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A cross-national comparison of perceived strategic importance of RFID for CIOs in Germany and Italy

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ABSTRACT

Purpose: Drawing from literature on innovation, strategy and culture the objective of this study is to explore the role of perceived potentials and perceived strategic importance on CIOs' perspective on RFID technology in two different cultural settings.
Methodology: Based on survey responses from 463 German and 157 Italian IT decision makers we analyzed the data with PLS structural equation modeling.
Findings: We show that perceived potentials of RFID influence the perceived strategic importance which positively influences CIOs' intention to invest in RFID. The composition of perceived potentials affecting the strategic importance of RFID differs significantly in both cultures. In Germany, potentials attributed to RFID are improving quality, automating manpower, reducing counterfeits, and improving customer service. Italian CIOs value reducing stock inconsistencies, optimizing stock keeping, and improving customer service as RFID potentials. Regardless of culture, findings show that company size hardly has impact on perceived strategic importance.
Originality/value: This research shows on a large empirical basis cultural differences in the perception of RFID in two countries using PLS.

1. 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 (Landt, 2005), it has only recently come to the awareness of the public. New auto-ID technologies, most notably RFID (Sarma, 2004), 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 (Luftman, Kempaiah, & Nash, 2006).

The aim of this study was to explore CIOs' perspective on RFID technology in two different countries. The topmost research questions of this study therefore are:

1. What factors influence perceived strategic importance of RFID among IT decision makers?
2. Do cultural differences between German and Italian CIOs matter?

Using CIOs as a source of information, we investigated the role of perceived potentials and strategic importance in RFID, and how CIOs plan to act in regard to this issue. We want to shed light into the cultural differences in determinants (especially perceived potentials) and effects of perceived strategic importance of RFID.

2. Related research

2.1. 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 (Finkenzeller, 2003; Want, 2004). In comparison to other well-known auto-ID technologies such as the barcode, RFID offers the following advantageous characteristics for the user (Agarwal, 2001):

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- *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.

2.2. RFID potentials: improve efficiency, enable new products and services and gain competitive advantage

There is empirical (Karkkainen, 2003; Loebbecke & Palmer, 2006), conceptual (Asif & Mandviwalla, 2005) and simulational (Lee, Cheng, & Leung, 2004) 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 real-time enterprise (RTE) visionaries. No 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 (Haller & 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 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 (Staake, Thiesse, & Fleisch, 2005), asset/product tracking, industrial warehousing, product handshaking, safety and security, condition monitoring, positioning/locating, and theft or tampering detection (Wilding & Delgado, 2004). Other examples highlight the potential for completely new services such as enriched museum tours (Hsi & Fait, 2005).

RFID can enable enterprises to bridge the gap between the real world and its representation in information systems (Haller & Hodges, 2002), 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.

2.3. Cultural dimensions

Culture at various levels, including national, organizational, and group can explain behavioral patterns or attitudes and also influence the successful implementation and use of a technology (Leidner & Kayworth, 2006). Understanding culture is therefore important to the study of information technologies, especially in the context of emerging technologies. Hofstede (1984) defined culture as "a collective programming of the mind". Culture, also known as national character, has been referred to as patterns of personality characteristics found among people within the same nation (Clark, 1990). Culture is generally agreed to be reflected in artifacts such as the symbols, heroes, rituals, and values that are typically learned from the environment (Schein, 1985). It is widely believed to shape individual values and to affect behavior (Hofstede, 1984, 1991, 2006; Straub, Keil, & Brenner, 1997).

For the purpose of this research we will apply Hofstede's cultural dimensions since they well explain cultural differences in the two country samples we examine. Four common problems facing people worldwide were theorized by Inkeles and Levinson (1969) and reflected in the data collected by Hofstede (1984). Hofstede analyzed a large data base of employee values scores collected by IBM between 1967 and 1973 covering more than 70 countries, from which he first used the 40 largest only and afterwards extended the analysis to 50 countries and 3 regions. Taking into account the work of Inkeles and Levinson (1969), Hofstede labeled the four dimensions as power distance (PDI), individualism (vs. collectivism) (IDV), masculinity (vs. femininity) (MAS), and uncertainty avoidance (UAI). Data collected from over 116,000 respondents in 66 countries resulted in his empirical definition of the four dimensions of culture. His work still has great impact today and in fact, most research on national culture uses Hofstede's concepts and measures (McCoy, Galletta, & King, 2007). In order to discuss our results in the light of cultural differences in the German and Italian sample, we will briefly discuss each of Hofstede's dimensions.

