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STRATEGIC IMPORTANCE OF RFID - THE PERSPECTIVE OF IT DECISION MAKERS IN ITALY

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ABSTRACT

RFID technologies are currently considered a hot topic in the IT arena and have been described as a major enabling technology for automated, contactless, wireless data collection. Little is known about the perceived strategic importance of RFID among IT decision makers, current RFID usage, companies' intentions to invest in RFID and companies' visions of RFID application. This research contributes quantitative data on IT decision makers' view of RFID across various industries and company sizes in Italy.

RFID is currently not very widespread. Many IT decision makers have not even heard about it. Those who have thought about the topic perceive RFID as a strategic issue. They expect the importance of RFID to rise significantly over the next few years. Companies' RFID budgets will rise over the next 5 years and IT decision makers are willing to invest in the technology. However, RFID is not a topic of high priority on the IT agenda. IT decision makers hope for more process accuracy and reduction of errors. Moreover, they see RFID as a means to enable new service, even though they do not think it could influence their core competencies significantly.

Keywords: RFID, IT strategy, IT investments, Diffusion, RFID vision, CIO

INTRODUCTION

RFID is currently widely discussed throughout scientific and non-scientific media. Although it is not a new technology, the first publications date back to 1948 [12], it has only recently come to the awareness of the public. New auto-ID technologies, most notably RFID [24], have drawn the attention of many companies due to factors including: the need for more efficiency and security in supply chains, enhanced technologies, cost pressure, standardization initiatives, and prominent promoters such as Wal-Mart, Metro, and Tesco. When the Society of Information Management (SIM) conducted its last survey of IT executives, RFID was rated among the top 20 developments in application and technology [16].

The aim of this study was to explore CIOs' perspective on RFID technology. Using CIOs as a source of information, we investigated the strategic importance in RFID, RFID as an enabler for RTE, and how CIOs plan to

act in regard to this issue. The research was conducted using an independent, non-profit German CIO network organization to obtain interviewees.

RFID 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 [6] [27]. In comparison to other well-known Auto-ID technologies such as the barcode, RFID offers the following advantageous characteristics for the user [2]:

- Unique identification: Applying e.g. the "Electronic Product Code" (EPC) standards, RFID tags can identify classes of products as well as individual items.
- No line of sight: RFID tags can be read without direct line of sight even if 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.

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

- 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 the standardization organization 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 and do not know what to do with the additional data.

Improve Efficiency, Enable New Products and Services, and Gain Competitive Advantage

There is empirical [15] [11], conceptual [3] and simulational [14] evidence that RFID has the potential to accelerate, enrich, and automate: In short, change the information flow in business processes. Contemplating its characteristics, it is not difficult to derive potential to improve process efficiency and effectiveness as promised by the RTE visionaries. Non line of sight avoids an object having to be turned several times before the tag can be read, as is often the case with barcode labels. Hence, less manual intervention on the object is required. 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 enhanced product data to be stored on the tag and the ability to add information during an object's life cycle. In combination with sensors, the tag could carry additional up-to-date information about temperature, humidity or pressure in the object's environment [8]. 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 already enables new products, services and solutions. Application areas are versatile and span various industries. RFID is, for example, used to improve issues in anti-counterfeiting [26], asset/product tracking, industrial warehousing, product handshaking, safety and security, condition monitoring, positioning/locating, and theft or tampering detection [29]. Other examples highlight the potential for completely new services such as enriched museum tours [9]. The following selected examples 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 harmful or useless drugs as well as making 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 these goals [27].

Automotive: Facilitating highly targeted recalls. If a specific delivery unit of a specific car component turns out to be defective, automotive manufacturers usually have to recall 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 know exactly which cars carry the relevant components and avoid expensive and useless inspections of all vehicles. BMW, for example, sees RFID as a major opportunity to cut costs of recall actions.

