

RFID ROLLOUT – WHAT CAN WE LEARN FROM EDI?

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In this article the authors examine the IOS technologies RFID and EDI. RFID is a new technology with great potential for creating interorganizational networks such as decreasing cost or better access to information. This potential is the reason why many companies today must decide whether or not to adopt RFID in their supply chain. Using RFID has far-reaching consequences for companies, such as the intertwining of existing relationships between companies or the reorganisation of existing business processes. New technologies do not just provide new opportunities, they also create new problems. This article will assess possible problems surrounding the implementation of RFID. This analysis should help companies prepare for any difficulties they may encounter. To do this, the authors show how lessons learned from problem-solving in the area of EDI can be applied to RFID. Therefore this article takes a closer look at standardisation, integration into existing IT-systems and the need for trust in collaborative supply chains. Besides examining potential problems, the authors also give an overview of the possible costs and benefits of RFID. Hence the authors compare several surveys about the costs and benefits of EDI, in order to define possible costs and benefits of RFID. This article also includes a description of a cost benefit-sharing model for a collaborative supply chain.

Keywords: RFID, EDI, interorganisational networks, technology

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1 Motivation and introduction

Today, more and more companies have started to use radio frequency identification (RFID) as an alternative to the common bar code identification. RFID allows them to identify and locate parts and products in their own company or a long their complete supply chain. RFID is a technology that enables automatic identification and location detection of items. This helps to save working time and to speed up business processes. In order to do this, companies need to put RFID tags on each item, install an RFID reader at each point of interest and adapt there information systems so that the new additional information can be integrated. RFID is also a technology that improves data exchange between collaborating companies and thus helps to build interorganisational networks more easily. To summarise RFID is a technology that can generate a competitive advantage for companies.

As is the case with all new technologies, the implementation of RFID is a challenge. A new technology means new opportunities but also new problems which have to be solved. For example, companies have to adapt their existing information systems, reengineer their business processes and adjust their communication and collaboration with partners in the supply chain to the requirements of the new technology. To deal with the future challenges of RFID, the main approach of this article is to forecast upcoming problems of RFID by looking at the already implemented technology Electronic Data Interchange (EDI) and its problems in the past. In this article we also show how the solutions found for EDI can be adapted and transferred to solve the problems of RFID. This article is structured as follows: After the introduction we describe the history and the future of RFID in the second chapter. We also specify the advantages of RFID technology, it's importance for companies and what companies can expect from RFID in the future. We then describe possible changes for companies and take a look at the challenges involved in RFID. We take a closer look at the problem of standards, IT integration and the importance of trust in an RFID based supply chain. After concentrating on RFID, we focus in third chapter on EDI technology. We give a general introduction to EDI and show the comparability and similarities of both technologies. Here we also look at the dimensions standards, IT integration and trust. Using EDI solutions for future RFID problems is the topic of the fourth chapter. We examine the benefits of EDI, the network effects, cost benefit sharing and what will be important for the future of RFID. The fifth and final chapter summarizes the main arguments of this article. The conclusion also shows the main results and ends with a critical evaluation of RFID implementation problems and the solutions which have been developed.

2 The RFID technology

After the introduction and motivation of the first chapter we now describe RFID technology itself. We begin with a general presentation of the history followed by an assessment of the future of RFID. After that we show what is needed to generate the benefits of RFID technology. For this reason the authors take a closer look at need for standardisation, the opportunities of integrating the RFID data into existing IT-systems and the need for trust in collaborative RFID based supply chains.

2.1 The history and future of the RFID technology

The technique of sending and receiving radio waves was already used in World War II. A transmitter was put into each plane which broadcast a specific signal when receiving signals from a friendly radar station on the ground. RFID works in the same way. A signal is sent to a transponder which wakes up and answers. Either it reflects a passive signal or broadcasts its own active signal (see Jilovec 2004). Since the 1980s RFID has been used in tracking and access applications. RFID quickly gained attention because of its ability to track moving objects (see Sabzevar 2004).

