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Sebastian Kot, Beata Skowron-Grabowska
Czestochowa University of Technology

INFLUENCE OF RFID SOLUTIONS IN SUPPLY CHAIN

1. Introduction

RFID's core technology is not new. But its implementation on a grand scale – in large volumes across global boundaries for a vast array of products – is a new and complex challenge for supply chain managers today. In particular, mandates by Wal-Mart and the U.S. Department of Defense have acted as key drivers, spurring RFID implementation with the ultimate goal of attaining real-time visibility at the individual product level.

There are many new projects being introduced into everyday practice. It is hard to choose those which will be the most successful ones. Enterprises from different branches of industry are seeking best solutions suggested by researchers. One of such good solutions implemented by many companies is technology named RFID. Through RFID technology the supply chain can be used to improve customer service by tracking relations and finding new solutions in serving key customers. Enterprises within supply chain offer greater efficiency and improved effectiveness while using RFID.

2. Defining RFID

RFID is a technology for the automatic identification by radio of physical objects such as industrial containers, palettes, individual products and also people. The identification event takes place over transponders located in or on the respective objects, which can be addressed without physical contact, over the so-called "air interface", by the antenna on a scanner device. Typical areas of application for RFID lie, adjacent to classics such as animal identification or access control systems, above all in supply chain management, where the technology makes possible simplified goods turnover, automatic stock control in the storeroom, the sales floor, theft protection, product tracking etc.[1]

[1] F. Thiesse, *RFID, Privacy and the Perception of risk: A Strategic Framework*, "Journal of Strategic Information Systems" 2007 No. 16, pp. 214–232, 215-216.

Table 1. The overview of RFID technology diffusion

Year	Type	Organization adoption	Contribution
2001	Transportation	Active transponders for a fare collection	RFID tags monitored passenger access to public transportation
2002	Automobile SCM	RFID tags improved tracking, quality on a Ford line in Mexico	Improved quality control
2003	SCM	RFID picked up steam with hightech tracking for supply chain management	Improved SCM
2003	SCM	RFID emerged in the supply chain	Applied to SCM processing
2003	Automobile SCM	Automotive industry drove the RFID market	RFID applied to SCM of automotive industry
2004	Retailers	RFID speeded up concession purchases at Seahawks stadium	Improved waiting times at the cashier
2004	Software	Oracle Corp. launched RFID programme to meet initiatives	Database software developed RFID software
2004	SCM	Ultra-low-cost UHF RFID tags were designed for supply chain applications	Decreased tag cost for SCM
2004	SCM	RFID became a major niche as a livestock tracker	Used for Inventory check
2004	SCM	RFID systems were integrated into the manufacturing supply chain	Used for SCM management
2004	SCM	Used in supply chain	Used for SCM management
2004	Library security	RFID was used for security and media circulation in libraries	Used for library Management
2004	SCM	Radio frequency identification systems used in SCM	Used for SCM management
2005	SCM	Used for supply-chain applications and implementation issues	Used for SCM management
2005	Food industry SCM	RFID used in Foods & Vegetables supply chain and prevented from product recalls	Used for SCM management
2005	SCM	The potential impact of RFID on supply-chain management	Used for SCM management
2005	Construction	RFID applied to the construction industry	Used to many construct parts management
2005	Airlines	RFID helped airlines track assets	Used to tracking passenger luggage
2005	e-supply chains in grocery	Future impacts of RFID on e-supply chains in grocery retailing evaluated	Improved SCM in grocery management
2005	SCM	Successful RFID supply chain was lunched	Diffused of SCM

Source: Ch. Chao, J. Yang, W. Jen, *Determining Technology Trends and Forecasts of RFID by a Historical Review and Bibliometric Analysis from 1991 to 2005*, "Technovation" 27 (2007), 268-279, p. 273.

RFID technology can be connected with the identification of objects through the transmission of radio waves from and RFID tag attached to an antenna to an RF reader. The information transmitted by the RF tag is reproduced back into digital

information that can be overtaken on to an enterprise information system. RFID applications include access control systems, automated toll collection systems, theft-prevention systems electronic payment systems and automated production systems[2].

