
The Strategic Importance of Supply Chains and the RFID Radio Data Identification System

Submitted 10/08/19, 1st revision 15/09/19, 2nd revision 22/10/19, accepted 11/11/19

Katarzyna Witczyńska¹

Abstract:

Purpose: The paper presents the issues related to the process of supply chain management. It presents the essence and classification of supply chains and the interpretation of global supply network management.

Design/Methodology/Approach: Using systems theory as a basis, a RFID utilization and outcome(s) performance model was developed from the literature. The study uses surveys conducted among twenty companies in the 2016-2017 research year. Enterprises that use RFID technologies in the supply chain were analyzed.

Findings: The Findings indicate that application of RFID technology leads to improved manufacturing efficiency and manufacturing effectiveness, while improvement in efficiency lead directly to improved organizational performance, and improvements in effectiveness lead directly to improved supply chain performance.

Practical Implications: Certain policy implications and obligations accrue are companies that use RFID technology in their supply order to manage the company more efficiently.

Originality/Value: The publication presents the results of research carried out in enterprises using the new RFID system as a modern technique of supporting supply chain management to increase the efficiency of cooperation throughout the entire supply chain.

Keywords: RFID technology, supply chain performance, manufacturing efficiency, Radio frequency identification.

JEL codes: O40, C23, O52.

Paper type: Research article.

¹Uniwersytet Wrocławski, Instytut Nauk Ekonomicznych, katarzyna.witczynska@uni.wroc.pl

1. Introduction

Through analysis of current international business development and the importance of the supply chain, three key stages can be identified. The first stage begins at the end of the Second World War and lasts until the end of the 1980s. It is characterized by a dynamic increase in foreign direct investment (FDI) and the creation of transnational corporations (TNC), and thus intensifying the market globalization process. The increase in international trade and the emerging needs of transport and storage have initiated the development of international logistics as a specialized field of knowledge and profession. After the breakup of the so-called "Iron Curtain" the period between the beginning of the 1990s and the end of the 20th century marks the second stage of the development of international business. It was characterized by further internationalization of business operation enterprises.

After the year 2000, we can discuss the third stage of international business development, where economic regionalization processes grew and expanded, accompanied by the intensive phenomenon of enterprise relocation. The result of these processes is the separation of places of production or processing of goods from places of their consumption. This separation is the reason for international supply chains. The concept of the supply chain is relatively new.

Oliver and Webber (1992) introduced it to the dictionary of logistic terms in 1992, replacing the previously used term: "*logistics and operational management*." International supply chains are collections of interdependent logistics processes implemented in individual links to coordinate the flow of goods, financial resources, and knowledge from the locations of raw materials to the final recipient. International supply chains perform strategic functions for international companies. The strategic nature of the international supply chain results from the possibility of analyzing and shaping it in terms of the competitiveness of enterprises, which are its links, and the competitiveness of a group of enterprises composed of all participants in the chain.

2. From Supply Chains to Global Value Chains

The supply chain is a network of suppliers, producers, wholesalers, and retailers, performing the functions of supply, production, storage, and distribution. The supply chain consists of a network of factories and contractors which supply raw materials and components, then convert them into semi-finished products and components. Finally, they produce the end product and enable consumption by the final consumer. Transport and storage are vital elements of the supply chain. All literature definitions point to three basic characteristics of the supply chain: subject structure, i.e., clearly distinguished entities participating in the supply chain; the basis of flow understood as products, materials, goods processed, and transferred through subsequent links in the supply chain, objectives, functional scope, and areas of cooperation of participating entities.

Enterprises in any supply chain must make decisions, whether independently or jointly in five areas: Production, Stock, Location, Transport and Information. The collection of these decisions defines the scope of possibilities and efficiency of the supply chain. The most commonly described goals of the supply chain in terms of logistics are: minimizing costs resulting from the flow of goods and information while maintaining a high standard of customer service, short delivery times, trouble-free flexible delivery, optimization of inventory with adjustment to market needs.

