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# Start a Grassroots RFID Initiative! The Relevance of Communication and Showcases on the Success of RFID.

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# **Start a Grassroots RFID Initiative!**

## **The Relevance of Communication and Showcases on the Success of RFID.**

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### **Abstract**

Since about 1994 there are now more microprocessors than humans on this planet. With technology advancements and lowered prices the trend will go on. But in a world of ubiquitous connectivity, computing-not computers-characterizes the next era of the computer age. Enabling technologies that support wireless connections, such as Radio Frequency Identification, are being implemented in many businesses to optimize processes and to track and trace objects automatically. But researchers around the world are already working to develop further applications and ideas related to ubiquitous computing beyond tracking and tracing. To discover why most discussions outside the university and the consulting arena haven't yet reached the point where the consumer perceives RFID as a living technology, we conducted a study during a large trade fair in Germany. The results and implications are presented in this paper.

### **1 Introduction**

The multifarious term "Ubiquitous Computing" (UbiCom) is widely used throughout business and media today. The vision behind UbiCom was described more than 10 years ago by Mark

Weiser as the “Enhancing of computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user.” [Weis91, Weis93]. Weiser coined the term in reference to computers that assist people in their daily lives at home and work [BCLM05]. Favored by technological development processes, such as miniaturized chips, the vision comes closer these days [Mano01; GeKC04; FIMa05]. Despite the basic ideas of Ubicom, the potentially ubiquitous available technology, Radio Frequency Identification (RFID), is currently integrated mostly in tracking and tracing processes to improve and optimize logistics. In order to focus on the topic RFID in the consumer world, we conducted a study on RFID during an international consumer electronics trade fair in Germany. The results show that current discussions of RFID in the media are misleading. Most media discussions center around privacy issues, mostly because “Ubicom systems are relatively unusual” [Beck03] and designers of Ubicom systems lack a certain amount of knowledge about the ideas of potential users. There is also a gap between media communication and public perception, in that both Ubicom and RFID seem to be rather unknown entities. The question arises whether discussions about privacy hold back the full potential of RFID applications in both consumer and business arenas and thereby restrict future developments. The aim of this paper is to show why researchers as well as practitioners should focus on more showcases and prototypes for consumers that include reasoning about privacy, but also start discussions based on valid application development regarding usage and benefits to the consumer. The main question is how to show the benefits of a technology based principally on invisibility. What are consumers really thinking and what information could be made available to people in order to make the technology well-known so that the consumer is able to accurately evaluate it before using or purchasing it [DaKa73]? This paper describes the current state of interest in RFID technology in section two, followed by a description of the study design in section three. Section four points out the empirical findings of the study. In section five we propose a way to categorize discussions around RFID-related issues and finish with a conclusion and limitations in section six.

## **2 RFID in the Innovation Cycle**

RFID technology has been broadly discussed in literature [AbMy00; Matt02, Matt03; Flei04; FIMa05; FKTT06; KnLK06; Want06]. However, new or somewhat new technologies take a

long time to impact the lives of ordinary people [Norm99; Kaas05]. The adoption of “disruptive technologies” is an even longer and more complicated process. “Disruptive technologies” are technologies that may cause revolutionary changes in people’s lives [Chri97], a fact that is being spread by many Ubicom visionaries [Matt02; Matt03]. Christensen uses the term “Disruptive *innovation*” in his later work to underline that strategy creates the disruptive impact, not the technology in itself – only a few technologies have the intrinsic potential to be disruptive [Chri03]. Real “disruptive technologies” provide a new use case category for a technology that was previous unavailable. The question is to what extent can RFID be considered a disruptive technology and what would be the implication of this? Although RFID technology has been available since the late 40’s [Stoc48], within the last years we see a new era in mass usage [KnLK06]. The supporters of the technology, such as huge retail companies, regard RFID as an incremental improvement that helps to optimize their processes. In North America, especially the efforts of EPCglobal have mainly dominated the development of RFID applications with focus on the use cases of the aforementioned companies and have generated a main interest in supply chain management [FKTT06]. Fine, Klym et al. examine four key trends. First: the issue of standardization that leads towards interoperable applications. Second: most RFID systems exploit the combination of short-range radio-based communication networks that have thus far evolved independently. Third: they suggest that newer optical tagging systems should compete with RFID despite the performance advantages [FKTT06]. All of these can be considered to be more incremental than disruptive innovations, however as a final point, Fine et al. see RFID and tagging technologies making their way into the hands of end-users – which is currently not yet the case [WiDe04]. This would significantly increase the potential for disruptive rather than incremental improvements. The development of more grassroots projects would provide the necessary counterbalance to the tracking and tracing efforts [FKTT06]. Such grassroots tagging projects can already be seen in some areas of interaction design and human-computer interaction. Especially since large mobile phone producers introduced Near Field Communication phones including RFID readers, new ideas on bridging the gap between the real and virtual world pop up. Users can create their own data related to an object code, or use their own tags and ideas to build new applications, such as the Address Book Desk by Timo Arnall [Arna05] with a real use to people. Within the supply chain and logistics, RFID is more likely to be discontinuous improvements contrary to optical systems, but in the area of consumer application, RFID could still be a disruptive innovation. If

