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Implementation of RFID-based SCM in the South Korean Textile Industry

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Abstract

South Korea is known for its major manufacturing capabilities in semi-conductor, automobile, and IT industries. However, little is known about the competitive capabilities of South Korea's textile industry. The present study presents information about how Korean textile firms build their competitive capabilities on multiple fronts. Through a case study of two businesses operating in the South Korean textile and apparel industry, this paper illustrates a series of competitiveness enhancing initiatives, starting with the implementation of radio frequency identification (RFID). The main contribution of this article is the focus on how the interdisciplinary nature of the textile and apparel industry can benefit from and optimize the use of Information Technology through sustained efforts on multiple fronts. This study suggests that Korean textile firms approach their competitive capabilities in terms of strategic direction, innovative priorities, and operational focus. In the competitive global business environment, this could be the solution for the textile and apparel industry, by helping for the survival in the upcoming information age. Specifically, by adopting RFID-based SCM, firms can gain a competitive capability that promises sustainable growth in the future.

I. Introduction

In 2009, South Korea was the seventh-largest textile and apparel exporter, holding a 2-percent share of the global market ("South Korea," 2011). However, South Korea's textile industry is facing an unprecedented threat as competition grows, and sustaining competitive prices has become increasingly difficult in the global market. Recent changes in global economic circumstances, such as upsurges in the price of raw material and the rapid spread of free trade agreements (FTAs), have resulted in severe competition. Furthermore, in contrast to earlier days, outsourcing business processes to developing countries has become inefficient as labor and production costs soar.

In 2011, the Ministry of Knowledge Economy announced the policy to enhance the textile and fashion Industry, which is intended to boost the industry through joint private-government initiatives. The plan includes promoting research and development, strengthening manpower, enhancing South Korean brands, setting up regional business infrastructure, and utilizing FTA opportunities ("South Korea", 2011). In order to achieve global competitiveness, the Korean textile industry has harnessed Korea's unique culture and lifestyle along with its advanced IT infrastructure. The products of these companies are analyzed, and information on recent trends is shared in the Korean fashion market, creating knowledge spillover within the industry.

The apparel and textile industry has faced turbulent changes over the years. In particular, the recent economic downturn around the world hit the industry hard as consumers cut down their spending on apparel and textiles. The industry as a whole was forced to reduce production and supply chain costs and shift to manufacturing cheaper products to attract customers. On the other hand, the constant rise in the cost of labor in China and Southeast Asia has made this race for efficiency more difficult. This environmental turbulence has forced firms in the garment industry to reconsider their strategic directions to find niche markets and devise ways to sustain their competitive advantages over one

another. For example, some companies, like Zara, chose to pursue a high-end market segment by offering fashionable products in a timely way on a global scale.

The Korean apparel industry, in particular, has seen drastic changes over the years. Korean firms in this industry started as contract manufacturers. Over time, they acquired and developed manufacturing and apparel capabilities, which allowed them to transform from low-cost goods producers to high-value marketers (Kim & Kim, 1998). In accordance with this change, firms have repositioned themselves from low-cost manufacturers to flexible, value-adding manufacturers with efficient global supply chains. Exports created by the industry have significantly contributed to the growth of the Korean economy.

In today's global market environment, which relies heavily on information technology such as RFID, the textile and apparel industry strives to attain competitiveness by building efficient, yet flexible, supply chains. Firms in the industry are attempting to improve collaborative relationships along their vertical supply chains such as fiber, textile, apparel manufacturing, and retailing. The textile and apparel industry involves complicated and thin supply chains from raw material processing to fabric manufacturing to apparel design and from distribution to the production of final goods for customers. The complexity of the process necessitates smooth cooperation among the up-, middle-, and down-streams of supply chains. Many problems can arise along these supply chains, including lead-time, inventory control, and flexibility issues. In industries with high demand volatility, like apparel and textiles, 'stock outs' can cause serious damage to companies. The cost of a stock-out can actually exceed the total cost of manufacturing. When considering production costs, most firms fail to include stock-outs resulting in lost sales, and therefore do not measure this cost (Fisher, Hammond, Obermeyer, & Raman, 1994). Uncertainties due to demand volatility cause companies in the textile and apparel industry various managerial problems in terms of production planning, forecasting, inventory management, and timely distribution. According to Fisher