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 although this information can be highly relevant if the consumer suffers from allergies or other diseases. Doubts could be removed if the shopping cart could read the information stored on the RFID tag on the respective product and display 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 transport sensitive goods under specific conditions (e.g. frozen food or vaccines). RFID tags with sensors could allow inspecting and thus controlling if required conditions were met throughout the entire transport thus increasing product security and providing both logistician and client with accurate information.

RFID can enable enterprises to bridge the gap between the real world and its representation in information systems [8], thus paving the road toward the "real time enterprise", promising optimized processes over organizational boundaries, improving decisions through higher data quality, and improving integration of supply chain partners.

THEORETICAL BACKGROUND

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 although operational effectiveness is crucial for profitability, it is not strategy [20]. Metro's success in improving operations and cutting cost through RFID [4] and the automotive industry's report about positive return on investments of RFID solutions may not be of a strategic nature yet, but applications are still developing [13] and, as discussed in the previous sections, indeed can enable a company to offer new services not offered by its competitors. Various major consulting firms stress the impact of RFID on strategy. According to Gartner Research, RFID could not only revolutionize the way items are tagged and traced through distribution channels [23], but also hold "great potential for reshaping business strategies" [30]. But beyond consultants, vendors, and analysts, what do (future) users think? Research questions 1 and 2 addressed 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, but bit by bit RFID made its way into other industries and institutions. Companies are optimistic about RFID's potential to optimize and rationalize supply chain management [13]. 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 defence [18]. 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 [22]. 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, RFID. Trialability is the degree to which an innovation may be experienced. The better the individual understands how the innovation works under his or her 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 [13] many companies have launched pilot projects, thus creating 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 [22]. A similar approach is taken by Davis in his technology acceptance model (TAM), describing perceived usefulness as a determinant on adoption [5]. Perceived benefits have also proved relevant in Iacovou and

Benbasat's study [10] about the adoption of EDI and as well were considered in research conducted by Sharma and Citrus [25] on the adoption of RFID. In this study, relative advantage describes 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 such as the US Department of Defence have declared RFID a key technology, market forecasts have outbid one another [13]. Frost & Sullivan Research [7] predicts a growth in the RFID marketplace of over 30 percent by 2010 as compared to 2003. Accenture [1] estimates the growth will be 40 percent. In a recent study, AMR research found that 69 % of respondents planned to evaluate, pilot, or implement RFID. They also forecast a market growth of about 40 %, to be reached within two years [21]. Research question 6 aims to verify if potential users share this view and 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

The SIM's 2005 study on application and technology developments concerning issues that IT decision makers are most concerned about [17] showed that RFID ranked 16th, suggesting it is a relevant matter, but not one of primary concern. To put these results into perspective, the position of RFID among our study's respondents IT priorities will be examined in research question 8.

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

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 upon the model describing the phases to gain information by Nieschlag, Dichtl and Hörschgen [19], a very established model in Social Sciences. The model was applied and customized to fit the research questions addressed in this study. Table 1 summarizes important design parameters of the study undertaken, whereas Figure 1 illustrates the survey execution.

Method:	Quantitative online survey
Foundation:	Literature review + 15 in -depth interviews with IT executives
Access to survey:	On invitation with personal unique access code
Runtime:	3. Apr – 7. Jun 2006
Participants:	157
Participants ' job position:	CIO (50%), CEO (11%), other (39%)

