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Strategic Importance of RFID – Empirical and Conceptual Insights

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Abstract
RFID is currently considered a hot topic in the IT arena. It is described as major enabling technology for automated contact less wireless data collection and as an enabler for the real-time enterprise, a future vision of Enterprise Information Systems. But little is known about the perceived strategic importance of RFID among IT decision makers, current RIFD usage and areas of application or companies' intentions to invest in RFID. In this paper we present a research model for analysing the perceived strategic importance of RFID and top IT decision makers' intentions to invest. The research model is applied in a quantitative survey among CIOs in Germany. We verify the research model and present empirical insights on CIOs' perceptions of RFID regarding its strategic importance, the relevance of RFID compared to other IT topics and their RFID vision for the future of their company. Finally, we develop a conceptual framework to asses, evaluate and implement RFID applications in companies

Keywords
RFID, IT strategy, IT investments, survey, RFID vision, CIO

Introduction

Radio Frequency Identification (RFID) is currently widely discussed throughout scientific and non-scientific media. Although it is not a new technology – the first publication dates back to 1948 – it is only recently that the public and the mass market really get aware of it (Landt 2005). The need for more efficiency and security in supply chains, enhanced technologies, sinking costs, standardization initiatives and prominent promoters such as Wal-Mart, Metro or Tesco have drawn the attention of many companies in various industries to new auto-ID technologies, most notably RFID (Sarma 2004). When the Society of Information Management (SIM) conducted its last survey asking IT executives for the key issues they were facing, RFID was among the top 20 developments in application and technology(Luftman 2005).
This study aims to explore CIOs' perspective on RFID technology. After a short introduction into technology and application areas, it is investigated if CIOs see strategic importance in RFID

and how they plan to act in regard to this issue. The research is conducted in an independent, non-commercial German CIO network organization.

Technology

RFID is a technology for automatic identification and data collection (Auto-ID). It allows an object or person to be automatically identified at a distance, using an electromagnetic exchange (Pering, Ballagas et al. 2005). In comparison to other well-known Auto-ID technologies as for example the barcode, RFID offers various advantageous characteristics to the user (Agarwal 2001):

- Unique identification: Applying e.g. the EPC standards, RFID tags cannot only identify classes of products, but individual items.
- No line of sight: RFID tags can be read even if there is no direct line of sight, the tag is covered, dirty or otherwise obscured from view.
- Bulk reading: If they are in range of a reader, multiple RFID tags can be read at the same time.
- Storage capacity: RFID tags can store significantly more information than just an identification number.
- Dynamic information: RFID tags with read-write capability allow information to be updated or changed whenever necessary.

However, RFID is not yet a mature technology. There still are a number of issues that remain to be solved:

- Effects of metal and liquid: Tags operating on radio frequency are not completely unaffected by materials in their close vicinity. Signals can be attenuated or detuned by metals or liquids.
- Multiple Standards: In the past, several different frequencies and standards have been used for RFID solutions. Although EPCglobal has now designed a comprehensive new framework, it will take some time to establish.
- Amount of data: Collection and communication of enhanced object information inevitably leads to huge amounts of data. It is unclear how this data should best be integrated into the enterprise information systems. A common approach is to endorse ERP systems with RFID middleware. Moreover, enterprises still lack reasonable services, i.e. do not know what to do with the additional data.

Improve Efficiency, Enable New Solutions, Open Door to Real Time Enterprise

RFID has the potential to accelerate, enrich and automat, in short, change the information flow in business processes (Strassner and Schoch 2002). Contemplating its characteristics, it is not difficult to derive potentials to improve process efficiency and effectiveness. Non line of sight avoids that an object has to be turned several times before the tag can be read, as it is often the case with barcode labels, requiring less manual intervention. Tags can still be read when the respective objects are already assembled or integrated in a product. Moreover, multiple reading reduces process lead time. Increased storage capacity allows to store enhanced product data on the tag, and to add information during an object's life cycle. In combination with sensors, the tag could carry additional up-to-date information, for instance about temperature, humidity or pressure in the object's environment (Haller and Hodges 2002). Accurate information and identification increase process transparency, making processes more secure.

But the potential of RFID goes beyond improving the efficiency of existing processes. RFID can enable new products, services and solutions. Potential application areas are versatile and spanning various industries. To name some, RFID can be used to improve issues in asset/product tracking, industrial warehousing, product handshaking, anti-counterfeiting, safety and security, condition monitoring, positioning/locating, theft or tampering detection (Wilding and Delgado 2004)[1]. In the following, selected examples will illustrate this point:

- Healthcare: Combating counterfeit drugs. Individual identification and seamless tracking of drugs from production to consumer would ensure their authenticity, thus protecting consumers from hurtful or useless drugs and make it more difficult for counterfeiters to place their products on market. The U.S. Food and Drug Administration rates RFID as the most promising technology to achieve this goals (U.S. Food and Drug Administration 2004).
- Automotive: Facilitating highly targeted call backs. If a specific delivery unit of a specific car component turns out to be defective, automotive manufacturers usually have to call back all cars of a certain type produced in the critical time span. If each component could be traced individually during the complete assembly process, the manufacturer would exactly know which car carries the relevant components, and thus avoid expensive and useless inspections of all other vehicles. Enterprises like BMW see this as a major opportunity to cut call back cost through RFID usage.
- Retail: The intelligent shopping cart. Without spending a considerable amount of time inquiring, consumers often cannot be sure about characteristics and ingredients of the products they are buying. But this data can be highly relevant if the consumer suffers from diseases, such as allergies or diabetes. Doubts would be removed if the shopping cart could read the information stored on the RFID tag on the respective product and dis-

[1] For an overview over selected case studies, see (Wilding and Delgado 2004) .

play it to the shopper, possibly along with allergy warnings or preparation suggestions. Metro Group already experiments with smart shopping carts in their RFID pilot store.