(1997), apparel is an innovative product characterized by quick delivery to customers, a short lead time, a short life cycle, and diversified consumer needs. Due to these characteristics, the decision to keep a lean inventory can be problematic as it increases the risk of stock-outs and lost sales, weakening partnerships along supply chains (Abernathy, Dunlop, Hammond, & Weil, 2000). Therefore, the purpose of this study investigates how textile and apparel firms utilize RFID to promote SCM in the attempt to develop competitive capabilities. Based on a case study of two firms, this paper examines what additional changes implementation of RFID has brought to textile and apparel supply chains.

II. Literature Review

1. Competitiveness challenges in the South Korean textile and apparel industry

Since 1980, the Gyeonggi area has been the center of the textile industry for knitting, dyeing, and finishing thanks to its proximity to Seoul, the capital of South Korea. Whereas, weaving factories have been developed in the Gyeongbook area, and the apparel industry has developed in Seoul (Kim, Oh, & Kim, 2013). In 1919, the Kyongsung Corporation, which produced cotton textiles, was established with national capital (Korea Federation Textile Industry, 2012a). In the 1920s, the silk textile industry boomed, and, in the 1930s, the spinning industry developed rapidly. The ready-made apparel industry was also established in the 1930's. In the 1960's, the synthetic fiber industry was established, and firms such as the Korean Nylon corporation produced PVA and nylon fiber (Chung, 2002). At this time, due to a 5-year economic development plan in Korea, the textile industry rapidly developed into a strategic industry. Generally, the synthetic fiber industry was more developed than the natural fiber industry because natural fiber sources were limited in Korea whereas synthetic fiber could be sourced in the immediate area (Bae, 2005).

In the 1970s, value-added textile production increased

by 6.5 times. In particular, textile exports increased by 13 times, accounting for 30% of all exports. Therefore, the Korean textile industry was one of the big three, along with Hong Kong and Taiwan (Korea Federation Textile Industry, 2012b). The apparel industry faced a turning point when the large company, Bando fashion, jumped into the mid- and premium-priced category (Chung, 2002). In the 1980s, the market in developed countries was pre-occupied with focusing on high-value products and differentiation strategy. On the other hand, Korea, Hong Kong, and Taiwan focused on mid- and low-priced production with low labor costs. This worked as a driving force behind Korea's emergence as a powerful country (Kim & Park, 2010).

The volatile environment in the 1980s and the 1990s forced the Korean textile industry to evolve. As the Multi-Fiber Arrangement (MFA), an international trade agreement on textiles and clothing, was put into action, protective trade policies became the global standard. In most countries, textile imports were regulated in an attempt to vitalize their own textile industries, and thus the mass producers in the South Korean textile industry lost many export opportunities. In other words, the decrease in exports resulted in oversupply within South Korea. Furthermore, as the global markets formed a blockage, the market coverage of the South Korean textile industry was reduced due to the sandwiched position between developed countries and developing countries (Korea Federation Textile Industry, 2012c). Finally, when Korea became a member of OECD, the domestic market opened its gates to foreign textile products (Chung, 2002).

Domestically, the Korean textile industry worsened as several conditions weakened global competitiveness: the lack of labor, increase of labor and material costs, and oversupply. This resulted in textile firms in South Korea outsourcing their business operations to developing countries, which offered mass labor at a comparatively lower wage (Kim, 2011). The number of textile firms investing overseas showed a sharp increase, from 164 firms in the 1980s to 1491 firms (investing \$1.9 billion overseas) by the end of 1997 (Chung, 2002).

Cultural shifts were also visible as the Olympics were hosted by South Korea in 1988. The increased exposure of South Korea to the world widened the gateway to foreign markets, and cultural exchanges became more common. In response to diversifying consumer tastes and needs, the South Korean textile industry transformed from mass production to small quantity batch production. The Korean government also sought to improve global competitiveness by enhancing the efficiency of production and distribution processes based on advanced IT. As a result, the South Korean textile industry evolved into a higher value-added industry.

