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FROM THE FACTORY FLOOR TO THE SHOP FLOOR – IMPROVED SUPPLY CHAIN FOR SUSTAINABLE COMPETITIVE ADVANTAGE WITH ITEM-LEVEL RFID IN RETAIL

Abstract.*Technological innovations change our lives at a very fast rhythm and, many times, they can have the same effect on the way businesses are carried out.Industrial development is triggered by the changing consumption and production patterns. But in some cases, it takes a while until the right use of a new technology is found and until it can bring the expected benefits to the activity. This is the case of RFID tagging, that started in the 1990s at a pallet and case level and had not bring the major improvements people expected. But the discovery of the item-level tagging brought significant benefits to the retail industry, from the manufacturing stage, the logistics, to the shop floor presence and until the product is bought by a client, sometimes even for after sale warranty. This paper intends to analyze the advantages brought by the RFID item-level tagging to the retail business. After an introduction that covers shortly the history of the RFID use in manufacturing and retail, the authors will define the RFID worldwide market and will explain the numerous ways in which this technology can be used in different industries. The third chapter of this paper will establish the business value of RFID in supply chains in retail, based on examples of success stories. As this technology needs to be implemented by all actors across the supply chain, the analysis will not only focus on the retail level, but will also evaluate the benefits of using RFID in logistics and in manufacturing operations. In conclusion, the paper will reveal arguments in favor of RFID implementation at an item level to all actors across the supply chain, as it can represent a starting point for every professional intending to improve its retail business.*

Keywords.*Supply chain management (SCM),Manufacturing operations, RFID, Technological innovations.*

JEL classification: O30, O33, L20, L81

1. Introduction

Technological innovationsimprove our lives many times without us being aware of it. But if you enter a Decathlon store and want to buy a sport outwear, you will be amazed by the fact that the cashier just needs to pass the pieces of garment over the cash register without scanning anything or that you can go to an automatic register, scan yourselves the products and pay without speaking to anybody. This is possible due to the introduction of RFID tags on almost all references sold in this network, that just need to be read from a distance by a special machine.

This is only the advantage of the RFID tag that we can see for ourselves. This technology is now implemented in order to trace a product from the factory floor to the shop floor, bringing numerous benefits to the retail industry, especially the garment one. More and more apparel retailers choose to use the RFID on their products, this technology bringing increased profitability, visibility, security, cost savings and better client service to any supply chain (Florea, 2015). Also, this technology can help companies adapt to changing consumption and production patterns, as customers are more aware of environmental issues. For example, sustainability concerns in the fashion and clothing sector have letto a number of non-governmental organizations and business-led initiatives towards more sustainable production and consumption patterns (Markkula and Moisander, 2011).

The history of RFID is not a lean one. The technology dates back from the 1940s but only during the 1990s manufacturers and retailers found it useful and began to implement it, Procter&Gamble and Wal-Mart being amongst the first companies to adopt it. Seeing the dimensions of these two companies, analysts would have predicted a great future to this technology but soon it began to show its drawbacks. A McKinsey report of 2011shows that in the early days, RFID reader reliability was far worse than originally expected, necessitating manual inputs to correct for reader errors (McKinsey Global Institute, 2011). Also, the per-tag costs did not decline as quickly as anticipated and thus companies didn't reach the economies of scale they predicted at the beginning. Furthermore, there are some natural limitations to the use of RFID, as metals and liquids effectively block radio waves (Gaukler and Seifert, 2007). Moreover, this technological innovation may have encountered resistance from organizational buyers, as do the diffusion of many new industrial products (Bao, 2009).

Nevertheless the technology improved during the last couple of years and RFID is seen more and more as a competitive differentiator. In a survey conducted by Accenture (2012)for the Voluntary Interindustry Commerce Solutions Association (VICS) in 2012, more than a half of the companies questioned had already implemented/piloted item-level RFID, the benefits being better inventory accuracy, visibility, and insight, enabling them to improve in-stock positions and increase sales.

In fact, the RFID tracking at a pallet or case level is not the answer. It is the item-level tracking, as seen in the Accenture survey, that can bring a lot of benefits to the retail business, as part of the company's information system. Information

systems are technological innovations created and used by companies, but is necessary for them to understand the organization(Allen, 2000). Furthermore, Logistics Information Systems can help companies be more dynamic and manage the collaboration and relationships all across the supply chain (Imeri, 2012).