- Transport / Logistics: Logistic enterprises often must transport sensitive goods under specific conditions, e.g. frozen food or vaccines. RFID tags with sensors could allow inspecting and thus controlling if those conditions were met throughout the whole transport, increasing product security and providing both logistician and client with accurate information.

In the above-mentioned and in many other cases RFID can enable enterprises to bridge the gap between the real world and its representation in information systems (Haller and Hodges 2002; Fleisch and Mattern 2005); and by this build the road towards the "real time enterprise", promising optimized processes, better decisions through higher data quality and better integration of supply chain partners. But to be able to tap the full potential of RFID, enterprises must define which targets they want to hit by implementing this technology. To do so they have to be aware about the strategic impact of RFID and develop a well defined RFID strategy. Therefore the main aim of our study was to figure out to which extent the strategic importance of RFID is perceived among top IT decision makers, which investment behaviour they show and which RFID visions they have for their companies.

Literature Review and Development of the research model

In the following section the used research model is introduced. It is based on eight main research questions which are deduced from a literature review.

The Strategic Importance of RFID

Michael Porter describes strategy as "performing different activities from rivals' or performing similar activities in different ways" and emphasizes that mere operational effectiveness indeed is crucial for profitability, but it is not strategy (Porter 1996). Metro`s success in improving operations and cutting cost through RFID (Collins 2005) and the automotive industry's report about positive return on investments of RFID solutions (Kraft and Schauler 2005) may not meet this definition, but applications are still developing (Lange 2004). Various major consulting firms stress the impact of RFID on strategy. According to Gartner RFID could not only revolutionize the way items are tagged and traced through distribution channels (Roussel, Fenn et al. 2005), moreover it holds "great potential for reshaping business strategies" (Woods 2006). But beyond consultants, vendors and analysts, what do (future) users think? Research question 1 and 2 address this topic:

RQ 1: What is the diffusion rate of RFID?

RQ 2: How do CIOs assess the strategic importance of RFID?

Determinants on Perceived Strategic Importance

The first sector to use RFID technology was military (Schmid 2004), but bit by bit it made its way to other industries. Companies place hopes in RFID's potential to optimize and rationalize Supply Chain Management (Lange 2004). ABI research projects that certain industries will be particularly active in the field of RFID, including consumer packaged goods and retail, automotive, military and homeland security (Maselli 2003). This suggests that certain industries are more inclined to adopt RFID, forming the basis for research question 3:

RQ 3: Do characteristics of the responding companies such as industry and size influence the perceived strategic importance of RFID?

Diffusion of innovations theory identifies five attributes of innovations influencing their adoption: relative advantage, compatibility, complexity, trialability and observability (Rogers 1983). Supposing that adoption will only take place if an individual sees a certain importance or usefulness in an innovation, these factors could also influence the perception of strategic importance of an innovation, in this study this is RFID. Trialability is the degree to which an innovation may be experienced with. The better the individual understands how the innovation works under his or her own conditions, the more likely he or she will be to adopt it. Observability is the degree to which the results of an innovation are visible to others. Although the diffusion of RFID is currently low (Lange 2004), many companies have launched pilot projects, thus creating a certain trialability. Along with vendor's demonstration projects and other available information, these pilot projects provide observability for others. Consequently, research question 4 refers to RFID experience:

RQ 4: Does the level of experience with RFID influence the perceived strategic importance of RFID?

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers 1995). A similar approach is taken by Davis in his technology acceptance model (TAM), describing perceived usefulness as determinant of adoption (Davis 1989). Perceived benefits have also proved relevant in Iacovou and Benbasat's study about the adoption of EDI (Iacovou and Benbasat 1995), and as well was considered in Sharma and Citrus' research on the adoption of RFID (Xu, Sharma et al. 2005). In this study, relative advantage would describe potential benefits and improvement due to RFID in comparison to barcode technology. Hence, research question 5 addresses perceived potentials of RFID:

RQ 5: Do perceived potentials of RFID influence the perceived strategic importance of RFID?

Willingness to Invest in RFID

Since wholesalers such as Wal-Mart in the USA, Metro in Germany or Tesco in the UK and public authorities as the US department of defense have declared RFID a key technology, market forecasts outbid one another (Lange 2004). Frost & Sullivan predicts a growth in the RFID marketplace of over 30 percent until 2010 compared to 2003 (Frost & Sullivan 2004), Accenture even 40 percent (Accenture 2005). In a recent study, AMR research finds 69 percent of respondents planning to evaluate, pilot or implement RFID. They also forecast a market growth of about 40 percent, but already to be reached within two years (Reilly 2005). Research question 6 aims to verify if potential users share this view. Research Question 7 links the above described strategic importance with the willingness to invest.

RQ 6: Do CIOs plan to invest in RFID?

RQ 7: Does the perceived strategic importance influence the willingness to invest in RFID?

RFID in Comparison to Other IT Topics

In the SIM's 2004 study on application and technology developments IT decision makers are most concerned about (Luftman and Stevens Institute of Technology 2005), RFID was found to be on rank 17, suggesting it is a highly relevant matter, but not of primary concern. To put the results of the before-mentioned research issues into perspective, RFID's position among the respondent's IT priorities will be examined in research question 8.

RQ 8: How important is RFID in comparison to other IT topics?