Through this review, it is clear that the Korean textile and apparel industry has met many challenges in sustaining competitiveness and has continued to the constantly changing environment. In a profound sense, the textile industry is a complex mechanism, as a result of the interrelations among information, technology, and culture, that goes beyond simple production (Korea Federation Textile Industry, 2012d.).

2. RFID-based SCM in the textile industry

Increasingly, textile firms compete with their network capabilities for their global market competitiveness (Brewer & Speh, 2000; Park & Hong, 2012; Shih & Agrafiotis, 2017). It is crucial for all manufacturing industries, including the textile industry, to implement rapid, responsive strategies that expedite the transition from small and medium-sized, labor-intensive businesses to information and technology-oriented businesses (Roh, Hong, & Min, 2014). Supply chain management (SCM) enables firms to correspond with the changing market by reflecting various consumer needs in a timely manner. While traditional SCM has used bar code systems, from production to distribution, as the primary platform for communication, the lack of real-time information sharing and quick responses along the supply chain can cause problems from fiber production to manufacturing to retailing. Consequently, some firms employ radio frequency identification (RFID) systems to enhance real-time communication among the various supply chain

partners. RFID based SCM optimizes the benefits of collecting information in real time from production to distribution. It also allows timely responses to changing market and consumer needs (Hur, Ahn, & Kim, 2011; Moon & Ngai, 2008; Roh, Kunnathur, & Tarafdar, 2009).

RFID is an important tool for enhancing the performance of inventory management. Major global retailers, such as Walmart and Costco, use RFID technology to improve warehouse logistical efficiency in terms of reduced out-of-stock rates, enhanced replenishment efficiency, and better inventory management. Globally renowned apparel retailing leaders, such as Prada, Gap, Benetton, Levis, and Gardeur, also greatly value the benefits of applying RFID technology (Roberti, 2006). Most research on RFID applications in apparel retailing has focused on adoption of large-scale applications for leading global companies using in-depth interviews or questionnaire survey approaches (Moon & Ngai, 2008). Since RFID adoption in Korean textile industry is the beginning stage, this study focuses on case analyses of two Korean textile firms to understand how these firms could build competitive advantages in the saturated market and enhance their supply chain networks using emerging information technology, such as RFID.

III. Case Study

This case study focuses on how Korean textile firms have approached competitiveness challenges since early the 2000s. In particular, we discuss the implementation of information technology, particularly RFID, into SCM in the textile and apparel industry. RFID plays a key role in enhancing inventory management and shortening lead-times. Inventory management and lead-times have a significant effect on the profitability of the textile and apparel industry, so RFID based SCM reduces inventory costs, increases inventory turn-over, and synchronizes downstream and upstream supply chains more effectively. It helps accurately address consumer needs and reflects their purchase behaviors by directly accessing purchase

histories, and it relays this information to the manufacturing process. RFID based SCM is also a key factor in enhancing the efficiency of global outsourcing by solving problems in the textile and apparel business. Such predicaments can include difficulty in communicating between headquarters and offshore-manufacturers, responding immediately to consumer needs, and shortening lead time. Last but not the least, information in the textile and apparel industry streamlines from up the supply chain (textile finishing, dyeing, and manufacturing) to the middle (apparel manufacturing) to downward (retail distribution) (Kwon, 2008; National IT Industry Promotion Agency [NIPA], 2010). RFID based SCM effectively integrates isolated information into the circulation of streams within the industry.

However, implementing RFID in SCM is not an easy task. That is, the textile and apparel industry differs from other industries due to severe seasonality and susceptibility to trendy designs. First, the life cycle of a product is comparatively shorter than that of other industries, resulting in high the Stock Keeping Units (SKU). Second, the majority of the industry consists of small- or medium-sized firms, as they are more adaptable to the industry. Therefore, the expense of RFID implementation stresses the financial capabilities of these firms. Furthermore, it is challenging to link upstream and downstream flows of materials and information together on account of their delicate nature. All these challenges complicate RFID implementation in textile and apparel SCM.