The development and implementation of the management idea that goes beyond the enterprise bring new opportunities to reduce costs, increase the level of efficiency, and create the potential for the company's future success. Heskett (2001) showed this opinion is based on the observation of real cooperating companies along the so-called supply chain. Considering the nature of the supply chain, we have to take into account the fact that the term "supply chain" is often replaced with the term "supply network," and instead of the logistics chain, we discuss the logistics network (Witkowski, 2004). This is due to the observation of an economic relationship, in which flows between enterprises are usually not linear, but occur between many dependent producers and distributors.

The idea of creating functioning economic networks consists of competition and formal or informal cooperation of many companies between where there are no clear subordinate relations. According to Jarillo (1991), central coordination conducted by a large company to increase the efficiency of the network as a whole has been recognized as one of the features that characterize this organizational system. On this basis, the logistics network can be understood as a group of independent companies competing and cooperating to improve the efficiency and effectiveness of product flow and providing information following the expectations of customers. Many authors recommend that logistic networks be analyzed from a systemic point of view. Jahre and Fabbe-Costes (2007) suggest that supply chains should be referred to as networks when logistics processes are carried out in more than one supply chain.

Supply networks consist not solely on the flow of goods and accompanying information, but also cash flow. The concept of the supply chain is a broader concept than the term supply chain. Supply chains, characterized by central coordination of flows, constitute a special case of the supply network. Supply networks can have different hierarchical systems and types of relationships between their participants, which are defined as links by the network theory. There are different types of logistics networks. For example, the classification, according to Witkowski (Witkowski, J. Supply Chain Management), will be presented below:

a) Polycentric networks:

- Local, based on personal contacts;
- Supply, based on technical ties;

- Supplies based on equity;
- Virtual, based on information ties.

Table 1: Types of organizational configuration of the supply network

| Supply networks | | | | | | |
|---|---|------------------------|--|--------------------------------------|-----------------------------------|--|
| Polycentric | | | | Hierarchical | | |
| Local networks based on personal contacts | Supply networks based on technical ties | Equity supply networks | Virtual networks based on information ties | Coordination by a production company | Coordination by a trading company | Coordination by a logistics or brokerage company |

Source: Jarosław Witkowski, *Theoretical foundations of supply chain management*, Warsaw PWE, Warsaw 2003, pp. 20-21.

b) *Hierarchical networks* (with a central coordinator) where further differentiation depends on the nature of the coordinator's enterprise: production, commercial, logistics, or brokerage (information intermediary). Table 1 shows examples of a supply network.

Business benefits to companies due to the use of the supply chain:

- Obtaining valuable information thanks to the SCM systems used, which collect, process, and then provide ready information to the market;
- The quick response caused by a seamless flow of information about changes in supply chains and outside of it;
- Savings generated by better planning of supply, production, or distribution;
- The supply chain has a synchronized mode of operation;
- Reduced inventories due to the use of JIT (just in time) methods, i.e., synchronizing production plans with suppliers, which results in lower stock;
- Reliability in delivering goods to final buyers.

Ensuring the exchange of information between all cooperating units is also one of the primary conditions for activities in the supply chain. The most important types of international supply chains are:

- 1) Predatory, agile supply chains, demand-driven chains where all links are skillfully and quickly adapted to current demand, and in conditions of hyper-competition.
- 2) Hybrid - connecting various links of the chain in a horizontal arrangement, e.g., supply management link, suppliers directly with the needs of customers in a fast and coordinated manner.
- 3) Green supply chains that connect all links with reverse logistics and waste disposal.

4) Viable supply chains where the supply is dynamically equalized, e.g., using transferring production links to a country with low costs of producing goods or services.

5) Product supply chains created as part of the product integration of the international supply chain, mainly for a narrow range of goods or services, moving in an exclusive distribution channel.

Management of the global supply network should focus more on improving management and distribution efficiency by improving efficiency and effectiveness, rather than supply chain management.