As companies have just started for a few years to implement item-level tracking, many professionals are not yet aware of its benefits. This article intends to analyze the advantages of item-level RFID but also the implications of the implementation, as this technology must be used by all actors along the supply chain, from the manufacturers, the logistics companies to the retailers. The field literature has not covered until now this subject in an extensive manner, so the objective of this article is to gather all information from white papers, articles and works in the field, industry surveys, but also from success stories of item-level implementation. In this way, the second chapter of our article will define the RFID worldwide market and will detail the numerous ways in which this technology can be used in different industries. The third chapter will establish the business value of RFID in supply chains in retail, based on examples of success stories. As this technology needs to be implemented by all actors across the supply chain, the analyse will not only focus on the retail level, but will also evaluate the benefits of using RFID in logistics and in manufacturing operations. In conclusion, the paper will be able to supply arguments in favor of RFID implementation at an item level to all actors across the supply chain. The objective of the authors is to supply the professionals in retail business with a basis to work on in order to improve the efficiency of their activity and to show them that this new technology can bring them advantages in many ways.

2. Application of RFID in Business and Industry

Many people never heard of RFID but they are seldom confronted to it, especially when they bought a pair of jeans and forgot to cut off the big square label. That big label contains a RFID tag that will be detected by readers when entering a store and this will trigger an alarm.

RFID comes from radio-frequency identification which uses radio-frequency electromagnetic fields to transfer data. The purpose is to automatically identify and track tags attached to objects. The system used consists of three components: a tag, a reader and back office data-processing equipment. There are several types of tags; the IDTechEx report(2015) divides them into five types: passive RFID, battery assisted passive, active RFID, Real Time Locating Systems (RTLS) and chipless RFID.

Although the technology is not new, dating since the 1940s, the application of RFID in manufacturing and supply chain began to be implemented after the 1990s. Attaran(2007) stated that the application of RFID in supply chain was new in 2007. But as a lot of companies discover the benefits of using this technology, the growth rate of this industry had been very important during the last 8 years. The research company IDTechEx(2015), which has tracked the RFID market since 1999, finds that in 2015, the total RFID market is worth $10.1 billion, up from $9.5 billion in 2014. In retail, the application of RFID adopted for apparel tagging will demand 4.6

billion labels in 2016. Also, RFID in the form of tickets used for transit will demand 800 million tags the same year. In total, IDTechEx expects that 8.9 billion tags to be sold in 2015 and 10.4 billion in 2016.

This technology is already implemented in many industries due to factors like: mandate from major retailers, supplier collaboration, and the pursuit of perfect demand information (Attaran,2007). RFID has useful applications in a lot of fields, as follows:

- Transportation and logistics – In order to control costs, increase productivity, and improve customer satisfaction, companies are interested in keeping track of goods through the entire distribution process. With the aid of RFID, companies can accurately track every item throughout the supply chain and improve efficiency, saving hours in cross docking, yard management and pick-up and delivery operations(Intermec, n.d.).
- Manufacturing sector – Manufacturers use this technology mainly for tracking parts all along the assembly line, this being useful when implementing the JIT (Just-in-Time) management. Zelbst et al. (2014) find that RFID technology coupled with ERP systems enable manufacturers to become more efficient by eliminating wastes associated with managing raw materials, work in process and finished goods inventories.
- Retail industry – A Motorola 2010 white paperpresents the advantages proven by the implementation of RFID in retail: inventory accuracy, loss prevention, logistics benefits, customer-facing applications. The paper argues that this technology can bring 99,9% inventory accuracy, 60%-80% reduction in out of stock, 75%-92% faster counts, among many other benefits (Motorola, 2010).
- Agriculture – Due to state regulations on food traceability, players in the fields of agriculture, cattle and food production benefit from the RFID technology as it enables capturing product location information nearly at no labor costs (Kelepouris et al., 2007). Also, RFID is an effective technology for tracking products in supply chain as it can provide real-time information on the inventory, logistics and the freshness in the cold chain, helping to reduce manual labor activities as well as theft and misplacement incidents of the food products(Shi et al., 2010). In cattle production, farmers use electronic tags to improve the accuracy of the records and remove the human error in tag reading, individual identification helping them to discover the superior animals in the stud(Allflex, n.d.).
- Health care – RFID tags allow greater accuracy and speed for tracking assets in health care environments, enable automatic calibration for sophisticated electronic devices, can decrease errors and provide appropriate validation, positively influencing patient outcomes and enhancing staff safety. Also, health and medical facilities can improve infection control processes by effectively tracking reusable assets and verifying cleaning and sterilization procedures(HID, n.d.).