2.3.1. Power distance (PDI)

Power distance is a measure of the (interpersonal) power between a superior and a subordinate as perceived by the secondary (Hofstede, 1991). It refers to the extent to which the less dominant members of organizations and institutions accept and expect that power is distributed unequally. It represents inequality (more vs. less), but defined from below, not from above. It suggests that a society's level of inequality is endorsed and accepted by the followers as much as by the leaders. Power and inequality, of course, are extremely fundamental facts of any society. In low PDI cultures, employees believe that inequity should be minimized, whereas in high PDI cultures, employees believe that an amount of inequity should exist. In low PDI environments, the hierarchical system is considered simply an inequality of roles, constructed out of convenience, and dynamically dependent on the situation. Compared to the average score of European countries, Germany has a lower PDI score, while Italy has a slightly higher PDI score (weighed against the mean for European countries).

2.3.2. Individualism (vs. collectivism) (IDV)

Individualism refers to the relationship between the individual and the group and describes the degree to which individuals are integrated into groups. On the individualist side we find societies in which the ties between individuals are loose, here people are self-oriented. On the other hand, in collectivist settings, we find societies

in which people from birth onwards are integrated into strong, cohesive in-groups, often extended families which continue protecting them in exchange for loyalty. Belonging to an organization or group is important as well as gaining approval from the group. Regarding the German and Italian culture, both cultures show a medium to high score on individualism, slightly above the average score of European countries.

2.3.3. Masculinity (vs. femininity) (MAS)

According to Hofstede's definition (1984, 1991) of the masculinity vs. femininity dimension, a culture that ranks high on masculinity is associated with an emphasis on work goals, such as earnings, promotions, and assertiveness. On the other hand, cultures that rank high on femininity stress nurturance and personal goals, having a friendly, congenial environment. In a masculine society, families socialize their children towards assertiveness, ambition, and competition (Hofstede, 1991), while families in a feminine society socialize their children towards modesty and solidarity. In organizations, masculinity is reflected in opportunities for high earnings, recognition, and advancement. Femininity is reflected in management practices emphasizing the quality of interpersonal relations and quality of working life.

The cultures in Italy and Germany both score high on masculinity (exceeding the average score of European countries) meaning that males focus on work goals, while females are encouraged to follow more traditional, tender, and modest roles. People in these countries that score high on masculinity most often believe that the traditional goals of men are more important; those from countries that score low on masculinity feel that the traditional goals of women are more important.

2.3.4. Uncertainty avoidance (UAI)

The uncertainty avoidance dimension deals with a society's forbearance of uncertainty and ambiguity. It indicates to what extent members of a culture try to avoid ambiguous situations by establishing formal rules and rejecting nonstandard ideas and behaviors. Uncertainty avoiding cultures try to minimize the possibility of such situations by strict laws and rules, safety and security measures (Hofstede, 1984). In organizations, employees can reduce uncertainty by relying on clear procedures, strategies, and rules. Individuals from cultures scoring high on this dimension tend to seek ways to reduce uncertainty (Hofstede, 1984). High UAI is associated with a low motivation to achieve, less risk taking, and less ambition.

The opposite type, uncertainty accepting cultures, are characterized by a greater willingness to take risks (Hofstede, 1984). Low UAI is associated with a strong motivation to achieve, more risk taking, and more ambition. People within these cultures are more tolerant and contemplative, and not expected by their environment to express emotions (Hofstede, 1984). Italy scores rather high on the uncertainty avoidance dimension while Germany in contrast has a lower UAI score. This lower score can be interpreted as a greater willingness to accept risks in unplanned situations, such as e.g. the introduction of a technology.

3. Research model, hypotheses, and construct development

3.1. Hypotheses and research model

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 (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 may not be of a strategic nature yet, but applications are still developing 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, but also hold "great potential for reshaping business strategies" (Woods, Peterson, & Hirst, 2004). But beyond consultants, vendors, and analysts, what do (future) users think? How do CIOs assess the strategic importance of RFID?

Diffusion of innovations theory identifies five attributes of innovations influencing their adoption: relative advantage, compatibility, complexity, trialability and observability (Rogers, 1995). 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 (Knebel, Leimeister, & Krcmar, 2007) 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 we hypothesize:

H1. Experience with RFID positively impacts on 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 a determinant on adoption (Davis, 1989). Perceived benefits have also proved relevant in Iacovou and Benbasat's study about the adoption of EDI (Iacovou & Benbasat, 1995) and as well were considered in research conducted by Sharma and Citrus on the adoption of RFID (Sharma & Citurs, 2005). In this study, relative advantage describes potential benefits and improvement due to RFID in comparison to barcode technology. Hence, Hypothesis 2 addresses the perceived potentials of RFID:

H2. The perception of potentials of RFID positively influences the perceived strategic importance of 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 Defense have declared RFID a key technology, we see especially larger companies paying attention to the strategic potentials of RFID. We hypothesize therefore:

H3. Company size positively affects the perceived strategic importance of RFID.