that were the case, it is important to locate the technology in the innovation cycle to determine which steps are necessary to create applications that are widely accepted by the users. Broad consumer acceptance would then automatically lead to greater acceptance of important industry use-cases such as item-level tagging. According to Sheffi, RFID “Is still not out of the fog of innovation: the benefits of the technology are not entirely clear, especially its advantages over bar code technology” [Shef04]. Furthermore he states that the discussions about standards and privacy issues are indicative of a technology still in its infancy. One of the aspects of technology is that the move from invention to innovation, only takes place when consumers adopt and accept a technology in large numbers [Shef04]. Based on Davis’ early work regarding technology acceptance [Davi89], Davis and Venkatesh suggest that pre-prototypes can also be used to assess usefulness [DaVe04; Kaas05]. Most RFID applications are within the supply chain, and as a result there are fewer prototypes visible and testable to the consumer, thus limiting their possibilities to accept the new technology. The question is how far the focus on technology acceptance will help the dissemination of RFID. Consumers and users might prefer to experience it first. Rogers describes the innovation adoption process in five steps “Through which an individual [...] passes from first knowledge” [Roge95] to finalizing the adoption decision. The dissemination itself is regarded as the process by which an innovation is communicated through various channels among members of a social system [Roge95]. Rogers defines five adopter categories in his work: innovators, early adopters, early majority, late majority and laggards. While the innovators are risk-takers, the early adopters are opinion leaders who make the initial evaluation of an innovation and communicate the result to the other members of their group. If the early adopters are convinced by innovators that a technology is worth it, the technology can spread into the mass market after crossing the “chasm” - the different needs of early adopters and early majority [Moor02]. The decision to accept an innovation depends on the innovation-decision of other members, and here networking exerts a major influence. This also means that communication channels such as mass media have a powerful effect on spreading the message. But the most trustworthy channel for leaders of opinion is word-of-mouth - even more so than mass media. The adoption of innovation is therefore largely an information processing activity to which potential adopters have gathered enough information on the particular innovation [Hain05]. Rogers also states that the available information about an innovation may positively influence its adoption probability [Roge95]. In the case of RFID, this would mean that - if the invention RFID is an innovation and if we are

still “in the fog of innovation” more information (equals experience and visible benefits) on RFID is crucial for large-scale adoption. We used the free tool “Google Trends” to ascertain discussions about RFID, showing the interest of the Internet users in specific topics. Search queries reflect a late majority indicator since people start searching for a specific term when they have already heard about it via a different channel. For example, if someone had heard about RFID in the media they might be conducting a search about it.

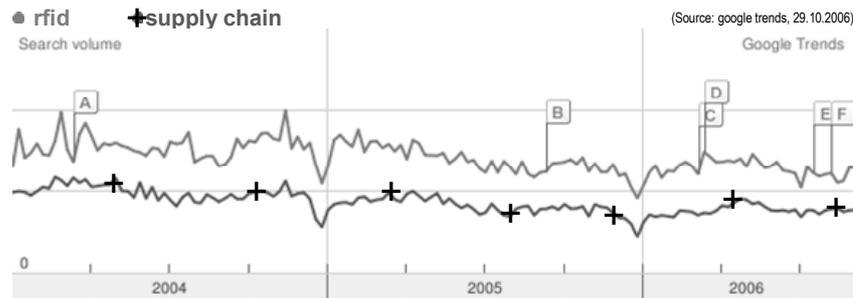


Fig. 1: The search queries for RFID and supply chain (Source: Google Trends)

Figure 1 shows that search queries for RFID and supply chain show a similar course over time. The queries maintain a stable level; therefore people might search for supply chain and RFID in the same manner. Nevertheless, RFID still proves to be of value outside classical track and trace applications. Figure 2 compares a real consumer product like the Apple™ iPod® with RFID. It can be clearly seen that for a significant period the news reference volume was almost equal while the iPod® related search queries quickly exceeded the RFID search queries. The news reference volume maintained the same relation for a while until new iPods® were released. However, iPod® search queries rose sharply, consistently maintaining a higher amount than RFID-related queries. This indicates significant media-based coverage and shows the interests of the majority of internet users after the adoption of previous groups (See Figure 2).