Table 1: Key Data of the Study

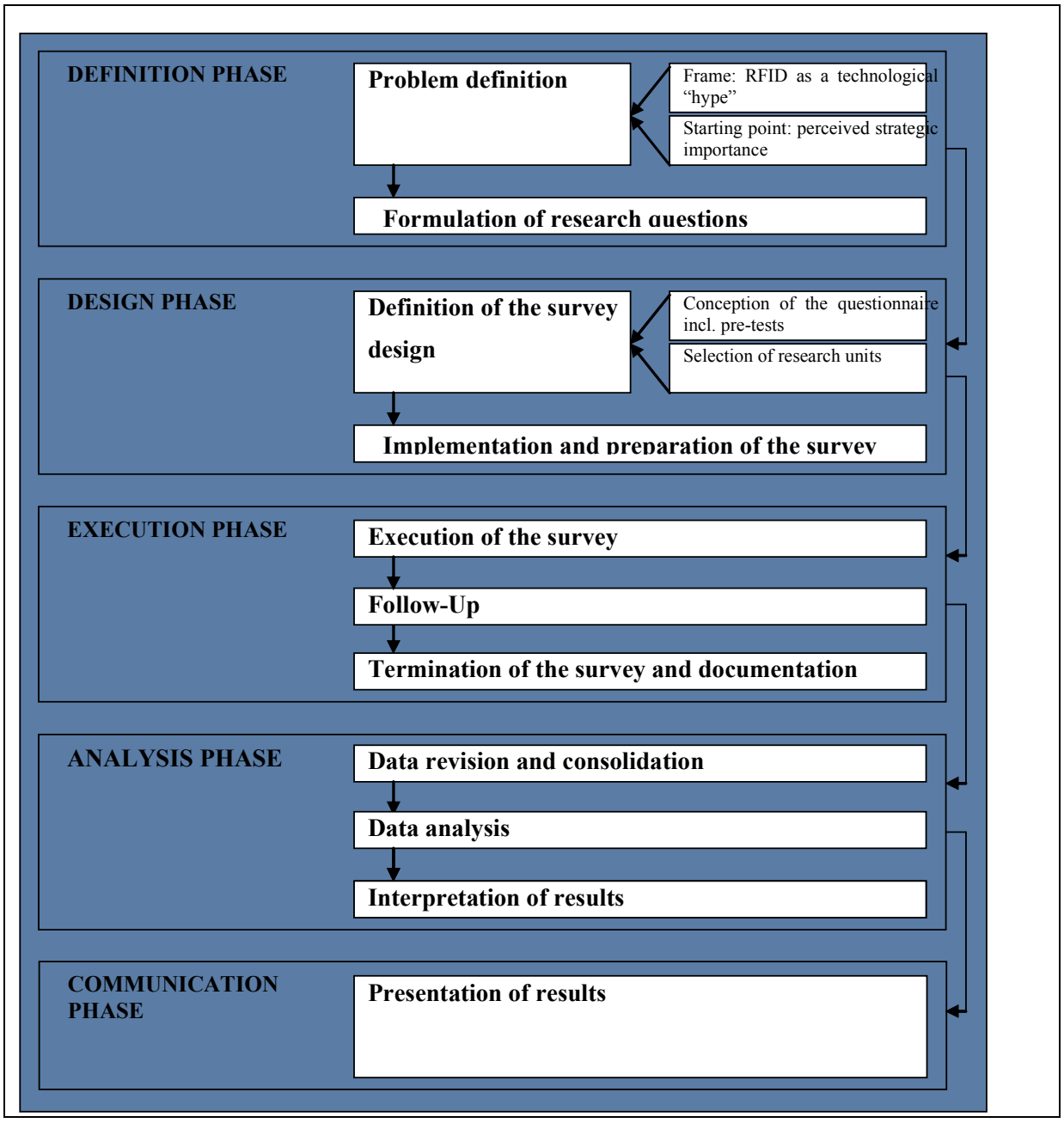

Figure 1: Survey Execution and Process
(Adapted From [19])

EMPIRICAL FINDINGS

Characteristics of Participants

In total, 157 IT decision makers participated in the survey, of which all but one were male. The age group 31-50 had the highest representation (69.2%). Asked for the main business activities of their company, participants indicated retail (45.2%), consumer goods (21.7%), manufacturing (21.7%), transport / logistics (15.9%), automotive (10.8%), pharmaceutics / healthcare (7.0%), IT (3.8%), other (9.6%). Company sizes measured in number of employees varied; the majority (75.8%) had less than 250 employees, 19.1% had between 250 and 1000 employees, 3.8 % between 1000 and 10000 and 1.3% exceeded 10000 employees. Most respondents were chief information officers (CIO) (50.2%) or chief executive officers (11.9%).