As a result, the Korean government has stepped up to help propel the usage of RFID to improve supply chain management for many textile and apparel firms, where complicated production process along the supply chain take place (Kim, 2008). Hence, the u-IT project was initiated to give financial aid to firms and encourage them to adopt RFID in their supply chains. The Basic House and ShinWon were representatively involved into the u-IT project.

1. The Basic House

The Basic House sells its products at its own stores as well as in large department stores. The company adopted the Global Outsourcing/Collaboration System based on RFID in May 2009. Mind Bridge, one of their apparel brands, with 86 stores operating in Korea, implemented the RFID system in the first year of the project. The Class, one of the other apparel brands of The Basic House, with 73 stores, implemented it in the second year.

1.1 The purpose of RFID implementation

The main purpose is to create high value-added products by reducing lead-time and quickly reflecting consumer needs and trends. Implementing an RFID system enables the company to connect its overseas factories in China and Vietnam with its logistic hub and retail stores throughout the supply chains. The RFID based collaboration network links major domestic and offshore textile and sundry subsidiary manufacturers to apparel manufacturers, streamlining sourcing and order placement.

1.2 Progress

In May 2009, The Basic House became one of the main subjects in the u-IT new technology diffusion project. The project included improving collaboration processes from headquarters to collaborative companies and a building real-time management system from production to logistics to sales. For the first year, renewable RFID tags were attached to 1,320,000 pieces of Mind Bridge brand garments. The RFID-based system for sourcing and placing orders was built to communicate between 12 apparel manufacturers and two textile and subsidiary manufacturers. For the first time in the textile and apparel industry, The Basic House used recycled RFID tags instead of brand new ones to reduce cost and adopt an environment friendly policy. A multi-encoding apparatus was developed to encode over a million pieces at once.

Also, The Basic House developed a shielded RFID gate, which was placed at the Deokgye logistics center. The shielded RFID gate automated stock management,

greatly improving accuracy and efficiency. When the garments are ready for shipping, a worker would put an RFID tag on the packed box with the clothing, and then read the tag linked to the items packed within. The boxed items would pass through the shielded RFID gate into and out of the factories' warehouses. The shield narrows the RFID interrogator's read zone, thereby preventing the device from unintentionally reading other tags in the vicinity, and thus making the system more reliable (J. Kim, 2009). Furthermore, an RFID based location management system was also developed for product stocking, classification, storage, and automated location management.

In the second year, RFID tags were attached to all categories of garment, and their RFID operation infrastructure expanded from one logistics center and one distribution center to 40 retail stores. An RFID based kiosk system was also installed at retail shops to

implement global sourcing, post management, product planning, and returned goods management (NIPA, 2011).

1.3 Outcome

a) Textile and subsidiary manufacturer

Before adopting the RFID system, it was difficult to properly manage the sequenced processes of receiving label data, production, quality control, packing, and delivery. Therefore, it was difficult to predict the precise delivery time. According to NIPA (2011) in cases of OEM (original equipment manufacturers) and CMT (Cut-Make-and-Trim) a close connection plays an essential role between textile and subsidiary material delivery times and apparel production schedules. The schedule management and label delivery, based on SKU, was also handled poorly. By implementing a web-based RFID system, The Basic House can now manage sourcing, stocking, and releasing online. Production