Consolidating all eight research questions the following research model emerges (Figure 1)

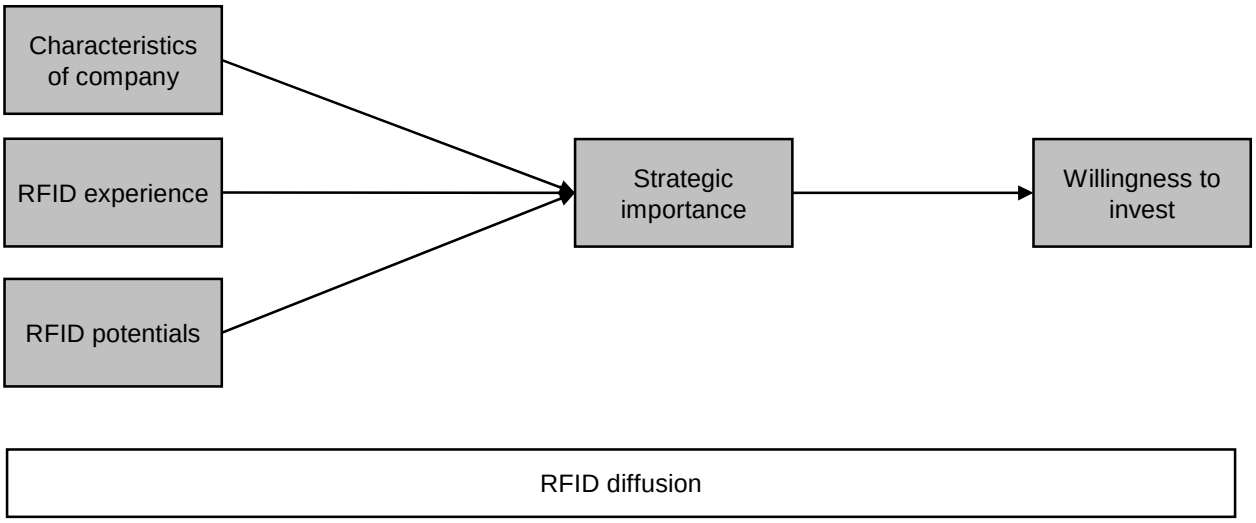


Figure 1: Partial research model (source: own illustration)

Research Design

The research questions deduced from literature review were supported by the findings from 15 semi-structured interviews with IT executives in various industries. Design and execution of the survey are based on the model describing the phases to gain information by (Nieschlag, Dichtl et al. 2002), a very established model in German social sciences. The model was applied and customized to fit the research questions addressed in this study. The study was conducted in a non-commercial German CIO network, the "CIO Circle". All 450 members, representing virtually all industries, were sent a personal invitation to take part in the survey. Table 1 summarizes important design parameters of the study undertaken, whereas Figure 2 illustrates the survey execution.

Research framework	Explorative study
Research method	Online survey
Period	11th November 2005 – 2nd January 2006
Universe	Members of the "CIO Circle", a non-commercial CIO networking organization (450 members)
Sample type	Census
Approach to contact potential participants	Personal e-mail invitation containing personal unique access code for survey website
Rate of return	Approx. 25 % (114 data sets)

Table 1: Study design parameters (source: own illustration)

