

PERFORMANCE ANALYSIS OF RADIO FREQUENCY IDENTIFICATION TECHNOLOGY IN MANAGEMENT OF FASHION AND FOOD RETAIL SUPPLY

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ABSTRACT

There has been an improvement in the accuracy, effectiveness and real-time visibility of operational information of retail supply chain management as a result of Radio Frequency Identification (RFID) technology applications. However, research studies of RFID performance across different product sectors of a retail supply chain are still inadequate. Hence, the main purpose of this research is to carry out an empirical study with a view to evaluating the performance effects of RFID technology and applications in the supply chain management of a leading United Kingdom (UK) retailer with emphasis on food and clothing products. Contributions of various scholars to literature are reviewed; the RFID impacts on management of retail supply chain are explored via interview, observation and examination of archival documents; and comparative analysis which gives similarities and differences of RFID impacts on the products was considered. It is found out that there are integrated opportunities in item tagging with RFID as witnessed in clothing supply chain and is recommended to be deployed on food supply chain. The paper therefore concludes that the performance of RFID integration into Supply Chain (SC) of retail industry irrespective of product sector, has aided in realisation of supply chain efficiency, optimisation of product management and attainment of competitive advantage for the case company.

General Terms

Radio Frequency Identification (RFID) technology.

Keywords

Supply Chain (SC), Retail Supply Chain (RSC), Supply Chain Management (SCM), Return Of Investment (ROI), Point Of Sale (POS), and Out Of Stock (OOS).

1. INTRODUCTION

Businesses today are in the world of stiff competition affirming Darwin's theory of survival of the fittest. Supply chain management as a part of organisational operations is equally involved in this competition. The dire need to satisfy customer demands and, interest to save valuable operational cost and time; organisations have been trying to obtain solutions to enhance the management and quality of their supply chains [1]. One of these solutions, in the last few years is Radio Frequency Identification (RFID) technology applications, which companies have been successful deploying as an integral element of their supply chains. Every company considers supply chain management and inventory control as the main keys to its success, survival and even tools via which it can attain competitive advantage and become a strong market player [2].

Radio Frequency identification (RFID) technology has since its emergency generated so many discussions and attracted great attention especially as it affects information processing in logistics and supply chain management of business processes. Academic researchers and business owners have also been showing interest because of huge benefits the technology offers to supply chain management over the other existing identification and data capturing technologies. RFID is an innovative IT tool that gives

organisation the opportunity to gather a vast amount of information regarding products and assets. In fact, it has permeated every sphere of human life that has to do with identification of objects, goods, product, animal, human being, equipment, and so on [3].

RFID, an automatic identification and data capturing technology, is contributing greatly in various ways to supply chain through its unique identification of objects, non-line of sight technology and real-time, live, streaming data-gathering features [4]. Supply chain managers have been converting these technological features of RFID to their business benefits and they have begun to witness savings in time, resources and cost by its deployment in their business activities. In recent years, applications of RFID in supply chain have diffused into various areas; inventory management, asset tracking, transportation, object identification and location, and environmental sensors in industries such as apparel, automotive, healthcare, retail, and logistics, manufacturing, shipping, security among others. However, it is the retail industries that first saw, and continue to see the integrated opportunities in the technology. From records, Wal-Mart, Tesco, Metro, Target, Gillette and Marks and Spencer are some of the pioneer of RFID applications in their retail operations [4],[5].

Although, RFID has permeated significantly into products supply chains of retail organisations in the last one decade due to the sophistication on software and devices, determining accurate calculation for RFID return of investment, impact analysis across the sectors and its usage for sustaining and maintaining competitive advantage are still critical challenges [6]. These challenges are even of greater concern to retailers in apparel industries, which has so much invested in the RFID implementation and also to food industries that are to meet government regulations on food safety and quality. Consequently, recognising all derived benefits that the apparel sector has obtained from RFID performance and, comparing them with those of the food sector, both in the immediate and future terms contributes immensely toward the revelation of impacts across all products sectors, investment analysis and parameters for competitive advantage.

There have been a lot of researches focusing on RFID impacts, drivers for adoption in several industries, implementation challenges and benefits on retail and supply chain management of organisations, however, little research has been done to examine these related matters across different product sectors of retail supply chain. Therefore, this paper seeks to identify, analyse, evaluate and compare performance effects of RFID technology on the Supply Chain Management (SCM) of a retail industry using food and clothing sectors of Marks and Spencer as a case study since Marks and Spencer is among the first retailers that saw RFID potentials and has since been implementing it in its supply chain. Due to escalating cost of resources and the retailer's dealings in short shelf life products;

fashion and food, the researcher of this study is motivated to investigate and analyse the performance effects of RFID on the two products and see RFID performance at a retail supply chain management.

2. LITERATURE REVIEW

2.1 Supply Chain Management and RFID

[7] defines Supply Chain (SC) in concise and complete forms as: *"The supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer"*.

There has not been any clear definition and sample for retail supply chain, as different retailers adopt the one that suits their business operations. However, [8] defines retailing as *"...the set of business activities that add value to the products and services sold to consumers for their personal or family use"*.

Hence, retailers are the links between manufacturers or suppliers of products and services and the end consumer. Therefore a typical retail supply chain consists of the manufacturer, distributor, retailer and consumer. In this context retail supply chain will be viewed as consist of vendor, distributor, retailer and consumers. Therefore, the flow of physical goods, cash and information in retail supply chain follow the same traditional pattern. Picking, packing, warehousing and transporting are the major activities that are connected to a retailing supply chain.

Nowadays, retailing is conducted through many medium such as internet, direct sales or advertisement sales and not only limited to sales of products and services in store. Globally, there are threats retail industries faced in their supply chain; fast growing technologies, innovations possess opportunities and challenges, ownership and creation of unique brands as a result of strong market competition and pressures from consumers for better service and information delivery [1],[9]. Hitherto, retailers were not recognised as having impacts on supply chain decisions, but currently, retailer is now seen as another powerful member of the chain aside the consumer. The basis of the influence that retailers possess as mentioned above is their accessibility to information from consumers than suppliers, data that are generated from point of sale (POS) at the store level on every transaction.

The definition of Supply Chain Management (SCM) is seen as a concept that involves all processes of managing and planning sourcing, procurement and logistical operations in order to deliver superior customer value at less cost to the supply chain [10]. In today's competitive business, it is viewed as management of logistic activities as well as manufacturing operations, coordination of processes and activities with and across marketing, sales product

design and finance and information technology [10], [11].

Supply chain managers have been converting RFID technological abilities (such as non-line of sight readability, simultaneous reads, and unique identification) to their business benefits. Over time, supply chain managers have greatly realised an unquantifiable benefits from RFID applications in their businesses. These benefits such as, out of stock reduction, cycle time reduction, supply chain uncertainties reduction, and operational cost reduction, have provided them the needed strength to excel in their daily operations and avail them opportunities to compete favourably in the global business activities [12].