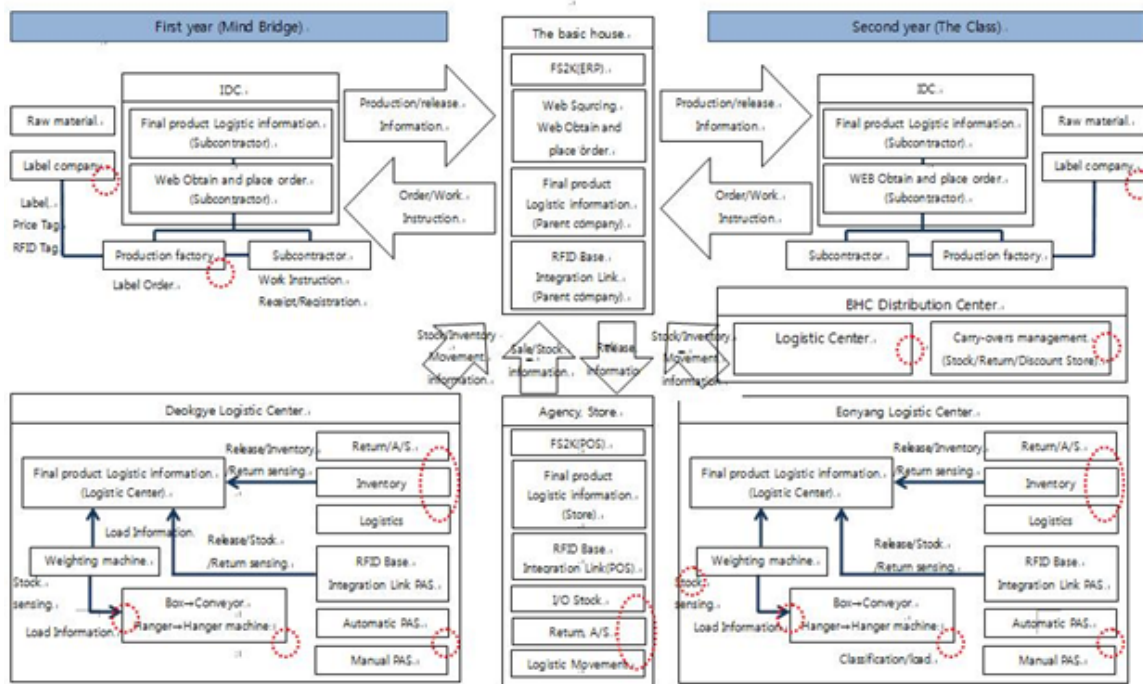


Figure 1. Flow Chart of The Basic House RFID Pilot Project Process (NIPA, 2011)

planning can be established by production schedule, and headquarters could figure out upcoming textile and subsidiary material stock information on a real-time basis. Subcontractors can utilize PDAs (Personal Digital Assistants) and local personal computers networked with the parent company RFID system, which has helped to minimize RFID adoption costs (NIPA, 2011).

b) Apparel manufacturer

The processes of stocking textile and subsidiary materials, sewing, final product construction, quality control, packing, and delivery were managed by hand and off-line communications (mail, fax). This was problematic, causing mistakes and resulting in numerous claims. Implementing a web-based stock/release system linked to the RFID system made it possible to recognize release information on a real-time basis from offshore production locations to the domestic headquarters.

c) Logistics and distribution center

The RFID based logistic information system made it possible to efficiently manage the stocking/releasing of final products. Movable RFID readers helped manage inventory and transfer inventory information to retail stores on real-time basis.

d) Retail store

The Retail Point of Sales (POS) system offered real-time information to retail stores as well. It enabled stores to receive product release information from headquarters' enterprise resource planning (ERP) system and, at the same time, send stock, inventory, returns, and after service information to headquarters by tracking product information in real time.

2. ShinWon

In July 2006, ShinWon, a manufacturing company in the textile and apparel industry, implemented an RFID-based SCM network.

2.1 Purpose

ShinWon adopted an RFID-based SCM network to improve and promote collaborative information sharing between ShinWon and subcontractors regarding

production and sourcing. ShinWon tried to manage the whole process from manufacturing to logistics to domestic demand management (NIPA, 2010). ShinWon's implementation of an RFID-based SCM network is particularly important in multiplicative layers. First, it was an innovative attempt to collaborate and share the process between large- and small-sized firms. Second, it was an inter-industrial approach among businesses in the textile and apparel industry. Furthermore, ShinWon proposed a standardized form for the process that would optimize the potential of the RFID-based SCM network.

2.2 Progress

In the beginning step of textile manufacturing and finishing, three fundamental systems were developed and implemented at the same time: a textile releasing information system, an offshore textile and apparel manufacturing information system, and an information sharing system between ShinWon and its subcontractors. These implementations led to cutting down costs, preventing accidents, reducing lead time, and managing information efficiently. Accurate inspection using RFID prevented accidental short quantities when accepting delivery from subcontractors, in turn drastically reducing the costs (J. Kim, 2009).