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 2 years (Reilley, 2005). Hypothesis 4 links the above described strategic importance with the willingness to invest.

H4. Perceived strategic importance positively influences the willingness to invest in RFID.

We furthermore assume a significant difference between the perceptions and attitudes of CIOs in Italy and Germany due to their cultural differences as similar findings have been reported from the intercultural application of the technology acceptance model (McCoy et al., 2007). It is important to analyze the results not only

Table 1
Research hypotheses.

No.	Description of hypothesis
H1	Experience with RFID positively impacts on the perceived strategic importance of RFID
H2	The perception of potentials of RFID positively influences the perceived strategic importance of RFID
H3	Company size positively affects the perceived strategic importance of RFID
H4	Perceived strategic importance positively influences the willingness to invest in RFID

at the level of RFID itself, but also through a cultural lens. Because different cultural groups may have different conceptions of what leadership should entail, i.e. different leadership prototypes and what may be considered strategically important. Several earlier studies revealed that within Europe various cultural clusters can be distinguished (Hofstede, 1991). Koopman, Hartog, and Konrad (1999) showed that two broad clusters or patterns of cultural values can be distinguished within Europe, contrasting the North-Western and South-Eastern part of Europe. Within these clusters, differences in leadership prototypes to a certain extent mirror differences in culture.

Since Germany belongs to the North-Western and Italy to the South-Eastern cluster we expect to see significantly different empirical results when testing the hypotheses in both cultures. We will discuss such potential differences through the lens of Hofstede's cultural dimensions described above.

Table 1 summarizes the research hypotheses.

3.2. Construct development

The following table depicts the operationalization of the constructs "company size" (CS), "RFID experience" (EX), "perceived potentials of RFID" (PP), "perceived strategic importance" (SI), and "willingness to invest in RFID" (WI) used in the model (Table 2).

3.3. Data collection

The theoretical framework in Fig. 1 has been operationalized and transferred into a structural equation model (SEM). Each construct

Table 2
Operationalization of constructs.

Construct	Item	Question/indicator
CS	S14Q14	How many employees does the company have?
EX	S02Q01	How much experience does the company have with using RFID?
PP	Which potentials does RFID have in your opinion? (*five-point Likert scale from totally disagree—totally agree*)	
	S09Q08	Improve quality
	S09Q09	Automate/reduce manpower
	S09Q10	Reduce errors
	S09Q11	Reduce counterfeits
	S09Q12	Reduce inconsistencies in stock
	S09Q15	Optimize stock keeping
	S09Q16	Improve customer service
SI	S07Q06	By using RFID we can gain strategic advantages
	S07Q07	RFID has a strategic importance for our company
	S07Q08	RFID is one of our top IT topics
WI	S07Q09	RFID helps us to build up new core competencies
	S07Q10	RFID helps us to use our current core competencies in a better way
	S08Q01	In general, I would endorse the implementation of RFID
	S08Q02	RFID is a topic we will invest in

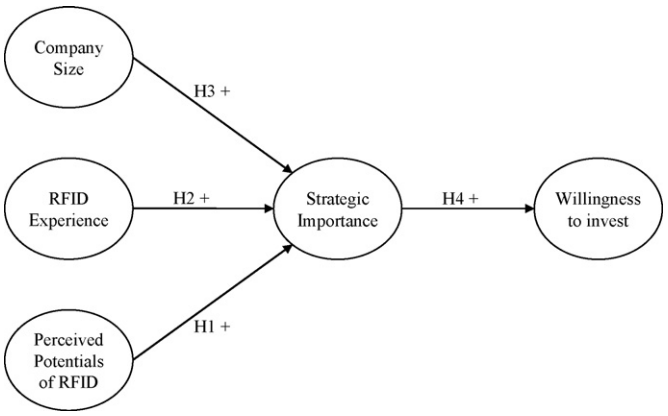

Fig. 1. Research model.

is represented by a set of indicators, i.e. questions in a questionnaire, which were measured on a five-point Likert scale. Whenever possible, existing measures from prior studies were adopted and adapted to the context of this research.