Nowadays RFID is used in many different applications. Tags are commonly used for animal identification, beer keg tracking, anti-theft systems, bookstore tracking, pallet tracking, building access control, airline baggage tracking as well as for apparel item tracking. The technology was interesting because of the simplification of many processes. For example RFID tags can be read without any physical or visual contact. This improves stock taking a great deal. The tag can withstand a harsh environment. It is possible to read many tags at the same time; so called bulk reading. But nevertheless the ability to track items almost in real time provides much better transparency of the product flow. At the moment, many different companies all over the world are carrying out pilot studies to identify their company-specific benefit of RFID.

The recently developed Gartner Hype Cycle expresses the flow of RFID (see figure 1). Although the technology is located at the “trough of disillusionment“ at the moment regarding to the Hype Cycle the technology will improve in the near future. As the cost of RFID tags falls, it is expected that RFID tag will be widely used either at the package level or at the individual item level for many products (see Gonzalez et. al 2006). It is questionable whether an RFID tag may ever become as cheap as the printed barcode but because of the many advantages of RFID it may become the preferred solution.

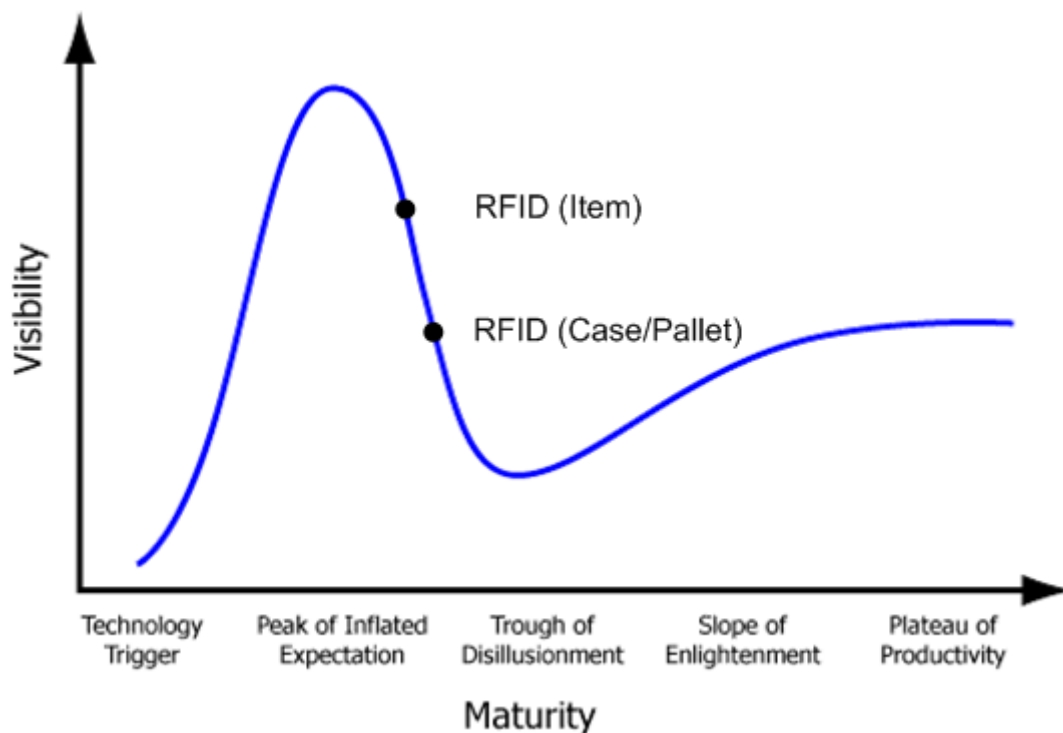


Fig. 1: Gartner Emerging Technologies Hype Cycle 2006 (see Gartner 2006).

2.2 Requirements for using RFID technology

As we pointed out in chapter 2.1, RFID is a technology that will become important for companies in the future. That is the reason why in the last few years companies have been gathering a lot of experience in the area of RFID to prepare for the future. Chapters 2.2.1 to 2.2.3 will show the reader some of the upcoming problems that companies have to deal with to make RFID successful for their business. The authors take a closer look at standardisation, IT-systems integration and trust in collaborative RFID based supply chains.