Results: RFID Diffusion (RQ 1)

Concerning their knowledge of potential applications of RFID, only about one fifth of the participants described it as good or very good (21.5%), 40.9 percent as average and the rest as poor or very poor (37.6%).

The experience with RFID systems among the respondents was low. Only a very small number have currently implemented a RFID system in their company (6%). Some were planning (1.5%) or building (3.3%) an RFID application. About a third was conducting tests (33.3%). 83 percent had not yet thought about the topic. The remaining 1.5 percent had conducted tests, but then decided to reject the technology.

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). Thirty two people answered the question. The answers have a slight positive tendency distributed across all categories (mean=2.50; std. dev.=1.218). To gain more insight, the respondents were then asked for their opinion on RFID influencing their core competencies. On average the respondents neither agree nor disagree that RFID could influence their core competencies regarding the better exploitation of existing core competencies (mean=2.94; std. dev.=1.261) and the build-up of new core competencies (mean=2.82; std. dev.=1.105). The same is true for the question if they thought that through RFID they could generate competitive advantages (mean=2.76; std. dev.=1.091). As these results all go in line with the strategic importance, in the following sections only the strategic importance will be further analyzed.

Looking beyond the present, the major part of the respondents (80.0%) expects the importance of RFID for their company to rise in the near future (Figure 2). Sixty-six percent of the 38 persons who answered the following question believed that RFID already is or will become crucial for the success of their company within the next six years.

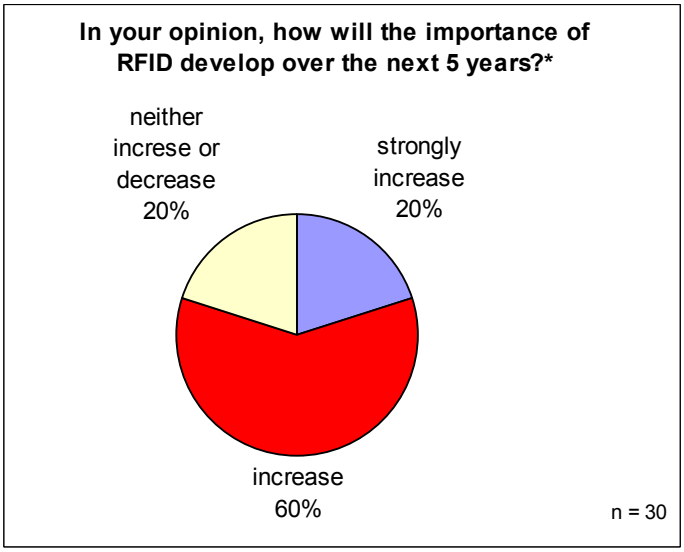

Figure 2: Future Importance of RFID

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

Characteristics of company and respondent (RQ 3)

Regarding the company size and characteristics of the responding persons such as age and individual knowledge about RFID, only one significant correlation with the perceived strategic importance can be found: The one between individual knowledge and perceived strategic importance (r=0.365; p=0.040).

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 (Table 1). The closer a company is to RFID application, the higher they seem to assess its strategic importance. An exception is the category "conducted tests, does not intend application". This category is neglected here, as it only consisted of one answer.

Table 2: Cross Table of RFID Experience & Perceived Strategic Importance

	Strategic Importance of RFID	
RFID Experience	Mean	Std. Dev
Applies RFID (n=9)	1.78	1.093
Implementing RFID (n=4)	1.75	0.5
Conducted tests, intends application (n=1)	4.00	-
Tests in progress (n=9)	2.44	0.726
Conducted test, does not intend application (n=2)	2.50	2.121

Annotation: 5-point scale from "totally agree"=1 to "do not agree at all"=5; n=25

Perceived potentials of RFID (RQ 5)

On average all participants agreed on the presented potentials of RFID (Table 3). A correlation analysis using Spearman's rank correlation coefficient was conducted to measure whether perceived potentials influence the perceived strategic importance. A significant positive relationship can be found between for all presented potentials except for "consistency in the integration

of data across the supply chain" (Table 3). The strongest correlations with the strategic importance could be observed for "improve customer service", "reduce errors" and "optimize stock keeping".