3. The International Supply Chain: The Case of IKEA

IKEA is an enterprise that can serve as a role model in the global supply chain. The IKEA supply chain includes the following processes: product conceptualization and design, sourcing of raw materials and components, purchases, production, distribution, transport, and, in the final stage, retail sales in individual stores. Key elements of the IKEA supply chain: large volume, effective use of transportation (no empty transports), efficient and effective product flow networks on a local and global scale, the concept of flat packaging - eliminating empty spaces, which minimize the negative impact on the environment.

The system created by IKEA optimizes all flow processes in the enterprise, whose logistics chain is expanded to form an extensive network. It eliminates waste of time, materials, inventory, or space while contributing to customer satisfaction, who receives the product faster and at a more favorable price. While minimizing costs, the IKEA logistics system ensures that the customer meets his/her needs and achieves his/her satisfaction with the products and services used.

4. Supply Chain Management

For the first time, the term "supply chain management" appeared in literature in 1982, and was initially associated primarily with the reduction of inventories within the enterprise and the companies cooperating with them. The creators of this concept are considered Oliver and Webber (1982), who wrote about the supply chain in the context of the role that the top management of international companies should play in recognizing conflicts, the goals of various functional areas of the organization that cause an uncoordinated flow of products, information and financial resources (Christopher, 1982).

One of the first definitions of supply chain management in the logistics context (Witkowski, 2003) was the definition that was planning, coordinating, and controlling the flow of materials, parts, and finished products from suppliers to recipients, which include two separate flow streams (materials and information). An example of logistic interpretation is also the supply chain model spread by the

Supply Chain Council (SCC), and it's been existing since 1996. The association, similarly to the APICS organization for MRP II class systems, has developed a reference model about the function of software tasks for the supply chain management. The reference model developed by SCC containing the principles and elements used in the creation and computerization of supply chains is called SCOR (Supply Chain Operations Reference). The SCOR model regulates operations related to planning, purchasing, manufacturing, and supplying products in the supply chain.

Management of integrated supply chains began to develop rapidly in the early 1980s. However, it should not be forgotten that the source of the theoretical and methodological foundations of the management concept discussed was the results of research conducted on distribution channels and cooperation of production companies and systems integration, published at least twenty years earlier. Researchers in supply chain management even refer to the achievements of the late 1950s and early 1960s. This is, especially true for Forrester's publication, which, by examining flows between suppliers and customers, pointed to the problems of excess inventory to suppliers as a result of a gradual increase in information distortions about small changes in demand as they moved away from the market, which became known as the "bull effect".

The latest methods of supply chain management developed between the years 2005-2013 were preceded by the reconstruction of research on the supply chain. Experience to date has been limited to transport, inventory management and optimization of logistics networks, and demand analysis. The new approach is that supply chain management should be combined with financial, marketing, or information management to ask the question of how and why. The modern supply chain influences the competitiveness of the transnational corporation. There were even theories that integrating all functions of strategic management with logistics can be described by 53 other scientific disciplines such as sociology, philosophy, political sciences, and psychology besides economics.

Supply chain management aims to provide the highest value to the customer at the lowest cost for the entire chain and includes managing relations with: • suppliers, recipients and clients. Each organization on the path of material flow in the supply chain alters its characteristics and increases its value. Controlling the flow of goods and related-information is an essential task of supply chain management. This management is harmonious with planning and controlling the flow of goods through all phases of creating worth. Values added to goods from the place of obtaining raw materials through production to the final buyer.

The end goal is to offer these goods to buyers at the right place and time, in the right quantity and quality, and at pre-determined costs. Thus, effective supply chain management often translates into a reduction in operating costs, and an increase in the level of customer service.

The most frequently formulated goals of supply chain management in terms of logistics are:

- Minimization of the total costs of product and information flow while maintaining the level of quality of delivery service required by customers;
- Ensuring the shortest possible lead time, and the highest possible reliability, frequency, and flexibility of deliveries at the appropriate flow costs;
- Optimization of inventory levels in the supply chain scale along with the flexible adjustment to the preferences in handling the distribution of individual market segments.

