivity, and boost operational efficiency. Utilizing radio waves, RFID facilitates contactless and wireless information retrieval, revolutionizing how businesses identify, acquire, and communicate with tagged items, eliminating the need for goods positioning before scanning, thus significantly increasing efficiency.

RFID technology has demonstrated effective applications across diverse industries, including retail, healthcare, fashion, automobile, aviation, supply chain management, and large-scale manufacturing (Khorasani et al., 2020). Major players in various sectors have embraced RFID to fortify security and improve visibility (Khorasani et al., 2020). According to Lopez et al. (2022), the garment retail industry has shown a growing interest in RFID components as a result of the falling costs of RFID components and improvements in technological infrastructure. This demand indicates that there may be a possible revolution in the way that retailers manage information regarding their business processes and client bases.

Despite promising prospects, the implementation of RFID technology in the apparel retail area faces challenges. Organizations grapple with hesitation regarding Return on Investment (ROI) models, technological comprehension, and evolving RFID landscape. This research aims to tackle these challenges by developing a comprehensive framework that outlines the returns of implementing RFID technology in retail operations.

This study focuses on the retail sector, recognized for its proactive acceptance of technology, driven by industry-specific demands. Market projections indicate significant growth in RFID technology within the retail sector, with a substantial increase in the international market for RFID tags/stickers and technology sales (Frost and Sullivan, 2020). The universal market for RFID tags is expected to witness a robust Compounded Annual Growth Rate (CAGR) from 2022 to 2030, with RFID technology sales expected to exceed \$49.7 billion by 2027 (Businesswire, 2023). This growth

is fueled by the global deployment of RFID tracking systems, showcasing a trend that continues to gain momentum.

As the market for RFID technology expands, a thorough understanding of its benefits and challenges becomes crucial. This research takes an integrated approach to address industry-wide and retail-specific concerns associated with the efficient and affordable implementation of RFID technology. The study aims to answer key questions regarding the existing position of RFID implementation in the apparel retail industry, optimal leverage points inside the retail supply chain area, principal benefits of RFID technology, then critical challenges in adoption and cost-effective resolutions. This investigation will provide valuable insights to guide the successful integration of RFID technology in the dynamic landscape of apparel retail industry.

1.1 Background of RFID Technology

RFID technology comprises of two main components: an RFID tag and an RFID reader, both of which are integrated into a computer system. During operation, the tag is able to collect data in real time and transmit it through the use of electromagnetic waves (Das, 2002). In general, these tags comprise a tiny chip and antenna. The chip is responsible for the storage and processing of data, whereas the antenna permits the reception and transmission of information. In many applications, a semiconductor chip retains relevant information regarding a product or shipment, thereby allocating it a distinct and exclusive identification number. The numerical value in question constitutes an integral component of the data kept within the embedded chip of the tag, thus allowing the compilation of a great deal of the items. Any RFID scanning device will immediately read and record the data contained on a tag whenever it is scanned by the device. The reader detects the object to which the tag is connected in real-time by tracking the movement of the tag. A reader transmits the digital identity of the tag and other information (Chen et al., 2009). RFID-based systems have three core components: The RFID Tag, The Reader, and The host computer system, which include middleware that converts tag data into useful information (Jeong, et al., 2020). Active RFID tags, which always carry a battery, and passive RFID tags, which use radio signals, are currently being used. In comparison to passive RFID tags, which are more cost-effective, active RFID tags have a bigger storage space and a greater functional frequency (Fahmy et al., 2019).

RFID technology was initially developed in the early 1920s using radar to identify enemy planes during World War II. (Sellers, 2021). It is currently employed in commercial business applications, such as distribution networks for automatic identification, and is revolutionizing businesses by ensuring real-time information. By January 2005, Wal-Mart's June 2003 instruction to its top 100 stakeholders to employ RFID tags on pallet-level transporting merchandise encouraged RFID interest (Kumar, 2023). Moreover, there are discrepancies in RFID usage across various geographical areas, with Europe exhibiting a considerably lower rate of adoption than North America and Asia (Alhalafi & Veeraraghavan, 2019). Europe's relatively slow deployment of RFID technology in the retail industry can be explained a lower rate of acceptance, mostly driven by concerns about privacy issues and the need to wait until a more widespread adoption is visible (Alhalafi & Veeraraghavan, 2019).

1.2 RFID Technology in Apparel Industry

RFID has been successfully used in the apparel and fashion industries for more than twenty years. RFID technology remains an emerging field, and top companies in a wide range of businesses are increasingly using it to enhance security and visibility. Walmart was the first major shop to make use of the newly developed tracking system, which cost \$1.50 per tag (Jain, 2021). RFID is a cutting-edge technology utilized for precise tracking of inventory. Over the years RFID technology is already employed by Wal-Mart, H&M, Target, Uniqlo, Zara, Decathlon, Tesco, Sainsbury's, Sears, Best Seller which are all big clothing retailers. Even though more clothing stores say they are interested, putting these processes in place is difficult for them. Even though it seems like progress is being made, the large original investment needed to fully integrate RFID technology has made it harder for it to be used. RFID tags were used to cost approximately one dollar each in 2000. Since then, the price has slowly decreased, but for ordinary usage, the price will need to go down even more to approximately below five cents per tag.

When analyzing the practicability of RFID implementation, it is crucial for organizations to change their mindset from perceiving it as an additional expense to acknowledging the possible enhancement in value that this technology could bring. Efficiency resides in utilizing the abundant information obtained from the tags without incurring supplementary expenses in terms of labor. The efficient utilization of this data can enhance the quantity of products on shop shelves, monitor critical items, and manage the flow of components, which will ultimately result in advantages that

can be quantified. If the accumulated value surpasses the cost of the tags, RFID installation becomes a viable option for a corporation, irrespective of the individual price associated with each tag.

Numerous studies support cost-benefit assessments of RFID investments for supply chain stakeholders (Dubosset et al., 2021). Additionally, RFID system configuration in supply chain networks has been studied to influence deployment tactics (Kouhalvandi, 2022). However, little study has examined how item-level RFID technology in stores affects sales and revenue.

1.3 Research Gap

The classification of literature into practical papers and academic papers, as advocated by researchers such as Sarac et al. (2010), continues to be relevant even after a decade. The available literature on RFID exhibits significant divisions and shortages, aligned with the observations made during the literature evaluation. This research suggests that RFID technology deployment issues and solutions may not boost effectiveness and efficiency. The authors believe RFID's ultimate worth is strategic use of generated data for decision-making and leadership. Impact of Poor Operational Standards and Optimization Issues on the Effectiveness of RFID Implementation in Organizations. The assessment of RFID compatibility within an organization is dependent upon the identification of the requisite capabilities. The research argues that organizations should make ongoing efforts to strengthen their processes to enhance strategic performance, while acknowledging that RFID integration follows operational standards (Pfahl & Moxham, 2012).

The establishment of trust between retailers and suppliers is essential for effectively utilizing and deploying the information derived from RFID implementation. The challenge of occupying sensitive information across the supply chain poses a significant obstacle to this endeavor (Pfahl & Moxham, 2012). The main importance of establishing trust between stakeholders lies in their ability to minimize risks and opportunistic behaviors by encouraging transparency, resulting in mutual benefits for both parties involved (Singh & Teng, 2016).

Azevedo and Carvalho (2012), examined how RFID technology improves apparel distribution operations. Their study examined the implementation of RFID in apparel and clothing sector. They found RFID was used in shipping operations, tracking supplies and clothes, collecting completed

items, managing procedures, and monitoring merchandise through different phases. RFID implementation, especially change management, was difficult, leading to a request for further study of RFID acceptability and adoption in enterprises. The retailer groups were those intending to adopt RFID but lacking information knowledge, those already using active RFID tags, taking into account a shift to passive ones because of their reliability and cost-effectiveness for retail operations, but hesitant to change the operating system, and those using passive tags and considering expanded use but worried about costs. The existing research has not examined change management and departmental collaboration for RFID acceptance and deployment. According to Rizzi et al. (2016), classified RFID installations in apparel retailing, highlighting the technology's numerous retail applications. This methodology does not address RFID compatibility in organizations. RFID compatibility with organizational goals and difficulties must be addressed, even though past research on RFID advantages lacks empirical support and practical implementation. Moon and Ngai (2008), demonstrated that RFID improved operational efficiency, sales, and profit in fashion retail supply chains despite implementation costs, system compatibility, accuracy of data, managerial attitudes, and employee acceptance. Beyond consumers, this study examines managers and worker's RFID opinions. Due to sensitivity, compatibility with current systems and data accuracy will be examined without installation expenses. According to Leung et al. (2014), enterprises examine RFID based on their strategy before adopting it due to its illusive benefits and management ignorance.

Research papers have focused on business strategies, especially matching emerging technological approaches inside corporations. According to Johnson et al. (2020), strategy is an organization's "long-term direction" and frequently translates into performance assessment but with different views. This research used efficiency, which includes internal and external operational efficiencies, to understand how apparel retailers perceive RFID's expected benefits of RFID. Before implementing an innovative approach or instrument, an organization needs to evaluate its applicability and practicality (Johnson et al., 2020). Integrating a firm's competitive strategy with its supplier approach becomes more important as a global supplier network becomes a competitive advantage (Elg et al., 2012). RFID connects all of the logistics aspects of a business's activity.

Over the last several decades, many studies have examined the drivers, advantages, and problems allied with the use of RFID technology in the apparel supply chain. However, few studies have focused specifically on analyzing the challenges of RFID technology in the apparel business. RFID has

the scope to transform inventory management and boost operational efficiency, but few studies have examined the particular challenges apparel retailers experience when using this technology. There is significant potential for effectively addressing obstacles and reducing barriers for developing a sustainable, user-friendly, and economically workable RFID solution applicable to the apparel industry. The research analyzes apparel retailer's RFID adoption issues and proposes strategic solutions customized to the industry's particular requirements to close this gap.

1.4 The Objective of the Research

The main purpose of this research is to investigate and resolve the issues with RFID technology that apparel retailers and consumers face.

1. What are the challenges for Apparel Retail Industry to use RFID Technology cost-effectively and widely?
2. How can Apparel Retail producers solve the identified challenges cost effectively?

This research aims to improve RFID deployment feasibility in apparel retail enterprises. This study examines compatibility as a whole with RFID technology preparedness in organizations. The idea of compatibility may offer challenges; however, the primary objective is to review the relevant literature to discover compatibility factors that can, following the outbreak, be analyzed together with empirical data. The assessment of the theoretical framework revealed many key characteristics that are regarded as having the greatest significance. These aspects include capabilities, present computer systems, data accuracy, current methods, current implementation costs, return on investment, and overall acceptance. I want to enhance and refine these characteristics further within my theoretical framework. The need to analyze this topic arises from the challenge encountered in recognizing the factors that make RFID well-suited with the supply chain of an individual business, as shown by the existing body of research. The reason for picking RFID was chosen because it is a new technology because of its whispered relevance based on previous studies. In addition, the appropriateness of its close connection with my professional background and the fact that the company where I am working has been engaged with RFID tags, sticker printing and encoding, and RFID solutions provided for over a decade have been taken into consideration. To ex-

plore apparel retail company's cost-effective RFID technology deployment possibilities, I will conduct a qualitative analysis.