As unit of analysis top IT decision makers from two countries – Germany and Italy – were chosen. From November 2005 to January 2006, 3171 top IT executives from various industries in Germany were invited to participate in an online survey by a personal letter containing a personal unique access code for the survey website. From April to June 2006, the same survey was conducted in Italy and 2820 top IT executives from various industries in Italy were invited to participate in an online survey by a personal letter containing a personal unique access code for the survey website. We received 463 usable questionnaires from Germany and 157 questionnaires from Italy.

4. Survey results

4.1. Demographics

In total, 463 companies of various industries and company sizes took part in the survey (return rate 14.6%) in the German sample. The industry most represented was manufacturing (36.9%), other relevant industry groups were automotive (18.4%), services (16.0%), retail (14.3%), consumer goods (11.7%), IT (11.7%), transport/logistics (11.0%), pharmaceuticals/healthcare (8.4%) and other (22.9%). Companies with less than 2500 employees represented almost 75% of the participating organizations. Most respondents are CIOs (72%).

In Italy, 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 10,000 and 1.3% exceeded 10,000 employees. Most respondents were chief information officers (CIO) (50.2%) or chief executive officers (11.9%).

4.2. Industry differences

RFID is a topic that is perceived as not equally relevant for all industries. For some industries RFID might be a support technology, for other industries technology might enable totally new and integrated business processes. Especially industries such as transport/logistics and retail associate many opportunities with this new

Table 3
Industry differences regarding the perceived strategic importance of RFID[a].

Industry	Germany			Italy		
	Mean	*N*	S.D.	Mean	*N*	S.D.
Automotive	3.07	56	1.126	3.33	3	1.155
Consumer goods	3.17	41	1.138	3.20	5	0.837
Defense	*1.50*	2	0.707			
Transport/logistics	2.75	40	1.276	*1.33*	3	0.577
Pharma	3.10	31	1.248	*1.67*	3	1.155
IT	2.88	26	1.479	3.50	2	0.707
Telecommunications	3.08	13	1.498			
Manufacturing	3.21	94	1.190	*1.89*	9	0.782
Retail	3.07	41	1.311	3.00	11	1.342
Services	3.15	40	1.528	3.00	2	1.414
Consulting	3.14	21	1.558			
Other	*4.08*	26	1.129	3.50	2	0.707
Average	3.14	431	1.297	2.63	40	1.192

[a] Empty field indicates that industry did not have RFID in place or in planning and thus did not qualify to answer question for strategic importance of RFID (defense, telecommunications, and consulting in Italy sample).

technology. Regarding our data, we had a broad industry mix in both data samples, but not all industries were represented equally. Thus, we tested for significant bias that could influence our PLS model results. Table 3 analyzes the perceived strategic importance of RFID by industry. While overall the mean values for perceived strategic importance are similar in both groups, we identified a few potential outliers (marked in italics in Table 3). In order to check if these outliers are significant, we conducted a one-way analysis of variance (ANOVA) and also post hoc tests (mainly Student–Newman–Keuls procedure, Tukey-HSD, and Scheffé). The results indicated no significant industry differences on a 0.01 level of significance. We therefore could include all data points in the model analysis.

4.3. Experience with RFID

Since experience with RFID is one of the key determinants not only in our model, but for the overall understanding of the CIOs' perception of RFID, we examined this determinant separately from the overall PLS model test.

We analyzed the experience with RFID of both samples by asking for the current status of RFID implementation. While overall RFID technology is not very widespread and established in companies in both samples, Table 4 shows that the level of experience among German IT decision makers is higher compared to the level of RFID experience among Italian IT decision makers. This fact has to be taken into account when interpreting the results of the PLS model. We will consider these differences in the level of experience among the two groups and their possible biasing effect in the discussion section.

When cross-tabulating the RFID experience of the companies with the perceived strategic importance, a comparison of the means reveals different values in all of the categories and also across the countries (see Table 5). Regarding the German sample, companies which had already conducted tests, but did not intend to apply the technology, also did not believe in its strategic importance. In contrast, a positive tendency was noticed for those intending to adopt the application. Those most convinced of RFID's strategic importance were companies currently implementing the system. This group even surpassed those companies already applying it. In the Italian sample, the companies which apply RFID or currently implement RFID are the most convinced of RFID's strategic importance. The value of 4.00 (which indicates almost no strategic importance) seems to be an outlier as this was only based on one response.

Table 4
Experience of both countries with RFID.