Radio frequency identification (RFID) is a miniature tag enclosing an integrated circuit chip and an antenna, and has the facility to respond to radio waves transmitted from the RFID reader in order to send, process, and store information. Three components are the base of the RFID system: a tag, a reader and back office dataprocessing equipment. The task of the tag is to hold unique identification information of a product to which it is attached. Another task is for the reader, which emits and receives radio waves to read the information stored in the tag. The dataprocessing equipment which is in an enterprise processes all the assembled data. This equipment can be either a personal computer or complex networked enterprise management information system[3].

From a supply-chain management perspective companies have touted the benefits of RFID, particularly its ability to create a seamless flow of information through all layers of the supply chain in near real time and to provide such detailed customer information that suppliers can tailor products and services to an individual more accurately than ever before. At the same time a lot of firms are realizing cost savings by deploying RFID technology internally to monitor production processes[4].

One can observe in table 1 that in many large enterprises RFID can be used to track assets from secure computers to livestock. In libraries RFID help to reduce costs related to lost inventory as one would suppose. At present a library can take a complete inventory of its holdings in a few days rather than months, and everybody can check the move of books in and out. RFID is very helpful in e-grocery by reducing costs of keeping inventories.

3. RFID technology

In order to show the RFID works in practice it is necessary to point at the main elements of RFID system tag and antenna and the energy source. A RFID tag has no power source of its own. It relies on its antenna to receive radio waves emitted by the reader and converts these radio waves into electrical power. The data kept in the chip can be transmitted back to the reader via the tag antenna. Because of that

[2] G. Lekakos, *Exploiting RFID Digital Information in Enterprise Collaboration*, "Industrial Management & Data Systems" 2007 Vol. 107 No. 8, pp. 1110-1122 , Emerald Group, p. 1111.

[3] N.C. Wu, M.A. Nystrom, T.R. Lin, H.C. Yu, *Challenges to Global RFID Adoption Technovation* 26 (2006) 1317-1323, p. 1317.

[4] R.E. Spekman, P.J. Sweeney II, *RFID: from Concept to Implementation*, "International Journal of Physical Distribution & Logistics Management" 2006 Vol. 36 No. 10, pp. 736-754 Emerald Group, p. 736.

the antenna plays a key role in the radio communication between the tag and the reader. Radio waves will be reflected and refracted differently by the different materials to which a tag is attached.

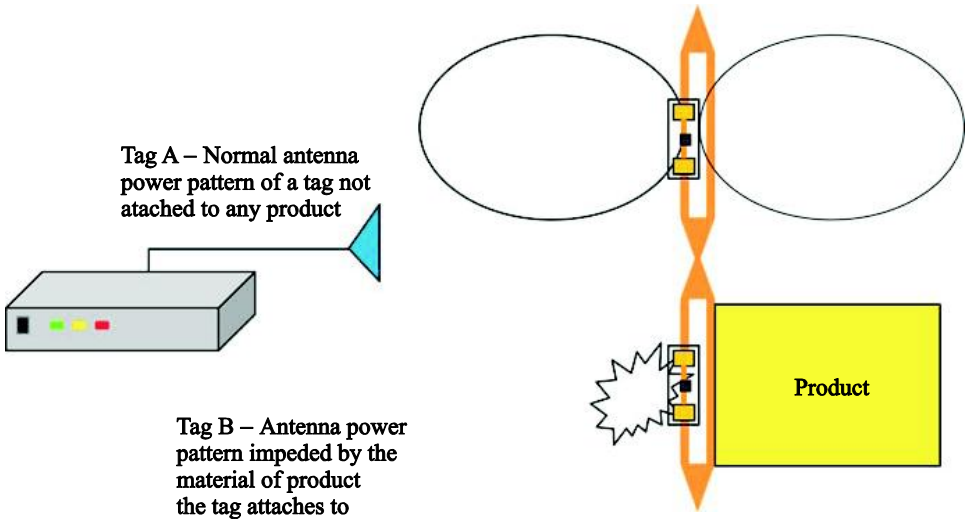

Fig. 1. Antenna power patterns of RFID tags

Source: N.C. Wu, M.A. Nystrom, T.R. Lin, H.C. Yu, op. cit., p. 1317.

In the above figure one can observe a difference between the regular antenna power pattern of a stand-alone RFID tag and that of an RFID tag attached to a certain radio-absorbing material. There are a lat of different materials, which include substances, which absorb RF energy. One of such substances is carbon. This system is useless for such a kind of materials but it works properly with products without absorbing materials.