However, there are existing challenges in supply chain management which have been usual threats to the performance of SC of any firm. The three identified challenges and the solutions provided by RFID technology are briefly discussed in the following paragraphs:

The first identified challenge in supply chain management is 'Inventory Inaccuracy'. The difference between inventory in information system and the actual real life inventory is known as inventory inaccuracy which always affects firm's supply chain performance [13]. [13],[14] classified causes of inventory inaccuracy as transaction errors, shrinkage errors (theft, shoplifting and paperwork) and inaccessible inventory and supply errors. This 'inventory inaccuracy' frequently leads to unavailability of products for sale, increased/higher inventory cost, lost sales, inadequate updated inventories, overstocking and out-of-stock (OOS) situations [4],[14].

[14] reported that application of RFID technology can offer better product traceability through real time data capture properties that enable improvements in the supply chains against these inventories inaccuracy errors. Although RFID cannot eliminate all errors, errors can be detected quickly by considering the existence of this problem in planning processes, they can be dealt with effectively. [15], in their numerical experiment concluded that 47-65% cost savings and inventory visibility whenever RFID-enabled inventory management is implemented in supply chain. RFID technologies have been solving supply chain problems due to inventory inaccuracies by increasing shelf availability, inventory visibility of products and reducing product shrinkage [14].

The second identified challenge in supply chain management is 'Information Distortion or Bullwhip Effect'. This is a fluctuation and amplification of demand from the downstream to the upstream of supply chain. The main cause of this sudden increase is the lack of information sharing among the chain actors in supply chain. The demand variations of the customer become increasingly higher as they flow through backward in the chain [16]. [17] opined that RFID

applications therefore can decrease the bullwhip effect and improve supply chain performance by better visibility obtained through real time information of items and locations. It is equally observed through studies that lead time reduction using RFID possibilities can as well reduce bullwhip effect [17]. Overall, RFID technology can treat bullwhip effect by taking the chain as an entity as well as reduction in information distortion through data capture and real time-communication assets [17].

The third identified challenge in supply chain management is 'Ineffective Replenishment Policies'. In order to optimise customer satisfaction, replenishment procedures are very important methods for obtaining the size and number of orders [18]. It is from level of inventories in the information system that replenishment policies decisions are made. Inadequacy of replenishment policies sometimes leads to loss of sale, discounting items out of seasons and inaccurate stock level. Due to low or non-availability of products in the shelves or stores, the inventory will consume more money and time [14]. Therefore, an RFID technology allows real time inventory information to be obtained and ensures accuracy of inventory level [14], [19]. There will be an increment in the receiving throughput, and by managing the inventory automatically the inventory level are always known, as anything below the threshold of stock level, the system generates a replenish order. Replenishment reduces out of stock situation thus increasing sales and customer satisfaction and frequency and speed of replenishment are improved by RFID application in replenishment decisions [19].

2.2 Food and Fashion Supply Chain

Food and Fashion supply chains seem to be the commonest within the retail industries due to their characteristics and challenging situation to the logistics management of retail industries. These two retailing types are examined on the most commonly identified characteristics such as high volatility, short life cycle, low predictability and high impulse planning.

High Volatility: Consumers' demands for clothing items are very volatile and quickly changing. This is due to the fact that demand for fashion is dependent on life style factors like culture, movies, festivals, season and even music stars [20]. For food products, the demand is on the current taste of the consumers, other rival products of the same taste and use, and quality of the products and its storage life time [21].

Short Life Cycle: Food products like meat, milk, egg, produce are sourced from various location globally to satisfy customers, however, the life cycle of these products start counting from the they were produced or harvested and have a short shelf life cycle [22]. The resulting spoilage and fast expiration of these products are peculiar challenges of food chain. On the other hand, fashion products are designed from the first instance with the aim of capturing the feeling of the

customers within a specific time [23]. Here, it means fashion trends changes very quickly with time even a fashion can change overnight. Food life cycle is in days while fashion life cycle is seasonal.

Low Predictability: This feature is highly related to the last one, the high volatility of products demands. Due to rapid changing of marketing situation and pressure from other competitors, it is rather impossible to forecast the exact demand for food and fashion products during a particular period of time.

High Impulse Purchasing: Both products are often bought by the consumers without any pre-planned, but by the spur of the moment. This occurs primarily because of the feelings to satisfy first two basic necessities of life; **Food, Clothing** and Shelter.

As briefly observed above, the special characteristics of these products are creating in the logistics management of the retailing company a very challenging situation. Therefore, the product retailers cannot continue using traditional supply chain concepts and methods to make decisions, but to further and take into account how to optimise their chain activities with available solutions. This is because of special effects of these products in retail markets.

2.3 RFID in Supply Chain

Radio Frequency Identification (RFID) is a contactless, electronic and data capture technology that is made up of tag formed by a chip connected to an antenna, a specialised reader that gives out signals in form of radio waves and gets responses from tag by reading its memory, and middleware that links RFID device with organisation information systems [4][24]. Radio Frequency Identification (RFID) can be best described as a wireless storage chip that is attached to an object and its package for identification, tracking and tracing in a unique and real time manner without the need for line of sight [4],[5],[25],[26].

Due to the perceived benefits the retailers could get from RFID, its usage is considerably growing. Benefits such as operational efficiency, better visibility, cost reduction, enhanced security and customer service, information accuracy and increased sales. Tracking and tracing, inventory update and accuracy, cost and time savings and collaboration among members of supply chain are the possibilities from RFID usage. Several major retailers today envisaged capabilities of the RFID technology to better integrate and enhanced their supply chain, build on their efficiencies significantly bring down overall cost of operations significantly [9],[24].

Giant retailers like Wal-Mart, Metro, Gillette, Tesco, Marks and Spencer among others, are the pioneers of RFID implementation in the supply chain and are using RFID because of the potentials it possesses; reduced time to take inventory, improved inventory accuracy and customer experience and satisfaction [25],[27],[28].

According to a study reported by [4],[5] which

compared the benefit of RFID on SCM of US and Korean retailers, The study shows that data system automation is a key factor to improve inventory management for US retailers, while for Korean retail, it can improve the efficiency of the store operations and demand management; and that business strategic management is a main RFID benefits for both US and Korean retailers.

RFID applications have permeated so many industries, some of the common industries were highlighted and discussed in the studies of [4],[24],[25],[29]. In a survey of RFID applications by [25], RFID has penetrated into businesses such shipping and distribution, health, document management, toll collection, supply chain management, human and animal tracking; each sector with several potentials that RFID provides.

In the publication of [17], the author identified how RFID can aid in the drastic reduction of inventory inaccuracies, bullwhip effects and ineffective replenishment policy and other associated benefit like inventory visibility, shelf availability and better product traceability. [30], in their research on RFID adoption in retail find out that for retailers to tap effectively the RFID opportunities, these potentials must be situated within implementation choices of their business. For example, RFID enabled environmental monitoring is a benefit for food industry which may not applicable to shoe manufacturer. Moreover, [31] performed quantitative and qualitative cost-benefit analysis on RFID implementation in supply chain of pharmaceutical industry and concluded that RFID has provided anti-counterfeiting solution into the chain which assures genuineness of products and that return on investment (ROI) is realisable.