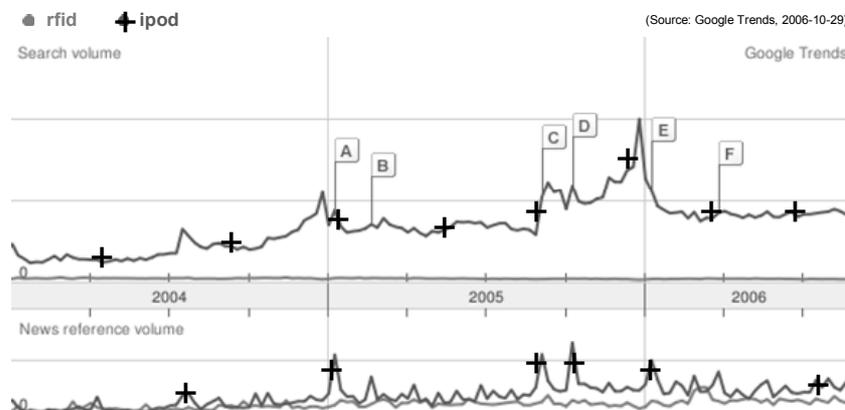


Fig. 2: Comparison of search volume vs. news reference of the consumer product iPod and the not-yet-consumer-product RFID (Source: Google Trends – Letters A to F mark relevant incidents)

Comparing the amount of search results for the term „spychips“ (German: Schnüffelchips) with “RFID” in Google shows 302.000 search results for spychips vs. 55.400.000 for RFID. However, more consumers might remember the discussion on “spychips” than any industry RFID proposal. The usage possibilities of RFID have led to many discussions within the media in terms of data security and privacy issues. The absolute number of Google search queries on the term “RFID” in Google trends worldwide is almost constant. Also, it can be stated that the type of news varied from highly positive to more negative in the last several years. It was initially euphoric (A) while in more recent times we see a focus on negative issues such as RFID viruses (E). The influence of negative news is shown in the chart below. Here Scott Silverman announced the idea of implanting RFID chips in immigrants and guest workers. This has led to a very high number of web-logs mentioning the quote (See Figure 3).

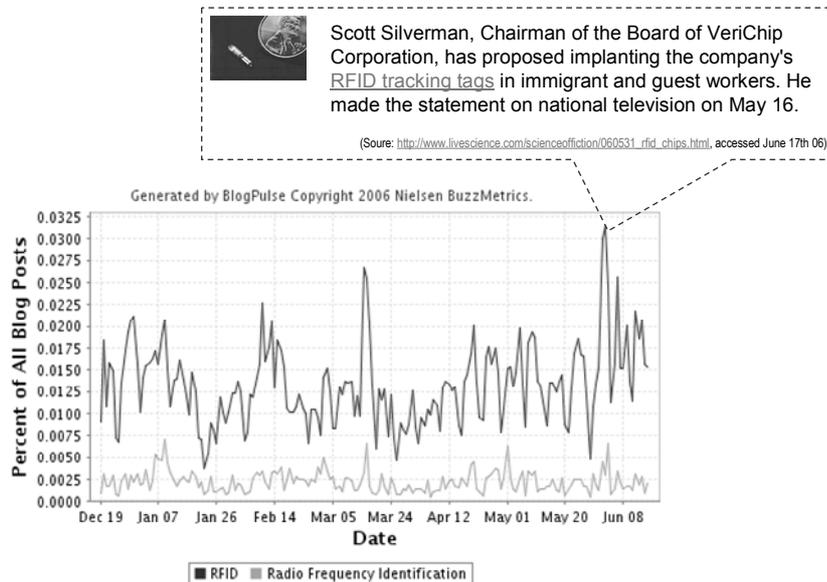


Fig. 3: The reaction in web-logs to bad news (Source: BlogPulse - We chose to search for both the acronym RFID and the term Radio Frequency Identification, because some web-logs use the acronym while others the whole set)

Clearly, privacy is an issue for RFID applications, but overall negative media coverage leads to a significant increase of reporting in many communication channels on the Internet, such as Weblogs, Communities, etc.. Since we are not able to determine the difference of opinion leaders' opinions and other consumers with the tools used above, it seems that the search queries show an interest in the technology that is not at the same intensity than it could be for being consumer good (A test with myspace.com instead of iPod® shows an even higher difference). Although researchers and experts are very aware of the potential opportunities and

threats of RFID, the consumers might not be able to judge them appropriately. The aforementioned statements show that RFID is a potentially interesting technology for mass markets, one that *might* lead to a disruptive innovation – an effect that could cycle back into business – where the value of RFID is already proven in many cases [FICD05]. Our research focus was centered around seeing how people currently value RFID and what their opinion is of the technology. Therefore we decided to conduct a study during a world trade fair that deals with information technology and RFID. Without pre-qualifications, we asked people at the fair about different aspects of RFID. The next section describes the study design.