This research does not prioritize installation expenses owing to the complexity of RFID investment analysis for retail operations. RFID solution placement in the supply chain affects financial results, making implementation estimates difficult in this research. Instead, this study addresses compatibility criteria essential for educated RFID system acquisition. It also advises apparel retailers on affordability and sustainability when switching from active to passive RFID tags. This research also aims to help emerging retailers embrace RFID by bridging the information gap and enabling informed adoption choices.

2 LITERATURE REVIEW

This chapter examines RFID technology's benefits, adaptation methods, costs, and ROI in the apparel business. This study describes RFID adoption's numerous stages and highlights its key components and characteristics from an implementation standpoint. The theoretical underpinning for this research endeavor is explained below. It also explains the methodology used in the process of developing the framework. Furthermore, it presents a theoretical model intended to address the difficulties associated with the application of RFID. This section also emphasizes the significance of using a methodological approach to the collection of data to successfully inform this theoretical framework. This chapter provides an in-depth understanding of RFID implementation and its different dynamics within the context of the apparel sector by concluding with a comprehensive theoretical model and detailed breakdown of its components.

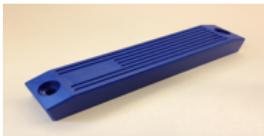

2.1 RFID Technology

RFID technology is comprised of two major components: an RFID tag and an RFID reader, both of which interact with computer systems. To collect data in real-time and send it over radio waves, the tag component serves as the objective. Both a small chip and an antenna are often included in the construction of tags. Information is stored and processed by the chip, while the antenna is responsible for getting and conveying that information. The chip is responsible for doing both of these things. Embedded circuits, also referred to as chips, are commonly employed in many contexts to store relevant data related to a particular item or shipment. A piece of merchandise or

consignment under observation received a unique identification number. The number represents data contained in the tag's computer chip. It efficiently keeps all necessary item information on the chip. RFID readers near tags gathered the above data. The reader reads and stores RFID data. Thus, the person watching can track the tag's latitudinal movement and the entity to which it is associated. The reader may track the tag's movement in real-time to send its digital ID and other data to a computer. Two kinds of RFID tags are used: active, which has a battery, and passive, which does not. The antenna's signal powers the passive RFID tag. Active RFID tags feature an internal power source that powers the chip and sends the signal to the RFID reader. In general, active tags contain a greater memory capacity than passive tags and exhibit a much wider variety of functionalities. Passive tags are fundamentally more cost-effective than active tags.

Table 1: Differences between Active and Passive RFID Tag

(Source: Author's own)

| ACTIVE RFID | VS | PASSIVE RFID |
|---|-------------------|---|
|  | |  |
| 433 MHz and 2.45 GHz | FREQUENCY | 860 960 MHz |
| 150 Meters | READ RANGE | 15 Meters |
| Typically \$20 to \$50 | COST | Less than \$1 per tag |
| Smaller than a Smartphone | TAG SIZE | Smaller than a business card |
| Medium to Very Large | ASSET SIZE | Very Small to Very Large |
| Oil, Gas, Construction, Mining | INDUSTRY | Healthcare, Manufacturing, Retail |
| Outdoor Applications | LOCATION | Indoor/Outdoor Applications |
| Screws, Rivets, Zip Ties, Welding | ATTACHMENT METHOD | Adhesives, Epoxy, Zip Tie, Welding |
| Internal Battery | POWER | Powered by RF Waves |
| Batteries last 3-5 years and typically can't be changed | PAIN POINT | Less effective around water and metal |

The phrase "RFID tag" is frequently employed as a general identification including many types of tags, labels, and cards. Ultra-high frequency (UHF), high frequency (HF), and low frequency (LF) are the three frequencies at which passive tags can function at (Sikorski et al., 2020). Passive tags have the potential to operate at all three frequencies.

- UHF technology is significantly fast-tracking the speed and efficiency of obtaining information. Some UHF tags can be identified from greater than or equal to 25 feet (8 meters) away, with readers capable of simultaneously identifying multiple tags. A cargo of hundreds of individually tagged containers can be accounted for using UHF in the few seconds it takes for a vehicle to enter or exit a distribution point. However, due to the encircling materials, UHF is sensitive to environmental factors such as reflection, damping, and detuning. When Wal-Mart adopted a policy requiring its suppliers to use RFID technology, they particularly specified the usage of ultra-high frequency (UHF) passive tags (Want, 2006). The typical distance of the matter under discussion tends to be between 20 and 30 feet. The mentioned organizations show enhanced speed abilities, but at the cost of more energy use.
- The high-frequency (HF) tags have a reach of less than 3 feet and demonstrate improved accuracy when applied to metal objects. HF tags can be read several inches apart, offering tag and reader placement flexibility as well as greater processing speed and accuracy. Each tag has more memory using HF processing.
- LF is an economical choice for situations where tags can be placed consistently on objects, and readers can read them one by one at close range. The LF practically never reacts to things like water or metal.

2.2 RFID Sustainability

Apparel and textile enterprises are responsible for ten percent of the world's total carbon emissions and continue to be the second most polluting sector, after only the oil industry (Conca, 2015). Realizing that it is a \$3 trillion business worldwide, this should not actually come as unexpected. More than 150 billion clothes are produced each year, which is sufficient to provide 20 fresh clothes to each and every individual on the earth each and every year. According to Adanur (2017), over 70 million trees are felled annually for the purpose of manufacturing synthetic materials. These materials include rayon, viscose, modal, and lyocell. A study conducted by Pandey et al. in 2020 found that the apparel textile business is the second-biggest polluter of freshwater resources in the world, following the agriculture sector. Material production results in the depletion of natural resources, and the processes of harvesting and manufacturing materials pollute both

the air and the water, so creating substantial threats to the environment. As a result of companies' efforts to remain competitive, the industry also creates substantial social issues related to inhumane working conditions in nations with cheaper labor costs. Financial limitations on administration for cheaper prices and faster lead time, plus an international marketplace, make it challenging to establish apparel company safety measures. Fortunately, the impact on the apparel industry is not restricted to the surrounding environment. Concerns regarding society and the economy are now a focus. In fact, the 2013 Rana Plaza building catastrophe in Bangladesh enhanced slow fashion. Over 1,100 people lost their lives as a result of the collapse of the buildings in which they were working (Kabir et al., 2018). Workers were making inexpensive Western clothing as rapidly as possible without regard to health and safety. Buyers were unaware and uninterested in the way their two-dollar tube socks were produced.

These surfaces of the industry require more research on ways to render the apparel industry environmentally conscious. According to Denuwara et al. (2019), RFID has been demonstrated to increase the financial effectiveness of businesses; nevertheless, the benefits that it provides to society and the environment have not yet been fully translated. "Universal scope, large-scale, dynamism, competitiveness, and extensive resource usage" were all features that are associated with the apparel industry, according to Garcia et al. (2019). RFID benefits differ for each industry, as each has its own unique business processes. RFID use in the textile industry is driven by economic benefits such as improved supply chain administration, fraud prevention, lower financing costs, and better customer service. Retailers with a worldwide presence need to differentiate what they sell, improve their connections with customers, and foster brand loyalty to remain competitive. This is possible through RFID adoption, which is a part of retail development, such as online shopping.

Table 2 illustrates how RFID technology improves textile manufacturing and retail operations.

Table 2: Apparel supply chain RFID benefits: Financial benefits by subject are listed.

(Source: Martin, 2014)

| Operations | Impact |
|-----------------------------|---|
| Visibility and traceability | RFID technology has the potential to facilitate the tracing of a product's origin and enhance the visibility of its whole supply chain. |
| Brand protection | RFID tags enable items to be monitored along their supply chain. This allows customers to utilize smart devices to verify product authenticity. This assists in handling brand reputation successfully. |
| Inventory management | Retail outlets apply RFID technology to enhance stock accuracy and minimize stockouts. |
| Asset tracking | RFID can track non-sellable office or lab elements or sellable items that require marketing. Tracking them could significantly boost supply chain visibility and item return. |
| Production processes | In production, RFID technology could improve product receipt, product aggregation, pallet/part movement tracking, inventory management, and transport verification. |
| Logistics processes | In shipping, RFID could improve freight receipt, RTI tracking, and loading verification. |
| Retail processes | Retail inventory management, stock counting, and picking validation can all benefit through RFID technology. |

According to Nativi and Lee (2012), the average return of recyclable material in a supply chain that employs RFID has increased by 87%, indicating that RFID systems are more beneficial to the environment than non-RFID systems. RFID is environmentally, socially, and economically sustainable (Denuwara et al., 2019). RFID improves fiber recycling efficiency, accuracy, and safety. RFID can reveal the garment material, country of origin, and supply chain. RFID improves inventory accuracy by tracking what consumers purchase and when, which helps estimate demand. RFID can boost inventory accuracy and forecasting, minimize store stock and waste apparel, and traceability in the apparel value chain, covering strength production, package tracking, yarn production, chemical handing out, and employment utilization, and impact transparency and social sustainability (Denuwara et al., 2019). RFID allows apparel to be traced back to yarn manufacturing, thereby improving supply chain transparency. Because RFID can check authenticity, it can prevent counterfeiting, leading to increased sales and labor.

2.3 RFID Implementation in the Apparel Retail Industry

The retail industry is crucial internationally. It's the second-biggest sector in the United States by business and employment. Retailers are investing in technology, with "the area of technology" determining success. RFID helps retailers stay profitable and competitive in both the short and

long term. Major North American, European, and Asian retailers value RFID. Walmart was the first to recognize that RFID technology could potentially save money in its delivery and supply facilities. Tesco, Marks and Spencer, Decathlon, Mango, H&M, Metro Group, and others use RFID technology. Most Asian retailers anticipate RFID integration to enhance business lines, with the exception of China. Chinese retailers use RFID for shipping and private tagging for workplace monitoring. Japanese retailers track lady's shoe and apparel sales with RFID tags for profit. RFID implementation in retail is slower than expected, requiring more empirical research to reduce adoption uncertainty. Practically generated conceptual analyses of RFID adoption may be helpful, because they prompt proper inquiries and obstacles.

Despite substantial study on technological adoption and spread, specific technical adoptions have not been studied (Rogers, 1995). Information systems technology adoption has been studied individually and organizationally (Alshehri et al., 2013). RFID is unique among technologies like the Internet and EDI (Electronic Data Interchange), hence its adoption warrants examination. Potential RFID users are inhibited by infrastructure costs, environmental impact, high-ranking leadership, second-order learning, financial commitment, and organizational changes (Ngai et al., 2014). RFID adoption research has stressed the relevance of adoption demand, especially when analyzing technological lifetime. RFID technology adoption has been slower than expected due to information technology hype (Bendavid et al., 2013). Technological advances are widely adopted because businesses shift their views of those who adopt and those who don't (Keating et al., 2010). Knowing what influences an organization's RFID adoption is crucial. Various researchers have proposed different procedures for deploying RFID in organizations.