In a comparative study by [32] on RFID adoption in retail and manufacturing sectors, research findings revealed that better inventory management, improved security and customer service levels and increased sales are more significant benefit to retailer than manufacturer. The comparison equally indicate that tracking and tracing, automated shipping and receiving and, identifying shopping behaviour of customers and item tagging are supply chain activities that RFID is mostly used for in retailing supply chain.

Also, [33] quantified the performance evaluation of RFID applications in supply chain of printing industries and reported that item-tagging is the best form from which a retail business especially printing industries benefits in their supply chains. The authors developed a framework as a lookup table for evaluation of RFID performance in business supply chain. In addition, [34] concluded in his research that RFID implementation on the shop-floor retailing business is a panacea for survival, and creation of competitive advantages; the author equally said that if attention of RFID utilisation is shifted to marketing rather than sole concentration on logistics and supply chain, the business will survive and compete effectively. According to [27], proper

implementation of RFID can save time, material and money and make retail company more competitive for years to come, and the most valuable benefits a retailing supply chain can gain is in demand management, order fulfilment, supplier relationship management and return/recall management.

In their research report on 200 companies profiled and researched extensively for twelve years published by IDTechEx, [35] specifically reported that in retailing; especially apparel sector alone demands over 1 billion RFID labels which are the highest in comparison to other industries and that market for animals, food and farming will rise from \$1.17 in 2011 to \$4.09 billion in 2021. [6],[30] also contended that there are daunting challenges associated with RFID applications in supply chain; High cost of implementation, lack of Return On Investment (ROI), high efficiency of other technology, imperfect read rates of RFID tags, lack of in-house technical personnel to implement and maintain RFID system, incompatibility of RFID standards, material's special demands, difficult in installation and implementation, concerns regarding the compromise of data during transmission, uncertainty around security of stored data and physical storage sites, privacy concerns are potential for Government legislation.

Marks and Spencer, the case under study reported that they have been tagging 3.5 million trays and dollies of their refrigerated food supply chain with about 70% of the products of perishable in the chain; the company gained through RFID 83% reduction time for each tagged dolly, 15% reduction in shrinkage, a reduction lead time and also an inventory management [4]. In May 2013, Marks and Spencer has rolled out globally RFID in all its stores with the item tagging on all clothing ranges [36]. Research has equally shown that other retail giants like Metro, Target, Tesco, and others are greatly benefitting from RFID in their supply chains.

Improved product availability and ease of location enabled by RFID in retail shops have a significant impact on the inventory system, sales and customer satisfaction, as there is an improvement on the means personnel and customer locate items within the retail chain [26]. [30], in their research on RFID adoption in retail find out that for retailers to tap effectively the RFID opportunities, these potentials must be situated within implementation choices of their business. This shows that the benefit a retailer gets from RFID depends on its business type. For example, RFID enabled environmental monitoring is a benefit for food industry which may not be applicable to shoe manufacturer.

However, as earlier stated, and eventually found out from this review, it shows that no research has been done on evaluating the performance of RFID comparatively on supply chain of two products of a retail firm; clothing and food, the focus of this study. However, researches have been conducted on fashion

and food industries with respect to RFID applications but not on two products comparatively. The study therefore intends to fill the research gap identified. The outcome of the empirical study provides some insights from this retailer this research used as case study; Marks and Spencer.

3. METHODOLOGY

The research was carried out using a mixed method approach; the primary data in this study includes interview and observation while literature review sources and examination of archival sources which are secondary data form the basis of interview and give background knowledge for this research as well as case study. The researchers has carried out visitation and observation of two Marks and Spencer sites, a retail store and a depot, with a view to seeing how RFID systems are being used to manage supply chain of the case study. In this research, interview and literature search has been used to locate available facts and details of the case under investigation. Most of the documents are obtained from the company websites, newspaper articles, periodicals and journals.

Thematic analysis of the findings from the case study is done and the significance of each theme is quantified by the sources that referred them. These themes are further summarised into another codified themes for ease of analysis. Findings and themes from the study are further discussed, so as to ensure adequate background for conclusions and answers to research objectives. Firstly, the first case which is the food supply chain is presented and the investigation results are presented according to the methods and materials used. Thereafter, the clothing supply chain is presented and the results from data collected are presented as it is in food supply chain.

4. RESULTS

4.1 Food Supply Chain - Case 1

4.1.1 Document and Archives

'Marks and Spencer (M&S) had tagged 2.5 million of the plastic trays from 115 suppliers within a week for products delivered seven depots it uses to ship fresh and chilled produce around its supply chain, orders are processed faster, packing and picking errors and inaccuracies are significantly reduced' [36].

Also, Ian Mumby, head of food logistics, speaking at food business forum in Barcelona in 2008 remarked that more than 100 firms are supplying six depots using plastic cases with RFID labels. He equally reported that the RFID technology which has read rates of 98% at tray level and 89% at pallet level has proved robust. He equally added; scanning of products as they go out to shops has also reduced wasted stock through improved accuracy. This implies that suppliers also are always 100% certainty of number of trays and class of products they have dispatched. He further remarked that each

tagged food crate has a seven year life, making the technology cost effective but that M&S was years away from tagging individual foods [36]. He gave an instance of worldwide fruits which increased its deliver accuracy from 95% to 99.8%. The delivery accuracy to M&S depot was so accurate that their shipments were not even checked on receipt and payment was made on advance shipping notice. More than 4.5 million trays and 500 dollies are now being tagged with RFID used by M&S with one million tags being read per week [36].

Another supporting evidence, In M&S Annual report 2013 shows that the company's food business accounted for 45.2% of the total turnover of £10.9bn in 2013, an increase of 3.9% above 2012 [37]. This implies that RFID usage in the food chain among other business factors accounted for the significant contribution of the turnover. A brief look at the total revenue of M&S is presented in **Table 1** and graphically represented as shown **Figure 1** below.