RFID technology permits non-line-of-sight, non-contact, and multiple-tag simultaneous-reading capabilities, which is more effective than other systems of product tracking. Even though, RFID readability can be affected by the relative position and orientation of the tag antenna and the reader antenna, because antenna orientation affects its power pattern.

In fig. 2 the typical components of RFID system in trade enterprise are shown. In the bottom-left corner of the diagram, there is a set of RFID tags that represents the tagged merchandise[5]. The store also has readers stationed within the shelves and at the checkout lanes. The readers must be configured and managed to work properly with the information system. The "RFID middleware" symbolizes software units that hold these responsibilities. The edge information systems characterizes enterprise applications that have components used inside the company. The

[5] H. Bhatt, B. Glover, op. cit., p. 32.

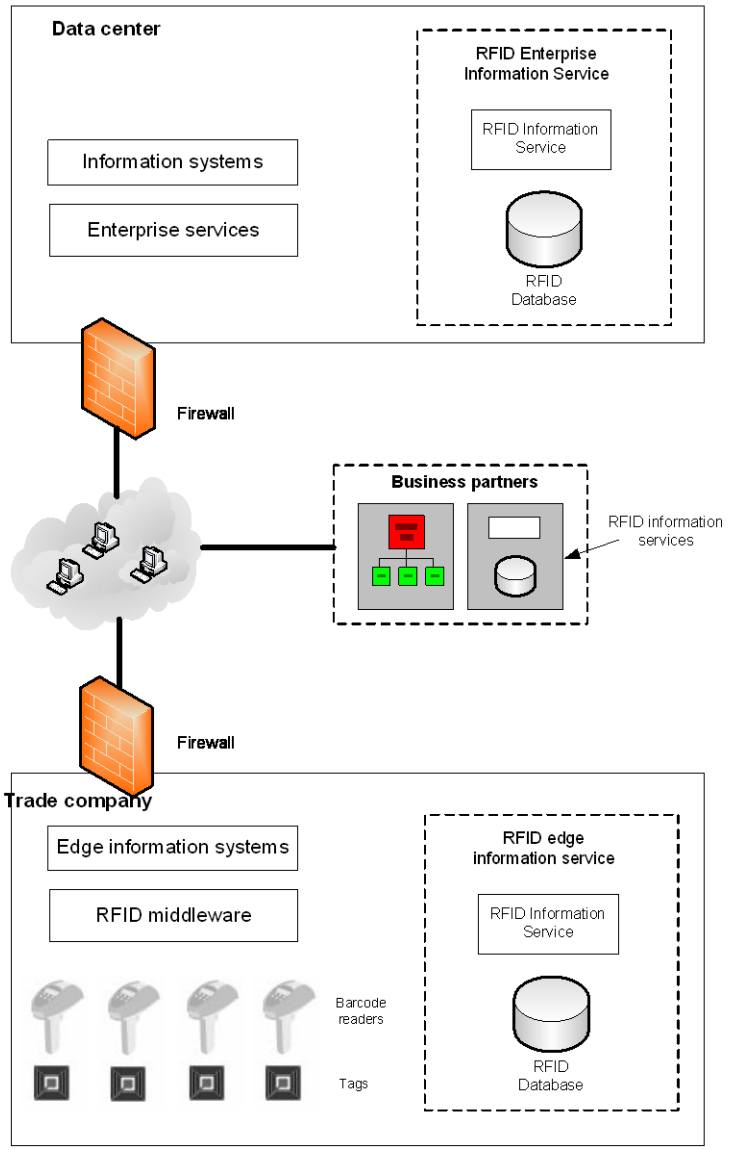

Fig. 2. RFID system components

Source: H. Bhatt, B. Glover, *RFID Essentials*, O'Reilly, 2006, p. 32.

RFID information service shows in what way to store RFID data at the edge. One can observe how the enterprise's data centre and business partners' data centre work together.

4. RFID used in supply chains

RFID system implemented in supply chain can be very supportive in solving a lot of problems. One of such problems is better efficiency of material and information flow among different supply chains.