### 3 Study Design

For the study we selected a large trade fair (CeBit 2006) with presumably technologically savvy visitors. According to the organizers, the percentage of professionals in attendance was extremely high in 2006 (85% of all participants). Since the trade fair had more than 450,000 visitors and 6,262 exhibitors, we concentrated on the main hall with RFID as a major topic (#6) as well as the two adjacent halls (#5, #7). The following table (Tab. 1) gives an overview of the research design.

Research framework	Quantitative analysis/survey
Method of data collection	Personal interview with questionnaire
Period	Thursday, March 9 <sup>th</sup> 2006 and Saturday, March 11 <sup>th</sup> 2006
Measuring method	Interval 7-item-scale
Universe	World's largest trade fair for digital IT and telecommunications solutions for home and work environments; halls 5-7; Visitors of the fair.
Sample type	Random
Sample number	n=336

Tab. 1: Study data

Within a quantitative analysis in a non-representative framework, the sample type was random since the interviewers randomly approached participants in the halls. They used industrial personal digital assistants (PDAs) with questionnaire software installed (Software: mQuest). The only pre-definition was the relation of the sexes, since typically 30% of the participants at this trade fair are female.

#### *Characteristics of the Participants*

Within the study 30% of the participants were female and 70% were male. The primary business of their companies was information technology (47%), followed by research (12%),

insurance (7%), government (7%), retail (6%) and others. Most of the companies employing the participants had 20 to 99 employees (33%), followed by smaller companies ranging from 1 to 19 employees (29%). Among the participants only 5% worked for large enterprises with more than 10.000 employees.

*Research Questions*

The research questions were based on the aforementioned theoretical findings. Based on the premise that positive information is the key issue behind the diffusion of innovation, we asked the people about their knowledge (subjective, objective), importance (company, personal) and benefits of RFID on a 1-to-5 scale with “1” having the highest rejection and “5” having the highest acceptance. Based on the theoretical overview in section 2, we tested two hypotheses:

H1: Participants who work in branches, in which RFID prototypes already exist and are exposed to public media coverage, view RFID more positively (communication).

And, H2: Personal attributes play no role in the evaluation of RFID (gender, position)

The following section describes the findings.

**4 Empirical Findings**

*Results of Knowledge about RFID*

To get an overview of the basic knowledge of the participants we first asked if they knew what the abbreviation RFID stands for. 90% correctly identified the acronym RFID as Radio Frequency Identification. Following that, we asked the participant to rate their knowledge of RFID, which we defined as subjective knowledge (Figure 4).

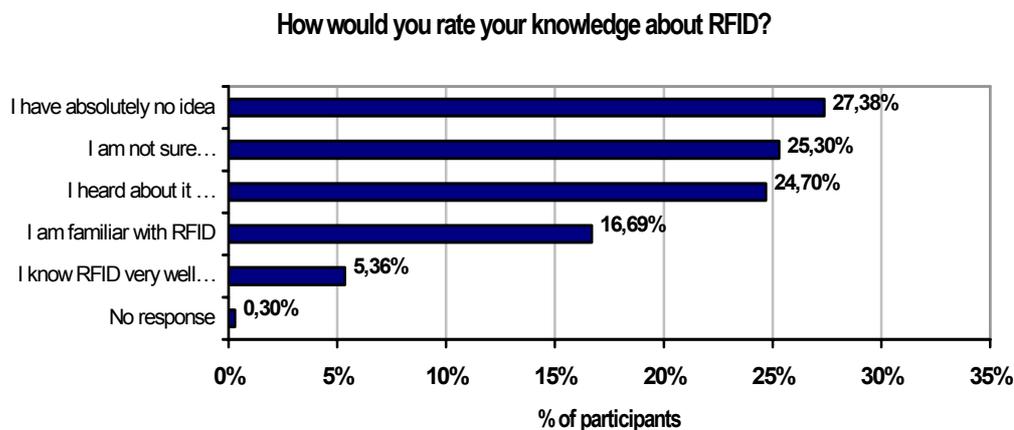


Fig. 4: Question on subjective knowledge

More than 75% of all participants rated their knowledge from “non-existent” to “I’ve heard about it”. Only a few people considered themselves to be significantly informed. Although the people did not think they know much about RFID, a clear connection emerged between answers to the question “In which areas do you see the most value of RFID?” and the branches that have been exposed to the most RFID media coverage: logistics and retail (Figure 5).