Table 1 Showing Contribution of Food Sector to M&S Revenue (Source: [37])

	Q1	Q2	Q3	Q4	Annual
Clothing	-5	0.2	-2.1	-2.6	-2.4
Home	-6.1	-1.4	-2.5	1.4	-2.2
General Merchandise	2.9	0.1	-2.2	-2.2	-2.4
Food	2.9	3.9	2.7	6.3	4.5
Total	-0.9	2.1	0.3	2.6	4.1

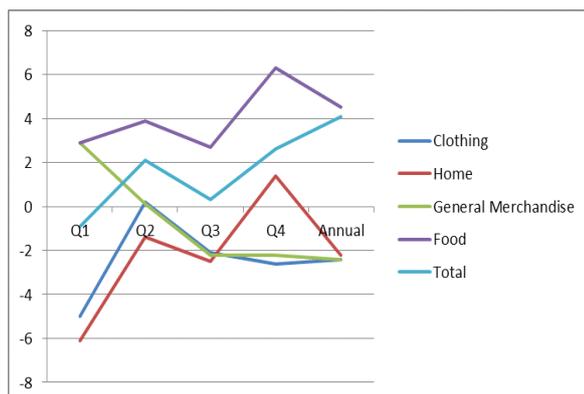


Figure 1 Showing Contribution of Food Sector to M&S Revenue (Source: [37])

4.1.2 Interview

In an oral interview with **Depot Manager** on August 14, 2013, he said that with RFID, there is an improved throughput and accuracy as food crates are sorted automatically. This is made possible as suppliers now

write to tags which have detailed information of food items. RFID has also greatly assisted in reduction of spoilage and contamination in food items and in guarantee customer health and safety as demanded by government legislation. In fact, at the depot here, there is a better delivery and receiving throughput as well as faster scanning process of pallets at receiving and discharging points. RFID technology is really beneficial as it reduces time and cost of supply chain activities such as sorting, picking, and transporting within the depot. He, however, declines comment on whether the firm recoup savings from investment on RFID applications.

Store manager in an interview said that food products are accurately tracked of temperature, humidity and expiry dates. The food safety is guaranteed and customer fulfillment is highly achieved as products are always available for consumption and that order and replenishment are on established trends. However, inventory control and replenishment are unlike clothes because items are not individually tagged, manual efforts are used to take inventory of food products and shrinkage and spoilage incidents are high. He believes item tagging if considered is the best form from where M&S can get more value on food products, as it is the most contributors to M&S's revenue in the last three years despite competition from rival companies. Reading rates of tags on crates of foods are not 100% at the receiving point which he noted is a challenge to full availability of product information. In his additional comment, future item tagging of food products will improve information availability to item level to facilitate is sharing within the chain and for coordination.

Logistics/Receiving manager (Store) said that RFID introduction has reduced inventory cost and poor demand forecast of products. He further revealed that with gate like readers, hundreds of several crates of food that used to take a day to receive and sort now take 2 to 3 hours to receive, sort and make available on the shop floor. More importantly he said tagged reusable pallet saves money and time, improve receiving process and promote green solutions. By virtue of his position, he affirmed that RFID is incredibly beneficial in product visibility, improved sales, availability of varieties of items and revenue enhancement. He further said if individual food items are not tagged, the shelf or crates can be tagged in the shop floor that can trace a missing item, alert for replenishment and notify if expiry dates of products are imminent. Information that are gathered at the receiving point are automatically shared with all participants in the chain and served as a reference point for ordering and management. He too said reading rate accuracy of food products with metal containers is still an issue.

IT manager (depot) in an interview session with the researcher remarked that RFID has provided the firm with highly accurate information, automation method of data capture, enhance safety of food as well as the

efficiency of food supply chain. There is an increased efficiency in receiving at the depot, and picking, packing and shipping to the retail stores. Simultaneous reads of several items make scanning of pallets and cases faster, contactless of items with RFID reduces data entry errors and provide real time information. Most importantly minimal human effort requirement as sorting are done automatically, this in turn saves time, money and enhance inventory control. In his final submission, he said, passive RFID tag captured information about food condition from supplier to the store, enable cost effective tracking and traceability of food items as they moves from the supply chain. Temperature sensing and data logging RFID tags performs greatly in cold chain management. Information about each food products are gathered and sent to government agency responsible for food quality and standard. He however, the costs of RFID components are still too expensive and that the top management can only know if the investment on RFID project is profitable.

4.1.3 Observation

At the depot managed for M&S by GIST, a logistic company, it is quite amazing as hundreds of thousands of food pallets meant for 105 shops which upon inquiry by the researcher were meant for South East of England, London and France are accurately, efficiently and quickly sorted out. As pallets move through the mobile reader, product information, required temperature in the transport, shelf live dates, stores to be delivered are automatically capture on the enterprise applications.

At the store, the receiving point where RFID technology is utilised in getting cases at a fast rate; the receiving throughput is high and scanning process is accurate and take less time and people for inventory control. However, it is not used in taking items to the floor and stocks them on the shelves. At the shop floor, several food items were still seeing on the shelf spoiled, others are out of stock for hours without restock and many products especially meat, bread, milk and juice have on their barcode label dates of expiration that have passed and are still found on the shelves.

4.2 Fashion Supply Chain -Case 2

4.2.1 Document and Archives

According to Sachandi Berandi, M&S head of clothing, the firm was unable to offer customers the garments they wanted in the style, colour, and variation [36]. As a result, customers have the potentials to leave the company. At that time also, the company's forecast was unreliable as it depended on POS information which was only available after few days of sales. As a follow up to successful trial of RFID at pallet level for the clothing products alongside the food chain, the firm believed RFID could act as a springboard.

Sachandi was reported to have further said with a partial funding support from UK's Department of Trade

and Industries, as part of New Wave Technology Programme, M&S first tagged 10,000 individual items of men's suits, shirts and ties between October 13 and November 7, 2003 at its High Wycombe store near London. In the item-tagging trial period, 7,000 of the tagged items were sold. These items were tagged with what M&S called "Intelligent Labels" i.e. RFID operating at 868 MHZ [38]. Sachandi Berandi, head of clothing was reported to have said that the overall effects of RFID tags 'intelligent labels' for the customers have been not only in technology, but also in the massive increase in availability that they had seen on the shop floors.

Mr. Statuart Senior, IT director at M&S, that after the trial, the automatic tracking of stock gave a perfect outlook of the goods the firm have on the sales floors and in the warehouse [38]. The ultimate aim of the firm is item tagging, therefore, supplier were convinced to use RFID label on each clothing items so as to get further RFID benefits like better stock accuracy, improved availability of products, better replenishment and even accurate tracking of stock in the backroom. He said *'if we can have an improved data, we can replenish accurately'* [38]. A report that a cost of tag at the trial was 30pounds (30p) as RFID has not been commercially viable then. With the RFID usage, the financial results of M&S showed that sales for six months to the end September, 2006 of £3.9bn up by 11% on the same period in 2005.

Benefits from item-tagging as remarked by Stuart are that staff carried out in-store inventory more quickly and more frequently than in the past. In a press release by M&S on June 8 2006; individual stores are said to be reporting improvement in sales from using RFID technology resulting from item tagging.

James Stafford, Head of RFID project at M&S also emphasised that item tagging will give opportunities for improvement of visibility of the supply chain, from garment production to its arrival in-store [36]. Despite the potentials of item tagging, there were issues of consumer privacy, security and cost of item tagging, and read rates of the readers available.