1. According to Bhattacharya (2015), adopters need to be aware of the technology as well as its features. RFID can be used throughout the fashion supply chain, from raw materials to consumers (Nayak et al., 2015). According to Ting et al. (2013), the adopting organization should determine a scope for the project's implementation and specify its goals while considering RFID technology's limitations. Several RFID implementation and evaluation frameworks have been recommended for various industries (Ngai et al., 2010). The author also said the company must evaluate if RFID is the proper solution to address supply chain difficulties to satisfy the purpose and scope. The implementation's suitability is also vital, as not all retail firms have the necessary commodities, stores, or IT systems for RFID adoption. Highlighting the problem and solution aim may also increase the process and project suc-

cess (Ngai et al., 2010). Understanding RFID's potential and boundaries of RFID enables organizations to avoid exaggerated hopes and confusion (Ting et al., 2013). The author also added that the RFID-adopting company must select solutions that will have a major effect on its efficiency. Without identifying any issues that RFID could fix, the entire implementation would be worthless.

2. Tornatzky and Klein (1982) found that low-cost technologies are more likely to be adopted. RFID tags, software, hardware, organizing information and integrating, and company procedure restructuring are costly for enterprises. This could prevent companies from using them. Several studies have proposed that the price of RFID can be used as a measure of its application (Brown & Russell, 2007). Thus, companies that see RFID technology as costly in comparison to its advantages are less likely to choose it. While calculating cost simulation, it is important to justify that costs associated with RFID backing systems should be rationalized in terms of return on investment (ROI) by comparing them to time and money saved via technology, reduced inventory, and other efficiencies. The investment rationale is crucial because it quantifies the expected results of the operation, which are essential for going forward with the venture. To guarantee economic and operational feasibility, execution performance, scalability, hazards, and the anticipated longevity of the solution must be considered (Tan & Kritchanchai, 2006).
3. After studying RFID technology, establishing a plan, and determining what the objectives of the implementation are, the company that wants to use it should put together a team that will steer what will make choices about the implementation (Ngai et al., 2010). According to Ting et al. (2013), it is essential to establish future objectives at this stage in order to provide the project team with a sense of accomplishment associated with the accomplishment of objectives. Adopting new ideas requires the support of top management. The choices adopted by top management will affect the growth and development of the company, as decisions made at a higher managerial level have more weight (Carpenter et al., 2004). RFID deployment involves sufficient funds, restructuring processes, and employee reluctance to change; therefore, managerial support is crucial (Wang et al., 2010). Because RFID technology introduction is difficult, top management develops a dedicated project team of RFID experts, management of projects experts, stakeholders from relevant organi-

zational areas, and top management. Thus, the team must collaborate to effectively determine the execution's goal. The project team will be motivated for a winning strategy that takes into consideration business and technological opportunities, as well as any constraints placed on the company's traditional evolutionary path; while utilizing limited firm abilities to satisfy customers and beat the competition (Teece, 2014).

4. Once the business process and cost simulation have been analyzed, the next step is to devise a innovative process that better encounters the desires of RFID installation. Requirement evaluation, software and hardware selection, and the launch of the new procedure should all be part of the RFID scheme design stage (Ngai et al., 2010). Multiple studies have indicated that organization size affects technological adoption (Rogers, 1995). Big enterprises frequently possess the capacity to test new ideas before deciding whether to embrace them (Premkumar et al., 1997). The adoption of RFID technology depends on organization size (Wang et al., 2010). Therefore, only large companies are in the initial race to adopt any new technology and lounge innovations. At the beginning of innovation, the focus of an investigation of requirements is to identify specific problems that can be addressed by RFID as a solution (Ting et al., 2013); gears, such as tags for RFID, antennae, and readers, are needed for an RFID system; this gear should be chosen according to the environmental parameters specified in the requirements assessment process. Evaluation is a common step in the process of selecting hardware and software; it serves to shed light on the features of each product to decide which one is best suited to the available situations. Choosing hardware and software often involves analyzing them. This procedure seeks to determine how every component of hardware and software works and which choice is best for the current scenario. As stated by Tan and Kritchanhai (2006), pilot implementation may be defined as the testing stage for a new application that incorporates innovative technologies and principles.
5. This procedure ends with the implementation. The deployment of innovation requires sufficient technical and personnel support. Companies without IT competence may lack awareness or ability to implement new technologies. Research on innovation dissemination has linked IT skills to adoption and is recommended for RFID adoption studies because IT skills may decrease integration costs and efforts with current systems (Premkumar et al.,

1997). To teach personnel about the RFID scheme, the development team should first describe its benefits and enhancements before providing education regarding the equipment and solutions. Employees must become familiar with RFID technology and new procedures; therefore, training is crucial. Retailers need to monitor how well their RFID system is doing compared to their own expectations so that they may make any necessary improvements in light of changing market conditions (Ngai et al., 2010).

2.4 Inventory Management and Operational Efficiency

RFID technology is gaining traction. RFID tags are being applied in a broad range of industries because of growing interest and better technology. This pattern is especially noticeable in handling supply chains, where restrictions stemming from conventional approaches abound. Problems arise from a lack of consistency in product identifiers over the product lifecycle, the complexity of monitoring the product, or the need to individually identify each component instead of the item itself (McFarlane et al., 2003). Thus, RFID has enhanced product monitoring, inventory levels, and inventory control in industrial products supply chains. McFarlane elaborates on the possible long-term advantage with regard to holonic actions, including individualized goods and flexible production, distribution, and stockpiling networks. In addition, he elaborates on how product identification may increase a product's transparency or observability at all stages. The possible advantages of deploying RFID technology in those particular domains include an increase in productivity, a decrease in expenses, an enhancement in service, or an expansion in strategic impact. The improved and more precise exchange of information in logistics systems is made possible by real-time data interchange (Saygin et al., 2007). More transparent networking makes it simpler to gather data on supply and demand, which aids managerial decision-making and speeds up the introduction of innovative procedures (Saygin et al., 2007). In addition, Moran et al. (2003), explained that better shortages of supplies, as well as more precise ordering, arise as a result of enhanced visibility into inventories, which assists in maximizing warehouse facilities and capabilities. This, in turn, contributed to higher results. The detection of shrinkage and the decrease in trash brought on by increased item rotation are two factors that contribute to price savings.

According to Haddud (2011), organizations use new technologies and innovations to gain a competitive edge, hence RFID technology in supply chains improves efficiency and business operations. Ali (2012) highlighted that RFID brings value to the supply chain and greatly improves opera-

tional efficiency. Organizations want to improve supply chain management. In general, RFID automates product tracking.

2.5 Challenges of Implementing RFID Technology and Corresponding Solutions

Many challenges surround RFID's potential in operations (Sabbaghi & Vaidyanathan, 2007). These concerns include process complexity, integration, interdependency, and security. More studies are required to improve the RFID transmission range and reduce congestion. In addition, technology suppliers and consultants must integrate modern smart tags, barcodes, and RFID devices into clients' current company operations (Viehland & Wong, 2007). RFID technology adoption is difficult because companies must integrate it with other technologies used in supply chains and restructure their business operations to get competitive benefit. RFID technology produces more data than barcode technology, necessitating new information warehousing systems for efficient processing and mining at an affordable cost. External integration must improve capacity and efficiency planning when a firm adds primary suppliers and subsequent consumers to its supply chain. The RFID system's privacy, security, and authenticity are crucial factors in supply chain applications (Sarma et al., 2002). Additionally, because RFID is a wireless technology, consumers may have safety concerns due to the possibility of surveillance and analysis of traffic on the connection between the tags and the reader. Data storage, transfer across wireless networks, and real-world safety of data centers are all potential points of data compromise (Chowdhury et al., 2018). Because many different parties outside of the supply chain may be able to read tags or databases containing information about them, these apps may be especially liable to security threats. Applying appropriate training to new technologies may train frontline employees with accurate information and dispel falsehoods. Effective training should include both academic and practical knowledge to reduce resistance during its early implementation. Training should clarify the advantages and modifications of the latest technologies, which may be intimidating. To ensure customer and operational staff buy-in, demonstrate the system and explain its advantages and adjustments throughout the training (Ngai et al., 2010).

The primary contribution of this research is the investigation of the state of the RFID implementation marketplace and the barriers preventing the extensive use of RFID technology. Growth in organizations and increasing profits have resulted from successful RFID implementation, which has improved organizational responsiveness, effectiveness, and efficiency (Adhi et al., 2021). Accord-

ing to Sahlgren et al. (2017), firms that make appropriate use of RFID are able to become more agile, which in turn enables them to address the needs of their consumers in a manner that is both more efficient and effective. Technology alone does not make things better and RFID does not differ. RFID is not an answer to any of these problems. RFID can help organizations in a number of ways, but only if it is used with other suitable technologies to reach an ideal goal. Operations are the lifeblood of a business, and statistics show that organizations would do well to allocate considerable resources to developing effective operational strategies (Khalili et al., 2013). Given the importance of operational tactics, it is reasonable to see them as weapons that may be used in competition (Khalili et al., 2013). The next phase, which comes after the strategic choice has been taken, is to put the strategy into action. It is important to note that when we discuss putting a strategy into action, we are referring to the process of constructing the strategies as well as the process of putting the strategies into action (Johnson et al., 2020). Johnson et al. (2020) posed two main questions to determine feasibility. "Do resources and capabilities exist for an effective strategy implementation? If not, how can they be obtained?" Practice these questions on all the resources affecting the suggested plan. Introducing emerging technology may boost cost savings, delivery speed, and logistic accuracy but requires proper management and implementation (Brown, 2001).

2.6 Theoretical Framework

The selection of the best product is crucial when implementing RFID technology in the retail supply chain for the wide range of applications of RFID tags, their usage throughout the distribution chain, the value of understanding and being aware of it, the impact of employee attitudes, and the adoption process. Some organizational factors and perceived organizational advantages facilitate technology adoption, but a lack of enablers might restrict adoption. According to Tornatzky and Klein (1982), the majority of the elements that are associated with technological acceptance in general include technical, managerial, and environmental factors. These factors may also apply to the adoption of RFID technology. Competitive edge, difficulty, transmission, split, expenses, revenue, harmony, acceptance from society, feasibility, and observability were the ten attributes that were utilized the most frequently. There was a continuous correlation between adoption studies and comparative advertising, complexity, compatibility, and cost. Subsequent IT implementation studies have similarly identified these relevant characteristics (Cooper & Zmud, 1990). RFID and other emerging technology-adoption issues include software and hardware costs. Adopting such a

system is expensive for companies. However, employing such technologies may save organizational money because of their superiority over their predecessors.

Additionally, In the investigation that is being done on the topic, a broad variety of variables have been discovered as either beneficial or harmful to the adoption of emerging technologies. This research investigates a few elements that are thought to be significant in order to gain better knowledge of the adoption of RFID technology. The antecedents of intention to use RFID technology are identified and analyzed within the context of the proposed investigation framework for RFID adoption. The theoretical framework highlighted RFID tag kinds, supply chain applications, and how knowledge and awareness affect employer attitudes, deployment, consumption, etc. The implementation structure of RFID is built around four key contexts: technology, organization, environment, and attitude. In each of these categories, the elements that are crucial to RFID adoption are addressed. RFID implementation in the apparel retail industry provides the necessary information to determine the most crucial compatibility factors.