2.2.1 The need for standardisation

One issue to point out is the cost of standardisation. Standards are an essential condition for interoperability and a driver for cost reductions, but have not fully established yet. Therefore, early users of RFID technology are in a danger of adopting the wrong standards; a costly mistake both in terms of money and time (see Azif/Mandviwalla 2005). Companies implementing RFID technology try to develop their own standards with regard to tag language and the frequency at which they operate. When these tags pass through the supply chain, the lack of standardisation creates havoc for organisations (see Jones et. al 2004). Today, there are many standards set by companies and this prevents the areas of application of

the technology from being extended. To have a collaborative supply chain, the tag languages and system usage must be standardised.

2.2.2 The need for integration into existing IT-systems

The goal of RFID technology is to provide meaningful data that can be used to improve efficiency and to make profits by channeling the data to the right users. That means companies should invest in business applications that make use of this data (see RFID Journal 2006). For instance, the production planning application can exploit real time stock information to determine the MRP-based requirements and then automatically produce requests if the stock level is below the required level. Similarly, if the company has an existing IT-system, it must be integrated into the RFID infrastructure to obtain the pertinent data provided.

In the year 2004 ABI Research estimates RFID integration services revenue will surpass that of hardware by 2007. Apart from the capital costs incurred for the servers, enterprise applications, readers and middleware, companies have to spend money on operating expenses. Forrester Research believes that companies would spend more on process optimization, data analysis, user training etc. than on the capital investment itself (see Walker 2004). In addition, the cost of consultants, additional hiring, reallocation of staff, maintenance contracts, tag and reader testing can be considerable. In a report published in March 2004, Forester Research estimated that a \$12 billion consumer products goods manufacturer would have to spend \$128,000 on consulting and integration, \$315,000 for the time of the internal project team and \$80,000 for tag and reader testing (see RFID Journal 2006).

2.2.3 The need for trust in collaborative supply chains

As we have seen, RFID is a technology that helps to automatically share information with other partners along a collaborative supply chain. Partners along the supply chain can use this information to enhance their business processes. One example of such an improvement could be the ability to forecast manufacturing errors, which was described in an article by Schlitter et. al (2007).

The information required for improvements to be made is very sensitive and could contain strategic knowledge. Companies in a competitive environment would not be willing to share such information. However, companies in an environment of trust will be willing to give the necessary information to trusted partners along their supply chain. Yang et al. (1995) define trust as “the willingness of a party to be vulnerable to the actions of another party based on an expectation that the other will perform a particular action important to the trust or, irrespective of the ability to monitor or control that other party”.

So relations based on trust among companies in a supply chain have an important impact on the success of coordination efforts. Building partnerships based on trust and which are supported on the technical side by RFID, can lower transaction costs. A partner can eliminate its forecasting efforts if it trusts the orders and forecast information it receives from other partners in its supply chain. A survey done by Kumar (1996) investigates how trust changes collaboration and what the positive results of a trust-based collaborative environment are. The following is a list of the most important results:

- Exploit complementary skills to reduce transaction costs.
- The trusting party can cut monitoring costs.
- Quick response to opportunities in the market.
- Develop better solutions to the customers' needs.
- Trust is crucial to long-term mutually beneficial collaboration.

3 General information about EDI

After to the description of the RFID technology in the second chapter, the third chapter focuses on EDI technology and describes the general use and appliance of EDI in companies. The general information of this chapter is the basis for the comparison between RFID and EDI in the following fourth chapter.

EDI is a popular inter-organisational system (IOS) that was extensively introduced in the nineties. There is actually no basic requirement that reading partners must have the same document processing systems. For instance, EDI involves some standardised transactions such as purchase orders, invoices etc, where the supply chain partners use EDI translation software to put the data into an industry-wide format from their internal business systems. The receiving partners then translate this data into their business formats. This type of data transfer is much more secure and much faster than traditional mailing and faxing. Since trading firms have their own data processing format, a common standard is needed in order to exchange information. Therefore, for technologies such as EDI, standard selection and the intermediate software play important roles in the success of applications (see Davis/O'Sullivan 1998). Williams et. al. (1998) found out that lack of information consistency among companies is the main obstacle faced in implementation.