The key elements to manage the supply chain are:

- Locating production plants and warehouses;
- Transport activities;
- Storage and handling;
- Shaping and inventory control;
- Collection, processing, and transfer of information accompanying the physical flow of the product;
- Cooperation with marketing in the area of customer service;
- Packaging and leftover material management.

In addition to the interpretation of supply chain management from a logistics point of view, more and more authors emphasize integrating features and the need for space-time synchronization of demand flow management with the physical flow of product supply. The views of the authors emphasizing the integrative aspects of sustainable cooperation of enterprises for which the supply chain and supply chain management are broader concepts than the logistics chain and their management is distinguished by:

- Process orientation, which means treating activities and flows implemented in supply chains as processes;
- Recognizing the significant opportunities for cooperation of chain links in research and development, logistics, production, marketing, and financial processes;
- Striving to optimize the value added to the products and services offered, and as a result, increase the value of the supply chain itself;
- The need to integrate and coordinate the following three streams: material, information, and financial flows.

Since the mid-nineties of the twentieth century, there remains a dominant view that the cooperation in supply chains begins initially at the stage of product creation and development. Demand planning and order fulfillment are the next stages of basic processes that should be managed on a chain scale. The analysis of the relationship between the product and the supply chain provides an even broader scope on the

cooperation within supply chain management. Under these variants, R. Cooper and R. Slagmulder distinguished between the stages of creation and implementation.

Table 2. *Matrix of supply chain management areas*

| Network design | Product Design | Production |
|---------------------------|-------------------------------------|--|
| Joint product design | I Product and network configuration | III. Formation of the production network |
| Relationship optimization | II. Joint product design | IV Optimization of processes in the supply chain |

Source: S. Seuring, M. Goldbach, *Cost Management in Supply Chain*, Physica-Verlag, Heidelberg 2002, p. 18.

Analysis of the relationship between product design, production, and network design allows you to determine the following areas of supply chain management: product and network configuration, product design, the formation of production networks, and optimization of processes in the supply chain. Operational management, closely linked to strategic, concerns techniques, and technologies supporting strategic decision-making, and new solutions in this area include: RFID as a new way to identify goods in the supply chain; a team of techniques for using voice commands, e.g., pick by voice, to issue orders regarding the relocation of inventory, EU directive called WEEE (Waste Electrical and Electronic Equipment) for the implementation of sustainable supply chains for environmental protection for recycling. These methods can be introduced and implemented by the subject for information technology, which aids in making proper and necessary decisions while providing the essential information needed to manage the supply chain properly.

5. RFID in the Supply Chain

RFID is a technique that uses radio waves to send data and power to an electronic system, which labels objects through a reader. RFID is a technology that wirelessly recognizes objects labeled with a microscopic microprocessor. The structure of the system and the RFID principle is very simple: special devices called tags, chips, or markers are attached to objects, containing electronic systems with encoded data with a receiving and transmitting antenna. Data is read by radio waves using an RFID reader with an antenna. Sodhi (2004) showed, that compared to bar codes, read-only tags can be “read” faster (< 100 milliseconds) and in a variety of visually challenging conditions such as dust, snow, and within packing material. The tag continually reports the item’s location, condition, and status to any reader connected to on-site information systems or to remote databases via the Internet. Most often, we find RFID technologies in systems corresponding to the location of people or goods. One of the primary purposes of RFID technology is to track the exact location of an item anywhere in the supply chain or store.

All participants in the supply chain can use the RFID system: from producers to distributors and retailers. By investing in RFID, you can increase the efficiency of your cooperation across the entire supply chain. RFID technology gives countless opportunities for innovation within large enterprises with complex logistics processes. The more complex the processes, the more a company can benefit from using RFID. Furthermore, RFID can increase the profitability within companies by a large number of goods, extensive location, large storage space, constant warehouse movements, the unit value of goods, and the presence of stages of recorded packaging.

Thanks to the technology behind RFID, it has become possible to automate the receipt of goods from warehouses and distribution centers around the world, all under one system. This includes both deliveries from producers and returns of old collections from stores. All goods accepted into the distribution center are registered within the RFID tunnel. The readings can then detect if the multipack is homogeneous, which eliminates the need to unpack individual cartons for delivery.