- Public sector – Governments have been using RFID for many years in fields like military asset management, environmental monitoring and personal identification. But nowadays we can see an expansion from military and security applications into a greater number of civilian- oriented projects, such as medical services and the environment(Edwards, 2009).
- Pharmaceutical – Certain medications need to be kept within certain temperature ranges when transported, and RFID solutions can track and monitor shipments, log temperature data and send it in real time to the transport company, that can take action before the product is harmed(Greengard, 2015).
- Library & Document Management – Solutions based on RFID provide identification of books and media for public and academic libraries with applications in library collection inventory, item search, self service loan, self service return, and library collection security management(Invengo, n.d.). Also, companies that need to store a lot of files, like law firms, turn to RFID technology to identify and track the legal files. A 3M implementation at a law firm in Boston increased accuracy in locating files from 35% to 98%(Collins, 2004).
- Security industry – RFID implementations can be used in order to enforce security in a lot of areas: military and defense, ports, hotels and casinos, control stations, borders, schools, banks, prisons, buildings, refineries, tunnels, subway.

3. Business Value of RFID in Supply Chains in Retail

3.1. RFID – from pallet tagging to item-level tagging

The history of RFID changed a lot during the last couple of years due to item-level tagging. At the beginning of the implementation of RFID in supply chain and retail business, suppliers tagged pallets and cases of products, which would have given information only during the transit activities. Once the products arrived on the shop floor, they were taken out of the cases and thus, they were no longer tracked. This is why for a long period of time retailers and suppliers stopped putting much emphasis on this technology, even if in the 90' everybody was very interested in it.

The solution was in fact item-level tracking and this is what is happening now. One product can be followed from the production stage, through the transportation and cross-docking and on to the shop floor, until the moment it is bought by a client. Sometimes, the RFID can even be used after the sale, for exchange or warranty.

The opportunity to start using RFID must be embraced by all the actors involved, from the manufacturer, the logistics companies to the retailers, who must approve of this investment. Accenture (2012)suggests a simpler way to begin thinking about this opportunity is to consider the increased sales, as pilots showed that the technology is having a big impact in reducing stock-outs and related missed sales opportunities, thus increasing sales.

A 2004 survey done by two Harvard professors showed that no less than 31% of the buyers that didn't find the product they looked for will go to another store to buy it. Corsten and Gruen (2004) studied survey data from more than 71,000 consumers in 29 countries to learn how clients react to stock-outs. When they can't find the product they look for, clients usually do one of the following: buy the item at another store, substitute a different brand, find a substitute of the same brand, delay their purchase until the item is back on stock, don't buy the item at all. Depending on the product category, 7% to 21% of consumers will continue shopping but won't buy a substitute for their desired item at the store and 21% to 43% will actually go to another store to buy the item. The study suggests that retailers can lose nearly half of intended purchases when customers encounter stock-outs.

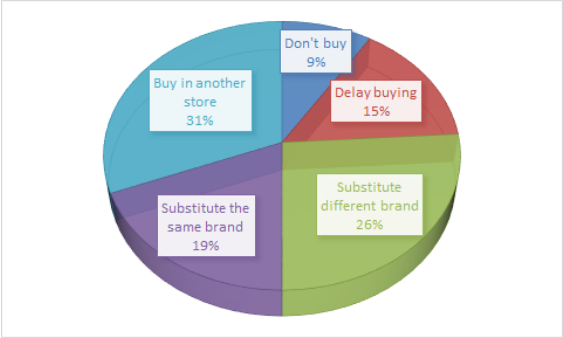

Figure 1.Consumer response to stock outs
Source: Corsten and Gruen (2004)

Thus, retailers and suppliers can be easily convinced by the benefits of item-level RFID just by doing a simple estimation based on mathematics. A lift of sales of only 4% is necessary to break even the RFID investment, as the total variable cost of tagging each item is 20 cents (cost of tag material + labor) and the average unit margin in a category is $5(Accenture, 2012). The same surveys show that revenues are usually increased by 10% after a RFID implementation.