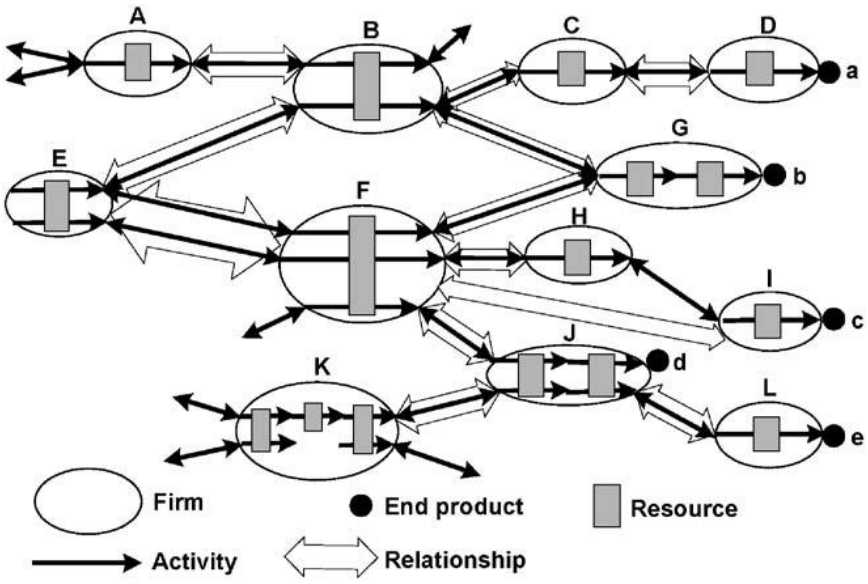

Fig. 3. Supply chains and usage of RFID

Source: A. Dubois, K. Hulthen, A.Ch. Pedersen, *Supply Chains and Interdependence: a Theoretical Analysis*, "Journal of Purchasing & Supply Management" 2004 No. 3-9 (10), p. 7.

In fig. 3 five supply chains (ending in products a, b, c, d and e) related with one another are shown. Three of them are using RFID technology while another two are not. Cooperation between these supply chains causes certain problems. In order to understand the collaboration within and among supply chains, an empirical example is shown in fig. 3.

The local enterprise F is a producer of components. On the other hand, companies involved in any sort of supply chain identify products differently. Enterprise F in fig. 3 makes two elements that end up as parts of three different end products (b, c and d) that can be different models of the same product. How firm F perceives the products resulting from its activities will presumably impact on the firm's behavior in relation to its counterparts. For company F there are also other products of relevance. Two products are used as input, and are supplied by company E. These products can be raw materials with RFID tags put on them. Company E also vends one of these products to enterprise B, which also implemented RFID, after which it is further improved by organizations C and D into end product a. In addition, F

company actions enable to produce three products that are further refined by firms G, H, I and J into end products b, c and d. This way of arranging the activities means that the supply chains are successful by describing the final products with the use of RFID system in the example consume resources also activated in other chains. Consequently there are large numbers of equally supporting products, activities and resources involved in this example. If companies G, H, I, J applied new technologies such RFID or others, the exchange processes, which take place among members of the supply chain would be quicker and more efficient. The exchanges taking place within different supply chains make it possible to identify products as parts of that exchange.

While things are changing very quickly, it can be difficult for organizations to decide where, when, and how much to commit to any particular RFID product or standard. The following guidelines offer a strategy for approaching RFID. There are several steps that may help in achieving success, while ignoring any one of them can go ahead to lost opportunities or failure[6].

1. Determine the business need.
2. Evaluate potential changes.
3. Develop a long-term roadmap.
4. Start small.
5. Run in parallel with existing systems.
6. Be flexible.
7. Share with partners.

These seven points are good in implanting new projects in enterprises not only RFID. The development of a good plan is the base for any project and than managing it much easier.

5. RFID implementation and project management

Successful RFID implementations follow best practices in project management as well as proven operations-management principles. This conclusion is based on many longtime studies and experience combined with consulting work to key RFID companies and detailed tracking of several important RFID implementation initiatives.

Specifically, following seven success factors can be noticed[7]:

1) Develop a Clear Strategy With Top Management Support**.** Like any project that promises to add business value, an RFID implementation calls for a clear strategy that enjoys the consistent commitment and support of senior management. As

[6] H. Bhatt, B. Glover, op. cit., p. 34.