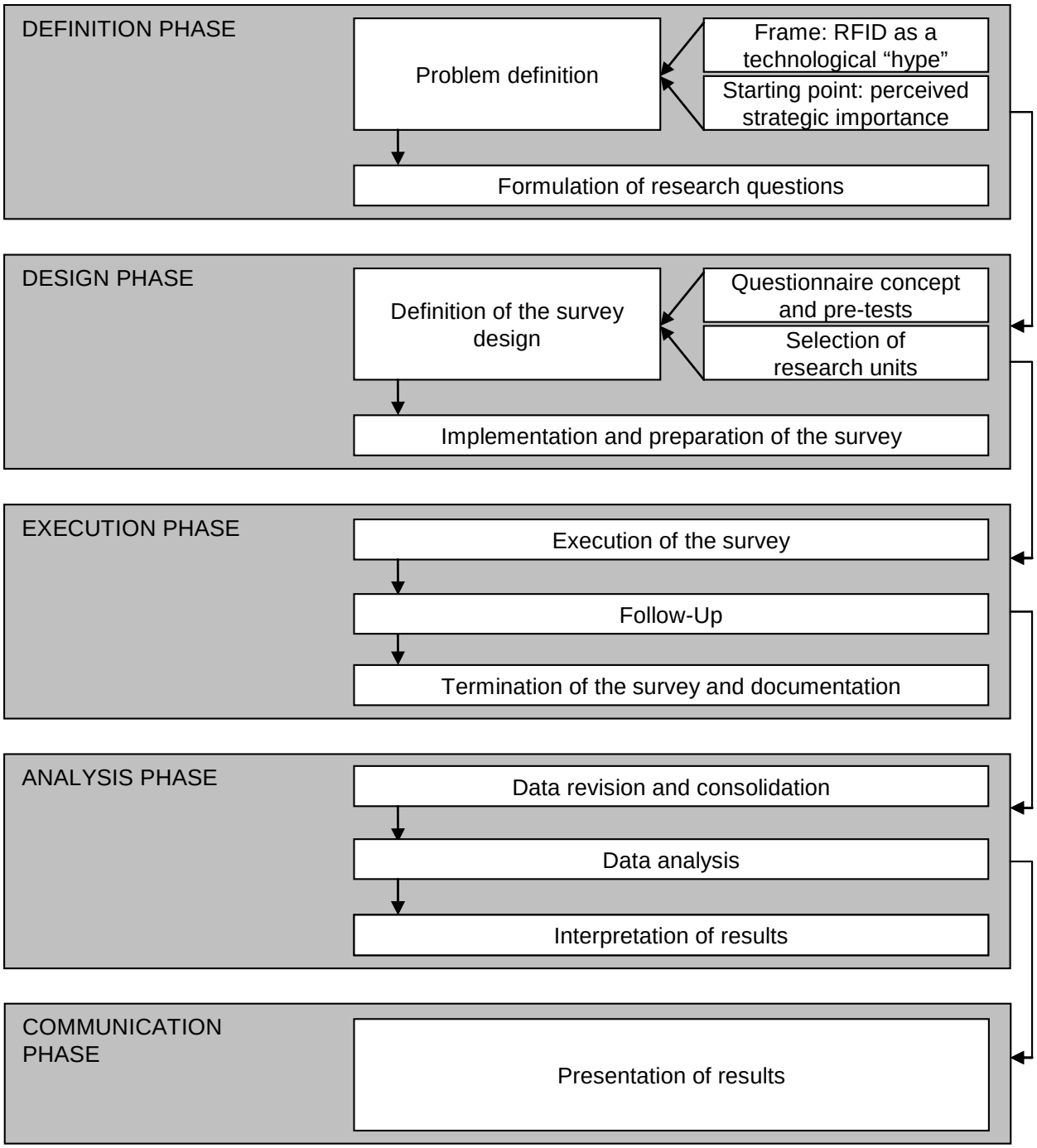


Figure 2: Survey execution and process (source: adapted from (Nieschlag, Dichtl et al. 2002))

Empirical Findings

Characteristics of Participants

In total, 114 members of the CIO-Circle participated completely in the survey, of which all but one participant are male. The age group 42-50 was represented mostly (n=66), followed by the group 31-40 (n=33). Asked for the main business activities of their company, participants indicated Manufacturing (32), Service (22), Transport / Logistics (20), Automotive (19), Retail (16), Consumer Goods (13), Consulting (11), IT (10), Pharmaceutical / Healthcare (10), and Other (22). Company sizes measured in number of employees vary, the majority (n=70) has less than 2500 employees, 20 exceed 10000 employees. Most respondents fill the position of Chief Information Officer (CIO) (n=88).

Results: RFID Diffusion (RQ 1)

The experience with RFID systems among the respondents is low. Only a very small number have currently implemented a running RFID system in their company (n=8). Some more are planning (n=12) or building (n=17) an RFID application. About a third is conducting tests (n=38). Another third has not yet thought about the topic. The remainder has conducted tests, but then decided to reject the technology (n=11).´

Concerning their knowledge of potential applications of RFID, half of the participants describe it as good or very good (n=57), 41 as average and the rest as poor or very poor (n=15).

Results: Strategic Importance of RFID (RQ 2)

The participants were directly asked to assess the strategic importance of RFID for their company on a 5-point scale (“Totally agree”=1 to “Do not agree at all”=5). 73 people answered the question. No particular tendency is revealed, the answers are almost evenly distributed across all categories (Mean=3.05). To gain more insight, the respondents were then asked for their opinion on RFID influencing their core competencies. Similar to the assessment of strategic importance, the average of the respondents neither agree nor disagree that RFID could positively influence their core competencies, with a slight positive tendency regarding the better exploitation of existing core competencies (Mean=2.78), and a slight negative tendency regarding the build-up of new core competencies (Mean=3.33). Nevertheless, they tend to agree that through RFID they could open up competitive advantages (Mean=2.61). As these results all go in line with the strategic importance, in the following analyses only the strategic importance will be further analyzed (for details, see Table 4).

Looking beyond the present, almost all respondents (91%) expect the importance of RFID for their company to rise in the near future (Figure 3). 68% of the 75 persons who answered the following question believe that RFID will get critical for the success of their company in the future. 54.7% even believe this to be the case in less than 4 years.

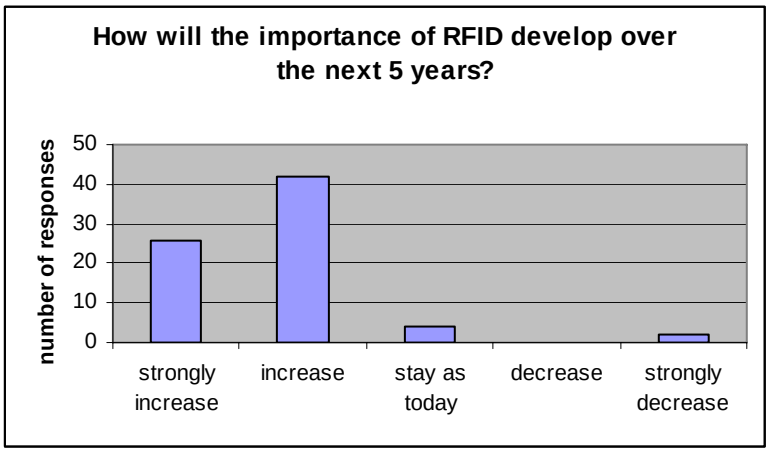
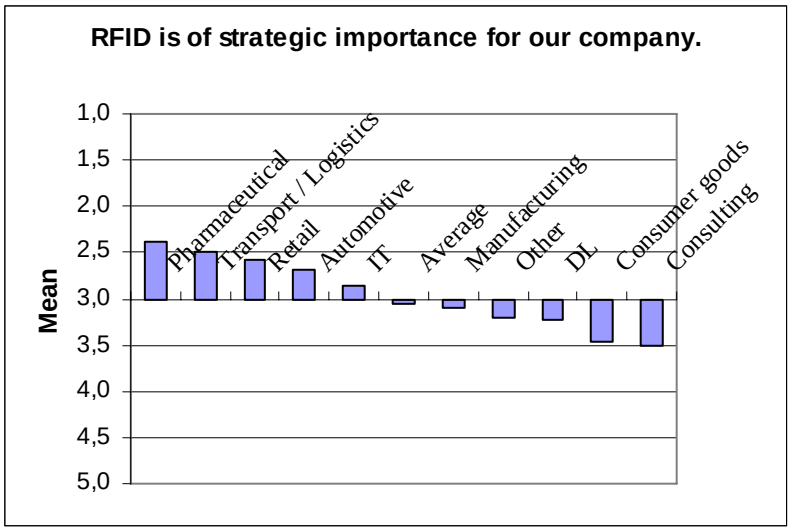


Figure 3: Future importance of RFID (n=74; source: own illustration)

Results: Determinants of Perceived Strategic Importance (RQ 3-5)

Characteristics of company and respondent (RQ 3)

Figure 4 shows the analysis of the perceived strategic importance for each of the industry groups. A comparison of the means shows that the perceived strategic importance of RFID indeed does vary in between the industries. Although the differences are not drastic, it is obvious that pharmaceutical (healthcare), logistics, retail and automotive tend to attribute a positive strategic importance to RFID, while other industries, e.g. manufacturing, assess it more negatively.