In order to better understand the level of implementation of RFID in retail, we have chosen to analyze four store networks that use this technology successfully.The companies were chosen after an extensive research which regarded the following: articles from economic international journals and online databases, information from the specialized websites, internet research. These companies were chosen for following arguments. Decathlon and American Apparel are international retail companies, present in many countries along the globe, with implementations of RFID in many of their stores. Both companies sell products under their own brands and manage the entire supply chain. Macy's and Bloomingdale's belong to a big American retail group and were included in a study on RFID implementation. The authors have also chosen a small company, GIKS, a Belgian retailer for the degree of implementation, as the company uses this technology not only in the stores, but also

in the distribution center. The success stories were elected taking into account the degree of implementation and the willingness to communicate the results obtained.

Decathlon

Decathlon is a French retailer of sport equipment and outwear, present in 21 countries and having no less than 884 stores worldwide. Its turnover was in 2014 of 8.2 billion Euros, covering no less than 20 brands and almost all sports that a client would like to practice(Decathlon, 2015).

Decathlon already deployed a RFID implementation, starting 2011, in all 262 stores in France and is beginning to do the same in the other countries where it is present.

American Apparel

American Apparel is one of the most important retail company in the world. Its 2015 annual report states that the firm has no less than 10,000 employees and operates 239 retail stores in 20 countries and a global e-commerce site serving over 50 countries worldwide(American Apparel, 2015). The company is vertically-integrated, acting as manufacturer, distributor and retailer of branded fashion basic apparel. American Apparel manufactures domestically, thus enabling them to more quickly respond to customer demand and changing fashion trends, and to closely monitor product quality. This vertical integration makes it easier for this retailer to implement the RFID technology all along the supply chain, which it has been doing since 2012.

Macy's and Bloomingdale's

The Macy's and Bloomingdale's stores belong to the same American group, owning no less than 885 locations in US. In 2009 two Bloomingdale's stores were included in a study conducted by the RFID Research Center at the University of Arkansas and in 2011 they began to implement RFID on a broad national scale (University of Arkansas, 2009).

GIKS

GIKS mode is a Belgian fashion retailer owning 6 stores and a distribution center, and planning to open its seventh location in 2016(Swedberg, 2015).

Although the suppliers are the first actors that need to implement the system from the manufacturing stage, in most of the cases the retailers are the ones taking the decision and thus triggering implementations all along the supply chain. The analysis will thus start with the retailers.

3.2. Benefits of RFID in retail

The companies that we are analyzing found the following benefits to using the RFID technology at an item level.

Decathlon discovered that the use of RFID allows the stock adjustment with more precision in order to respond to the client's needs(Decathlon, n.d.). Also, the following advantages are emphasized by Decathlon: accelerated passage at the cash desk in stores equipped with RFID readers, reasonable prices due to lower costs (storage, transport, less theft), improved after sale service (the exchange of products

becomes possible with the payment ticket), more security (less theft means lower prices for the products).

Almost all products sold in the Decathlon stores are now tagged with a RFID system: apparel, shoes and non-metallic accessories. Since 2014, no less than 85% of the products were tagged from the factory and the percentage will be of 100% in 2017, according to Patrice Ribout, project manager. Also, the store staff can use the 'inventory rackets', which allow a precise and complete inventory, recording all the useful information (model, size, color, stock). The inventory can be done five times faster than before.

According to Swedberg(2013), **American Apparel** completed in 2012 an ongoing installation of a RFID system at all of its stores, consisting of fixed readers in the store room, as well as at the storefront entrance and at the point of sale. Employees also periodically utilize handheld readers to track which items are on the shelves. This system ensures full reading coverage and, due to the dividing of the store into zones, the software can determine in which zone the tag is located. If a customer tries on a garment and leaves it at a wrong place, the staff members can quickly locate it and return it to its location. The software also informs on the out-of-stocks, as a certain tag is no longer read in the store area. At the beginning of the implementation, in 2011, after having deployed the technology in more than 50 stores, Stacey Shulman, VP of Technology, stated that the system improved inventory accuracy up to 99.8% but also reduced employee theft. Internal shrinkage had declined by an average of 55%(Roberti, 2011).