2.3 Outcome

a) Textile and apparel manufacturing

RFID tags were attached after a textile was manufactured, finished, rolled, and packed. The tags were classified automatically based upon the quantity of textiles and delivery destination using an RFID gate and movable reader. After inspecting tag information, textiles were stocked at the warehouse.

b) Logistics center

Final apparel products with RFID tags containing all information were then packed in constant quantities in boxes or hangers. After the tag information was compared to the released information from the sewing company for inspection, apparel products were stocked at the warehouse. Apparel products were classified automatically based upon quantity and delivery

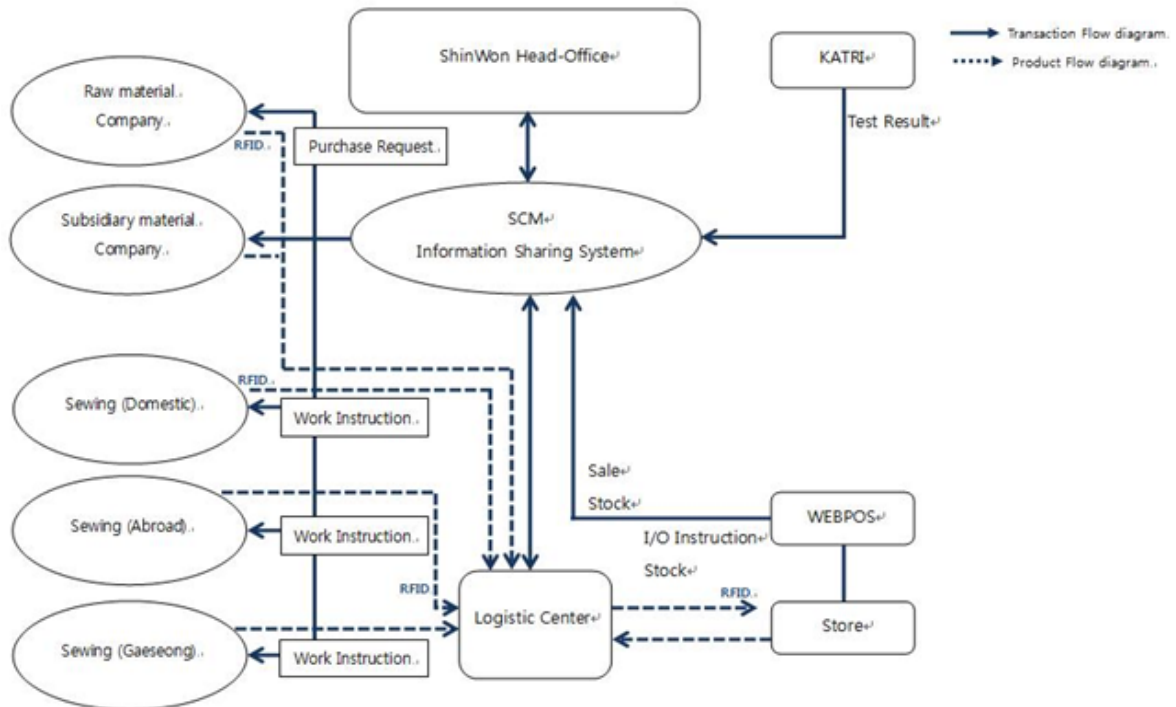


Figure 2. Process Flow Chart of ShinWon's Logistics System (NIPA, 2010)

destination by an RFID gate and movable reader.

c) Retail store

Returns and customer services were recognized in real-time using the RFID tag attached to apparel products stocked at stores.

3. RFID implementation

This study focuses on case analyses of two Korean textile firms to understand how these firms could build competitive advantages in the saturated market and enhance their supply chain networks using emerging information technology, such as RFID. The domestic and global market requires firms to adapt to changing circumstances, including information technology and international agreements such as the World Trade Organization, FTAs, and so on. In this environment, the textile and apparel industry requires overall strategic

direction in order to survive in the competitive global market. Sustainable competitive strategy in the global market involves global supply chains that enable firms to deliver highly valued products to world-wide consumers (Bhatnagar & Sohal, 2005; Hong & Hwang, 2011; Park, Fujimoto, & Hong, 2012; Park, Hong, & Roh, 2013).