Table 3: Table of framework

(Source: author's own)

| Technology | Organization | Environment | Attitude |
|-------------------------|-------------------------|----------------------|----------------------------|
| Complexity | Top Managements Support | Competitive Pressure | Possible resistant |
| Compatability | Company Size | External Support | Change Managements Support |
| IT Infrastructure | Financial Support | Catalyst Agent | Acceptability |
| Current Computer System | | | |
| Suitable tag | | | |

Technological elements include the distinctive attributes of an invention, as delineated by Tornatzky and Fleischer (1990). The appraisal of technology encompasses many factors, including the level of maturity of the technology, its inherent characteristics, associated tags, its compatibility with the firm and its goods, and the technical aspects of its implementation, such as hardware, software, and IT infrastructure. An organization's readiness to deploy RFID will influence its suitability with this technology. This includes investment, upper management, and the company's size. Competitive pressure, government regulations, and customer preparedness are environmental challenges (Tornatzky & Fleischer, 1990). Does the organization as a whole, and its supply network in particular, have a positive outlook on RFID implementation? Consider the level of buy-in, the

extent of help, any potential pushback, and how you plan to handle changes during the transition. Is there a disconnect between what is desired and what can be achieved using an RFID system?

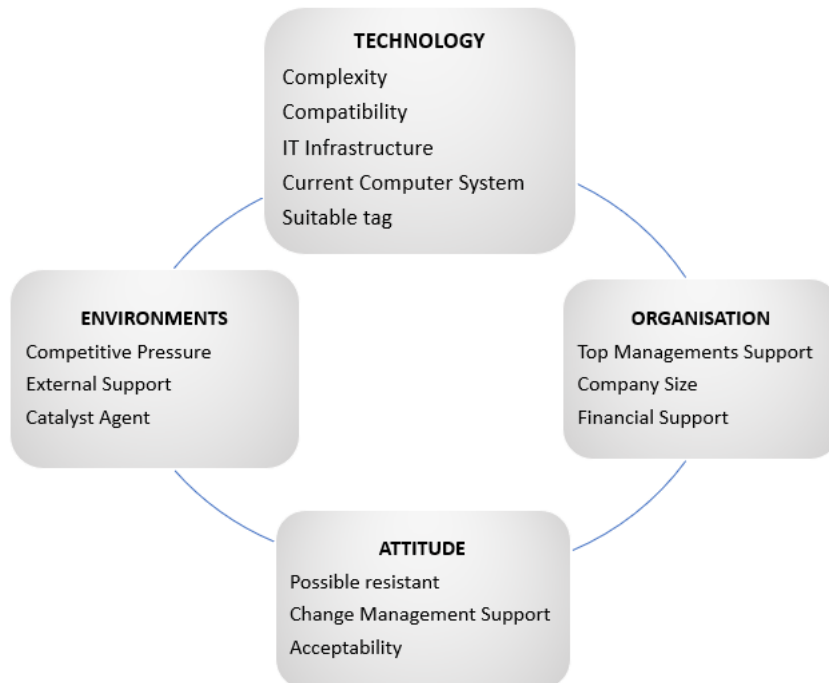


Figure 1: Conceptual Framework of RFID Adaptations

(Source: author's own)

Figure 1 shows the conceptual standards for method analysis. The conceptual model and empirical data from the interviews supplemented the qualitative study. This conceptual model enhances results and provides practical and theoretical advances. After studying the empirical data and compatibility features, this conceptual model should be able to provide realistic apparel retail sector suggestions. The theoretical contributions of this conceptual model include studying the compatibility of other fashion businesses that want to deploy RFID.

In the present study, retail adopters prefer RFID implementation, whereas those who do not are non-adopters. Experts, RFID adopters, and non-adopters are considered to act identically. Adopters and non-adopters will be permitted throughout this study from now onwards. Adopters and non-adopters differ in four contextual aspects, revealing the adoption characteristics. The retail RFID adoption framework has many more theorized factors for its major pillars. This re-

search identifies parameters that predict RFID adoption but does not explore the links among the criteria.

3 METHODOLOGY

3.1 Research Approach

Deduction and induction are the two most commonly used methods for further scientific understanding, although abduction is a viable alternative (Eriksson and Kovalainen, 2008; Saunders et al., 2009). Deduction, as briefly described by Eriksson and Kovalainen (2008), places theoretical understanding at the top, using it to make inferences and form hypotheses that are subsequently tested through empirical studies. According to Saunders et al. (2009), deduction may be used as a model for theory testing by first identifying potential correlations between variables, selecting how those variables will be assessed, and then reviewing the findings to validate or alter the linked theory. Because logic mandates a certain sequence, it stands to reason that an inductive investigation will also adhere to this pattern (Eriksson & Kovalainen, 2008; Saunders et al., 2009). Because of its strict study model, a deductive research strategy is often only used for quantitative data collection (Bell et al., 2022; Eriksson & Kovalainen, 2008; Saunders et al., 2009). Induction builds theory, unlike deduction. Researchers that utilize an inductive approach claim that hypotheses are discovered through empirical investigation. More researchers use abductive models or integrate approaches (Eriksson and Kovalainen, 2008; Saunders et al., 2009). Saunders et al. (2009) also mentioned that the research method is adjustable because it depends on the issue and focus.

My research examines RFID technology's compatibility with the apparel retailer's distribution chain. To overcome this problem, one must understand IT infrastructure, RFID technology's capabilities and restrictions, and supply chain complexity. A study with that many variables must go beyond correlations. Many researchers employ an abductive paradigm to integrate methods (Bell et al., 2018, Eriksson & Kovalainen, 2008; Saunders, 2009). Bell et al. (2018) suggests blending and complementing deductive and inductive methods. Saunders et al. (2009) further propose that the research method is adjustable because it depends on the issue and emphasis. My focus is to present data in interviews using a deductive technique with a semantic level.

This study used a qualitative data-collecting methodology. This research will be directed through interviews with industry experts and individuals in senior positions within the apparel retail sector or affiliated companies involved in RFID technology. I am convinced that interviews would be more appropriate for the purposes of this examine.

3.2 Research Design

The current research employed qualitative research used in-depth interviews to acquire data. In qualitative study methodologies, sample procedures vary significantly from those used in quantitative research. Moreover, sampling methods in qualitative research provide a higher grade of flexibility (Coyne, 1997). In business research, quantitative and qualitative methods are employed to acquire data (Saunders et al., 2009). Quantitative approaches use numerical data, while qualitative methods use non-numerical data. However, qualitative data collection methods generally involve interviews, which are categorized. Theory-based interview questions will clarify the research question's solution. Avoiding leading questions to get the expected findings helps me deliver an objective critical review of the data collected (Collis & Hussey, 2014).

3.3 Data Collection

When conducting research, it is important to make decisions about the category of data that will be gathered for the research. Data collection techniques may be categorized into two distinct classes: primary data and secondary data (Collis & Hussey, 2014). Primary data are derived directly from the source and are often obtained through methods such as experiments, interviews, or surveys. Secondary data are acquired from pre-existing sources that have already been published, such as databases and inside records (Collis & Hussey, 2014). According to Saunders et al. (2009), the process of collecting data involves categorizing it based on primary and secondary data, and it is the responsibility of the researcher to make a deliberate decision regarding the method of data gathering. Primary data are often obtained from original sources, such as self-designed questionnaires, interviews, and experiments (Collis & Hussey, 2014). According to Eriksson and Kovalainen (2008), it is crucial to consider the study's objective, strategy, and questions as guiding factors when selecting an appropriate data collection technique. Insufficient consideration of the design of the data collection procedure may expose researchers to the potential of generating study outcomes that are misleading and inaccurate (Saunders et al., 2009). The use of secondary data may

be valuable in addressing research inquiries, provided researchers carefully consider their alignment with the purposes of their own study (Saunders et al., 2009). One of the benefits associated with the collection of secondary data is its time efficiency since it is relatively accessible and requires less time to obtain (Collis & Hussey, 2014). According to Bell et al. (2022), this implies that researchers conducting their own surveys and interviews may encounter significant investments in time. In addition to the potentially time-consuming nature of primary data collection, it is important to acknowledge the benefits of this technique. One such advantage is the potential for enhanced accuracy in data analysis. This can be attributed to the fact that primary data collection is better aligned with the study's specific goal, research questions, and methodological approach (Saunders et al., 2009). Given the research objectives, inquiry, and methodology, it is essential to gather primary data. This decision is based on the rationale that the current secondary data are deemed inadequate in addressing the study inquiry, owing to its intricate nature. The objective of this study is to scrutinize the feasibility of integrating RFID technology into the apparel retail industry's inventory and supply improvements. Consequently, it is essential to conduct a thorough analysis of the current competencies of apparel retail supply management.

Different types of interviews can be used to acquire primary data (Collis & Hussey, 2014). Semi-structured interviews used organized topics, matters, or themes, and allowed the questioner to make minor changes throughout every discussion (Eriksson & Kovalainen, 2008). An explanation study used semi-structured interviews to better understand variable relationships (Saunders et al., 2009). Based on these considerations, semi-structured interviews were conducted to gather the qualitative data.

Qualitative Data Collection

In the preceding segments of this chapter, a concise examination was conducted of the categorization of qualitative interviews into either unstructured or structured formats. This section provides a more comprehensive explanation of the rationale behind the selection of the interview style, as well as a more explicit demonstration of its alignment with the research objectives of this study.

A discourse will be conducted to explore the merits and demerits of qualitative data collection, as well as the specific factors that this research will consider throughout the process of obtaining qualitative data. According to Greener (2008), a distinction may be made between structured and unstructured data collection methods can be distinguished. Structured data collection typically pertains to gathering quantitative data, whereas unstructured data collection is often associated with qualitative data collection. Qualitative data collection methods may exhibit a range of structures that are contingent upon specific study objectives (Eriksson and Kovalainen, 2008; Saunders et al., 2009). Semi-structured interviews allow researchers the opportunity to use pre-established foundational questions throughout the interview process while simultaneously giving respondents the freedom to provide open-ended responses. This approach also permits interviewers to pose additional inquiries to go further into certain topics or areas of interest (Collis & Hussey, 2009).

Given the objective of this research attempt, which aims to enhance the comprehension of the harmonious integration of RFID technology within the apparel retail industry, it was deemed imperative to gather comprehensive elucidations from industry experts. The aforementioned rationale applies to the group of experts surveyed, as their input is anticipated to provide comprehensive insights into RFID technology. This includes valuable information pertaining to specific variables within a supply chain that are more significant. In this research, it is essential that respondent provide explanations that stimulate discourse, thus enhancing the relevance of the data-gathering process. Accordingly Saunders et al. (2009), asserted that semi-structured interviews provide the option to engage in probing, whereby interviewees may elaborate on their responses and create a conducive environment for debate. This qualitative data gathering method was designed to facilitate such interactions.

Interview Guide

In qualitative research, researchers must know the topic before interviewing (Pedersen et al., 2016). An interview guide containing topics and questions may also aid semi-structured interviews (Saunders et al., 2009). Thus, before completing the interview guide (see Appendix. 1-6), a list of topics related to this study's respondents was required. Using an interview guide may help maintain consistency in data collection and address research questions via open and wide questioning (Pedersen et al., 2016). Open questions need more complex responses than simple "yes" or "no"

responses (Collis & Hussey, 2014). In addition to open inquiries, “probes” are essential to add value and knowledge to the first response (Collis & Hussey, 2014). I considered this while creating an interview guide and provided open-ended questions and probes. The interview questions should relate to the research issue, but they should not be identical (Eriksson & Kovalainen, 2008). The interview data should be analyzed in depth to address the study question (Eriksson and Kovalainen, 2008). To do this, I ensured that the interview questions would assist in understanding fashion-retail supply chain systems and RFID implementation. I asked respondents about the present functions/systems and RFID deployment status in the apparel retail industry and the future prospect of RFID technology deployment. For the expert response interview, they were asked about the pros and cons of RFID technology, implementation, etc. (See the Appendix for the interview guidelines).