Table 3: Perceived Potentials of RFID

RFID has the potential to…	Mean	Std. Dev	Spearman's Rho	Significance
Reduce errors (n=32)	1.66	0.827	0.629	0.001
Automate processes (n=32)	1.91	0.893	0.415	0.026
Optimize stock keeping (n=31)	1.97	0.706	0.605	< 0.001
Accelerate the flow of goods (n=32)	2.00	0.803	0.489	0.007
Improve customer service (n=32)	2,00	0.803	0.717	< 0.001
Improve quality (n=32)	2.00	0.842	0.506	0.006
Consistency in the integration of data across the supply chain (n=32)	2.06	0.716	0.358	0.061
Reduce counterfeits (n=30)	2.10	0.923	0.450	0.018
Reduce inconsistencies in stock (n=27)	2.56	0.974	0.430	0.032
Annotation: 5-point scale from "totally agree"=1 to "do not agree at all"=5				

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=2.38; std. deviation=1.178). 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 ($r=0.739$; $p<0.001$).

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 expected in about 3 years. Then it will go down again, nevertheless being higher than today (figure3).

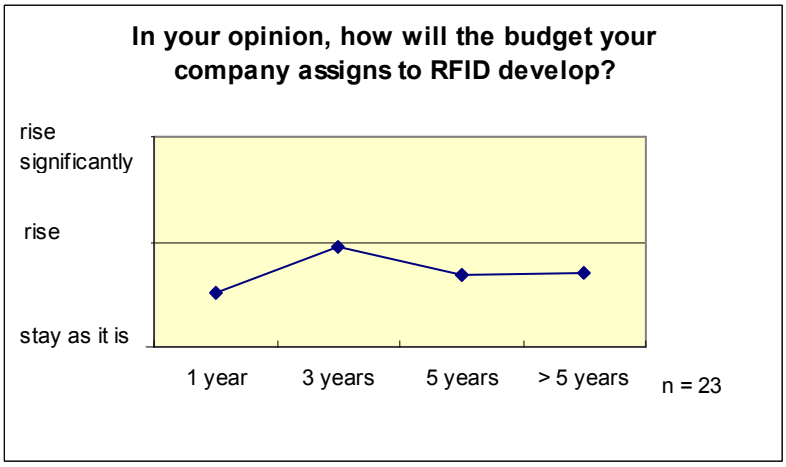

Figure 3: RFID Budget Development

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 3.23 (std. deviation=1.165). 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. A hundred and four participants followed the request, of which about 8 % mentioned "RFID" among the top IT topics. Approximately 11 % mentioned "tracking & tracing" or similar expressions. CRM (18%) and Business Intelligence (15.4%) were mentioned the most.

CONCLUSION

This research presented quantitative data on IT decision makers' view of RFID in Italy. Among the participating companies, RFID diffusion is very low. Many IT decision makers have heard about, and took interest in it, but are still far from implementation.

The opinion on the strategic importance of RFID is divided. The judgments seem to be influenced by RFID experience and perceived potential of the technology. Hope for improved customer service, reduction of errors and optimization of stock most attract CIOs to RFID.

Companies expect their RFID budgets to rise over the next years, especially within the next 3 years. As expected, a higher perception of strategic importance correlates positively with a higher willingness to invest in the technology.

However, RFID is not a topic of high priority on companies' IT agendas. The high-level concepts often associated with RFID in the media or in consulting, above all the "real time enterprise" or the "internet of things" have not yet found their way into companies' RFID visions. On the other hand, virtually all participants state that the importance of RFID will rise significantly over the next years. The technology might well turn out to be a sleeping giant.

Figure 4 summarizes the findings of the study.