In 2009 two **Bloomingdale's** stores were included in a study conducted by the RFID Research Center at the University of Arkansas. The study showed an improvement in inventory accuracy and a big reduction of 96% in cycle-counting time. It took two years for the management to decide, but in 2011 they began to implement RFID on a broad national scale with an emphasis on basic size-intensive replenishment categories so the company can ensure that all appropriate styles and sizes are properly in place on the selling floor and available for sale. Recent pilots showed RFID's ability to significantly improve sales, gross margins and markdowns by better leveraging inventory counts that are real-time and accurate (Business Wire, 2014).

According to Swedberg(2015), the Belgian fashion retailer **GIKS mode** has already deployed a RFID system at its distribution center and six stores to track its inventory from the distribution center to the point of sale and is planning on expending the implementation. Goods are tagged with chips from the factory and are scanned by staff members when arriving at the distribution center and then, when arriving in stores. Thus, the information about the stock is updated in the ERP system. When an item is sold, the ERP system is informed and it will automatically create an order for replenishment. Since the introduction of this system, the inventory was done with less errors and it was easier and more accurate. Before this system, the company conducted one inventory per year, at a cost of 12,000 euros and multiple days of manual counting. That cost will be virtually eliminated, as each

store's manager will be able to accomplish the same thing on a weekly basis in about 1.5 hours. The readers can count 30,000 items within about 45 minutes.

As seen before, the international consulting company Accenture conducted a survey in 2012 on item-level RFID on behalf of the Voluntary Interindustry Commerce Solutions Association (VICS)(Accenture, 2012). No less than 58 suppliers and 56 retailers in North American were questioned on the benefits of RFID implementation. Over half of the suppliers surveyed have implemented or piloted item-level RFID. The survey confirmed that many executives across the entire retail supply chain are convinced that item-level RFID can improve efficiencies and boost sales. The benefits were devided into operational and financial one. The operational benefits were: better inventory accuracy (99%), inventory visibility and insight, improved in-stock positions, shorter inventory periods, decreased inventory shrink rates, beter delivery control, reduced need for inventory adjustments. The financial benefits were: improved efficiencies, sales boost (at least 14%), real time visibility into business processes, better profit margins, cut transportation cost. The report also stated that the cost of RFID tags would continue to fall, as the rate of adoption increases and most major apparel and footwear retailers would adopt RFID technology in some part of their business within the next 3-5 years.

Another international consulting company, ABIresearch(Liard, 2009) details the benefits of RFID in the fashion apparel and footwear sector: shortened physical inventory processes and decreased need for human intervention. Also, amongst the reduced labor cost benefits, the elimination of out-of-stocks is the most important value proposition for adoption item-level RFID. If the technology is used to support in-store applications, this leads to additional top-tier value proposition. The same report points out the fact that an worldwide market of an estimated 15 billion pairs of shoes and 10 billion fashion apparel items means rising costs associated with conducting manual inventory of these items and thus, it is becoming more efficient to track them with RFID.

In a 2010 white paper, the company Motorolagathered data from its own and its partner implementations and presented the benefits of RFID tagging at item level: (1) reduction of out-of-stock by 60 to 80%; (2) better inventory accuracy between 98% and 99.9%; (3) reduction in cycle count time by 75% to 92%; (4) reduced inventory carrying costs by 30% to 59%; (5) reduced receiving time up to 91%; (6) improved conversion rate up to 92%; (7) increase units/transaction of 19% and $/transaction by 6%; (8) increase sales from 4% to 21% (Motorola, 2010).

The benefits of item-level tagging in retail store are inventory related benefits (improved inventory accuracy, reduced inventory management labor, reduced out-of-stocks, just-in-time replenishment, improved stock flow, reduced inventory carrying costs) and customer satisfaction benefits (efficient returns management, improved customer service, faster checkout, information-rich shopping).