Annotation: 5-point scale from "Totally agree"=1 to "Do not agree at all"=5, n=114

Figure 4: Strategic importance of RFID by industries

When analyzing the strategic importance by company size, the means suggest it is rated the higher the bigger the company is. This impression is confirmed by a correlation analysis, whereby Spearman's rank correlation coefficient was used. The correlation analysis indicates a modest negative relationship between company size and "RFID is of strategic importance for our company"[2] (r=-.371, p=.001).

Regarding characteristics of the responding persons such as age and individual knowledge about RFID no significant correlations with the perceived strategic importance can be found.

Experience with RFID (RQ 4)

When crosstabulating the RFID experience of the companies with the perceived strategic importance, a comparison of the means reveals different values in all of the categories (see Table 2) Companies with tests in progress on average have a neutral opinion of the strategic importance of RFID. Of those who already have conducted tests, the companies who do not intend to apply the technology also do not believe in its strategic importance. In contrast, a positive tendency can be noticed for those intending the application. The most convinced of RFID`s strategic importance are companies currently implementing the system, even surpassing those already applying it.

[2] 5-point scale from "Totally agree"=1 to "Do not agree at all"=5

	Strategic Importance of RFID	
RFID Experience	Mean	Std. Dev
Applies RFID	2.38	1.408
Implementing RFID	1.67	1.033
Conducted tests, intends application	2.42	1.311
Tests in progress	3.19	0.995
Conducted test, does not intend application	4.70	0.675

Annotation: 5-point scale from "Totally agree"=1 to "Do not agree at all"=5; n=73

Table 2: Cross table of RFID experience & perceived strategic importance (source: own illustration)

Perceived Potentials of RFID (RQ 5)

On average all participants agreed on the presented potentials of RFID (see Table 3).

RFID has the potential to…	Mean	Std. Dev
Improve quality (n=75)	2.16	1.027
Automate / reduce manpower (n=75)	1.93	0.811
Reduce errors (n=75)	1.81	0.817
Reduce counterfeits (n=69)	2.59	1.204
Reduce inconsistencies in stock (n=74)	2.20	1.047
Accelerate the flow of goods (n=73)	1.88	0.927
Consistency in the integration of data across the supply chain (n=74)	2.15	1.043
Optimise stock keeping (n=74)	2.38	1.069
Improve customer service (n=75)	2.16	0.959

Annotation (5-point scale from "Totally agree"=1 to "Do not agree at all"=5)

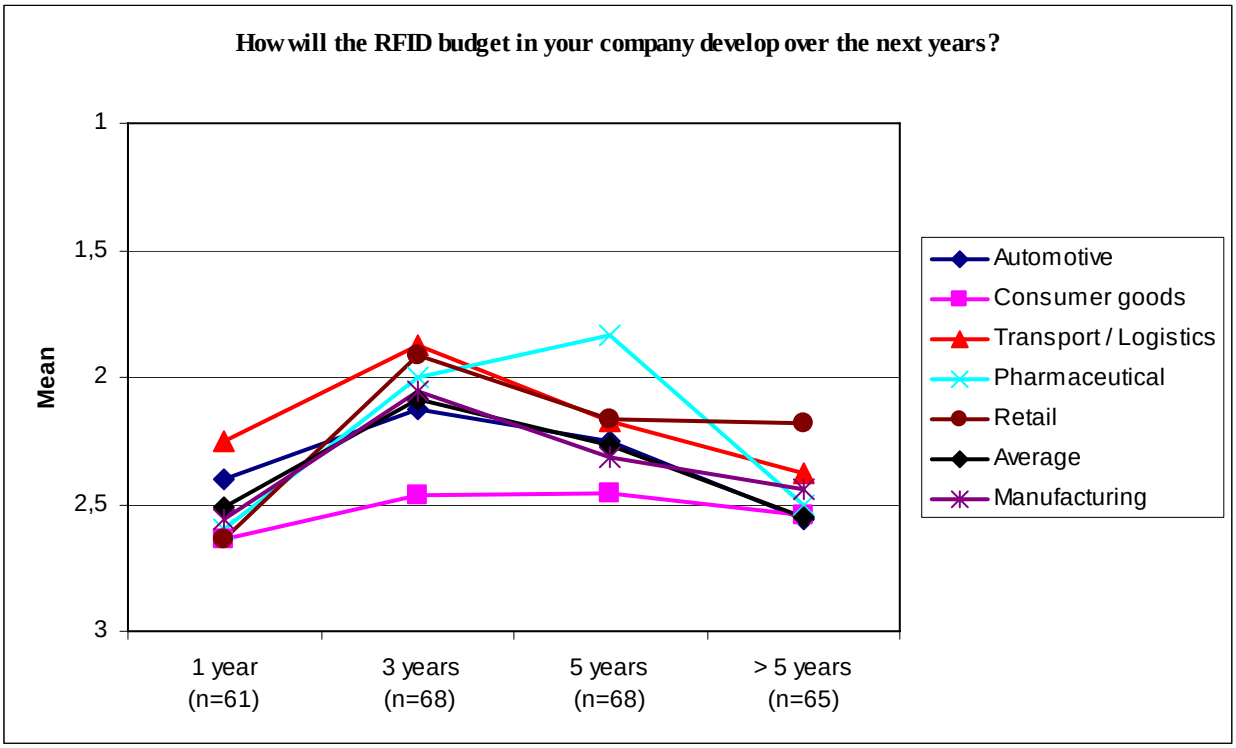
Table 3: Perceived Potentials of RFID (source: own illustration)