RFID experience	Germany	Italy
Applies RFID	6.7%	6.2%
Implementing RFID	3.3%	2.7%
Conducted tests, intends application	6.9%	0.7%
Tests in progress	31.3%	6.2%
Conducted test, does not intend application	14.2%	1.4%
Have not considered RFID for company use	37.7%	82.9%

In order to check whether experience and perceived strategic importance (measured with one single variable) are related, we conducted a correlation analysis. A correlation analysis using Spearman-Rho correlation coefficient confirms our assumption for the German sample, indicating a strong and significant relationship between "RFID experience" and "RFID is of strategic importance for our company" ($r = 0.522$, $p = 0.0001$). However, in the Italian sample, we do not see a clear relation between "RFID experience" and "RFID is of strategic importance for our company", indicated by a moderate, non-significant correlation ($r = 0.336$, $p > 0.1$). To explain these results we have to take into account that Italian IT decision makers hardly have any experience with the new technology of RFID (as described in Table 4).

Table 5
Cross-table of RFID experience and perceived strategic importance.

RFID experience	Strategic importance of RFID					
	Sample Germany			Sample Italy		
	Mean	S.D.	*N*	Mean	S.D.	*N*
Applies RFID	2.70	1.291	30	1.78	1.093	9
Implementing RFID	2.21	1.122	14	1.75	0.500	4
Conducted tests, intends application	2.38	1.115	29	4.00		1
Tests in progress	3.09	1.028	137	2.44	0.726	9
Conducted test, does not intend application	4.40	0.853	63	2.50	2.121	2

Annotation: five-point scale from "totally agree" = 1 to "do not agree at all" = 5.

4.4. Model validation

This section presents the results of the model test, including the test of the measurement model as well as the structural model. The research model was operationalized and transferred into a structural equation model to be analyzed with the PLS approach (Chin, 1998; Wold, 1985). PLS is particularly suitable if a more explorative analysis close to the empirical data is preferred. To our knowledge, there is no strong theoretical foundation or even empirical evidence on the interplay of company size, RFID experience, perceived potentials of RFID and perceived strategic importance as well as willingness to invest in RFID. Thus rendering an explorative approach seems to be most appropriate.

5. Formative measurement model

In our model, the construct "perceived potentials of RFID" has been operationalized in formative mode since the indicators meet the criteria put forth in (Jarvis, MacKenzie, & Podsakoff, 2003) for formative measurement models. According to the findings of (Diamantopoulos & Winklhofer, 2001) and (Chin, 1998) five critical issues determining the quality of the measurement model have to be investigated: (1) content specification, (2) indicator specification, (3) indicator reliability, (4) indicator collinearity and (5) external validity.

Content specification consists of defining the scope of the latent constructs to be measured. This is of particular importance, as within formative models the indicators form the latent variable. "The breadth of definition is extremely important to causal indicators" (Nunnally & Bernstein, 1994, p. 484), because "failure to consider all facets of the construct will lead to an exclusion of relevant indicators" (Diamantopoulos & Winklhofer, 2001, p. 271). The research model presented in this paper includes one latent constructs to be measured with formative indicators: perceived potentials of RFID. This construct was precisely defined and its domain intensively discussed, ensuring the proper specification of the applicable content of all the constructs deployed.

Indicator specification comprises the identification and definition of indicators which constitute the latent constructs. As the aggregation of all formative indicators defines the scope of the formatively measured latent variable, indicator specification is particularly important for models using formative indicators (Diamantopoulos & Winklhofer, 2001). The indicators used in this model were identified by intensive literature review and have been validated through more than 20 in-depth expert interviews with German and Italian IT executives who were knowledgeable about the topic of this research. Following their input, some initial indicators have been altered to become more precise and understandable to the target audience.

Indicator reliability analyzes the importance of each individual indicator that forms the relevant construct. Two quantitative arguments have to be accounted for: (1) the sign of the indicator needs to be correct as hypothesized and (2) the weighting of the indicator should be at least 0.1 as proposed by (Seltin & Keeves, 1994). The analysis revealed that three indicators in the German sample did not fulfill these requirements. In the Italian sample two other indicators showed incorrect signs. Although eliminating indicators which do not fulfill the set criteria is recommended by (Seltin & Keeves, 1994), all indicators were kept in the model since it emphasizes the differences in both data samples explaining different perceived potentials in Germany and Italy (see Section 8.2 and Appendix A for full figures). Because formative measurement models are based on multiple regression, substantial *indicator collinearity* would affect the stability of indicator coefficients (Diamantopoulos & Winklhofer, 2001). In this study, multicollinearity among the indicators used did not pose a problem. The maximum variance inflation factor was far below the common cut-off threshold of 10 (Cohen, 2003). Therefore, no further indicators needed to be rejected as no redundancy was identified.