The paper focuses on two companies, A and B, which participated in the u-IT projects to enhance SCM hosted by the National IT Industry Promotion Agency, a government-affiliated organization, of the Ministry of Knowledge Economy (changed to Ministry of Trade, Industry, and Energy in 2013). Table 1 summarized the two RFID implementation cases.

4. Developing competitiveness beyond RFID implementation

RFID is an emerging technology that is increasingly being

Table 1. Summary of Implementation of the Two RFID Cases

	The Basic House	ShinWon
Purpose	- Add high value to the products	- Collaborative information sharing between ShinWon and subcontractors
Diffusion	- Renewable RFID tags - Multi encoding capability (over a million pieces at once) - Shielded RFID gate - Automated stock management	- Implemented textile releasing information system
Scale	- Pilot study during the first year Each garment level, 40 retail stores	- Offshore textile and apparel manufacturing information system, and information sharing system
Outcome	- Manage sourcing, stocking, and releasing online on a pc or smartphone. - Real time communication on delivery, stocking, and sales information - Trace product information in real time	- Returns and A/S were recognized in real time

used in supply chain management. RFID technology plays an important role in supporting logistics and supply chain processes because of its ability to identify, trace, and track information throughout the supply chain. The technology can provide suppliers, manufacturers, distributors, and retailers precise, real-time information about their products. This accurate knowledge of the inventory results in lower labor costs, simplified business processes, and improved supply chain efficiency. If properly used, it has the potential to cut ordering lead time and inventory control costs, increase the accuracy of inventory information, help avoid stock-outs, and boost inventory turnover. In this study, we provide an overview of the current state of RFID applications in different industries and its impact on business operations.

IV. Conclusion

As opposed to seeing the textile industry as simply manufacturing, this paper views the South Korean textile and apparel industry as an interdisciplinary industry that fuses technology, culture, and information. The main contribution of this article is the focus on how the

interdisciplinary nature of the textile and apparel industry can benefit from and optimize the use of Information Technology through sustained efforts on multiple fronts—strategic direction, innovative priorities, and operational focus. With a specific case study and additional case illustrations, this paper examines a series of strategic initiatives beyond the implementation of RFID in SCM within the textile and apparel industry.

In the competitive global business environment, this could be the solution for the textile and apparel industry, helping it to not only survive but thrive in the upcoming information age. That is, by adopting RFID-based SCM, firms gain a competitive capability that promises sustainable growth in the future.

The existence of humanity is itself the history and future of the textile and apparel industry. As long as people live, there will be an unceasing demand for textiles and fashion-related goods and services that integrate vital basic human needs with the yearning for a rich and meaningful quality of life. Globalization and advanced technology (e-commerce, smart business) have taken us to a new era where demand has grown world-wide, necessitating the adoption of RFID-based

SCM.

The two Korean companies from our case study illustrate how textile and apparel firms have utilized RFID to promote adequate and effective SCM. From production to distribution, the traditional bar-code-based SCM has various weak points; for instance, it is time consuming, from the stocking to releasing process and the manual processes involved lead to inaccurate picking and releasing of product information. Because it is difficult to share accurate information in real time, it is costlier both in time and money. This critically worsens global competitiveness. RFID-based SCM implies increased traceability and visibility by automating the process of stocking, releasing, and inventory management.

The IoT (Internet of Things) combined with RFID will be the next generation technology in logistics and material management. Preparing for the IoT's arrival, several RFID market players have joined with cloud service providers, chipmakers, and other tech businesses to promote Ultra-High Frequency (UHF) RFID as an essential part of the IoT. In 2014, Google, Impinj, Intel, and SMARTRAC, along with the leading radio identification industry association, AIM Global, formed the RAIN (Radio-frequency Identification) Alliance. RAIN's stated goal is to promote awareness, education, and initiatives to accelerate UHF RFID growth and adoption in business and consumer applications worldwide. A RAIN effort to integrate RFID readers into smartphones will make the technology easily available to an entirely new user base: consumers. RFID's greatest potential within the IoT may be its ability to track people and the objects they encounter and use. A growing number of government documents now incorporate RFID chips, including passport cards and enhanced drivers' licenses.

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