Conducting the interviews

In anticipation of the interviews, I developed interview guidelines tailored to each participant with the aim of gathering diverse data and information pertaining to various areas within the retail business. It has been acknowledged that using a single interview guide for all interviewees would not be feasible or provide valuable insights. I sought to conduct interviews with specialists with substantial professional experience and extensive historical knowledge, particularly in areas that would be significantly impacted by the implementation and integration of RFID technology. In addition, I contacted manufacturers of RFID Inlays, developers of middleware solutions and solutions provider, information technology experts, professional having experience in RFID products sales, and individuals involved in RFID sustainability. The interviews were conducted using online methods to accommodate participants' varying schedules and availability. The primary objective of the interviews were to obtain substantial information. I want to create an environment in which people can engage in uninhibited and candid discourses. To do this, all participants had semi-structured interviews with open-ended questions, allowing them to express their thoughts and opinions at length (Saunders et al., 2009). I have attempted to cultivate an atmosphere during the interviews that resembles a meeting or discussion, as opposed to a rigid interview format. This approach is rooted in my firm conviction that such an environment may improve the pressure experienced by participants, thus fostering a greater sense of relaxation and facilitating more candid and accurate data-sharing. I strongly believe that the extent in which participants experienced a

sense of relaxation during an interview may positively influence the quality and usefulness of the information obtained. Therefore, the objective was to make a relaxed environment for the contributors. This was achieved by adopting a less formal approach and engaging in a conversational manner, focusing on the topics outlined in the interview guide. Here I will briefly explain to whom I interviewed the individual who responded and then provide the relevant information.

Tab4: Table of Interviews

| Respondent | Description | Time | Place |
|-------------------|----------------------------|-------------|--------------|
| Respondent 1 | RFID Expert | 40 Minutes | Online |
| Respondent 2 | RFID Service Provider | | Email |
| Respondent 3 | RFID Inaly Manufacturer | 24 Minutes | Online |
| Respondent 4 | RFID Sales Manager | 25 Minutes | Online |
| Respondent 5 | RFID IT Expert | 46 Minutes | Online |
| Respondent 6 | RFID Sustainability Expert | 29 Minutes | Online |

Six online interviews were conducted to obtain answers on the solutions for implementing RFID technology. The respondents in these interviews were individuals who were heavily engaged in apparel RFID-related business entities. Considering that most of the candidates came from a variety of geographical locations, the interviews were conducted in English. The majority of the interviews were recorded by zoom and team calls; however, one of the respondents was occupied on a business trip. He requested that he be able to answer via email, and he gave his responses via email. At the beginning of the interviews, I informed them about myself, my degree project, the subject I am studying, and the reasons I am studying it. I subsequently proceeded to describe their functions and what I meant to do with their responses, and I did so with the intention of recording them for the purpose of interview transcription. The interviews began with brief introductions, followed by occupations and everyday responsibilities. Questions concerning RFID were asked during each interview. These questions included what the interviewees understood about RFID, how they considered it to be beneficial to apparel retail brand owners, which RFID items would be most ideal for apparel retail embodiments, and what steps could be taken to decrease costs. (Appendix 1 to 6).

Sampling Procedures

The focus of this study is to thoroughly examine the challenges related to the implementation of RFID technology in the apparel retail industry to suggest possible solutions. To achieve this objective, a methodology centered on conducting interviews was used. The interviewees were nominated based on their diverse knowledge and experience in the field of RFID as well as their involvement in key operational areas. According to Saunders et al. (2009), it is not always advisable or even practicable to collect data from a complete community because of a deficiency of time, and the fact that doing so does not inevitably provide more helpful findings.

According to Eriksson and Kovalainen (2008), qualitative investigations often do not use a systematic sampling method and do not aim to produce generalized conclusions or probabilities in their analysis. The participants consisted of individuals with various responsibilities, such as specialists in RFID technology who have practical RFID solutions, provide experience to retailers, people representing companies that provide omni-channel RFID solutions to retailers, RFID IT professionals, representatives from firms involved in RFID inlay manufacturing and end-to-end sales to retail brands, and individuals who are working to ensure sustainable RFID solutions. The criteria used to choose these respondents were demanding, thereby ensuring a diverse range of perspectives. The first respondent, a specialist in RFID, demonstrated a wealth of practical knowledge regarding the implementation of RFID technologies in the context of retail operations, thus providing significant perspectives on actual use. The purpose of the interview with the RFID specialist was to increase a thorough understanding of the technology's status to address common issues in the implementation of RFID by apparel retailers as well as the barriers faced during the deployment of RFID systems. The selection of the second participant was based on his extensive acquaintance and expertise in the field of RFID technology and its substantial impact on manufacturing and offering omnichannel solutions in respect of RFID solutions.

Additional participant in this study was sourced from established manufacturers specializing in RFID inlays. The contributions made by individuals were crucial in communicating the pragmatic elements involved in delivering RFID solutions to retailers. An additional participant, selected from a retail establishment specializing in sales and real-life experience, offered important personal insights into the comparison between retail operations using RFID technology and those that do not. The fifth participant, an information technology specialist employed inside the author's firm,

contributed valuable internal knowledge and practical perspectives to the process of providing solutions. Finally, a specialist in sustainability who specializes in providing sustainable RFID solutions to apparel retail organizations offered significant insights into ecologically responsible RFID solutions and the future prospects and demand of each RFID.

In addition, researchers who use an interpretative paradigm do not perform statistical analysis on the data that they gather; as a result, it is not necessary for them to choose a sample at random from the population (Collis & Hussey, 2014). According to Eriksson and Kovalainen (2008), the accessibility and appropriateness of the study participants are of higher relevance in qualitative investigations than in quantitative studies. Saunders et al. (2009) advise researchers to plan how to gain entry to a group or organization. Gaining access to these groups may be challenging. Quantitative data using questions and other stimulations. Closed and open-ended questions, the most common survey questions, helped researchers acquire primary data. The researcher created open and closed-ended questions.

3.4 Data Analysis

In this section, the author will examine data in connection to the research intends and clear opinions presented in interviews using a deductive technique with a semantic level.

Theme 1: Current Status of RFID Implementation in Apparel Retail:

RFID adoption in apparel retail has increased. RFID helps companies manage inventory, improve supply chain visibility, reduce shrinkage, and streamline operations. The respondents explained the current adoption status of the retail industry from the retailer's and brand owner's perspectives. One respondent explained that those who were stuck 10 or 15 years ago willingly adopted RFID technology.

Theme 2: Future of Passive RFID Tags Over Active Tags

Passive RFID tags have gained popularity in the apparel sector because of their low cost, small size, and suitability for tracking individual items. However, active RFID tags, with their extended read ranges and additional functionalities, may find applications in specific use cases, such as high-value

or high-risk items. While replying to question respondent 1, the passive RFID tag and the future are UHF, whereas active RFID tags have no future because they contain batteries and cannot be recycled. Passive tags can operate at three different frequencies: ultra-high (UHF), high (HF), and low (LF) (Sikorski et al., 2020).

Theme 3: Prospects of RFID Technology in Apparel Retail

The future of RFID technology in apparel retail appears promising. Continued advancements in all hardware and software, including standardized ecosystems, increased integration, and declining costs due to competition, and new players joining the race are likely to drive further adoption. Respondents 1 and 2 believed RFID is fascinating and showed that it has been examined for years but has never prioritized and placed inventory management on top benefits. Responses 3 and 4 also showed several RFID implementation potentials and are optimistic.

Theme 4: Principal Benefits of Employing RFID Technology:

The implementation of RFID technology in the retail industry offers multiple benefits. These include real-time inventory visibility, accurate stock levels, reduced manual labor, improved operational efficiency, faster checkout processes, and minimized stockouts. According to Ali (2012), RFID adds significant value to the supply management, and the development of the potential use of RFID remarkably increases operational efficiency. The respondent emphasized that the main prospect is inventory management and, once inventory is synchronized, all other channels automatically come under the umbrella.

Theme 5: Challenges and Solutions in RFID Implementation:

Challenges:

The high implementation costs hinder smaller retailers from adopting RFID. Challenges arise when integrating RFID into legacy systems. Challenges of selecting RFID embodiments, active RFID tags, Passive RFID tags because of the variety of usages and functions, and resistance from employees due to process changes and issues related to data security and customer privacy.

Short-term and Long-term Solutions:

As respondent 1, who is an RFID expert, explained that technology is mature, prices are expected to decrease and actually decrease, making RFID more accessible; providing comprehensive training programs to employees can mitigate resistance; and industry-wide standards and collaboration among stakeholders can address integration and privacy concerns. Understanding a standardized RFID ecosystem is important for obtaining long-term solutions.

Theme 6: Factors Driving Retailers towards RFID Technology

Several factors influence retailers to deploy RFID technology, such as the need for efficient inventory accuracy, supply chain visibility, reduced costs, enhanced customer experiences, and competitive advantage gained through operational efficiency and innovation. Moon and Ngai (2008) found that RFID enhanced operational efficiency, sales, and profit in apparel retail supply chains.

Theme 7: Challenges and Benefits of Integrating RFID into Existing Systems

Ensuring compatibility with existing systems is challenging. Transferring data from legacy systems to RFID-enabled systems can be complex. Through the provision of real-time data visibility, RFID integration contributes to overall operational efficiency. Both the precision of inventory management and the number of errors caused by human intervention have been improved. (Ngai et al., 2010). Respondent 1 said that RFID installation always needs the IT department's engagement from the adopting company, but that it is no different from other technical applications that require computer support. Many individuals have utilized such subsystems; therefore, they are accustomed to having a second RFID system, because many legacy systems are outdated. He added that the ERP must be sufficiently current to include a system of records and the accompanying information architecture

3.5 Verification of Results

This investigation is intended to result in more practical contributions, and the outcomes are intended to have immediate relevance. The focus is placed not only on the usefulness of the research, but also on its validity and dependability. According to Eriksson and Kovalainen (2008), the eminence of business study can be evaluated based on factors such as reliability, validity, and generalizability. The consistency of the study is what is meant by the term "reliability," and it refers to the level at which the investigation can be duplicated successfully if it is carried out step-by-step by another researcher. In qualitative research, validity refers to the capacity to accurately explain an event, and its primary goal is to persuade the reader that the report being presented is accurate. This may be accomplished via the use of "investigative induction," "triangulation," and "Affiliate check." (Eriksson and Kovalainen, 2008) In a case study, triangulation may be accomplished by the practice of qualitative and quantitative research methodologies, as well as through the combination of data from documents and data obtained through interviews. (Myers, 2019)

Credibility issues regarding the 'fit' between the real opinions of the respondents and the manner in which the researchers presented those views (Tobin & Begley, 2004). Furthermore, according to Kortjens and Moser (2018) and Tobin and Begley (2004), credibility is comparable to the idea of core validation in quantitative research because it concerns the concept of truth value.