External validity ensures the suitability of the deployed indicators and is of special importance for formative measurement models if indicators needed to be eliminated. External validity shows the extent to which formative indicators actually capture the construct (Chin, 1998). Following Diamantopoulos and Winklhofer (2001), external validity can be tested by using nomological aspects linking the formative construct with another construct to be expected as antecedent or consequence. As the path coefficient for H1 shows a substantial impact of "perceived potentials of RFID" on strategic importance at a significance level of 0.001 in both data samples, the formative operationalization of the construct is supported.

6. Reflective measurement model

The quality of the measurement model is determined by (1) convergent validity, (2) construct reliability and (3) discriminant validity (Bagozzi, 1979; Bagozzi & Phillips, 1982; Churchill, 1979; Peter, 1981).

Convergent validity is analyzed by indicator reliability and construct reliability (Peter, 1981). Indicator reliability was examined by looking at the construct loadings. In the model tested, all loadings are significant at the 0.001 level and above the recommended 0.7 parameter value (significance tests were conducted using the bootstrap routine). *Construct reliability* was tested using two indices: (1) the composite reliability (CR) and (2) the average variance extracted (AVE). Estimated indices were above the threshold of 0.6 for CR (Bagozzi & Yi, 1988) and 0.5 for AVE (Chin, 1998) in both data samples (see Appendix A).

Discriminant validity of the construct items can be analyzed by looking at the cross-loadings. As depicted in Appendix A, the loading of each indicator is higher for the respective construct than for any other construct. Therefore, the indicators of different constructs are not related to each other and discriminant validity is shown for both data samples.

7. Structural model

The adequacy of indicators in the measurement model enables one to evaluate the explanatory power of the entire model as well as the predictive power of the independent variables. The *explanatory power* is examined by looking at the squared multiple correlations (R^2) of the dependent variables. 26.9% (German sample) and 54.4% (Italian sample) of the variance in strategic importance is explained by the three independent variables. The R^2 of willingness to invest ($R^2 = 0.660$ German sample; $R^2 = 0.665$ Italian sample) is also encouragingly high. Fig. 2 shows that all dependent variables are well explained by their independent variables and therefore pass critical examination.

Predictive power is tested by examining the magnitude of the standardized parameter estimates between constructs together with the corresponding level of significance. Only one path coefficient in the German and two in the Italian sample do not exceed the recommended 0.2 level (Chin, 1998): company size, RFID experience (Italian sample). Boot-strapping revealed strong significance (at the 0.01 or even 0.001 level) of all dependent variables except for company size and RFID experience in the Italian sample (n.s.). Analysis of the overall effect size f^2 (Chin, 1998; Cohen, 2003) reveals that "perceived potentials" has a strong effect on "strategic importance" as well as "strategic importance" on "willingness to invest".

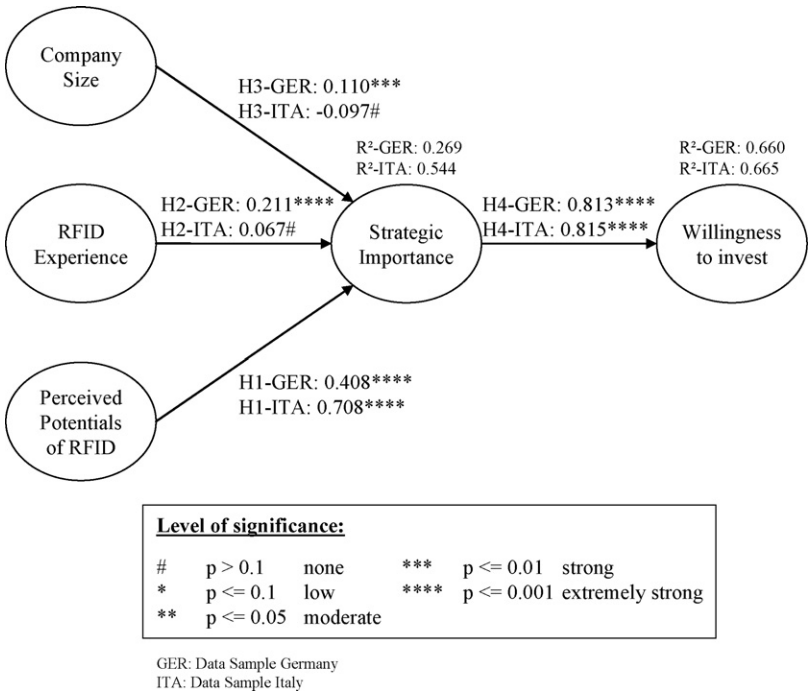

Fig. 2. Structural model findings.