Today many companies use EDI to carry out their daily business transactions. That fact that EDI is a sophisticated technology can also be seen in the Gartner hype cycle. In 2003 Gartner described EDI as an established technology on the "plateau of productivity" (see Figure 2).

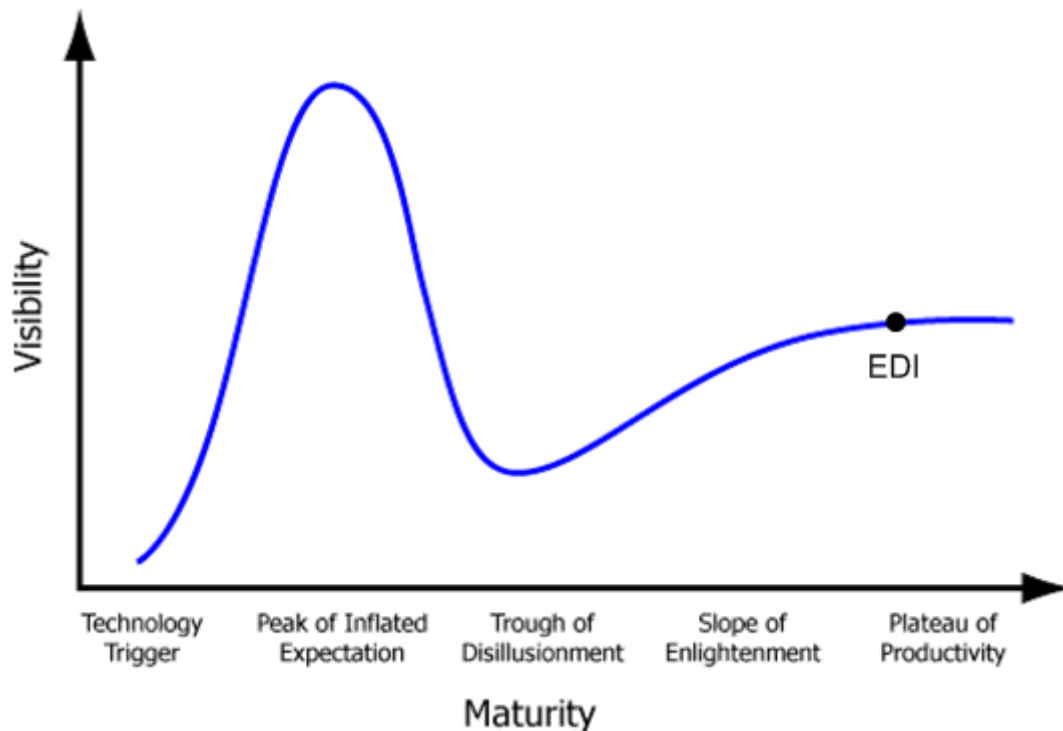


Fig. 2: Hype Cycle for Application Integration and Platform Middleware (McCoy, 2003).

4 The Comparability and similarities of EDI and RFID

In the last chapters we have shown what RFID and EDI focus on as individual systems. We will now examine what RFID and EDI have common. These technologies have various points in common and this is why the problems and solutions linked to EDI provide important information about the possible future problems and solutions for RFID. The comparison in this chapter is based on dimension standardisation, IT-integration, trust, network effects. We also take a look at cost and benefit including cost/benefit-sharing models for both technologies. In order to conduct a comparison, we understand both RFID and EDI to be technologies which help to automate data exchange between interorganisational networks of companies. This abstract level of comparison allows us to ignore the unimportant differences between the two technologies and helps us to concentrate on their common ground

4.1 Similarities of standardisation, IT-integration and need of trust between RFID and EDI

As it was mentioned above standards play an important role in data exchange between companies. As EDI became popular many standards came into existence. Renowned computer science professor Andrew Tanenbaum once said:

„The nice thing about standards is that there are so many to choose from. And if you really don't like all the standards you just have to wait another year until the one arises you are looking for.” (Tanenbaum 1996)

Every time business partners wanted to synchronize their systems they had to set up a committee to find an appropriate solution. In many cases this agreement process took a long time. The fear exists that because of the similarity between RFID and EDI a comparable procedure could be implemented. Clearly this must be avoided.