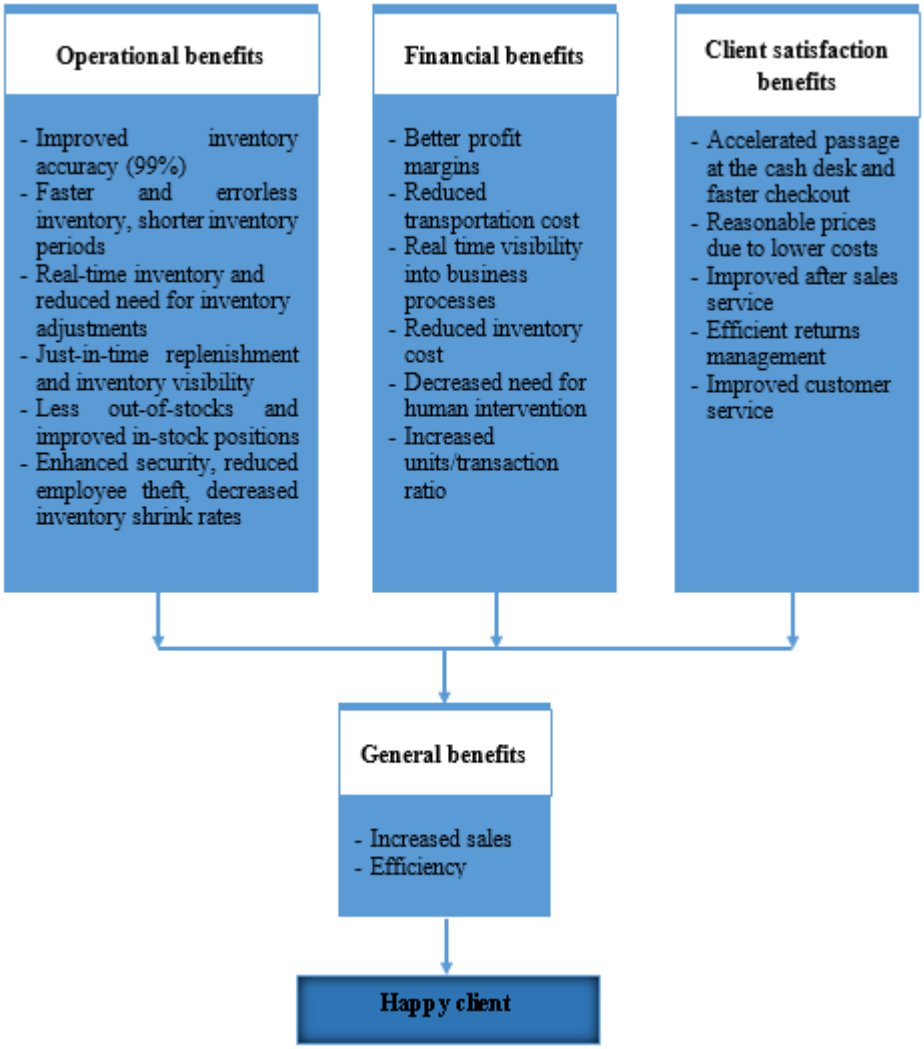

Figure 2.Benefits of item-level RFID in retail

The Motorola white paper also states that using the collective information from several systems like bar code scanning, payment terminals, inventory management, loss prevention and people counting can lead to improvements in many retail operations that create efficiency and improve margins. Also, RFID together with counterfeit protection and intelligent EAS (Electronic Article Surveillance) can help business track and authenticate products, saving considerable costs due to shrinkage and illegal activities.

After analyzing all this information and all these sources, we have summarized the benefits of item-level tagging in retail and divided them into three segment categories: operational benefits, financial benefits, cutomer satisfaction benefits, all

these leading to general advantages, like the improvement of the company's turnover. The detailed categories are shown in Figure 2.

After a thourough examination of Figure 2, a retail professional can be convinced that this technology can only bring improvements to its activity but he still needs to bring in his partners and make them accept this implementation, as the tag must be incorporated into the product from manufacturing. Thus, we will continue with the analysis of item-level tagging all along the supply chain, namely in logistics and manufacturing, in order to give this professional the right tools to convince his partners.

3.3. Benefits of RFID in logistics

According to the 2012 Accenture report, GS1 EPC standards, endorsed by VICS, increase visibility and efficiency throughout the supply chain and improve quality information flow between companies and their key trading partners.

We have detailed previously the implementation of RFID tags by **Decathlon**in their stores(Decathlon, n.d.). In order to achieve the benefits that we have analyzed, Decathlon implemented the technology all along the logistics chain. All the warehouses in Europe, and soon from the other geographical zones, are endowed with instruments to read the chips: tunnels on the conveyors, masts allowing the scanning of an entire pallet, readers at the entry of the sorting machines. This tracking covers all the chain, from the manufacturing to the shop floor, to the client's hands who can erase this trace when they pass the cashier desk. For those who want, the chips can be deactivated on demand (by a sales person, a security agent or by the client himself by putting the product in a special case). The time benefit, and thus the cost benefit, is considerable as all the logistics chain is followed.