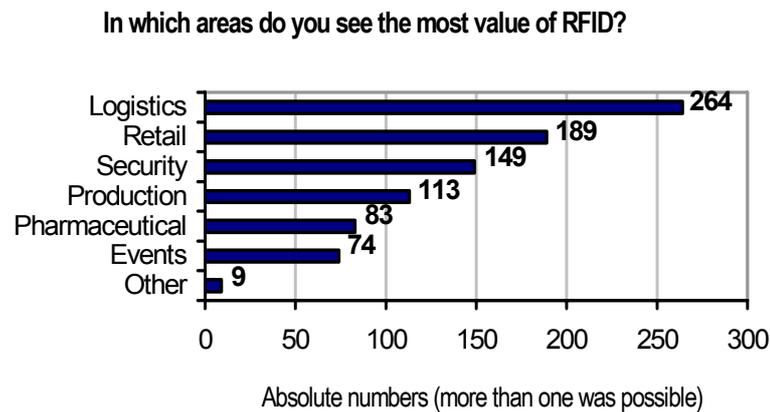


Fig. 5: Branches in which the participant sees the most value for RFID

#### *Company Sphere Results*

The second area of questions focused on company issues concerning RFID. The participants were asked to evaluate RFID for the company in which they are employed. People who specified no company were either students or involved in science or were not capable of evaluating RFID for their company. Only 24% considered RFID to be important for their company, while 44% saw no importance of RFID for their businesses. Bearing in mind that the survey was conducted *during a technology trade fair*, this is rather surprising considering the amount of RFID media coverage before the event. We also asked about the requirements for bringing RFID to mass markets: 82% of the participants said that the benefits of the technology needed to be communicated more clearly. Contrary to that finding however, 92% of all respondents answered that RFID is definitely coming. Since there are many studies on the market on the company perspective, we wanted to focus on researching the personal opinion of the people at the trade fair.

#### *Personal Sphere Results*

Evaluating something requires proper background information, or people will rely on other resources to determine personal opinions. The first question concentrated on the importance that people place on RFID in their daily lives. Only a few - 19% - rated RFID as being important for

their lives today. The rest responded either neutrally or did not see any relevance for RFID (Figure 6).

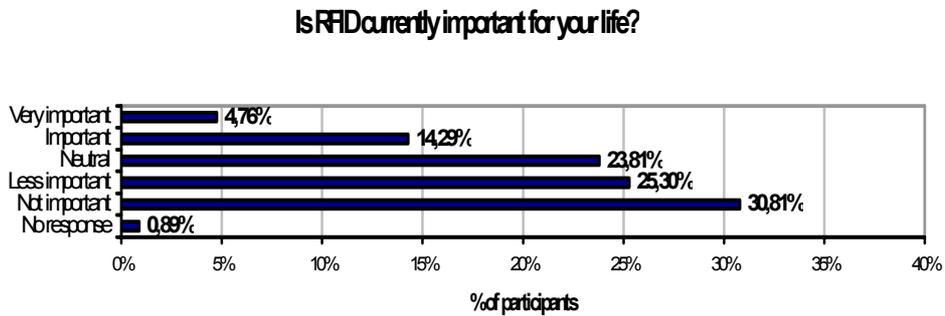


Fig 6: Importance of RFID in daily life

A possible explanation is that people do not see any benefits in RFID or they have not had any real contact with RFID, or finally there is currently no application that would add substance to people’s lives. RFID functions within the context of ubiquitous computing that is often times associated with control or perceived control. Research in this area on perceived control [GüSp05] exists in order to increase the acceptance of RFID applications. In our study, 47% strongly agreed that RFID would give others control over their lives, however, this also assumes that the people responding have enough information or experience with the technology to make an accurate assessment – which is not the case according to their own evaluations of how well they are informed (Figure 7).