The number of research interviews was adequate after retail specialists, RFID Inlay producers, machine sellers, middleware makers, and tag encoders were interviewed. Six individuals, including department specialists, were questioned. The questioned people work with RFID organizations and have diverse involvement. Spending time getting to know the place and context may build trust and extend engagement (Korstjens and Moser, 2018). In this study, semi-structured interviews through open-ended inquiries enabled respondents to debate their ideas and illustrate them in numerous situations, resulting in sustained involvement. Continuous observation involves identifying the characteristics that are most important to the subject or problem being studied (Korstjens & Moser, 2018). I identified the suitability factors most relevant for RFID implementation in this study, which we then examined in detail. Multiple data sources, investigators, or methods can be triangulated (Korstjens & Moser, 2018). I used investigator triangulation in the research by analyzing the data separately and then comparing our conclusions to determine whether they varied. If there was any confusion, the respondents were contacted to clarify their data replies.

The research process from the project's inception to publication and reporting is clearly specified and documented in audit trails (Korstjens & Moser, 2018). I have tried to be transparent about the research process and our results in this paper.

3.6 Research Ethics

When composing academic research, it is significant to reflect research ethics. There are ethical issues in preparing and completing the study. In these terms, ethics refers to "how you should act in relation to the rights of those who are the subject of your work or are affected by it" (Saunders et al., 2009). Thus, research ethics include creating and describing study subjects, planning research, accessing, collecting, processing, and storing data, analyzing data, and writing up findings ethically. This means you will have to make sure that the way you put together your work is both logically sound and morally acceptable to the people it affects (Saunders et al., 2009). Numerous ethical problems need to be considered at different times in this study. When you get access to data, there are people who are directly involved with what you are studying, and who are participants in your research (Saunders et al., 2009). In this situation, the participants are experts in the RFID industry with long historical work experience in numerous RFID-related companies and practical experience dealing with varied solutions. It is significant to fully inform the participants about the study during the planning and entry stages. This includes not only the topic and goal of the research but also how the degree project will be released and what their rights are. As Saunders et al. (2009) state, players have the right to privacy and should not be forced to take part. This means that they should not be forced to participate, and they have the right to quit at any time. The next step is collecting data, which leads to ethical problems. It is also important to remember that the people who agreed to take the study into account still have rights (Saunders et al., 2009). When collecting data, participants' privacy may be very important because it may affect how much they feel safe being honest, as some answers may be private. If individuals are told that they will remain anonymous, it is important to maintain that promise. This is particularly vital if names, addresses, and other sensitive data are comprised. When using interviews to gather qualitative data, it is important not to push the person being interviewed for a response or reaction because this can make the situation stressful for them. As Saunders et al. (2009) state, you want the person being asked to feel safe and at ease so that they can give honest answers.

However, one should also remember that one must not be so afraid of hurting someone that the interview is useless, which will hurt the researcher instead, which is also unethical (Saunders et al., 2009). There are no right or wrong answers and no answers that could hurt the people being interviewed. Instead, I worked on how to obtain the most accurate answers possible by letting the subjects pick the day and time of the interview so that it would not interfere with any other work they had to do. The information obtained from the interviews was the only thing I shared. I have used only the information presented. The research, instead, will be stored in the database at the Jamk University of Applied Science. This means that anyone can read the information, but I never think it will hurt participants from any perspective, and they have all been told about it and agreed to it being shared.

4 RESEARCH RESULTS

The key focus of this research is to acquire a more in-depth comprehensive understanding of RFID deployment and its implementation solutions within the apparel retail sector. In addition, the research aimed to identify and analyze the crucial characteristics of integration relevance to RFID implementation, and then analyze these features using the empirical data that gathered. The key components of compatibility—technology, organization, environment, and attitude—were discovered and divided in more depth. With the goal to accomplish what I set out to do, I led a qualitative investigation comprising semi-structured interviews. I have investigated what the various departments in the organization that were analyzed perceived as their present issues and their ideas on RFID, and I have also interviewed RFID specialists who may supplement the results in the theoretical structure. As a result of the qualitative research, I was gifted to obtain a more comprehensive understanding of the subject matter and provide responses to the research questions outlined below:

1. What are the challenges for the Apparel Retail Industry to use RFID Technology cost-effectively and widely?
2. How can Apparel Retail producers solve the identified challenges cost-effectively?

Through the examination of qualitative data in combination with adaption characteristics and previously published literature, RFID was shown to be adaptable across a variety of industries, par-

ticularly about the potential benefits it may offer in the apparel retail arena. Among the most important factors to take into account while utilizing RFID technology is the reduction of stockouts, labor costs, inventory costs, visibility, customer satisfaction, and the maximization of ROI. According to the findings of the research, there is an agreement between the theoretical framework and the projected capabilities of RFID applications.

In Apparel retail, the adoption of RFID is highly impacted by technical, environmental, and attitude aspects; however, organizational attributes did not demonstrate the predicted correlations associated with RFID adoption. Despite this, the cost analysis helped to strengthen the resource compatibility indicators in the framework, which demonstrates that the framework is useful in identifying compatibility indicators for RFID deployment.

Earlier research has shown the advantages and problems of RFID implementation; however, not all firms can use them. Respondents 1, 2, and 3 dominated the discussion on technological suitability. Since these three respondents had the highest technical understanding, they were anticipated to have the most fascinating opinions regarding the technology. The apparel company's computer systems allow RFID implementation based on technical compatibility. Initial ideas concluded that RFID deployment should be matched with present computer systems, which respondent 1 highlighted because he indicated that older technology requires major upgradation or a new channel to fit the existing setup. Thus, RFID compatibility is not reliant on present computer arrangements, but it will need IT division assistance or compatible technology change for integration.

However, the research showed that human interaction and technology could be needed to achieve 100% accuracy in RFID deployment. RFID is tough for apparel retailers due of their extensive supply lines. Respondents acknowledged the difficulties of RFID adoption but yet showed satisfaction with the technology's performance.

Based on the discoveries of the research, there are three main exposures to RFID adoption in the retail sector. Each of these exposures has its own set of problems and requirements for technology upgrades, project innovations, and education. In addition to the fact that it was accepted that there are difficulties in integrating RFID into the business operations of retailers, judgments about product prioritizing for RFID deployment were influenced.

The results of a comparative analysis verified that the deployment of RFID technology in price tags and hangtags resulted in the most significant benefits in a variety of areas, notably in terms of self-checkout. Price tags and hangtags were frequently preferred by large merchants due to the enormous quantities and operational productivity of these businesses in comparison to care labels.

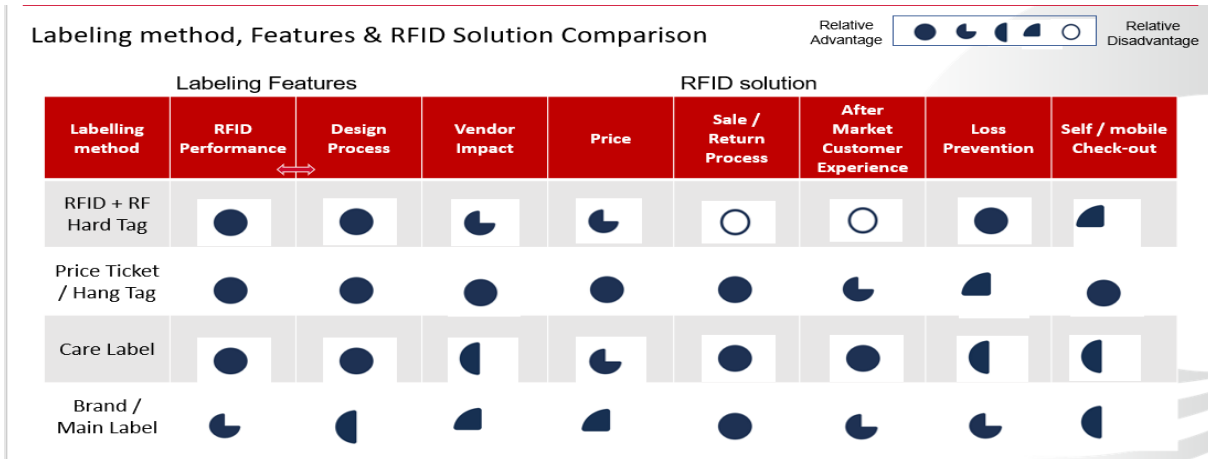


Figure 2: RFID Solution Comparison of selecting items.

(Source: fvg, 2023)

Based on the comparative investigation, I can say that self-checkout was one of the main areas where RFID installation in price tags and hangtags produced impressive advantages. Price tags and hangtags were once preferred over care labels by big retailers because of their operational productivity and high volume. Because of the high monthly needs of large retailers, hangtag inkjet machines UPH (unit Per Hour) of 20,000-250,00 pcs production, which is three-quarters higher than that of care labels. As a result, large retailers like Uniqlo, Zara, Marks & Spenser, and H&M choose to employ RFID on their price tags.

Below is an overview of the current RFID deployment scenario from a global retailer’s perspective.

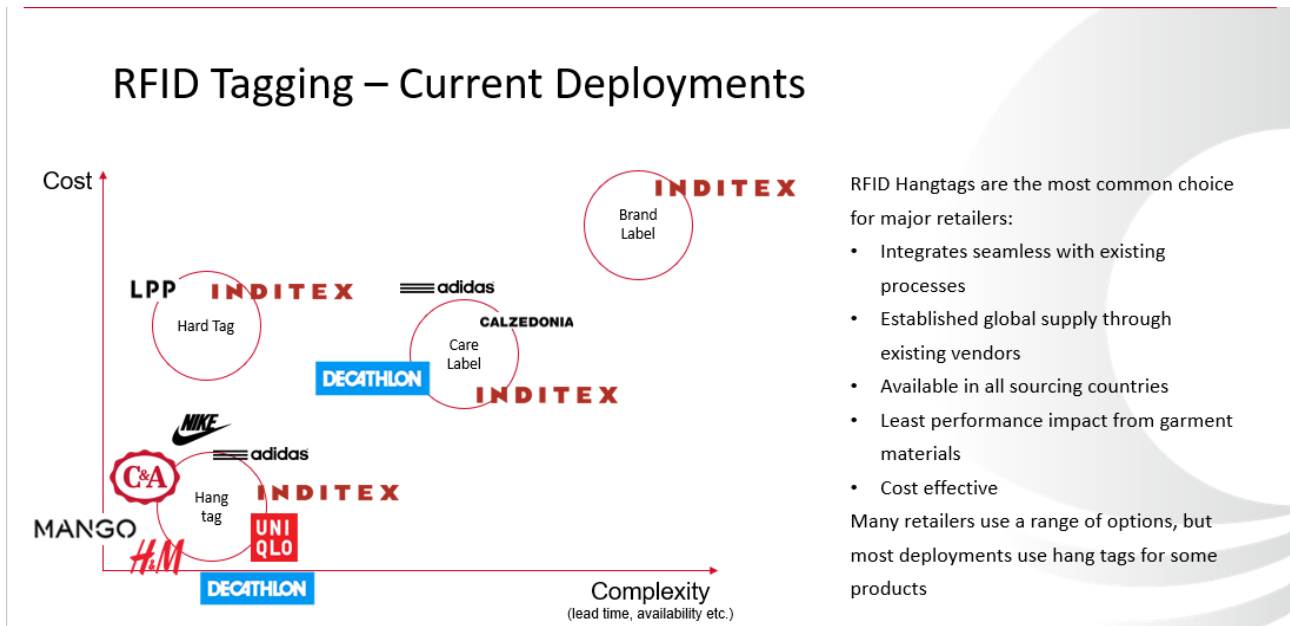


Figure 3: RFID tagging- Current Deployments

(Source: fvg, 2023)

The most popular choice among big retailers like C&A, H&M, Uniqlo, Inditex, adidas, Nike, Decathlon, etc., is RFID hangtag, as seen clearly in the cost and complexity figure above. RFID Hangtag is a great solution for many reasons, including its easy integration with current processes, availability of sourcing channels in nearly all nations that produce garments, cost-effectiveness, reduced impact on garment materials, and lead time control.