Weak impact has been shown for the effect of company size and RFID experience on strategic importance in both data samples. Fig. 2 depicts the findings graphically.

8. Analysis and discussion of results

RFID is not very widespread neither in Germany (Knebel et al., 2007) nor in Italy (Knebel, Leimeister, & Krcmar, 2006). The importance of RFID will rise significantly over the next few years in both countries. However, RFID is not judged as a strategic issue, nor is it a topic of high priority on the IT agenda. 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. Even though companies' RFID budgets will rise over the next 5 years and IT decision makers are willing to invest in the technology.

8.1. Key findings of the overall model

Overall findings reveal that perceived potentials of RFID have a significant impact on the perceived strategic importance of RFID. Furthermore, the perception of this strategic importance has a major impact on the intention of IT decision makers to invest in RFID—regardless of the cultural context.

Contradictory to our assumptions and findings in the literature, in our study company size does not influence the perceived strategic importance of RFID. The experience with RFID has an impact on strategic importance of RFID although only in the German context. Although these findings are true for both countries we found significant differences in both groups.

8.2. Group analysis

Drawing from research on the impact of different cultural contexts (Hofstede, 1991; Koopman et al., 1999; McCoy et al., 2007) we found significant differences of perceived strategic importance and also in the composition of perceived potentials in both cultural settings, Germany and Italy (see Table 4).

In Germany, strategic importance is heavily influenced by the experience with RFID and the potentials attributed to RFID. These potentials are improving quality, automating manpower, reducing counterfeits, and improving customer service (see Table 7 in Appendix A). In contrast, Italian CIOs assign the potentials of reducing inconsistencies in stock, optimizing stock keeping, and improving customer service to RFID (see Table 7 in Appendix A). In the Italian context, experience with RFID does not influence the perceived strategic importance at all. This finding can be explained by the fact that Italian CIOs have less experience with RFID compared to German CIOs. Thus, this factor cannot explain different influences the perception of the strategic relevance of RFID.

Overall, findings show that perceived potentials have a much larger impact on strategic importance in the Italian context compared to the German context. This finding is contrasted by the result that experience with RFID has almost no impact in the Italian context compared to the German context (see Fig. 2 and Table 4). Although company size hardly has an impact on the perceived strategic importance in both cultures, the difference between Germany and Italy is significant (see Table 6). While company size has a minor impact on strategic importance in Germany, in Italy it seems to play an almost negligible role. The impact of perceived strategic importance on the willingness to invest in RFID does also not differ significantly—it is extremely high in both cultures (see Table 6).

8.3. Analysis of cultural differences

While the impact of perceived strategic importance on the willingness to invest in RFID did not differ significantly in both data samples, we found significant differences regarding (a) the effect of experience with RFID, (b) the effect of company size, and (c) the effect of perceived potentials on strategic importance, which can be explained through a cultural lens. However, the similarities of the findings in both groups regarding the interplay of perceived strategic importance and the willingness to invest in RFID will be discussed from a cultural point of view in the last paragraph.

In terms of *experience with RFID*, the results showed significant divergence in both data samples. Italy obviously has much

Table 6
Level of significance for group samples Germany vs. Italy.

Sample Germany vs. Italy	*t*-Value	Degrees of freedom (df)	Level of significance
Company size → strategic importance	2.33	620	0.05
RFID experience → strategic importance	1.36	620	>0.1
Perceived potentials → strategic importance	−3.04	620	0.01
Strategic importance → willingness to invest	−0.04	620	>0.1

less experience with the new technology and is reluctant to the adoption of RFID in their companies. In Germany, a lot more respondents indicated first-hand experience and knowledge with the new technology. We can explain the differences we found in our study through Hofstede's *uncertainty avoidance* (*UA*) *dimension*. The UA index for the Italian culture is relatively high compared to the German culture. Individuals from cultures scoring high on this dimension tend to seek ways to reduce uncertainty, they are less risk taking and less ambitious (Hofstede, 1984). Italy might have less experience with RFID because they tend to wait with implementing emergent technologies before taking the risk associated with new and to some extent premature technologies. By waiting, Italian companies reduce the risk of uncertainty until others collected experience with RFID and Italian companies can enter as a "fast follower". German IT executives, on the other hand, score low on the UA dimension, which can be translated as a greater willingness to take risks (Hofstede, 1984). German IT decision makers seem to be more "engineers" that are very keen on inventing or applying new technologies. Consequently, Germany invests in RFID to a larger extent and is also among the early adopters of the technology.