Information from the RFID readings is compared with delivery information stored in the warehouse system. RFID can be used to manage the warehouse and record the location of goods. Then, based on RFID readings, order picking is carried out for stores. The process of monitoring shipments to various stores starts first with the automatic reading of the finalized carton to be shipped, and then the comparison of that carton with the initial order. The controlled process eliminates any unnecessary activities and misunderstanding on the store line. Goods are picked up at RFID gates and tunnels at respective points of sale, and hand-held readers are picked up from smaller locations.

RFID technology can provide you with the latest information on the inventory status throughout the store and backroom. This can further allow you to generate automatic orders to replenish your inventory and deliver goods to shelves in time for store sales. This system additionally eliminates the lack of inventory on store shelves and loss of sales. Moreover, RFID makes it possible to accurately locate goods within various settings such as warehouses, production halls, and stores. This information allows staff to understand the movement of various goods to their respective places along with statistical information that can increase sales.

Employees also can target and respond to the movement of goods in incorrect zones and districts. This high-tech activity allows potential customers to have increased reach for product availability. An additional benefit of RFID is its use on anti-theft gates. For example, the benefit is the time gained by eliminating the need to "clip" the goods and "unclip" the goods sold while maintaining anti-theft control. Another advantage is that it enables more frequent and much faster store inventory using mobile RFID readers (Liber, 2006). In summary, the RFID system allows for:

- Remote touch-free identification - everything is done remotely.

-
- Real-time management of production, logistics, and warehouse processes.
 - Instant readings at over 100 tags per second.
 - Managing car traffic control processes in car loading and unloading centers.
 - Identifying and tracking the movement of containers, pallets, cylinders, kegs, tanks, etc.
 - Tracking objects on production lines.
 - Automatic registration of goods issued/received.
 - Inventory in stores and of fixed assets.
 - Anti-theft devices and anti-counterfeit brand products.
 - Full control over warehouse/production status in real-time.
 - Shortening of loading/unloading time, which results in lower service costs, as well as shortening of process duration.
 - Being able to read the identifier in harsh environments such as heavy dust, dirt, frosting, etc., where the use of barcode technology may not have worked well.

More than ten years ago, Walmart² (an American supermarket chain) was one of the first companies to implement RFID to track pallets with goods at every stage of the supply chain - from supplier to distribution centers (Schuster, 2007). In 2010, a giant retailer proposed plans to place RFID tags on individual products. Other retail chains then followed in his footsteps. RFID has many other uses in the supply chain. For instance:

- RFID allows you to track products from its production in the factory to its delivery, then to the customer.
- Retail chains can use RFID to determine product position, quantity, and to improve store supply.
- RFID allows you to track inventory on-site, in transport, and at distribution centers.
- RFID can be used to determine the position of vehicles, tools, or equipment.

The ratio of benefits to cost is likely to be highest for firms that have high product variety, have most of their inventory stored in cases, and use case-level RFID. For instance, Hewlett-Packard has used RFID to save 20 percent on stock control costs at some production facilities (Lee, 2005).

The value of RFID is likely to be greater in the storage of maintenance, repairs, and operations (MRO) supplies that are expensive and have long supply lead times, especially if the cost of a shutdown is high. For example, Virgin Atlantic keeps spare part inventory and uses RFID to locate critical aircraft parts quickly and manage inventory better. However, RFID tags, despite many advantages, also raise

²Major organizations like Wal-Mart, the U.S. Department of Defense, Target, and Best Buy have required large suppliers to apply RFID tags to cases and pallets in recent years to improve supply chain performance. According to U.K. research firm Frost & Sullivan, retailers spent \$400 million on RFID in 2004, a figure that may exceed \$4 billion by 2011 (Biedermann, 2006).

security and privacy controversies. The technique of remote reading of identifying data can lead to undesirable effects such as ease of access to confidential data, e.g., consumer privacy, and the anonymity of buyers.