A correlation analysis using Spearman's rank correlation coefficient was conducted to measure whether perceived potentials influence the perceived strategic importance. A highly significant positive relationship can be found between "improve quality" ($r=0.379$; $p=0.001$), "accelerate the flow of goods" ($r=0.336$; $p=0.004$), "optimise stock keeping" ($r=0.436$; $p<0.001$) and the perceived strategic importance. The results also indicate a significant positive relationship between "automate" ($r=0.284$; $p=0.016$), "reduce errors" ($r=0.278$; $p=0.018$) and "improve customer service" ($r=0.245$; $p=0.038$). For the other statements, no significant relationships could be found.

Results: Willingness to Invest in RFID (RQ 6-7)

On a 5-point scale ("Totally agree"=1 to "Do not agree at all"=5) the participants were asked to comment the statement "We will invest in RFID". On average, the participants tended to agree to this (mean=2,41; std. deviation=1.122). A correlation analysis using Spearman's rank correlation between "RFID is of strategic importance for our company" and "We will invest in RFID" showed a highly significant strong positive correlation (r=0.784; p<0.001).

Asked how they think the RFID budget of their company will develop over the next years, on average all participants expected it to rise, the strongest rise is expected in about 3 years, then it will go down again, nevertheless being higher as today. When analyzed separately, with slight variations this trend is also true for the single industries. Pharmaceutical forms an exception and it does expect the RFID budget to grow even more in five years from now.



Annotation (5-point scale from "Totally agree"=1 to "Do not agree at all"=5)

Figure 5: RFID Budgets (source: own illustration)

RFID and Top IT Topics (RQ 8)

The statement "RFID is one of our top IT topics" (5-point scale from "Totally agree"=1 to "Do not agree at all"=5) was rated on average with 3.69 (std. deviation=1.115). To put this into perspective, the participants were asked in an open question to specify the three top IT topics their

company dealt with at the moment. 111 participants followed the request, of which 9 persons mentioned “RFID” among the top IT topics. 19 mentioned “Tracking & Tracing” or similar expressions. CRM and IT integration followed.

Conclusion

Consulting firms and vendors may praise RFID as a hot topic in IT, but in fact, virtually no company has implemented a running system. In many cases, tests are in progress, still leaving almost as many who haven’t even spend a thought on it. On the current agenda of IT decision makers, RFID plays only a minor role, but CIOs agree that this will change within the years to come.

The opinion of IT decision makers on the strategic importance of RFID is much divided. On average, their attitude can be described as neutral with no tendency to either direction. However, this perception seems to be linked to industry and company size. The pharmaceutical industry and transport / logistics see the highest strategic importance in RFID. Despite the high media attention, retail does not follow until rank three. To a certain degree, automotive also sees RFID as strategic, whereas manufacturing and the consumer goods industry tend to assess it negatively. The bigger the size of a company, the higher it rates the strategic importance of RFID. Hope for quality improvement, acceleration of the flow of goods and optimization of stock keeping particularly contribute to the assessment.

As expected, a higher perception of strategic importance correlates with a higher willingness to invest in the technology. This willingness could be turned into real investments, as all industries expect their RFID budgets to grow over the next years, especially within the next 3 years to come. Moreover, the participants expect RFID to rise in importance over the next few years.
Figure 6 summarises the findings of the study.

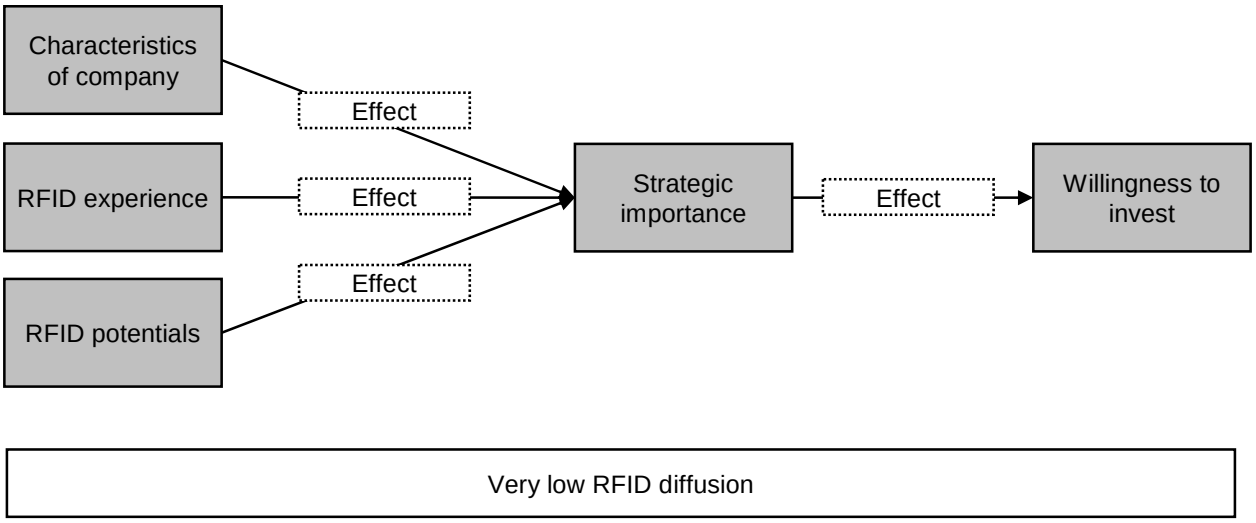


Figure 6: Results of the survey (source: own illustration)

Preparing for the Future: RFID Visions

So how do potential users and vendors see their company's RFID future?