In the area of RFID there are ongoing projects to develop such needed standards. One important standard which has already been developed and which is on the market is the Electronic Product Code (EPC) (see Chen 2006). Moreover, coordination between supply chain partners and synchronization between the respective business systems are important when exchanging data using inter-organisational technologies such as EDI and RFID. If we consider data stored in EPC, synchronizing data between supply chain partners becomes critical. Product information must be updated accurately and on time within and across enterprises to ensure a perfect match of data between the originator of the data and all users of the data (see Schutzberg 2004). Since EPC data relates to products, using RFID throughout our supply chain cannot happen without significant product data standardisation and synchronization of product data between and among companies. This seems to be more important in RFID since the real strength of RFID comes into play when we consider the frequency of data transfer Whereas EDI systems typically deliver data in batch mode, RFID is able to deliver real time data.(see Zebra 2007).

Comparability in IT-integration and business process re-engineering

Apart from financial investment, what we call “sophisticated” implementation requires mutual trust between trading partners and often business process re-engineering (BPR). Orman (1998) points out that even a small change in the use of information technologies may call for big structural changes at the macro and micro level for the full benefits of the new technology to be felt. Otherwise sufficient payback cannot be observed. Macro-level changes concentrate on the degree of centralization of decision-making including questions about the shape and depth of the organisation's hierarchies. Micro-level changes, on the other hand, deal with job definitions such as employee skill requirements, satisfaction and so on. These organisational changes are often ignored when EDI is implemented. Since that the scope of RFID is larger than that of EDI, BPR optimization become more important before launching such a big project.

RFID and EDI and there need of trust

Ratnasingam and Phan (2003) show that IOS technologies such as EDI and RFID highlight the importance of mutual trust among trading partners. Trust certainly plays a crucial role among collaborating partners. Partners have to be willing to develop the interdependencies and relationships needed in order to benefit from trade and to achieve their intended goal. The authors believe that common factors affecting this trust are the partners' financial status, their competency, benevolence, reliability, their ability to comprehend, their business culture, as well as their level of consumer protection, the laws and social sanctions they operate under, and finally their degree of success and their peer referrals. From an economic point of view, three forms of trust can be detected (see Koskinen/Pihlanto 2007):

1. Deterrence-based trust: Parties rely on social institutions for the threat of punishment.
2. Knowledge-based trust: One trading partner has enough knowledge to predict and understand the behaviour of the other trading partner.
3. Identification-based trust: Partners share common values and can act as agents for each other.

Companies that want to use RFID along their supply chain have to make sure that they do not solely consider the technical aspects of RFID but that they also establish an environment of trust to motivate the partner in the supply chain to share the information with other partners in their supply chain.

4.2 Costs and benefits of EDI and RFID

In the literature there are different types of categorizations to describe the benefit of technologies such as RFID and EDI. According to Mukhopadhyay and Kekra (2002), companies do not only enjoy operational benefits such as:

- Greater data accuracy,
- Less administrative cost
- Reduction in manual processing

They also enjoy strategic benefits such as:

- Establishing long-term partnerships
- Closer relationships with their trading partners
- Increased competitiveness, because of all of the above.

Mackay and Rosier (1996) carried out a survey on the Australian Automotive Industry, amongst 280-300 manufacturers. The study results point out some significant benefits including:

- Reduced administrative costs and postage costs
- Improved productivity and data accuracy
- Better customer service
- Flexible buying strategies
- Better cash management

Another survey conducted by Ferguson et. al. (1990) samples 1094 large U.S firms which were using or were planning to use EDI. This survey shows the following main benefits of EDI technology with the corresponding response rates. The percentages relate to the number of people that gave the corresponding benefits as their reason for using or wanting to use EDI.