In a press conference by Kim Phillips head of M&S packaging, he emphasised that RFID is the most beneficial in the high value departments of the firm, where there are complex sizing requirements, such as suits and tailoring, as it allows management of stock levels better visibility and right mix of products on display [36]. As claimed by Stuart Senior, head of IT; *'With RFID, inventory on shelves is readily visible, ensuring prompt restocking; inventory throughout the store, from the fitting room to the backroom is also visible. Even stock out and lost sales are reduced as each item can be traced to wherever it is. Over all, improved customer satisfaction and loyalty by delivering an improved customer experience. Items are in stock and available, and easy for employee to locate even if they are misplaced or in the fitting room. With*

the item tagging of cloth items, 100% inventory accuracy and visibility is achieved' [38].

At present M&S is using billions of tags supplied by Avery Dennison to tag its cloth items. In the future, M&S planned to expand the use of RFID scanning throughout the supply chain when it comes to increase accuracy and speed of distribution [38]. This worked so well that the firm reported that approximately 10 million RFID-tagged trays are now constantly shuttle around M&S supply chain [36].

In M&S Annual report 2011, p28 that the company's clothing business accounted for 45.2% of the total turnover of £8.7bn in 2011, an increase of 6.9% above 2010 [39]. This implies that RFID usage in the cloth chain among other business factors accounted for the significant contribution of the turnover. A brief look at the total revenue of M&S is presented in **Table 2** and **Figure 2** respectively.

Table 2 Showing Quarterly and Yearly Percentage Contributions of Clothing Section to M&S revenue (Source: [39])

	Q1	Q2	Q3	Q4	Annual
Clothing	-5	0.2	-2.1	-2.6	-2.4
General Merchandise	2.9	0.1	-2.2	-2.2	-2.4
Food	2.9	3.9	2.7	6.3	4.5
Total	-0.9	2.1	0.3	2.6	4.1

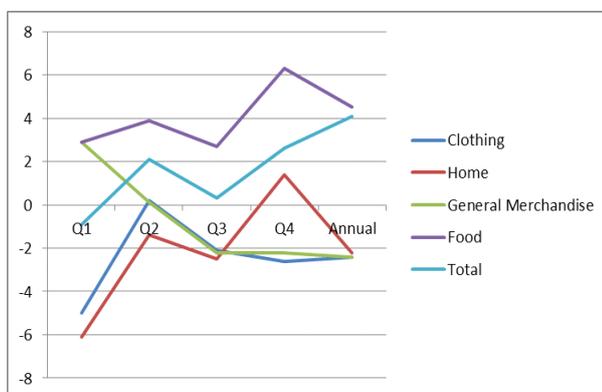


Figure 2 Showing Contribution of Clothing Sector to M&S Revenue (Source: [39])

4.2.2 Interview

Store manager informed the researchers that all fashion products irrespective of their prices are RFID tagged. The only exceptions as at the time of the interview are jewelries. This is as a result of reading problems of RFID on metal objects. He said in order to ensure stock accuracy on the shop floor, readers are used for scanning. He mentioned the key drivers of the RFID tagging as the need to reduce operational cost, stock accuracy, and minimisation of shoplifting

incidences. Interviewee also said clothing sector of M&S is getting the greatest benefit on RFID. He also gave information that M&S suppliers bear the cost of tags. To the store manager's point of view, it is incredibly beneficial in terms of inventory and finances. Scanning processes is tens of times faster with RFID system than it were with barcode scanning. In fact, the item tagging of clothing items has made inventory accuracy to 100% perfect. He wishes that in future, the checkout procedure in the store should be RFID enabled. Another issue at the moment he knew is that cost of item tagging is high.

Logistics/Receiving Manager (store) remarked that due to item tagging of individual clothing products, the receiving process is becoming much easier, as information about each product is known at the point of delivery to the store. The size, type and colour of each product are known and enable inventory and replenishment planning in the store. Products are tracked from the depot to the store and forecast of products to order is simpler and that backroom shelving is efficient. In his opinion, Out Of Stock (OOS) situation is significantly reduced and shelf availability of product to customers is improved. To him if by considering the benefits RFID has provided to cloth supply, M&S has greatly recoup from its investment on RFID. As per drawback of RFID, cost may be the only issue associated with RFID implementation.

IT manager (depot) opined that the RFID has been fully integrated into the clothing products. Each clothing items has RFID embedded in it and can be uniquely tracked wherever in the supply chain. In his own belief, automation of processes by RFID has helped greatly in product visibility, traceability and strengthening of supply chain. He however said incompatibility of RFID tags from different suppliers is a concern and that cost of individual tag on clothes is still expensive. Fake or counterfeit products insertions anywhere in the supply chain are prevented and visibility of items in the store ensures that right items are available at the right time to increase sales and protect profitability. He believes RFID may replace in future, the barcode technology.

4.2.3 Observation

In receiving schedule at the store observed by the researchers, cases containing 380,000 clothing items in 50 pallets were scanned using fixed readers, and information about each items were captured, scanning process that were said to be 1.5 hours for such a receipt only took 56 minutes. The reading rate was accurate and the items arrangement in the back store was efficient as clothing items were clearly packed on the shelves and racks initially labeled for them. The scanning at the receiving point was by one person rather than four people that were reportedly doing so earlier.

At shop floor, the simultaneous reads of several items make stock taking faster, the read rate on items is 100% accurate, and RFID reduces human errors and provide

real time information. In fact, minimal human effort requirement as sorting of items on the shelves and racks are done automatically, this in turn saves time, money and enhance inventory control. Several items can be conveniently tracked and scanned from 2 metres away from the scanners.

5. ANALYSIS OF FINDINGS

This section gives the analysis of the results from the last section which include findings from the interview, document and archives and observations in relation to a few major themes identified for RFID performance at M&S food and clothing Supply Chain. **Table 3** shows the identified themes and their occurrences in the materials and methods. It is evident from the table that at least two out of three sources have all the themes common to them while observation is the one with some missing themes.

Table 3: Research Themes from the Empirical Results

Themes	Materials and Methods		
	Interview	Archives	Observation
Improved and real-time inventory visibility	•	•	
Better shelf availability of products	•	•	•
Improved asset tracking and tracing	•	•	•
Reduced shrinkage and theft	•	•	•
Enhanced product quality and safety	•	•	
Reduced labour cost	•	•	•
Increased revenue and sales	•	•	
Reduced OOS situation	•	•	
Improved consumer safety, health and satisfaction	•	•	
Increased automation	•	•	•
High cost of implementation	•	•	
Privacy issues	•	•	•
Government regulations	•	•	
Materials' Special Demand	•	•	•

However, the missing themes from observation have

not invalidated the findings from the other two sources wherever the misses occur. As the researchers' observational limits to some confidential information have resulted in some of the missing themes.

In addition some of the themes when aggregated still led to single effects of RFID performance. The research themes earlier highlighted are further summarised for ease of analysis and discussion under the headings in the following section. As such, the qualitative analysis and evaluation for this study is stated in the summary section.

In the next section, detail analysis of the themes will be done on comparative forms on the two cases which results were earlier presented in the last section.

