Applications of Item–Level RFID for Retail Services

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INTRODUCTION

To win out in severe competitions, retail companies need to improve operation efficiency and profit margins by promotion of omni-channel retailing for enhancement of shopping services and customer satisfaction. This may be achieved by adopting advanced technologies, including cloud computing, mobile devices/payment, and Radio Frequency Identification (RFID) (Violino, 2013).

RFID, as a non-line-of-sight identification technology, has great potential to improve the process efficiency and visibility of supply chains. It was reported that RFID could improve the performance of distribution systems, including products dispatched and inventory in transit by 33.8% and stock availability by 45.6%, respectively (Vlachos, 2014).

With the advancement of RFID and related technologies in recent years, item-level RFID for tracking individual product items has become realistically possible, which is not practicable with traditional barcodes. Hence, a number of pilot projects have been conducted to adopt item-level RFID to enhance source-to-store supply chain management, including production tracking, pack-and-ship verification for logistics services, warehouse management, product anti-counterfeiting, and retail business enhancement. The success of item-level RFID application hinges greatly on generating and maintaining a trustworthy electronic pedigree (e-pedigree) that records the movement of each product item to uphold the integrity of the supply chain.

This chapter presents an item-level RFID-based system for improvement of retail business. The proposed system is primarily aimed to achieve better intra-organizational coordination within a retail enterprise through synchronization and management of information at item-level along the supply chain, with a possible extension in future development to facilitate inter-organization/cross-enterprise coordination. It is integrated with a track-and-trace anti-counterfeiting system to generate product identifiers (PID) for product items at manufacturing, and maintain trustworthy e-pedigrees for subsequent authentication and tracking of the product items in the supply chain.

Such an integral design approach facilitates implementation of various application modules for retail operations and management, including back-store inventory, anti-counterfeiting, smart shelves, interactive mirrors and fitting, and self-checkout services. Features of these modules can also be incorporated

to enhance brand image and customer experience. Moreover, intelligent algorithms may be developed to mine useful data captured by the RFID devices to facilitate business decision-making and proactive individual marketing. As such, the efficiency of store operations and the overall retail business may be improved substantially.

RELATED WORK

A number of studies have recently been conducted to illustrate possible applications of item-level RFID for better inventory control and replenishment, stock-out reduction, increased operation efficiency, improved customer experience and differentiation, better prevention of product theft, better brand protection by RFID-based product anti-counterfeiting, and hence improved sales in stores (Marco et al., 2012).

Condea et al. (2012) proposed an RFID-enabled shelf-replenishment method for inventory control and replenishment in retail stores. The simulation results show that the RFID-based policies have the potential to improve cost efficiency and service levels. Xu et al. (2012) compared classical and RFID-based strategies for inventory inaccuracy control in two-echelon supply chain, and concluded that traditional strategies are inefficient while technological approaches such as RFID are able to alleviate the inventory shrinkage problems. Metzger et al. (2013) developed a mathematical model for periodic review and RFID-enabled retail shelf-inventory management, and analyzed the impact of false-negative reads on the performance of RFID-based shelf inventory control policies. Their results show that for low to medium demand rates and low tag cost, RFID systems may operate at lower costs than periodic review systems, cutting cost by 25.7% while increasing service levels by 2%. Rahman and Ahamed (2014) proposed an FSA-based protocol to speed up the authentication process for item-level RFID tagged products in retailing.

In retail stores, RFID is used not only for inventory control and prevention of theft, but also for collecting customer shopping behaviors (CSB), in order to enhance in-store intelligence and services to improve customer shopping experience (CSE) and loyalty. Hou and Chen (2011) proposed an RFID-based shopping service system for retailers with large-spaced shop floors to generate customized shopping recommendations for individual customers in. Their study illustrates that the quality of shopping services in retail can be enhanced, and the sales volume of commodities increased considerably. Jung and Kwon (2011) used RFID to identify the shopping paths of customers in major sales areas by collecting and analyzing information on the customers' main travel paths. Based on such data, retailers can better understand the customers' consumption behaviors, and hence decide whether the product display and layout should be modified to increase sales volume.

The research works above have demonstrated the potential values of item-level RFID in supply chain management and retail business. However, these works tended to focus on studying some specific yet fragmented issues of RFID applications in supply chains or retail stores.

Therefore, an integrated item-level RFID-enabled system for retail services is proposed in the following section. This system adopts RFID and related IT technologies to establish a complete e-pedigree, from manufacturing to retailing, for real-time tracking and tracing of each product item in an entire supply chain. Such an integral approach greatly improves product visibility that facilitates collection and analysis of CSB to enhance retail business operations and store inventory management, which in turn help provide better shopping services to increase customer satisfaction and loyalty, and hence sales volume.

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