On average all participants agreed on the fact that the importance of RFID increases. To gain an insight about the respondent's future plans and activities in the field, they were asked to provide their RFID vision for their company. After a categorisation of these qualitative statements, four types of RFID visions emerged.

Type 1: The visible enterprise. Respondents in that group hope for real-time information and identification throughout the supply chain, creating complete transparency of all processes relevant to the company at any time. Statements in this category tend to be highly abstract, e.g. one respondent expressed: "RFID-enabled continuous and integrated information chain including suppliers and partners – the vitreous enterprise". Approximately 30 % of the visions provided were classified into this group.

Type 2: Precise, selected application areas. Respondents in this group as well expect RFID to optimize certain processes, but their agendas are more precise, often suggesting a few specific areas of application. For instance, one participant thinks RFID holds potential for "warehouse management with position sensing by transponders in the ground". About 14% bear such precise application in mind.

Type 3: RFID is to replace barcode. A relatively small percentage (about 5 %) at first aims to replace existing barcode technologies and maybe later considers enhanced applications of RFID.

Type 4: No vision. About 25 % explicitly state they had no RFID vision. In most cases, either they do not see any benefits in applying RFID (e.g. “It is not relevant for our main processes”) or the companies have decided to take an expectant, observant position (e.g. “curiously observing, costs still too high” or “there’s no need for us to be an early adopter”). 23 % provide no statement at all. The remaining 3% could not be classified.

These findings suggest that companies who have already begun to go in for RFID will successively expand RFID usage to more application areas. Observant companies may follow when the technology and standards are more established.

RECOMMENDATIONS AND SUGGESTIONS FOR ACTION

The above findings show that only a small group of companies clearly have explicit RFID applications in mind. Most of the companies either just have a rough vision or are not sure about possible benefits in using RFID. Potential users should keep in mind that the importance of RFID rises and cannot be ignored for much longer. It will not only be about replacing barcode, but will affect a lot more processes, products or services. They also should be well aware of the fact that RFID usage is not only a matter of their own choice, but can also be declared necessary or even compulsory on the part of business partners, as happened in the cases of Wal-Mart and Metro. It is therefore essential to keep watch of the RFID activities of close neighbours in the supply chain. Companies are well advised to concretize and substantiate their RFID visions to be able to clearly define their RFID strategy.

RFID will not have the same importance for all industries and branches. Therefore a one-fits-all strategy is not possible. The strategic importance of RFID depends on the company’s needs and possibilities which are determined by company characteristics and the specific business environment, e.g. customers, competitors, suppliers etc. To be able to develop an adequate RFID strategy and to define economically successful RFID projects, companies have to create a deeper understanding of possible business potentials of RFID applications.

Expert interviews with RFID technology leaders in retail, logistics, automotive and pharmaceutics revealed similarities in the way how these companies approached the new technology and the potential strategic importance for their companies. These insights are the foundation for the following four step procedure model as depicted in Figure 7. It can support potential RFID users to detect the specific strategic importance of RFID for their company. As the findings of this chapter’s study show, the knowledge of existing RFID potentials as well as the own RFID experience companies already gained, influence the perception of strategic importance. It has to be pointed out strongly that not all companies which evaluated RFID applications automatically perceive a high strategic importance. In fact the study shows a slight tendency that companies already applying RFID are not so convinced than companies currently implementing it. This

could be an indication that the results of the defined RFID projects did not fulfil the high expectations. Therefore the proposed procedure model has a strong focus on consequent and systematic preparation of project definition and implementation.

Not only potential users but also RFID vendors are confronted with major challenges in realizing RFID applications. RFID vendors should not underestimate the complexity of the topic RFID. High-level visions like the real time enterprise and strategic aspects do not work on a great part of the target companies, of whom many have little knowledge of RFID. It is the smaller aspects, like process acceleration, that could convince a customer of the importance of RFID. Also, it may render useful to concentrate now on a limited number of industries, e.g. healthcare and logistic, which now consider RFID more important than for instance manufacturing. Big companies are probably easier to win for the technology than smaller ones. Pilot tests may be useful to reveal application areas to the customer.

To generate a win-win-situation for both users and vendors these groups should process the proposed model in close collaboration. On the one hand the user gets valuable inputs of RFID knowledge and experience. On the other hand the vendor gets the chance to identify his customers' needs and (in the best case) to work out and implement customized concepts.