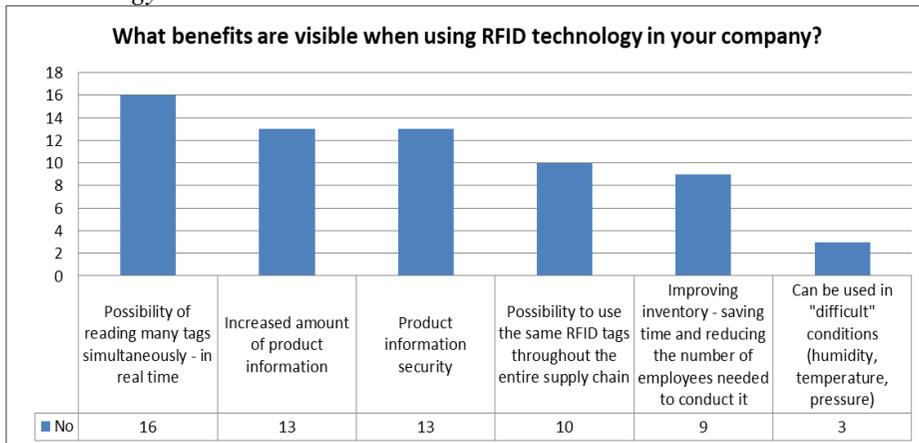
6. Results of Surveys in Polish Enterprises

Twenty enterprises responded to the survey, which was carried out in 2016-2017. However, after verifying for completeness of the questionnaires, only 16 enterprises operating in Poland were considered in the final analysis. The group of enterprises selected for the studies were not selected at random, but rather, from previously established contact networks. The respondents were all middle and senior employees and the respective surveys were conducted using a questionnaire. In the analyzed group of enterprises, 6 of them were Polish, 6 German, 1 Dutch, and 3 of mixed origins. The main goal of the study was to check whether the companies currently using RFID systems were doing so for better management or rather for savings benefits. The surveyed enterprises were first asked to answer the following main questions:

1. What are the visible benefits of using RFID technology in your company?
2. What are the factors that increase profitability from the implementation of RFID in your company?

When the first question was asked about the benefits of using 100% RFID technology - 16 of the surveyed companies responded with the possibility of using RFID for reading multiple tags simultaneously and in real-time. In subsequent places, items appeared highlighting the possibilities of using an increased amount of product information and security (including the risk of data loss).

Figure 1. Structure of the answer to the question regarding visible benefits when using RFID technology

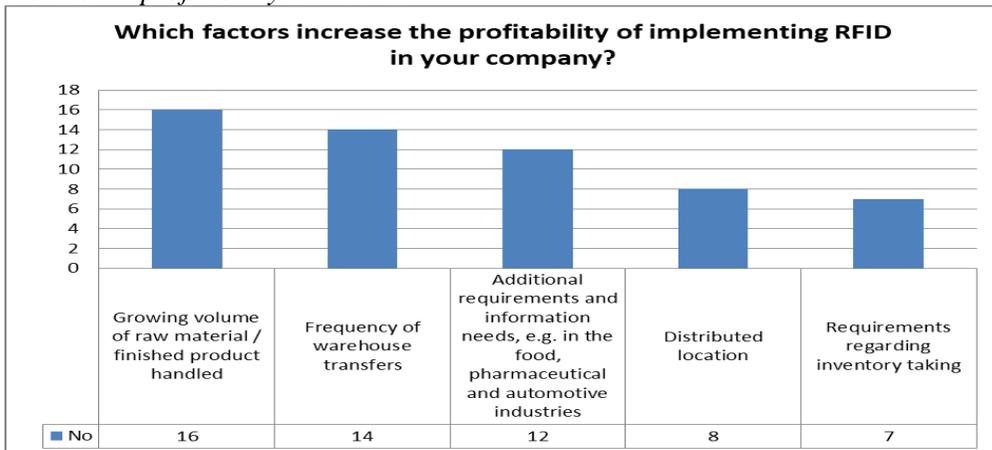


Source: Own study using data from companies.