Another example of RFID in logistics is given by the retail chain **GIKS**, that we have seen before. According to Swedberg(2015), the implementation of RFID at the distribution center proved an unexpected benefit, as the workers can now test each bar-code label before a garment reaches a store. Before, a faulty bar-code label, such as one that couldn't be scanned, wasn't usually discovered until it reached the point of sale. The company has also in plan to install a fixed RFID reader gate at the distribution center to make tag reading automatic.

The 2010 Motorola white paperalso gives us information on the benefits of item-level tagging in distribution and logistics like increased inventory visibility, lean inventory management, electronic proof of delivery, shorter invoice and payment cycle times and improved shipment accuracy. Item-level tagging provides a level of visibility that helps eliminate shortages, disputes and costly write-downs. These benefits are important as, according to Cârstea and Păun(2013), the activity of supplying material resources must be managed with the same efficiency as the activity of selling to the customers.

3.4. Benefits of RFID in manufacturing operations

The first actor that must implement an item-level RFID tag is the manufacturer, the supplier. Studying manufacturing plants in US, Zelbst et al. (2012) pointed out

that RFID utilization, facilitating the acquisition and sharing of information, positively affects manufacturing effectiveness and efficiency, leading to improved organizational performance.

RFID tags enable complete mapping and visualization of the extended lean enterprise, helping managers to identify improvement areas such as better inventory management and better manufacturing planning and control for supply chain management (Powell andSkjelstad, 2012).

A study made by Ngai et al. (2012) shows that RFID technology can help enhance the operational visibility, efficiency and effectiveness of the garment manufacturing process. Companies who need greater production flow visibility can gain a better understanding of what is going on in the production flow and have better coordination of employees on the factory floor. The study showed operational improvements that helped decrease operational costs and enhance profitability. The improvements were the following: increased production line visibility, reduced machine down-time, less non-working time for sewers, lower defect rate, less late delivery, reduced amount of overtime. Also, this implementation helped uncover previously hidden problems, like poor coordination among departments, and provided more accurate data for performance evaluation and payroll calculation.

According to the Motorola white paper (2010) item-level RFID can also bring benefits in manufacturing like the improvement of decision making, the decrease in workloads, better decision making, and the increase in efficiencies that drive down costs and provide a competitive advantage, especially for the SMEs (Ceptureanu, 2015; Motorola, 2010). A more detailed list of advantages is given:better raw materials forecasting/management, improved shipping verification, streamlined financials, increased automation via WIP/Kitting, reduced counterfeiting for enhanced brand protection and product authentication, reduction in concealed shortages.

4. Conclusions

The history of RFID shows us that although a technology might not be the answer to all problems, it can eventually find its place in some fields of activity and bring numerous benefits to it. After analyzing several sources of information, scholar and business derived, we have come to the conclusion that the item-level tagging can only bring benefits to the entire supply chain, from the manufacturer, the logistics companies, to the retail. The manufacturer can enhance the operational visibility and efficiency and the logistics companies can earn time and cost benefits. The retail companies are, in fact, the ones gaining the most from this technology with advantages in three main areas: operational and inventory related, financial and customer satisfaction improvements, all leading to better results for the company, like improved turnover and better profit margins.

The implementation of such a system requires all actors on the supply chain, from the manufacturer, the logistics company to the retailer to adopt it. We have seen from the examples above that, until now, big international companies have taken into it as they were in the following situations, whether they manufactured on their

own the products and they could implement the system on the entire chain, or whether they could pressure the suppliers to adopt it due to the big volumes acquired. In both cases, these companies were successful because of the strength given by the big volumes of products sold.

Thus, this study only covers the implementation of RFID by companies with great volumes of products moved along the supply chain. SMEs and companies with small volumes are not included because of the following limitations: this kind of implementation is not very developed among this category and small companies dot not communicate easily their findings. A further research based on a questionnaire analysis could shed some light on this matter. Also,this future analysis will discover whether this system can be easily adopted by small and medium companies and what would be their challenges. As technological innovations can generate sustained competitive advantage, this kind of analysis would provide them with an interesting tool.

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