- Quick response and access to the information (47.1%)
- Cost efficiency (20.4%)
- Customer request (19.2%)
- The effect of EDI on paper work (12.4%)
- Accuracy (9.8%)
- Etc.

Similarly to Ferguson et. al., a study conducted by Murphy and Daley (1999) tests the same categories of benefits among the customers of international freight forwarders (IFF). Their results lead to a similar ranking of benefits:

- Quick access to information (43%)
- Reduced paperwork (33.8%)
- Better communications (32.3%)
- Cost efficiency (21.1%)
- Better customer service (19.7%)
- Increased productivity (18.3 %)
- Etc.

Furthermore, Bidgoli (1999) emphasized that EDI increase the companies' competitiveness by providing the following advantages:

- Establishing close partnership relationships
- Better record-keeping, fewer errors in data entry, reduced processing delays, less reliance on human interpretation of data
- Speeding up the ordering, invoicing and paying processes
- Real time delivery/sales information to manufacturers, shippers, and warehouses
- Promoting decision-making with accurate up-to-date data

All the studies we examined showed that, the most obvious benefits of EDI implementation are, without exception, cost reduction and better access to information. Gaugler et. al. (1996) also supports this point. In this study, an

empirical examination of the level of benefits of EDI implementation depending on the degree of technical and organisational integration was undertaken. They categorized the benefits of EDI into five groups which can be seen in figure three.

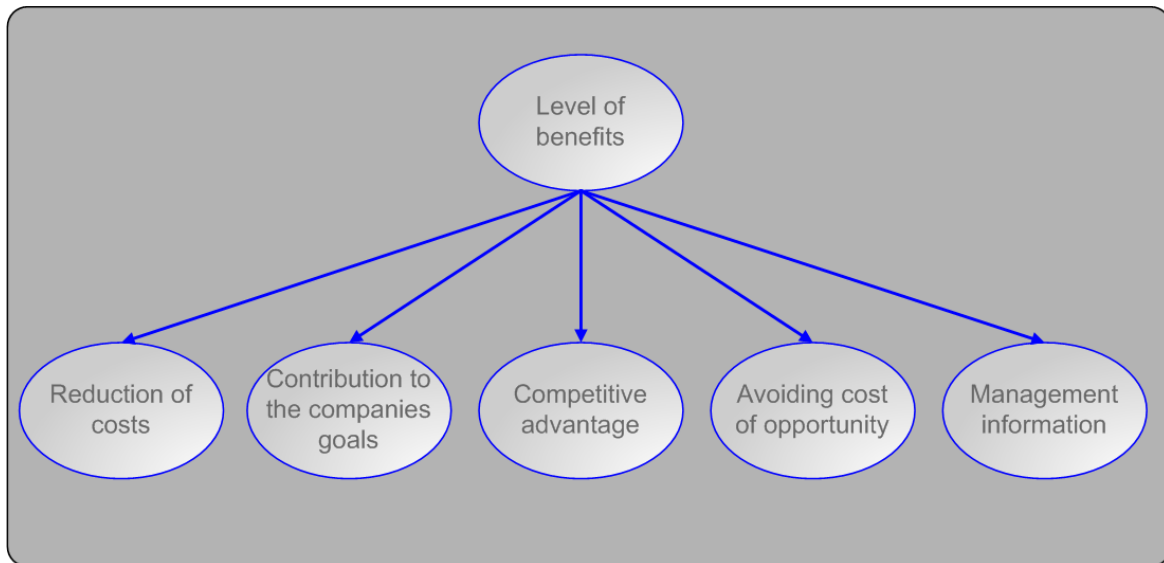


Fig 3: Categorization of the EDI benefits (see Gaugler et. al. 1996).

Even though EDI technology means companies enjoy considerable cost reductions, EDI users still represent a small fraction of potential users, considering the advantages of such a technology. An analysis carried out by Mackay and Rosier (1996) found that:

- 75% of companies adopting EDI use this technology not because of the advantages it offers but because they have been “instructed” to do so by their major supply chain partners who are mostly car manufacturers.
- With only 11.5% the next most cited reason was competitive necessity. This does not mean that these companies do not benefit from EDI, but they start to implement EDI primarily for “survival” reasons.