Also, the surveyed companies stated that it is possible to use the same RFID tags throughout the entire supply chain from producer to supplier. As an example, a comparison of RFID and barcode technology is given here, where there is a risk that it cannot be used along the entire chain due to another standard. RFID tags used in the "EPC (Electronic Product Code)" standard are readable by both the manufacturer, the agent, and the recipient.

To the second question, i.e., what are the factors that increase the profitability of RFID implementation in an enterprise? Enterprises showed that the most crucial factor is the volume of the range or the number of pallet places. Further factors include: the frequency of warehouse transfers - 88% of respondents, as well as additional information requirements and needs, including from the FMCG, pharmaceutical, or automotive industries. Specialized RFID tags give the possibility of using additional sensors to track the parameters of the environment and its documented recording over time.

Figure 2. Outcomes regarding various factor implementations and their respective increase in profitability with RFID



Source: Own study using data from companies.

The results from further research indicate that over 75% of manufacturers were surveyed, and around 65% of transport and logistics providers had implemented special teams with the mission to integrate radio identification applications better. The production market has been using the RFID system for years, and increasing the use of this technique through the entire supply chain can be achieved by reducing individual unit costs. Even though RFID began to be used de facto in supply chain management at the level of pallet handling, according to a recent opinion survey, 91% of IT managers stated that this technology is not cost-effective enough for the application of radiolabels onto individual products within the retail chains. Eighty percent of respondents believe that the RFID system is far too expensive for Polish conditions to start using this technique in retail within the next two or three years.

The remaining twenty percent of respondents think that the technique will be introduced in retail within a year. Half of all respondents estimated that it would take more than four years to introduce RFID into retail. Over 99% of surveyed engineers working in analyzed enterprises, praise the possibility of using the RFID system *while taking into account the areas where it is required to collect data accurately within specific deadlines and have good access to them for reading*. The use of RFID in its ability to access relevant information and update identifiers can be useful for the maintenance process at the plant.

A significant number of respondents indicated that the implementation of the system mentioned above in an enterprise might be useful in situations where it is difficult to maintain good legibility of bar codes or where wireless technology cannot be used. For example, some remote production equipment collect important data but have no accessibility to local wireless networks, and therefore, cannot attain updated information.

As indicated by 86% of respondents, RFID identifiers can be used successfully in recording the device's last official technical review, as well as the last failure code and repair performed. This enables technicians and engineers to be able to make decisions based on the current knowledge of the device's technical condition. 95% of respondents indicated that the radio's identification system enables the TSL industry employees to be able to obtain relevant information which would not have been made available to them, or been difficult to access. Besides, certain identifiers can store even more data and information, such as ten previous readings. This data will allow the operator to automatically capture the intensity of the changes in the parameter being assessed on-site, and will further enable them to detect and rectify defects with more precision. Troubleshooting technicians may benefit from the fact that the radio identifier can store all information about planned preventative maintenance activities, which, in turn, allow work to continue as per schedule when a strategically important device or machine is not operating.

The implementation of the RFID (automatic radio frequency identification) system is, unfortunately, far too expensive. Also, the overall process of system implementation is not easy to the instrument as it requires an in-depth analysis of the area where it will be used, as well as strict definitions of the operations that the entrepreneur wants to implement and supervise. Finally, the willingness of the employees to cooperate with the system is essential in systems success.

However, an appropriately implemented RFID system allows the use of the same RFID tags throughout the entire logistics supply chain. RFID tags, which are used in the "EPC" standard, allow readings by the manufacturer, the agent, as well as the recipient. The capabilities of the RFID system are much wider than the current system used on traditional bar codes, and it is estimated that the inventory time itself will be almost ten times shorter with RFID use. In conclusion, while the RFID technology may initially seem expensive, the use of this system over time will result

in significant cost-saving reductions, mainly through storage space management and reduction of unnecessary inventory and order failures. The results of the conducted research indicate that the profitability of RFID in companies is achieved by the increase in goods, storage space, as well as the individual value of the good itself.