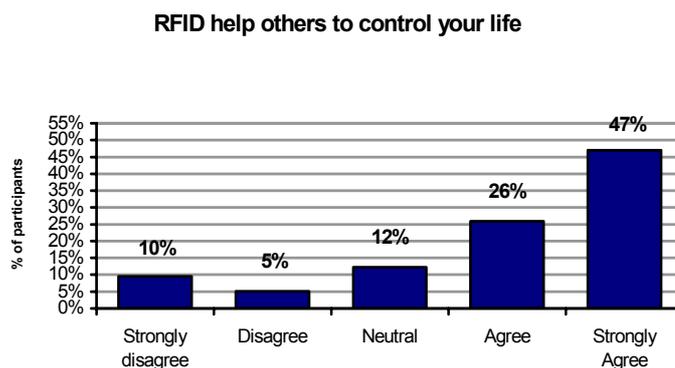


Fig. 7: RFID and control

To get a more detailed view of people’s opinion of the technology, we asked if RFID has already improved the life of the participant personally. While 63% did not see any personal

benefit yet, 10% were neutral. Overall, 19% saw a personal benefit or could at least imagine a use for RFID, 7% strongly agreed that RFID has benefits (Figure 8).

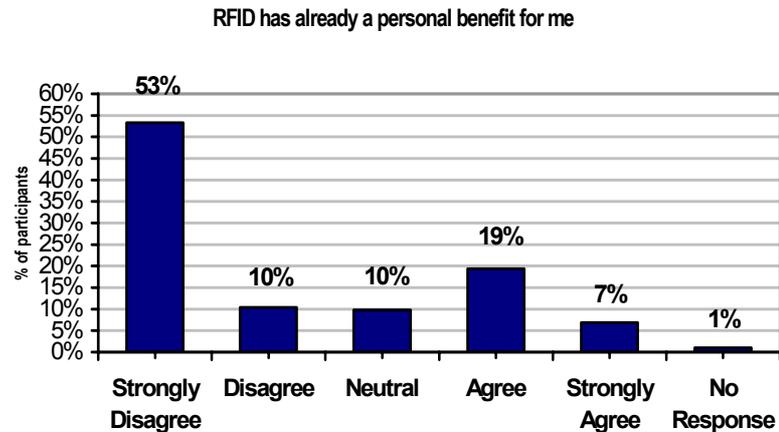
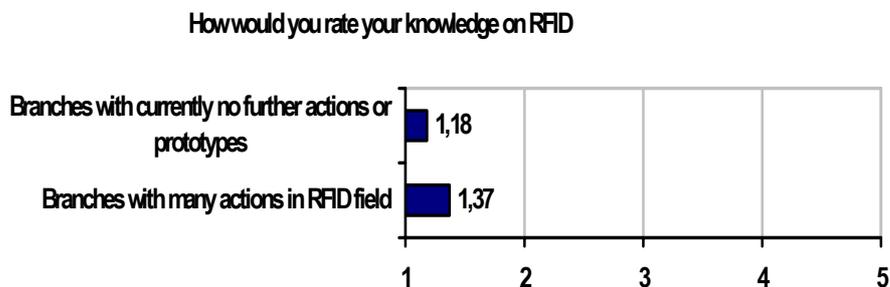


Fig. 8: Personal benefit of RFID

Another question concerned RFID and its influence on people lives (in whatever form). 52% of the answers were neutral, 15% of the participants assumed negative to very negative changes, and 20% rated the change rather positively. Based on these descriptive data, the picture of RFID that people had at the trade fair was rather negative. People are not necessarily informed about RFID, but in most cases rate RFID in exactly the same way that it is discussed in the media.

#### *Hypothesis Results*

The given results are possibly shaped by the position and or by the area in which the person works. Especially in terms of the personal sphere the answers from people in high or low positions were not significantly different. Contrary to that result however, people working in areas that have already seen prototypes and actions with RFID - such as information technology or retail - rate the degree to which they are informed higher than people working in other branches. (1= low level of knowledge in RFID; 5= high level of knowledge in RFID)



H1 assumed that people in different branches value the degree to which they are informed differently. This hypothesis proved correct as well as for H2, where we postulated that neither gender nor branch plays a role in the current evaluation of RFID.