The Mackay and Rosier study concludes that the two following exogenous variables play a key role in observing the benefits of EDI:

1. The size of the company.
2. The company’s trade volume.

Small companies mainly suffer from a low number of transactions, and furthermore they have few partners willing to assure the use of EDI and bear the high costs associated with software, hardware and training that outweigh the benefits. Many small and medium-sized enterprises face these difficulties due to the lack of financial, administrative and technical resources (see MacGregor/Bunker 2000).

Riggins and Mukhopadhyay (2001) also point out that small companies often do not have the necessary infrastructure needed for EDI. There are several EDI products which allow firms to adopt some form of EDI. However even minimal computer technology requirements can sometimes be an obstacle for these companies.

Therefore big companies sometimes subsidize their smaller suppliers so they can implement the technology. Substantial costs force many companies to implement so-called “door-to-door” EDI, where the firms use a few applications on a front-end system without integrating it to their internal systems (see Riggins/Mukhopadhyay 1994). Benjamin et. al (1990) state that reluctance to spend money and a desire to keep costs to a minimum make it impossible for companies enjoy the real benefits. However, the cost of EDI often turns out to be higher than its benefits and this affects the implementation of EDI.

We have discussed the benefits of EDI and can now take a closer look at the cost of EDI. Only if the cost/benefit ratio is positive, meaning that the benefits outweigh the costs, will companies be willing to invest their money in this technology. King et. al (2002) emphasize the following major cost factors that impede the implementation of EDI:

- Significant initial investment
- Reorganisation of business processes
- High maintenance costs
- lengthy start-up period
- Use of expensive, private Value Added Networks (VAN)
- Lack of a standard EDI format (e.g. companies are forced to use several standards)
- Complexity of use (requires expensive training and probably highly qualified users)
- A converter to translate business transactions to EDI code.

Ferguson (1990) concludes that most of the respondents are ignorant about the benefits and real potential of EDI use and a considerable percentage do not understand what EDI VANs and EDI translation software can do. According to this study, the main barrier standing in the way of EDI usage is the “perceived high cost of setting up a trading partner”. 18% said that this was their main obstacle, putting it far above other costs such as issues of hardware and software compatibility (12.4%), training/education (8.3%) and lack of standard formats (8.0%), although these too are major cost factors which adversely affect implementation.

Another issue voiced by many experts is that these technologies require significant investment and therefore a good way to start is to run a pilot project beforehand.

Given the scope of RFID, which links companies in a more complex way than EDI, a pilot project becomes a critical issue. In the case of EDI, we are seeing a growing trend in companies to run small pilot projects with their IT services suppliers before committing to a long-term outsourcing contract. A pilot project helps a company to decide whether it is worth continuing and expanding the project and, if the results of the pilot project are satisfactory, to decide how to proceed with a full version. A vital point here is that the project has a clear critical success factor and key performance indicators, so that it is possible to measure and learn from success, or failure. A focused and well-targeted pilot project will increase the chances of successful implementation on a larger scale later. If properly evaluated, a pilot study reduces risks arising from large-scale failures (see Computer Weekly 2007).

During the implementation of EDI, companies encountered some problems, which are actually commonly seen in IOS technologies. The advent of a new IOS technology follows similar patterns. The following quotation is taken from a manager of an EDI pilot test complaining about his inability to control the actions of a trading partner:

“We didn’t know the readiness of the partner in terms of their experience with EDI. When we were finally ready to conduct the pilot they called to tell us they weren’t ready, and did not know when they would be! Their parent company wanted them to get on their networking system, which was different than ours. In the meantime our management was waiting to know how the pilot was coming.” (see Riggins/Mukhopadhyay 1994).

4.5 Cost benefit sharing as a solution for collaboration

As we saw in the previous chapter, only if the cost/benefit ratio is positive will companies be willing to invest in a technology such as RFID. We also noted that for big companies IOS technologies such as EDI and RFID can provide greater advantages than for small and medium sized enterprises. In order to find a satisfactory solution to this problem the following cost/benefit sharing models can be of use.