The global perspective of RFID implementation highlighted the significant steps of non-retail companies; for example, the shipping and delivery firm UPS considered RFID to be a very valuable tool; therefore, they invested a lot of money in RFID to build a full-form usage of RFID. They will use RFID stickers with UHF functions for RFID deployment. For the implementation to be successful in apparel, the organization that is adopting it will need to have the necessary abilities as well as a positive attitude toward the problems that it will face. Several of the respondents said that educating retailers or end customers is the most essential thing, and they argued that it needs the organization to be able to gather and utilize data in order to develop knowledge and expertise. Respondent 2 added “Focus on key use-case(s), implement in phases, reserve enough retailer’s own IT and project management resources.” Furthermore, it suggests that the implementing firm

will have to be diligent to enjoy the full advantages of RFID, since the process of accomplishing such might take a certain amount of time.

Table 5: RFID Challenges and Solution comparisons

(Source: author's own)

| Challenges | Solutions |
|--------------------------------|--|
| RFID Standards and Regulations | Understanding of Technical specifications, protocols, frequencies, data formats, and security requirements for RFID systems. |
| RFID Security and Privacy | RFID chips collect, store, and transmit sensitive information, such as personal identification, location, inventory, and transactions. |
| RFID Education and Training | RFID workshops, webinars, certifications, publications, and mentorships. |
| RFID Networks and Associations | Benefit from joining and participating in RFID professional networks and associations like rain RFID alliance |
| RFID Tag IC Chips | Chips Manufacturer: NXP Ucode 8, Ucode 9 , impinj M750, R-6P |
| RFID Antenna | Manufacturer: Grand Tag etc and Design by Avery Dennison & Arizon etc. |
| RFID Antenna Design Impact | Performance and Behavior of different materials |
| RFID Encoding Standard | GS1 TDS v1.13 Or v2.00 |
| RFID Bonding | Bonding IC chips with Antenna by Inlay Makers like Avery Dennison, Arizon, Tageos, Beontag, Talking Thing etc. |
| RFID Service Bureau | Converting Inlays to label. Printing and Encoding of variable data like Avery Dennison, SML & FVG. |
| RFID Tag Selection | Passive RFID tag with UHF |
| RFID Air Interface | GS1 EPC Gen2v2, ISO/IEC 18000-6 |
| RFID Reader | Global Manufacturer: Impinj, Blubird, Honeywell, Zebra, Nordic ID |
| RFID Middle Ware | Global Solution Provider: Integration of hardware with enterprise software system by SML, Checkpoints, Retail Reload, Nedap. |

The respondents who contributed in the interviews stressed the significance of technical improvements and the requirement for merchants to have a full understanding in order to enable the use of RFID equipment. For the purpose of ensuring interoperability and providing a foundation for the development of a variety of tags, readers, software, and accessories, the RFID ecosystem has been defined. It is also necessary to have an innovative mentality in order to capitalize on the technological developments that are occurring because the industry is always changing and the costs of technology are lowering. The participants emphasized the significance of concentrating on key use-cases, adopting RFID in stages, and aligning the leadership of the organization to guarantee a successful deployment of RFID technology. The respondent 2 added "Focus on core use-cases first and forget nice-to-have use-cases initially, implementation in stages helps to distribute the costs for several years, deploying multiple use-cases will unleash more benefits from the same tag." The respondent 1 while replying to the main challenges of RFID implements by retailers said "the major challenge is a lack of understanding and it's not the technology that's the problem. I don't see the technology as being the problem. The technology does exactly what it's supposed to do, and the guidance and the recommendations. People who work in this technology out there in most cases premature". He added that if an organization really wants to deploy RFID needs to be owned and managed by the sea level, it needs at least the CEO, CFO, and CTO on board to make sure that the whole organization is aligned.

5 DISCUSSION

This research intended to identify strategies for garment retailers to effectively adopt RFID technology in their retail operations, covering the first phases to the final interaction with end customers. RFID is a self-synchronizing technological system that facilitates automated interdepartmental linkage. The practice of RFID technology inside a retailer's system enables comprehensive tracking capabilities and significantly enhances operational efficiency. The implementation of RFID technology in the item-value chain has led to a dramatic transformation.

This research intentions to discover the essential steps involved in the deployment, assessment, and presentation of the RFID technology. By analyzing empirical findings, the study concludes that the integration of RFID is important in the retail industry because automation without this technology is unachievable. The integration of automation and the establishment of connections between supplier factories, distribution centers, retail outlets, and customers, facilitated by the use of RFID technology, contribute to the effective management and optimization of this supply chain, leading to enhanced satisfaction and operational efficiency.

The use of RFID technology is now on the rise, with increasing demand seen each year. However, the execution of RFID in stores has been delayed by a lack of adequate training and technical expertise among retailers. Consequently, many retailers have been reluctant to adopt and utilize RFID technology. The study aimed to identify the technological obstacles and their respective solutions pertaining to the current issues through the investigation of the following research questions:

1. What are the challenges for Apparel Retail Industry to use RFID Technology cost-effectively and widely?
2. How can Apparel Retail producers solve the identified challenges cost-effectively?

To obtain precise answers to the challenges encountered by multiple retailers in the apparel business, a diverse range of geographically and technically significant empirical data were gathered via interviews. Various multinational firms specializing in providing RFID solutions to retailers and other sectors were selected for the interviews. The determination of these discussions was to obtain accurate and up-to-date information on technological advancements, the present market

landscape, and future possibilities in this field. The empirical data were carefully reviewed on a word-by-word basis to obtain information that may be used to provide solutions to clothes shops on the use of RFID technology, explaining the methods and logic behind its implementation.

5.1 Answering the Research Questions

The key objective of the present study is to identify potential solutions for the obstacles encountered during the execution of RFID technology within the apparel retail sector, bringing light to a comprehensive range of perspectives. To conduct an in-depth study of industrial practices, technical issues, and stakeholder perspectives, several significant findings were identified.

The practice of RFID technology in apparel retail has significant potential for enhancing operational efficiency, inventory accuracy, supply chain management, and overall operational effectiveness. Nonetheless, the deployment of RFID technology presents a range of complicated problems, including factors such as the cost of implementation, complications associated with integrating RFID systems into existing infrastructure, technical constraints, opposition from professionals already used to establish methods, and the need to ensure data confidentiality and safety. The key target of this study is to provide a thorough analysis of the issues faced by the retail industry and to propose appropriate solutions. The recommendations include technical improvements, industrial practices, and management strategies aimed at achieving cost-effective solutions to overcome obstacles and facilitate easy integration and adaptation. The final objective was to enable the garment industry to fully realize the numerous profits of RFID technology.

Furthermore, this research highlights the need for a consistent RFID ecosystem that encompasses comprehensive training for retailers to effectively integrate RFID service bureau connections across several aspects. These elements include middleware, software applications, communication protocols, data storage formats, integration standards, tools used for implementing RFID chips, and adherence to legal requirements. This study examines the problems encountered by apparel retailers in integrating RFID technology while also proposing standardized techniques and frameworks for engagement and innovation.

5.2 Assessment of the Results with Earlier Literature

An earlier study found that RFID could improve inventory accuracy and forecasting, minimize store stock and waste apparel, and increase traceability in the apparel value chain (Denuwara et al., 2019). Traceability in the apparel value chain covers production, capable tracking, material production, chemical processing, and labor utilization, impacts transparency and social sustainability.

According to Ngai et al. (2010), many RFID implementation and assessment frameworks have been proposed for standardized implementation. These frameworks have been developed in various sectors. The author also said that the organization must determine whether RFID is an appropriate instrument to handle the defined difficulties associated with the supply managements in order for RFID to satisfy the specified purpose and scope. The suitability of the implementation is also a significant consideration, given that it is generally accepted that RFID implementation is not suitable for every business. This is due to the fact that not all retail firms possess the necessary products, stores, or information technology infrastructure for an RFID implementation. In addition, placing emphasis on the issue at hand and the desired outcome of the proposed solution has the potential to make the process much more efficient and contribute to the general achievement of the project.

Earlier researchers underlined that RFID adoption studies might highlight the relevance of adoption needs, particularly in the first phases of analyzing a technology's lifetime. According to Bendauid et al. (2013), the exaggerated expectations brought about by the excitement around growing information technologies have resulted in a slower rate of RFID technology adoption than anticipated. Considering this, the industry standard and ideal RFID Standardized environment have not been offered in a manner that is unique to the apparel retail business. RFID has reached a mature level despite the fact that many retailers continue to operate in the dark because of the standardized ecosystem. Over the years, various standards have evolved and many advancements have been made. This research recognizes the significance of the implementation process, as well as an analysis of the significance and advantages, and establishes a standardized setting for retailers so that they can comprehend the interoperability of various materials and hardware. Irrespective of the producer or user, RFID standardized ecosystems play an integral part in ensuring the interoperability of products. This is true regardless of the manufacturer. Additionally, standards serve as a

blueprint for businesses to follow when developing additional products, such as a variety of tags, readers, software, and accessory types.

It has been stated by a previous researcher that the project team will be motivated for an effective approach that takes into account business and technological possibilities, as well as any constraints placed on the company's traditional developing direction, while deploying the company's inadequate resources to meet customer demands and gain the benefit over participants (Teece, 2014).

5.3 Practical Implications

The retail establishment will be supervised on RFID compatibility and what to consider when choosing to deploy RFID. The RFID deployment process in Chapter 2.3 will generate concrete concepts. Firstly, the process of RFID adoption requires that the organization that will be adopting the technology should be familiar with both the already available technology and the features of RFID technology. Developing a scope is emphasized as another step in the process of executing RFID technology. For example, the objective of automating warehouse operations, omni-channel fulfillment capabilities, and activities in which the respondents noticed the highest potential for cost savings. After setting a goal, they may improve the execution concept to meet further of their demands, such as customer experience, sales, transparency, and sustainable measurability. In addition, a couple of respondents agreed that the scope of implementation is complicated and that this initial stage should be used to define it. Among other things, the advancement of technology and information technology (IT) systems in lead positions. The respondent 6 claimed that it is a critical system linked with a company's critical supply chain process, which indicates that the technological part is most important for RFID implementation. This linkage is only possible with successful technological integration. As mentioned in the process of RFID adoption, it is essential to have a detailed understanding of the possibilities and limits of RFID technology from a technological perspective. This will enable the adopting organization to avoid setting objectives that are too ambitious. Therefore, it is necessary to consider the possibility that the technology may not provide 100% accurateness.