7. Conclusions and Some Policy Implications

In modern enterprises, the focus is on reducing costs while increasing the efficiency of operations and productivity of assets. With that said, supply chains are of strategic importance in any company's management. When looking for a competitive advantage in these areas, cooperation in the supply chain is undertaken. As a result, the role of the supply and supplier changes. Suppliers and customers are being integrated, which is manifested in the use of appropriate supply chain management instruments. Traditionally, the management activities and areas belonging to the recipient are transferred to the supplier itself. These instruments include, among others - inventory management by the supplier, sourcing from one supplier, i.e., "delivery on time."

The use of these instruments is associated with the development of the supply chain and moving onwards to the next stages of strengthening cooperation between the supplier and the recipient. At the same time, enterprises, becoming participants in supply chains, get to operate on a global scale, in various political and social legal environments. The supply chain is co-operating in various functional areas of manufacturing, trading, and service companies, as well as their clients, between flows of products, information, and financial flows.

Modern techniques, including RFID technology, are used to track supply chains. The uses of RFID is revolutionizing in many areas of everyday life, and in the way, businesses operate. It is used in many industries to identify, track, and monitor objects with high precision. RFID can monitor the exact location of the given object in addition to its technical condition. Besides, the RFID identification system is used to mark goods, raw materials, and products for industrial and commercial records. This provides much faster and more accurate performance of daily work in the areas of production, trade, and business. Logistics and transport in the RFID system gain insight into the supply chain, which effectively manages the distribution channel, and as a result, reduces the costs of doing business. Tracking the supply chain eliminates the risk of goods being falsified from the producer to the consumer. RFID technology uses radio waves to identify people and objects remotely, which saves both time and money. By investing in RFID, a company's efficiency is increased across its entire supply chain.

Survey results among multiple enterprises indicated that the radio identification system enabled employees to obtain relevant information that would have otherwise not been available to them. As underlined by respondents themselves, the RFID system, once properly implemented, allows for the same information to be used

throughout the entire logistics supply chain. Research conducted in multiple companies showed that the benefit of implementing RFID had exceeded the expectations of entrepreneurs. Despite its initial high costs, the use of this system over-time allows significant cost reductions in areas of transport, storage, inventory, and distribution. This system has enabled the exchange of information and organized work - all while increasing the company's efficiency. The RFID system is exceptionally dynamic, as it is constantly changing and improving.

References:

- Biederman, David. 2006. RFID Gains Ground in Logistics; Companies are Adopting the Technology, Even if Immediate Benefits Aren't Clear. *Journal of Commerce*, February 20, Vol. 20, issue 2.
- Christopher, M. 1992. *Logistics, The Strategic Issues*. Chapman and Hall, London.
- Heskett, J. 2002. *Logistyka*, PWE, Warszawa.
- Fabbe-Costes, N. and Jahre, M. 2007. Supply chain integration gives better performance – the emperor's new suit? *International Journal of Physical Distribution & Logistics Management*, Vol. 37, No. 10, pp. 835-55.
- Jarillo, J. 1991. Co-operative strategies: the payoffs and pitfalls. *Long Range Planning*, vol. 24, No. 1.
- Lee, I. 2005. Radio Tag Revolution Under Way. *South China Morning Post*, June 25.
- Liber, J. 2006. RFID w globalnym łańcuchu dostaw. *Eurologistics*, nr 1.
- Oliber, R.K. and Webber, M.D. 1982. Supply-chain management: logistics catches up with strategy. In Christopher, M. 1992. *Logistics: The strategic issues*. Chapman & Hall, London, pp. 63-75.
- Sodhi, M. 2004. The Internet of things. *OR/MS Today*, February, also at www.ormstoday.com
- Seuring, M., Goldbach, M. 2002. *Cost Management in Supply Chain*. Physica-Verlag, Heidelberg.
- Schuster, E. Allen, J., Brock, L. 2007. *Global RFID The Value of the EPCglobal Network for Supply Chain Management*, Springer, New York.
- Witkowski, J. 2003. *Teoretyczne podstawy zarządzania łańcuchem dostaw*, Warszawa PWE, Warszawa.