### *Other Studies*

Other studies in the area of RFID also provide rather similar findings. A recently conducted study by Knebel et. al. deals with the Chief Information Officer's (CIO) perspective on RFID [KnLK06]. Among all participating companies the dissemination of knowledge about RFID was very low. In addition, many information technology decision makers have heard about and are interested in the technology but are still far from actually implementing it. The study also points out the oppositional behavior of many CIOs. On the one hand, companies expect their RFID budgets to rise over the next several years. But the high-level concepts discussed in the media or in consulting have not yet found their way into day-to-day reality of companies. Participants rated their knowledge about RFID as good or very good (42%), whereas only a small number have really ever implemented a RFID system for their company (7%). Considering this fact, CIOs think they know RFID, but the practical experience is still rather low. Nevertheless, industrial applications can be more easily programmed compared to closed loop systems in machine-based scenarios. Here questions about privacy play a less important role than in consumer markets where open loop and people-based is the rule [KnLK06]. Another study was conducted in 2004 by CapGemini on the consumer's perception of RFID [Park04]. In contrast to what media commentators often quote, only 10% of the people who have heard about RFID have an unfavorable perception. The top concerns were: "Consumer data used by third party" (69%), "Targeted more with direct marketing" (67%) and "Tracking of consumers via purchase" (65%). Yet again, most respondents assumed that RFID tags will be placed on all products within the next 5 years, and only 3% said RFID will not become reality. The conclusion also clearly shows that while not many people know about RFID, they are still very much interested in the technology. A recommendation that came out of the findings centered around disconnecting RFID from the broader privacy debate [Park04]. Another study in 2005 [CapG05] shows similar results, e.g. "Helping consumers to form a positive impression of RFID by debunking myths" might be a way to educate the consumer [CapG05].

## 5 Discussion: Information as a Key to Successful RFID Implementations

Sources of information, such as Google Trends, show that RFID has the potential to be a “disruptive technology” but so far this is not a reality. Existing applications are limited to logistical tracking and tracing, signifying that only a few people have actually had first-hand experience with it. Our initial findings lead us to believe that the image of RFID is based more on misinterpreted facts or preconceptions than on the facts themselves. The benefits of the technology are not noticeably tangible. Even at large trade fairs where the participants include a large proportion of innovators and early adopters, one would expect the leaders at shaping opinion to give a more positive view. This might explain the reason behind the massive negative media hype and the rather low popular acceptance of RFID: if not enough positive information is available in mass markets, then the networking effects cannot be realized. The chain of communication is disconnected. Although many prototypes exist in industry segments as mentioned above, broad acceptance is not simply a question of handling privacy issues but rather one of communication and experience. Most of the participants in our study rated RFID as either dangerous (control) or irrelevant to their companies and lives. Nevertheless everyone saw a positive perspective or at least agreed on a broad future for RFID. In order for RFID to bring more benefits to companies and people, the industry needs to lay the foundations for more showcases and prototypes that can be tested and experienced by the consumer and establish more effective communication. In branches where prototypes have already received media coverage, people consider themselves to be aware of RFID and value the technology more positively. From the perspective of the individual, everyone rates RFID the same. This means that additional consumer prototypes would help people understand the technology better and lead therefore to more useful discussions. The successful marketing of RFID depends primarily on getting people involved in using the technology. To facilitate the communication categorization of potential RFID applications we propose the following simple matrix of RFID application types with a different emphasis on application communication:

*Open loop vs. closed loop:* It is necessary to define open and closed loop since the terms are used in several different disciplines with differing meanings (e.g. in electrical engineering or sports science). A closed loop RFID application is defined as an application in which the RFID tag is only used within a single system - if the system feeds information on the tag back into itself [WCPR06] and the tag is not leaving the process of the system in which it was initially used. By comparison, an open loop application is considered to be an application in which the

RFID tag and its information can be used outside of the initial system in one or more systems. According to Fleisch et al. most applications today begin with closed loop systems because of the clear cost and benefit calculations [FICD05]. The degree of integration varies of course between open and closed loop systems with open loop systems more likely to bring RFID in contact with users.

*Machine-based or people-based applications:* In the case of the proposed matrix we define machine-based applications as applications that do not include interactions with people on a user level. This counts for most of the business-to-business applications where the purpose of the application is to use the information on the tag for controlling either other machines or for using it as an information source for other applications. People-based applications are primarily designed for direct person-to-person interaction and built for end-users and consumers. Examples are the FIFA World-Cup 2006 tickets [FIFA04] or the aforementioned Address Book Desk by Timo Arnall [Arna05]. The reason for this distinction has to do with the reactions in the media regarding privacy and data security questions. As soon as people-based applications are considered, discussions arise. In the case of the World-Cup tickets the usage of RFID led from negatively critical articles [FBUD '06] to the public call for the Chaos Computer Club (CCC) to send in the World-cup tickets for CCC intense research [CCC06]. To sum up, potential applications can be classified in the table as shown below in Figure 9.