Cash and Konsynski (1985) point out a typical complaint from companies implementing interorganisational IT systems. They state in their paper that IOS systems such as EDI lead to a situation where the costs and benefits from these systems are not fully under the control of the company itself, but rather the entire supply chain. Hence in comparison with traditional information systems, EDI poses a higher risk, which companies want to avoid. Certain firms act as “initiators” while the suppliers define as “adopters” are forced to adopt these technologies (see Schlitter et.al 2007). Adopters do not implement IOS (e.g. EDI) in a particularly

sophisticated way but simply do the bare minimum in order to meet the requirements of the initiator. This prevents both the initiator and the adopter from reaping the expected benefits. (see Riggins/Mukhopadhyay 1999).

Another interesting point that is also mentioned in the literature, is that the level of benefits for the firms in the supply chain networks increase as the level of implementation increases. This seems to be logical and explains the reason why companies are interested in enhancing their implementation level and improving their relationships with trading partners. However, in the case of both EDI and RFID, it can also be argued that the benefits are not evenly spread amongst companies. Angelas et. al (1998) stress that expectations of greater benefits from the implementation of the EDI system serves as a catalyst for a highly integrated execution of electronic data interchange in the logistics field and in supply chain management. In their study they observe 128 companies to examine whether the level of EDI success (e.g. customer service quality, user satisfaction with EDI network information and so on) and the ability of EDI to solve problems are in direct proportion to the level of implementation. The results of this study show that the level of EDI implementation is directly related to the level of overall success of the EDI system as perceived by customers, but not to the overall success level as perceived by suppliers. This study also found four factors which are crucial to making EDI beneficial for companies:

1. Use of a pilot project.
2. Use of cross-functional EDI teams.
3. Security and auditing control.
4. Training in EDI for the end user.

In the case of RFID, implementation also takes various forms. For example, RFID is used inside the firms, in a door-to-door system or to integrate the whole network. It has also been said that large companies such as Wal-Mart enjoy the benefits while the small and medium-sized companies shoulder the costs. Therefore, when examining the feasibility of RFID, EDI or similar business systems, one should not use traditional cost benefit estimation models in order to justify the costs of the technology, but rather one should look at other models which consider "interdependent benefits". Investment costs are a major barrier to RFID. This is also the main problem in EDI implementation (see Ghobadian et. al. 1994). In the case of EDI, we often see that a company that mandated its suppliers to use the technology subsidizes the suppliers to encourage them to do so. For instance, large companies usually provide software free of charge to suppliers that cannot otherwise justify the investment (see Riggins/Mukhopadhyay 1994). This could also be a solution for RFID implementation.

4 Conclusion

In this article we have shown that RFID and EDI are IOS technologies that are comparable and that new RFID technology can draw on experiences gained through the use of EDI technology. Therefore we have taken a closer look at standardisation, integration into existing IT-systems and the need for trust in collaborative supply chains. We have shown why the problems that EDI faces increase when it comes to RFID. We have shown that this occurs because RFID is able to provide a great deal more information than EDI, and increased quantities of data serve to magnify problems.

Moreover we have compared several surveys about the benefits of EDI in order to see what the possible benefits of RFID might be. We also pointed out that there are some generic problems which we face when trying to create benefit out of an IOS technology. We have showed that benefit and cost are not always generated at the same point. We therefore described the cost/benefit sharing as a solution. We have showed that benefit and cost sometimes are not generated at the same point. For example one company in a supply chain may have to invest a lot of money in a new technology and another company along the supply chain may generate a profit because of this investment. To solve this problem we have described cost/benefit sharing as a solution.

This paper has presented an assessment of the implementation problems surrounding RFID. This article has concentrated on EDI technology; however this does not mean that we have covered all possible problems relating to RFID implementation. This article also notes possible problems that may be encountered with RFID by looking at the problems which have already occurred in the EDI area. Further more problems can be identified through an implementation test and pilot projects. Conducting such tests can also be useful in identifying company-specific problems.

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