5.1 Analysis of the Themes

5.1.1 Supply Chain Coordination and Integration

It is observed from the previous section that improved food safety and quality and higher alertness to consumer health are the more significant benefits of using RFID applications in the food chain by M&S than in comparison to cloth chain. Improved quality control and visibility of shelf life of products emerged to be real benefits M&S have gained from RFID utilisation in food supply chain. RFID-enabled information gathering abilities on all food products as they move down the supply chain as required by law for safety and quality is a great benefit to food supply chain.

Better inventory management, brand protection, anti-counterfeiting and improved availability of products in trends, styles and sizes, and automation of replenishment process and improve security against theft are benefits more significant to the cloth sector than the food sector. Visibility of each clothing item due to RFID tagging of products up to item level is equally an exclusive benefit to cloth department.

Tracking and tracing within the supply chain to achieve real time visibility, shelf availability of products, OOS and reduced shrinkage and customer satisfaction, reduction in lead time are of equal importance for both sectors. Increased throughput at the delivery points in DC and stores, and automation of manual process like picking and put away are positive outcomes of RFID usage in both sectors.

It is also found from the results that RFID implementation in cloth gave a better real-time visibility of each item to all supply chain actors than food which only gave visibility at cases level. Coordination of food supply chain as identified in the findings is less coordinated than cloth as regard item tracking and identification, however, food product monitoring to the shop floor is the motive of RFID coordination to prevent spoilage and contamination. Meeting up government regulations and environmental conditions are activities that make food chain demand increased coordination and integration. Hence,

improved coordination and integration of supply chain which RFID provides, on perishability of products is less important to cloth than food if product life span is a criterion. The problem of materials' special need for RFID is a greater concern for food chain coordination as the water contents of food products affects read rate compare to cloth where read rate is 100%.

5.1.2 Cost

The scanning accuracy and speed of RFID system on receiving and in-store handling has further eliminated cost of human errors, provide savings in cost and time for labours. Cost savings in time and money are found to be equally important for food and clothing chains. Food sector saves more cost for tagging than clothing as their products are not individually tagged, while clothes spends more as they are individually tagged. Manufacturing costs of cloth will have included cost of each tags sewn onto them, whereas a cost of tag on pallet of food products is assumed to be shared by products in the crate. Tags on crates for food are reusable while on individual cloth are not reusable. So reusable of tags saves more money for the firm from RFID implementation than cloth. Imagine the loss from non-reusable tags in several millions of cloth items produce by this firm. Though, item tagging of cloth is money consuming, the return on investment in term of money and time in a longer term is positive as currently being seen in inventory management and supply chain coordination.

Sales revenue is enhanced resulting from RFID implementation by both products but for 2011 and 2012 as shown in **Figure 1 and 2** in the result section, food products contributed higher percentage to M&S total profit in 2013 while it is just 0.1% behind cloth in 2011.

In summary, RFID performance effects are seen on operating income of M&S retail supply chain for food and cloth, (refer to **Tables 1 and 2** respectively for references). As can be seen from the tables, cost of tagging especially for clothing is seemed to be eating deeply into the balance sheet of Marks and Spencer especially in annual report of 2013.

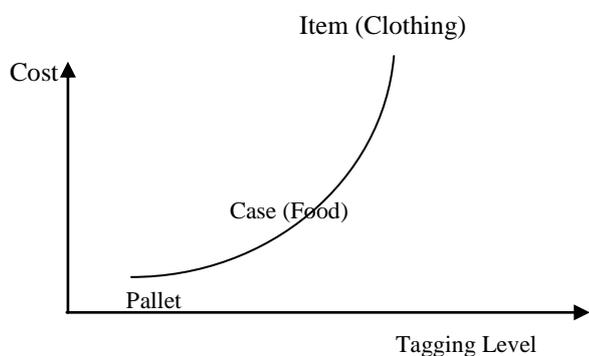


Figure 3: Showing Relationship Between Tagging Level and Cost (Source: Authors)

As the cost of implementation is a challenge to both sectors, food sector seem to be spending lower in term of using RFID tags and environmental sensors in the

chain up to case level as compared to clothing sector that implement to item level.

The graph (**Figure 3**) further confirms the above statement and the reason cost of implementation which majorly including tagging is higher for clothing than food. But despite the cost, the item-level identification and the outstanding benefits derived from it is quite significant.

5.1.3 Information Sharing

One of the significant performances of RFID technology in Marks and Spencer supply chain is the degree of information sharing among the retailer's supply chain actors. The firm is able to provide demand forecast of products thereby leading to reduction in OOS, and further enhance supply chain efficiency. This is achieved as a result of real time availability and visibility of inventories, customers' demands and product information to supply chain communities. Marks and Spencer realised more benefits by using RFID tagging on cases and products and more data are becoming available. There were also efforts to address the consumer health and safety and privacy challenges by Marks and Spencer and national legislation by provision of information on products to all stakeholders. Such efforts are given more importance by food sector when compared to cloth sector. Though, product recall/return is easier in clothing if compared to food, as tags information on cloth items is available at POS while food products case tagging ends at the store receiving point and information not available at POS. Food sector has more information to share than clothing sector; as information such as expiry date, quality certification, chemical components, temperature range, shelf life of products are far more important to share in food supply chain with all actors than any information for clothing. So, food chain information sharing needs make it to benefit more from RFID information sharing potentials than clothing.

Information gathering and sharing ability of RFID system has aided both sectors in their replenishment and shelf availability of products to satisfy their customers the more. Demands forecast for both products are enhanced by RFID application; this has a great positive effect on reduction of overstock and out of stock situation for retailer. As information is shared effectively in the retail chain, spoilage rate in food is reduced and provision of clothing items in sizes and style is optimised. As earlier said, it is observed that information sharing facilitate tracking and tracing of products especially environmental conditions which in anyway is of more important to food than cloth if the shelf life and nature of products is considered. In addition, availability of information on customer shopping behaviour is a task of more specific interest to clothing than food, because clothing is in trends, sizes, shapes and colour and choices of customer are important in order and replenishment activities. Lastly, information availability on each item is uniquely peculiar to clothing, which makes information

availability in real time accessible to all supply chain stakeholders with no application yet on food items.

5.2 Analysis of Cost and Benefit of RFID

For data protection and confidential reasons, M&S did not provide the real value of ROI on RFID application over the last years. However, it is evident from the results, that overall, a positive result has been obtained from the case study due to RFID usage in its supply chain. Nevertheless, analysis of the costs and benefits will adopt explanatory, exploratory and analytical forms and assumed numerical data will be used. The analysis of RFID cost and benefit will take the form of qualitative and quantitative evaluation; the point of contact in this report, that is distribution centre and store will be used as reference.