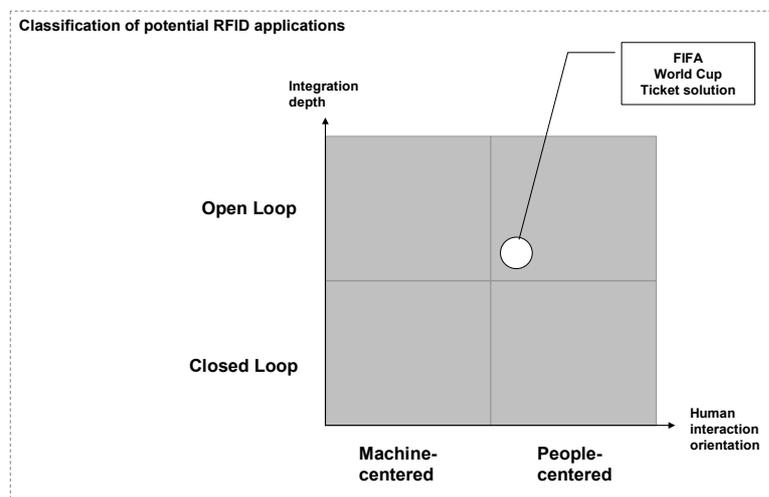


Fig. 9: Table for RFID applications (Integration depth, see [Fleisch, Christ et al. '05])

With most applications in operational business, identifiable in the first quadrant of the table, discussions of privacy issues are not in the fore. However, when it comes to open-loop, people-based systems, discussions will arise and emphasis should be on valid information or better experience with prototypes given to the users before introducing large scale applications.

## 6 Conclusion and Limitations

The theoretical framework shows that the adoption of innovations relies on positive discussions and useful information. The discussions concerning RFID center around tracking & tracing issues, supply chain support, and privacy and security issues. Privacy is definitely a very important topic, but should be discussed when people have had the chance to experience and learn about the technology with showcases and hands-on prototypes. If using the kind of model that Beckwith [Beck03] proposes according to Adams, information on the following topics should be given to the user: *information receiver* (who will use or have access to the data?), *information usage* (how will the information be used?) and *information sensitivity* (how sensitive is the data?). If this is done and shown, people will have the opportunity to use the application and decide freely if they like it, thereby giving RFID the chance to enter the consumer market place and cycle back on a major scale into industry and the world of small-and-medium enterprise. The acceptance of the technology and the potential benefits that come with it depend on information and perception. The study makes clear that people do not necessarily know enough about RFID to rate it properly. Using many more prototypes to show the real value of RFID in end-consumer areas would ultimately lead to a greater overall acceptance of the technology. This would also lead to more understanding and less fear of RFID-use within operational businesses. Even in his 1993 paper on Ubicom, Mark Weiser states that the establishment of “working prototypes of the necessary infrastructure in sufficient quantity to debug the viability of the systems in everyday use” is crucial to the research of Ubiquitous Computing. Even today’s surveillance technologies are more accepted because of their perceived benefit to people. People claim that they feel safer with surveillance cams - although statistics prove that surveillance cameras do not significantly prevent crimes in monitored areas [Wehr00]. In terms of World-Cup tickets for example, at the writing of this paper, no data was found on the chip that could have been used in a malicious way [CCC06]. If the benefits of RFID can be demonstrated to consumers with valid and fun prototypes, the overall perception might be better and the path will be clearer for its implementation in many areas. Many approaches allow the creation of fun prototypes, such as free RFID-kits given to schools and universities or application development competitions. The industry has the chance to and should sponsor and develop such events and actions. For researchers it is getting more important to conduct research in the context of real life of users with appropriate prototypes.

The nature of our research has had certain limitations. The research results are not necessarily representative since they are based on a random sampling of people without prior assessment of their qualifications. Compared to the total number of visitors to the trade fair, the questioned sample was too small to generate a representative number of interviews. Secondly, most questions were answered from a subjective point of view, e.g. for the question concerning one's knowledge of RFID, it isn't clear how to compare the individual assessment values since each participant may rate his or her knowledge with a different scale. In this way the exact dimensions of a particular aspect remain somewhat unclear - the use value of an application is a subjective determinant that can't be easily compared. Thus the study should be seen as an initial investigation that needs further evaluation at other fairs, public spaces or showcases. The usage of Google trends is not necessarily accurate and should be considered an approximation to the conclusions.

Moreover every RFID application must surely have an appropriate benefit to be for any use to the consumers. The usage of RFID for the sheer existence of the technology prevents an evolution of useful systems in the sense of the original vision. We emphasize a discussion on data security, but also see the chance to educate people on the benefits of this technology experiencing the technology. More grassroots projects and toolkits are a proposed solution.

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