[7] Based on: A. Fish, W. C. Forrest, *The 7 Success Factors of RFID*, "Supply Chain Management Review" 2006 No. 9.

is underscored by well-known project-management studies, senior management commitment is essential to any project's success[8]. Management therefore needs to examine the business drivers for and against RFID – including the financial analysis and qualitative issues at hand.

2) Implement RFID as a Project**.** Once management has fully bought into the strategy, the RFID implementation must be approached as a project with a beginning, middle, and end. This approach requires careful planning in terms of time, resources, costs, communication, and related projects – especially at the pilot stage. A successful implementation calls for project-management practices, including contingency planning, scheduling, contract management, resource management, cost control, performance and quality management, and project documentation[9]. A well--executed RFID pilot is critical to the overall success of the implementation. Even though pilot programmes almost always start small in terms of number of cartons or pallets that are tagged and suppliers and locations that are involved, they still need to be designed around the right applications.

3) Manage a Gradual Rollout: "Start Small, Dream Big". After successfully completing the pilot, the RFID programme should be rolled out to include all products. Again, careful planning and implementation are of paramount importance. Yet at the same time, the company needs to remain flexible as the rollout proceeds.

4) Continually Improve Procedures. Most of the publicized RFID implementations that we are aware of utilize the "slap-and-slip" approach, whereby the tag is "slapped" manually onto the carton or pallet just prior to leaving the warehouse. The key to a successful RFID programme, however, is to identify the areas where RFID can do the most to help streamline current processes. A typical starting point is to see how RFID could improve inventory flows across the extended supply chain, using value-mapping techniques before implementing the technology – not after. Later, it is worth evaluating how RFID systems can be applied to extend supply chain visibility back through the manufacturer, examining business practices and identifying where visibility and information from RFID would be most beneficial.

5) Work on Negotiation and Build Trust Among Flexible Partners. The negotiation processes among supply chain partners should be fair and flexible. It should address the needs of all parties, optimize the entire RFID system, and create a "win-win" solution for all. Partners should use project-management best practices for negotiation which include separating the people from the problem, focusing on

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[8] See: H. Kerzner, *Project Management. A Systems Approach to Planning, Scheduling, and Controlling, 8th ed.* (Hoboken, NJ: Van Nostrand Reinhold, 2003) and R. Loo, *A Multi-Level Causal Model for Best Practices in Project Management*, "Benchmarking" 2003, Vol. 10, issue 1: pp. 29-36. J. Collins, *RFID Implementation is an Art,* "RFID Journal", June 15, 2006.

[9] R. Loo, op. cit., pp. 29-36.

interests rather than positions, seeking alternatives for mutual gain and insisting on objective criteria[10].

6) Utilize a Cross-Functional Team. The best implementation results come from leveraging cross-functional teams that comprise personnel who have strong technical skills, are politically sensitive, have a strong problem and goal orientation, and are available and motivated to work on the project[11]. The teams should include the following: RFID suppliers; middleware experts; and staff from operations, logistics, purchasing, information systems. They must then be molded into a cohesive team, united by a common vision.

7) Fully Develop the Technology Throughout the Whole Supply Chain. To date, most reported RFID projects have only implemented tagging from the DC to the retailer. But to avoid mistakes like the ones made during desktop computer implementations in the 1980s, management should fully implement the technology for the entire supply chain system. Full implementation includes hardware and software – RFID tags, electronic seals, chips, printers, antennae, readers, data aggregation, filtering systems, middleware, tracking devices, network support, and information system infrastructure at the platform, network, and application layers.

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WPŁYW TECHNOLOGII RFID W ŁAŃCUCHACH DOSTAW

Streszczenie

Łańcuch dostaw, w którym zastosowano technologię RFID, jest globalną siecią powiązań integrujących punktów dostawców, producentów i klientów, gdzie są tworzone, transportowane i dostarczane produkty z chipami w technologii RFID produkowane z surowców i półfabrykatów dla różnych punktów odbioru z różnych punktów dostaw. Technologia RFID pomaga w rozwiązaniu wielu problemów związanych ze współpracą pomiędzy dwoma lub kilkoma łańcuchami dostaw. Wprowadzenie technologii RFID do łańcuchów dostaw jest ściśle powiązane z zarządzaniem projektami.