5.2.1 Qualitative Analysis

Firstly, the cost is analysed:

Initial investment = Hardware cost + Software cost + Planning cost

Service Cost = Training cost + Installation cost + Support and Repair cost

- Hardware cost majorly consists of RFID tags, readers, scanners, antennas and other supporting devices.
- Software cost consists of middleware, ERP, WMS, POS and others
- Service cost includes Software installation, staff training, system upgrade and maintenance and technical support

Secondly, the benefit is analysed:

Benefits are picked from both process and cost benefits and are highlighted below:

- Process benefit: better inventory visibility, automatic replenishment, Increased customer satisfaction, improved productivity, reduced OOS & shrinkage, Anti-counterfeiting, improved asset tracking and so on.
- Cost: Increased sales and revenue, positive ROI, reduced inventory cost, time and labour savings and so on.

5.2.2 Quantitative Analysis

In this section, all figures are assumed for analysis only.

Cost is first analysed:

- Cost of Tag (CoT): Assume the unit cost of Active tag (UcT) is 30 pounds and the total number of cases received at the store in a week is 50 and say it is constant for the year;

The total tagged cases (TgC) = 50 * 52 = 2600 tagged cases

$$\text{CoT} = \text{UcT} * \text{TgC} = 30 * 2600 = 78000 \text{ Pounds}$$

- Cost of Reader and Antenna (CoR): At the receiving point in the store, one mobile reader is used to scan the cases as they are being accepted into the store. Suppose the cost of one mobile reader is 6000 pounds.

$$\text{CoR} = 6000 \text{ Pounds}$$

- Cost of Software (CoS) = Say CoS = 3,000 Pounds

- Cost of Service (CoSe): Training cost, installation cost, maintenance and repair cost; assume 10,000 pounds annually.

Initial RFID project cost at store is approximately:

$$\begin{aligned} \text{CoT} + \text{CoR} + \text{CoS} + \text{CoSe} &= 78000 + 6000 + 3000 + 10000 \\ &= 97000 \text{ pounds} \end{aligned}$$

Then Benefit:

- Receiving into the store:

Recall from observation (in 4.2.3), assume the store receives 50 pallets of products per week, and per labour work time is 1.5hrs and 4 labourers are required and wage for the labour is 6.19 pound/hr.

The savings in time 4hr 4 mins, with 3600 = 1hr and 60s = 1min, therefore time savings in seconds is $(4 * 3600 + 4 * 60) = 14,640$ seconds

The store saves in cost (SC) = $(14,640 * 50 * 6.19) / (3600 * 1.5 * 4) = 209.20$ Pounds

- Inventory of Received Products: Assume the quantity of inventory as taken daily as observed is 7500 units of items, the time of inventory of received goods is weekly and 4 times in 30 days.

- Therefore the store saves in cost (SiC) = $14640 * 7500 * 6.19 / (3600 * 1.5 * 4 * 30) = 1048$ Pounds

- Resources Management: Suppose the benefits of resources management cost (RC) is 5,000 pounds per year.

- Total savings by the store in one week = $\text{SC} + \text{SiC} = 209.20 + 1048 = 1257$ Pounds

If this store operates effectively and RFID was in good condition for a whole year,

$$\begin{aligned} \text{Annual savings in cost (AsC)} &= (1257 * 52) + 5000 \\ &= 70,364 \text{ Pounds} \end{aligned}$$

In the second year, if the savings in cost is constant, the store would have saved close to double of the first year savings and the supply chain activities will have been further enhanced, giving the store additional benefits. Therefore from the case study result and this analysis, both food and clothing products have had a positive return on investment (ROI), the quantification of RFID benefits after being deployed in Marks and Spencer, not only cancel out the cost of RFID project, but also

provide noteworthy gains, due to improve in supply chain operations. Results from this cost and benefit analysis are summarised and as shown in **Figure 4**.

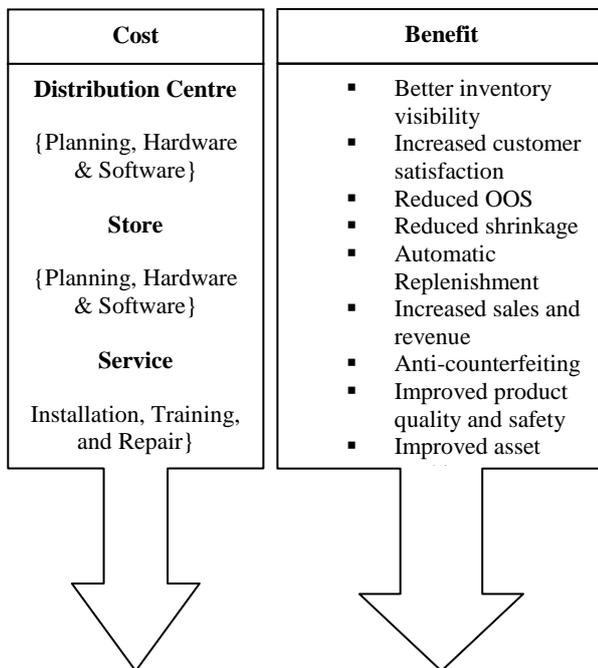


Figure 4: Showing Summary of Cost- Benefit Analysis of RFID (Source: ‘The Authors’)

6. DISCUSSION

The analysis section (section 5) has carried out a strong and rich evaluation of RFID performance in the retailing supply chain of Marks and Spencer. The evaluation of the case study has shown that the company has obtained substantial benefits from the use of RFID on management of food and clothing supply chains, all under integration and coordination of supply chain, information sharing and cost. In addition, peculiar benefits to each product chain investigated out of the RFID usage have been quite significant in processes improvement and in cost reduction.

Better availability of products in sizes, colour and shapes is a major benefit the fashion supply chain has derived from RFID performance. Enhanced coordination of cloth supply, information value of item tagging and reduction in inventory cost has proffered a lasting solution to supply chain bottlenecks as experienced by the fashion department prior to RFID implementation. Therefore, cost is greatly saved and loss is significantly reduced. Improved security and loss prevention are part of the significant contributions of RFID technology in the organisation and one of the compelling reasons for using the technology in SCM of Marks & Spencer. The business considers RFID as the lasting solution to product security to avert loss due to theft, spoilage and non-availability of products.

Food security from contamination and spoilage has been a potential RFID offer to the food chain. Supply

coordination and integration and sharing of information among chain actors have undoubtedly improve food safety and reduce products losses and cost from the loss. For clothing, losses from sales and thefts have been seen as prime factors of utilising RFID securing abilities in the supply chain. Marks and Spencer, having embedded RFID tags into the clothing items, counterfeiting action is eliminated, and if their customers are aware of this, they will make it an obligation to check for authenticity and differentiate Marks & Spencer products from the counterfeit ones and therefore adds as a competitive advantage and this reduces the incident of less quality substitute products.