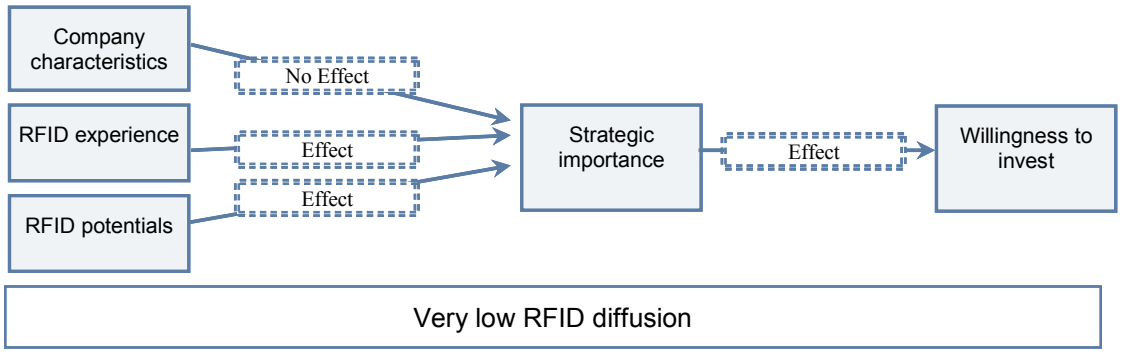

Figure 4: Results of the Survey

RECOMMENDATIONS AND SUGGESTIONS FOR ACTION

What are potential users and vendors to do about RFID? We will deduce several recommendations for both groups.

Recommendations for Potential RFID Users

Companies should look beyond the technology level when dealing with RFID. It will not only be a new technology to replace an old one, but will affect many more processes, products, and services. For many companies, instant action is not necessary. But as RFID's importance is on the rise, companies are well advised to keep watch of the RFID activities of business partners or other relevant stakeholders. As in the case of retail, where Wal-Mart or Metro demanded RFID application from their suppliers, or in pharmaceutics where the US Food and Drug Administration recommended RFID to prevent counterfeiting, companies may be forced to react quickly. Instead of acting just because of forced compliance, companies should explore how RFID-enabled solutions could generate competitive advantage if properly integrated into their IT strategy.

Companies might want to gain technical, economical and organizational RFID experience by moving along with

1. isolated, closed loop internal asset management processes on pallet/carton level
2. open loop cross-enterprise asset management on pallet level
3. item-based solutions as products and services

while continuously analysing present and emerging potentials and pitfalls, preparing for a series of infrastructure decisions and avoiding early interorganisational complexity. Time frames have to be set carefully in order to build up the technical and business intelligence to exploit the long-term RFID caused paradigm shift towards automated, event-driven communication as basis for a real-time enterprise with new services and radically different business processes and value chains / networks.

Recommendations for RFID Vendors

RFID vendors should not underestimate the complexity of the RFID topic. Customers appreciate the operative benefits that might be achieved through this technology, but they do not link it to abstract, possibly strategic long-term concepts such as real time enterprise. Vendors must improve their way of communicating RFID as an enabler for these visions and explain its impact on IT processes and IT strategy if they want to convince customers that RFID is more than just another technology. Some industries, e.g. healthcare, logistics, and retail are more ready for RFID than others, and should be addressed first.

OUTLOOK

Future research should analyse the diffusion of RFID and the corresponding strategic paradigm shifts towards RTE on a longitudinal level and contrast it to the diffusion of other complex IT concepts such as ERP or EDI. There is need for theoretical concepts and models that help understand, identify, design, deliver and exploit potentially disruptive IT-dependent strategic initiatives that deliver sustainable competitive advantages. Especially in the context of multi-national enterprises analyses of the role of different cultural backgrounds of decision

makers and corporate cultures might provide fruitful insights.

Further work should also attempt to determine strategic importance as a construct of different aspects instead of asking for it directly. Moreover, it should examine further factors that may take influence on the perceived strategic importance of RFID and intermediating variables as well as causal relationships. Additionally more in-depth insights on risks and success factors of how to systematically leverage the potentials of RFID and consequently the RTE are needed.

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