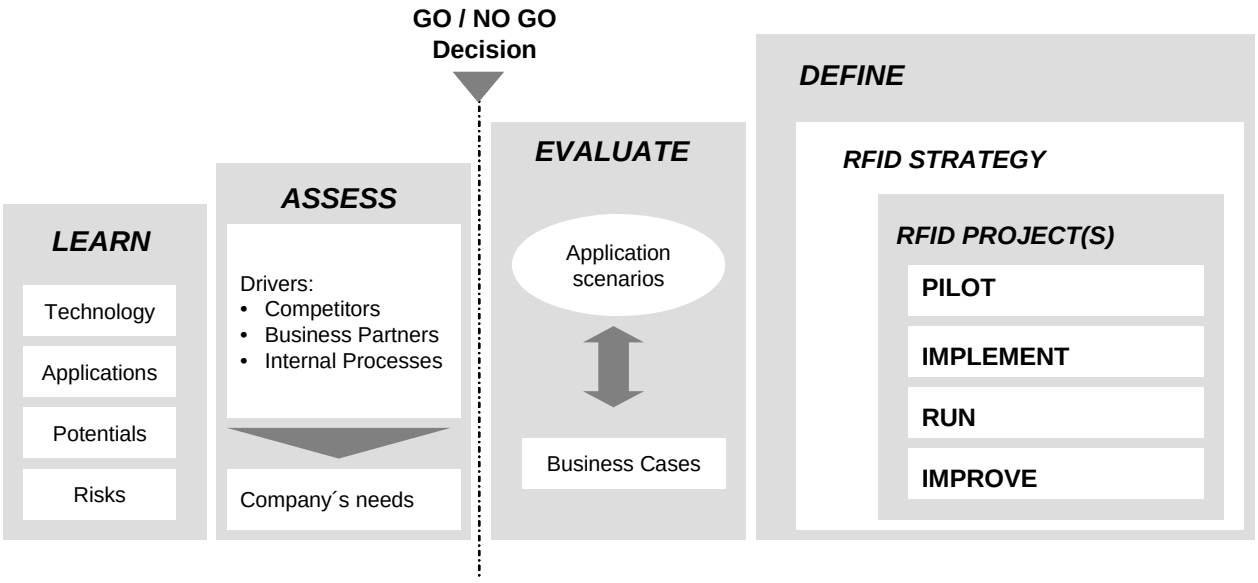


Figure 7: Approach for leveraging the potentials of RFID

Step I - Learn: The user company has to adopt knowledge about RFID such as basic aspects of the technology and its function, possible applications in its own or related industries as well as general potentials and risks. RFID has to be seen as enabling technology for new products and

process. The techniques of technology roadmapping are helpful in this and the next step to bring together the strategic use of technology and company's needs and challenges (Groenveld 1997; Möhrle and Isenmann 2002).

Step II - Assess: In this step the company has to detect its specific needs. Potential drivers of an RFID application have to be identified and systematically analyzed. Beside internal drivers such as process improvements, external drivers like market, competitors and business partners have to be considered. At the end of this phase the company should be able to estimate the company specific potentials and strategic importance of RFID. The company's principal (current) attitude towards RFID has to be defined. RFID vendors can support potential customers in these fist two phases with their expert knowledge on technology, industries and similar projects.

Step III - Evaluate: In case of a go-decision in step II different application scenarios have to be worked out based on the companies´ needs. Especially, RFID based solutions have to be compared against alternative technologies or solutions and strength and weaknesses have to be identified. The resulting opportunities and threats should be evaluated not only in regard to the technology but also to business cases and company strategy, e.g. by using the SWOT technique (Macharzina 2003). The scenarios have to be screened and evaluated according to the targets of the company.

Step IV - Define: With the insights out of the three previous steps the company should be able to develop an appropriate RFID strategy as a framework for the definition of RFID projects. The project definition itself has to include technical, organizational and social aspects. The planning has to consider the pilot phase as well as an action plan for the implementation. Existing models to develop and roll-out IT projects should be used (Boehm 1988; Broy and Rausch 2005). In this step not only the initial development but also the company wide rollout and the necessary support to introduce the new technology has to be considered (Klein and Krcmar 2003).

As illustrated above the described approach intends to support companies in identifying the strategic importance of RFID and derive a suitable RFID strategy. To guarantee its practicability guidelines have to be developed to lower the effort of collecting the necessary data and help companies to focus on relevant activities.

LIMITATIONS OF THE STUDY AND OUTLOOK

As a result of the explorative research approach the study has to deal with some limitation. The survey was carried out in a CIO network organization. Due to the self-selection of the network members the obtained results can not be regarded as representative per se. Furthermore the research study tested cross effects of variables only to a limited extent, whereas the collected data seem to reveal many effects that need to be analyzed in more detail in succeeding future re-

search. Future research should focus on potentially intermediating variables and further factors that may take influence on the perceived strategic importance of RFID.

Nevertheless RFID has proved to be an enabling technology for new business strategies that deliver sustainable competitive advantages for companies (e.g. in retailing or logistics etc). To efficiently exploit the potentials of RFID it is important to take a systematic approach both a strategic level with a long-time, company-wide horizon and on an project level when evaluating new product and service ideas or redesigning business processes. Here RFID users can benefit from the experience of RFID vendors and service providers to jointly assess, evaluate and define RFID projects. The results of the empirical study and the conceptual framework presented in this chapter could be a basis for companies to start thinking about RFID.

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	Industry																					
	Average		Automot.		CG		Logistics		Pharmac.		IT		Manufact.		Retail		Service		Consulting		Other	
Statistics	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
RFID is of strategic importance for our company.	3,05	1,32	2,69	1,08	3,46	1,33	2,50	1,20	2,38	0,92	2,86	1,68	3,10	1,41	2,58	1,44	3,22	1,64	3,50	1,76	3,20	1,55
How will the importance of RFID develop over the next 5 years?	1,78	0,78	1,69	0,48	1,83	0,39	1,67	1,03	1,63	0,52	1,50	0,76	1,70	0,57	1,58	0,67	2,00	1,25	2,83	1,17	1,73	0,65
By using RFID, we can open up competitive advantages.	2,61	1,23	2,25	1,13	3,15	0,99	2,11	0,96	2,13	0,83	2,63	1,85	2,52	1,25	2,42	1,51	2,80	1,62	3,17	1,72	2,82	1,33
RFID helps us to build up new core competencies.	3,33	1,28	3,19	1,05	3,54	1,27	2,50	1,29	3,38	1,19	3,13	1,36	3,43	1,36	2,83	1,53	3,20	1,55	3,67	1,51	3,18	1,40
RFID helps us to better exploit existing core competencies.	2,78	1,31	2,38	0,96	3,15	1,34	2,33	1,28	2,13	0,83	2,75	1,67	2,90	1,26	2,50	1,45	2,90	1,66	3,50	1,64	2,64	1,43

Table 4: Strategic Importance of RFID by Industries