It is obvious that opportunities realised by Marks & Spencer from RFID implementation such as improvement in businesses activities and processes are as observed in the existing literature. In both cases analysed, there has been a great improvement in inventory management, and productivity, labour cost reduction and supply chain efficiency. More so, in both cases, a value is placed on flexibility and accuracy within each supply chain activities. Inventory accuracy can better the replenishment policies of the two products, and real-time visibility and anti-counterfeiting is optimised when the information is effectively shared among supply chain actors. Improved food safety and quality as seen from the analysis seems to be the best of all benefits the food chain gained from RFID performance. Supply chain coordination and integration provided by RFID implementation is seen to eliminate food wastage and/ or contamination which are the main challenges food chain of the examined case were hitherto experienced. This results in cost savings and loss prevention.

The company had witnessed positive outcome from the first RFID trial on food chain and on pilot scheme on clothing in the early days of adoption. It is indeed from the first pilot that M&S realised increased in sales which ultimately resulted in positive return on investment (ROI) of time and money, this result refutes the claim in the literature that considers ROI as a drawback to RFID implementation. This further implies from the case study that RFID has the abilities to give quick return on investment on whatever product supply chain it is deployed. Contribution of the food chain to the firm’s revenue is a glaring evidence of positive ROI even when not on item tagging with RFID. In addition, clothing sector that has been the main focus of RFID tagging up to item level has indeed given the company the best supply chain efficiency it ever imagined. Positive ROI from these two chains has brought the best results in terms of increased profitability and competitive advantage. From the above illustration that cost-benefit analysis of RFID in the case under focus, shows that RFID benefits outweighs the investment.

The paybacks that Marks and Spencer has realised from RFID technology performance on its businesses can be illustrated using two criteria: first, the company operates an integrated retailer supply chain and second,

the company has different prices for its products which are from low to high. As per the first criterion and from the findings, the RFID implementation in the depot and the stores has been successful and innovative for the products, because, there has always been a better integration and collaboration among the several supply chain units. Hence, it is easily identified that RFID performance in Marks and Spencer has been very positive and excellent as it is an integrated firm like other case earlier mentioned in literature, Wal-Mart, Tesco and Metro Group, where successes had been recorded and competitive edge had been attained. Secondly, the prices of products determines the choice of RFID tagging as the price value of clothing products are from medium to high and added cost per item is low and still the company will be able to make gains and that of food products are within the low range, and with case tagging, profits are still being earned; inventory visibility and traceability of clothing item for clothing items and food products are assured. This is an expected result since ultimate aim of business is profit as mentioned in various literature sources, not just of RFID alone. Hence, RFID performance in the firm on both food and clothing has been very profitable for M&S based on the results and will, possibly, continue to be valuable. Despite the huge investment on the RFID deployment, the firm has been using its gain from the technology to get value for its business and be on competitive edge.

Improved productivity and time savings are other benefits that the retailer has realised from RFID solution in food and cloth. This is joined to the realisation of supply chain coordination, as product are delivered at the right time to the right time while, productivity, arguably enhances supply chain efficiency and decreases time and cost of operations. Improved productivity gives benefits to consumers as it can lower the cost of goods sold. In fact, this benefit is important as it brings competitive gain to business in market share. Here, it is seen how competitive advantage is gained by the retailer.

The perfect accuracy level of inventories in cloth and food are quite amazing. Few labour services are required in the management of supply chain for both products and less money require for labour cost. Item tagging is being found to give the highest accuracy, best product visibility and most superb supply chain coordination; this is deployed in cloth items and is missing in food items. Major challenges identified with RFID integration into the food chain is the lack of present technology to individually tagged food products, the read rate effects of food items on RFID and sharing of valuable organisation with food safety regulatory agency. While for cloth sector, high cost of item tagging is the associated challenge.

The assertions and discussions in the paragraphs above have fulfilled the overall paper aim of analysing, comparing and evaluating RFID performance on retail supply chain as seen from the research outcomes. By

and large, effects of RFID technology performance on the Marks and Spencer's supply chain management of food and clothing hover around coordination and integration, information sharing and cost savings. Other opportunities that Marks and Spencer has derived can be viewed as a flow from the trio.

7. CONCLUSIONS AND FUTURE RESEARCH

In this study, the main purpose has been on the evaluation of RFID performance on the supply chain management of retail industries, with a focus on food and clothing supply chain of Marks and Spencer. Therefore, this research summed up all findings from the case study investigated and sieve out the three major and common performance effects of RFID on food and supply chains, which are integration and coordination of supply chain, improved information sharing and cost reduction.

From the research findings as relates to food and clothing supply chains, supply chain coordination is quite significant to inventory control and management and contributes in no small measure to supply chain efficiency. Research study also indicates that food supply chain gave quick return on investment, save huge cost from wastage and spoilage and that its tagging level is cheap. However, this report suggests item tagging be deployed in food items with a view to get more benefits than it currently presents as provision of food item information can further enhance safety and quality and in turn eliminates completely food wastage. Findings further showed that clothing sector incurred higher cost in item tagging, but the overall benefits is outstanding in SCM and revenue generation resulting from shelf availability of products and increased sales. Item tagging made chain coordination, information sharing and cost savings more realisable from RFID than any other tagging level.

RFID applications facilitate fast and reliable information flow in both product sectors with food being discovered to need information to be shared quickly within the chain, as for instance a food contamination is a more serious supply chain crisis if compared to even thefts of clothes. What is more, each sector has priorities and benefits, for information flow efficiency, which RFID is providing at Marks and Spencer. Evaluation of cost to benefit indicated that benefits that RFID system offer to retailing supply chain management are found to outweigh the cost of implementation; investment return was seen to be quick and immediate. It is quicker as seen from the study in food products than in clothing items. However, the ideal approach in order to get the best performance of RFID from the findings is to employ item-tagging mechanism on all products as inventory visibility and real time information about each product is uniquely available to all supply chain stakeholders as witnessed by Marks and Spencer. This gives further chances to sustain and

maintaining competitive advantage. In addition, due to the business type of Marks and Spencer, the case study can be a useful reference for other organisations in the same industries that have implemented RFID and see how the technology performs on different product types and their supply chains.

In essence, the performance of RFID technology on better coordination and integration of supply chain of these different products is similar only with few different supply chain activities as point of their interests. RFID performance as observed from the case study has been so great and innovative, though there are still challenges of implementation especially on tagging of food items which could bring the best return to business; and cloth tagging which embedded tags which are really meant for security but are still being seeing as violation of privacy. Lastly, special handling of products, RFID read rates on products and tagging level are part of identified drawbacks of RFID performance on retail supply chain. Additionally, the quality of data gathered, though reliable, was not as outstanding as expected as some of the interviewees' familiarity and understanding with the RFID technology were not detailed.

Furthermore, the current study has only investigated RFID performance on food and clothing retail chain and within just an organisation. RFID and supply chain management are such broad fields that cannot be covered fully in a single research of this nature. For applications in other retail industries, further studies could build on this research outcome and investigate the comparative study of RFID performance in two or more retail industries in the same or different countries with broader data collection methods to obtain their similarities and differences. Near future possibility and retailer's gain of RFID embedment into individual food items is a challenge especially on read rates which is worthy of further research, and to see how food chain

wholly benefits from RFID technology.

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