Secondly, following setting the aim and scope, establish an implementation team. Set long-term objectives in the RFID adoption process to provide the project group a feeling of accomplishment

upon attaining milestones. One responder indicated that the complete adoption took several years. It would be helpful to have a team with RFID implementation and supply chain expertise, since otherwise the implementation would need a lot of study and learning. The team must also consider the company's implementation goals and departmental expectations. This technique will also reveal other departments' issues, expectations, and RFID's potential beyond the aim. The RFID adoption team should examine the business processes at this level. This helps to discover the weaknesses and errors that RFID systems can address.

Thirdly, shortly after acquiring all the necessary knowledge and understanding the project picture, the implementation team must consider financing opportunities, scalability, risk, and the solution's projected life cycle to ensure economic and operational feasibility. I present the theoretical and empirical findings of their usage. Theories and experiments show that logistics have the greatest saving potential because inventory and other warehouse tasks are time-consuming and costly. RFID may improve the efficiency. RFID technology has several advantages in logistics; however, achieving a 100% accuracy is challenging. Logistics ROI is easier to quantify. I first set implementation goals and purpose, and then conducted a cost analysis depending on firm size. It is crucial to remember that numerous expectations might yield ROI and invest in long-term objectives.

Fourth, RFID adoption analyzes hardware, software, readers, and computer equipment, as well as RFID suppliers and things such as tags, care labels, and other appearances, and selects the most appropriate items for integration. This level of RFID adoption focuses on the environment because RFID systems are affected more than other technologies. For example, metal has a huge influence on RFID tags, and in this scenario, I think there will be no difficulty with material or environment, but it is vital to decide where the readers should be and how they rely on the surroundings. For example, stores utilizing active RFID tags may have readers that support metal, which must be upgraded to read soft tags and integrated with the system. I also advise the corporation to conduct small-scale proof-of-concept testing before the system installation to ensure that the RFID solution is ready. After testing initial experience and expertise are unknown, making the test stage crucial. Omni-channel integration is crucial for project success and testing for everyone. Therefore, patience was important throughout the testing period.

Finally, upon setting the aim, scope, research phase, and where and to what they want to apply RFID, they can execute it. Because RFID results may take years to appear, continual training and periodic appraisal of the RFID system are required throughout installation. The research explains that immediate results are feasible, but this study shows that educating employees and regularly monitoring the system may provide superior outcomes. By regularly analyzing the RFID system, adopters can motivate innovation and RFID capabilities. Because it is impractical to expect an RFID system to perform effectively from the start, this is an excellent way to solve future issues. The last phase of RFID adoption involves regularly reviewing the RFID system's performance and comparing it to the specified objectives. In summary, RFID adaptability depends on its objective and purpose, and its scope must be determined. After choosing the aim and scope, we selected the tag type and placement. Additionally, I believe that the project team should engage diverse departments in their research phase, as varied viewpoints on implementation will reveal new RFID opportunities inside the firm. Because not all departments know what other departments face every day, it is important to mention. Again, patience is needed because it may take time and be imperfect at first, but this article suggests that the organization has reasons for deploying RFID.

5.4 Theoretical Contributions

This is not an extremely scientific investigation but an important theoretical development. According to Kovalainen and Eriksson (2015), the most accurate way to define an intense case study is a continual interaction between theoretical frameworks and empirical evidence. The drive of this research is to integrate theoretical ideas with practical evidence to enable the reader to gain knowledge from them and act appropriately (Kovalainen and Eriksson, 2008).

Previous research has mostly focused on bringing out the challenges, advantages, problems, and issues associated with RFID Technologies, but these studies have never focused on whether RFID is compatible and solutions to the implementation. This research has produced a new perspective on RFID implementation with a standardized ecosystem framework, in terms of what encouragement there is to deploy RFID. This study developed an innovative viewpoint on RFID implementation with a standardized ecosystem framework. This model may be adopted by other businesses that want to deploy RFID in their supply chain. This can be accomplished by increasing people's knowledge and comprehension of the fact that the framework is an essential component of the process of placing RFID systems into place. As stated previously, it might be challenging to com-

prehend such compatibility because it can be reliant on on a wide variety of factors. In this study, diverse compatibility elements were detected for each execution.

The model established for this thesis allows for RFID compatibility studies in apparel retail organizations. Since this theoretical model could answer the research problem and meet the thesis's objective, it would be fair to say that it is also a theoretical contribution to future RFID technology deployment in apparel retail research. Researchers exploring RFID deployment may utilize this theoretical framework for other apparel retailers that have not yet deployed RFID or comparable distribution techniques. I also think that scholars may expand on this framework to find matching factors other than the four found in this study.

5.5 Limitations of the Research

The focus of this research is limited to examining the obstacles to implementing RFID technology specifically within the apparel retail business rather than addressing the broader issues faced by other industries applying RFID technology. Furthermore, this thesis used data obtained from RFID service providers, hardware manufacturers, equipment suppliers, and service bureau providers. However, it did not include information on the specific circumstances and overall perspective of end retailers. This thesis primarily focuses on the prevailing demand for implementing RFID technology and concludes by discussing the present demand for RFID price tags, stickers, or care labels in apparel retailers. However, Digital Product Passport (DPP) does not offer much insight into prospects, despite its potential to revolutionize the current situation. It is my firm belief that conducting broader-scale research to assess various conditions for the implementation of RFID will provide a more universally applicable recommendation for organizations seeking to use RFID in their operational efforts. This research did not include an investment investigation of RFID implementation. This decision was made based on the idea that, during the preliminary stages, it would be more appropriate to prioritize the examination of implementation benefits and process knowledge rather than conducting a cost analysis.

5.6 Recommendations for the Future Research

This research provides a summary of the challenges experienced throughout the process of implementing RFID in the apparel retail business and outlines some potential standardized solutions.

New technologies provide exciting opportunities for retailers to connect with consumers and streamline their processes. Suggestions for further research on how to improve the integration of businesses with RFID implementation. Firstly, the research explores that many former researchers have presented the profound impact of RFID technology implementation in apparel stores for inventory and logistics management. What is needed is a detail-specific module establishment that influences a company's adaptability to deploy RFID. For example, comparative evaluations of different retailers' implementation of RFID technology in various contexts might show variances in obstacles, acceptance rates, and effective methods, providing a deeper knowledge of the technology.

Additional research on practical use cases of RFID implementation is required to provide retailers with better insights, especially when the industry moves from the longitudinal pilot project stage of the RFID-enabled warehouse process to the fully completed system stage. Personalized plans for small businesses that include a real-world case study are key to getting them to the "doing" phase.

The researcher could consider exploring innovative uses for RFID in the retail sector, as well as investigating the potential use of digital product passports (DPP) in the retail sector. DPP will help customers and businesses by providing guidelines for maximizing product longevity. Information acquired during testing, usage, maintenance, repair, and recycling will shed light on the durability of a product.

Sustainability is becoming a serious global practice. Therefore, it is assumed that the environmentally friendly features of RFID tags, as well as the disposal of tags and ethical considerations, are more specifically indicated. Even though there has been tiny research conducted on the subject lately after major companies in the retail business switched to RFID, I concluded that the topic is still relatively underexplored since RFID Technology is not being used by the majority of retailers.

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Appendices

Appendix 1. Interview Guide 1 (RFID Experts)

Background:

1. Where are you working?
2. How long have you working with RFID?
3. What is the current RFID technology usage in the apparel industry (market share of retail)?
4. What is the future of Passive RFID Tag over active tag?
5. What is the prospect of RFID technology in the apparel retail sector in the future?

RFID Related:

6. What are the principal benefits of employing RFID technology in the retail industry?
7. What is the main challenge of RFID technology usage and what could be short-term, long-term solutions?
8. What are the critical challenges encountered in implementing RFID within the retail sector?
9. What are the key factors retailers moving toward RFID technology in recent years?
10. What challenges and benefits are associated with integrating RFID technology in existing system?

Appendix 2. Interview Guide 2 (RFID Solution Provider)

Background questions:

1. Where you are working and how long ?
2. What is your position at the company?
3. What is your company's business and how it related to RFID?
4. How your work is related to RFID or RFID Implementation process?

RFID Related:

1. What are the principal benefits of employing RFID technology in the retail industry?
2. What are the core differences between an Active RFID Tag and a Passive RFID Tag in retail perspective?
3. What are the key factors apparel retailers moving toward RFID technology in recent years?
4. What do you see as the main challenges of implementing RFID and more specifically in retail industry?
5. What are the main bullet points retailers should keep in mind for RFID implementations?
6. What could be done to reduce RFID implementation costs in coming days?

Appendix 3. Interview Guide 3 (RFID Inlay Manufacturer)

Background questions:

1. Where you are working and how long ?
2. What is your position at the company?
3. What is your company's business and how it related to RFID?
4. How your work is related to RFID?

RFID Related:

5. What do you know about RFID technology?
6. What do you think RFID can provide or improve to any new company that intends to implement RFID?
7. What are the key factors apparel retailers moving toward RFID technology in recent years?
8. What do you see as the main challenges of implementing RFID and more specifically in retail industry?
9. What are the main bullet points retailers should keep in mind for RFID implementations?
10. What could be done to reduce RFID implementation costs?

Appendix 4. Interview Guide 4 (RFID Sales Manager)

Background:

1. Where are you working?
2. How long have you working with RFID?
3. What is the current RFID technology usage in the apparel industry (market share of retail)
4. What type of RFID is best fitted for the fashion industry RFID or Passive RFID?
5. What is the prospect of RFID technology in the apparel retail sector in the future?

RFID Related:

6. What are the principal benefits of employing RFID technology in the retail industry?
7. What is the main challenge of RFID technology usage and what could be short-term, long-term solutions?
8. What are the critical challenges encountered in adopting RFID within the retail sector and how to resolve them cost-efficiently?
9. What are the key factors retailers moving toward RFID technology in recent years?
10. What challenges and benefits are associated with integrating RFID technology with the existing software and systems in the apparel retail environment?

Appendix 5. Interview Guide 5 (RFID IT expert)

Background questions:

1. Where are you working and how long have you been working?
2. What is your position at the company?
3. What is your company's business and how it reacted to RFID?
4. What are the main tasks for this position?

IT Related:

6. What do you know about RFID technology?
7. What is the difference between an Active RFID Tag and a Passive RFID Tag?
8. What challenges and benefits are associated with integrating RFID technology with the existing software and systems in the apparel retail environment?
9. How does RFID implementation affect the rapidity and exactness of the replenishment process for sold items?
10. What do you see as the main challenges of implementing RFID in the retail industry?
11. What could be done to reduce RFID implementation costs?
12. What is the recommendation for future upcoming retailers to use active or passive tag

Appendix 6. Interview Guide 6 (RFID Sustainability Expert)

Background questions:

1. Where you are working and how long ?
2. What is your position at the company?
3. What is your company's business and how it reacted to RFID?
4. What are the main tasks for this position?

RFID Sustainability Related:

5. What do you know about RFID technology?
6. What do you think that RFID can provide from a sustainability perspective?
7. What do you see as the main challenges of implementing sustainable RFID?
8. How your company currently managing sustainability?
9. What are the main challenges with your current sustainability practice with RFID ?
10. Does sustainable RFID increase cost if so what to do to reduce additional cost ?