Regarding the determinant *company size* and its impact on the perceived strategic importance of RFID, we could see different industry structures in terms of firm size in both samples. In Italy, small firms dominate the industry structure, while in Germany we find the whole range from small and medium size to large companies (with more than 500 employees). This structure is also represented in our data. Even these differences can be partially explained culturally by Hofstede's *individualism dimension* (IDV). The IDV in Italy is relatively high compared to the German IDV score which is average with the mean score for European countries. In fact, Italy is one of only seven countries that have individualism (IDV) as their highest dimension (Hofstede, 1991). In terms of company size, Italy tends to be more individualistic while in the German industry culture, characterized by larger firms, people are very keen on belonging to a larger organization. People in such a collectivist culture act in the interest of the greater organization and do not necessarily follow their own beliefs. In Hofstede's words "the employee will act according to the interest of [his or her] in-group, which may not always coincide with his or her individual interests" (Hofstede, 1991, p. 63). In the Italian culture, which ranks higher on individualism, people want to stand out of the crowd and pursue their own goals. People in such cultures are motivated by their own self-conscience and make decisions based on whether an action will lead to personal gain. This motivation structure fits very well to Italy where smaller firms dominate the industry structure. The goals underlying the individualistic dimension are better achieved for individuals in smaller firms with a "one-man show" character.

Applied to the model, in Germany where we find the whole variety of company sizes ranging from small and medium enterprises to large companies, the impact of company size on strategic importance is larger because the variety is higher and we can conclude that strategic importance is perceived high the larger the company is. In Italy, company size is no influencing factor on perceived strategic importance, since the industry structure in terms of company size is more homogenous in this country and no differentiating issue.

When analyzing the items behind the construct perceived potentials of RFID, differences as well as commonalities between both countries could be identified. These findings can also be discussed from a cultural aspect. As we learned above regarding RFID experience, the Italian culture scores high on the *uncertainty avoidance index* (*UAI*). One way of reducing uncertainty is relying on clear procedures, strategies and rules, and information transparency (Hofstede, 1984). RFID can offer more reliability (especially in the retail sector, one of most prominent industries in the Italian data sample) by giving real-time information about products and stock information. Consequently, Italian CIOs can attribute potentials such as reducing inconsistencies in stock or optimizing stock keeping as opportunities and advantages of this new technology. As Germany ranks lower on the *individualism dimension*, German CIOs associate "automating manpower" as one of the greatest potentials of RFID. Achieving a higher level of automation would be contraproductive for "standing out from the crowd", one of the key issues of highly individualistic cultures.

Both countries regard "improving customer service" as one of the outstanding potentials. The perceived relevance of this attribute can be explained be the relatively low score of both countries on Hofstede's *power distance dimension* (*PDI*). Countries with low PDI scores indicate a greater equality between societal levels, including government, organizations, and even within families. This orientation reinforces a cooperative interaction across power levels and creates a more stable cultural environment. Applied to the item "improving customer service" CIOs in both countries expect a higher level of equality between the customer and the vendor through RFID.

Lastly, while we could not apply the cultural dimension of *masculinity* vs. *femininity* as explaining cultural *differences* in Germany or Italy, we can rather discuss *similarities* in this regard. Both cultures have comparable scores in this dimension, ranking relatively high in the masculinity dimension. In a masculine society, people are socialized towards very competitive, ambitious, and advancement-oriented behavior (Hofstede, 1991). We could use this finding for culturally explaining the strong correlation between strategic importance and willingness to invest in both cultures. Once, the strategic importance of the RFID technology is perceived as high and the technology is regarded as useful and differentiating, CIOs in both countries are very eager and ambitious to invest in the technology.

8.4. Limitations

The surprisingly strong results certainly need some words of caution that render our findings strictly exploratory and preliminary. Our data is limited as we have been able to analyze the causes of company size, RFID experience, and perceived potentials at one point of time only. This does not necessarily reflect the long-term situation, especially since RFID is such a volatile and emerging IT topic.

For example, experience with RFID in our data set was relatively low, especially in the Italian context. As the experience with RFID will rise among Italian CIOs, its impact on strategic importance might become much higher and also the attributes of perceived

potentials are likely to change over time. Also the finding that company size and especially industry type does not seem to matter as a factor influencing the perceived strategic importance might alter over time as it has to be observed if RFID will become a technology for all kinds of enterprises regardless of size and industry. In the future, industries such as transport/logistics or retail might use RFID to a much stronger extent and with a strategic intention compared to other industries such as consulting. In this case, industry does matter and one has to evaluate these results over time.

9. Conclusion and outlook on further research

Gathering empirical insights from 463 German and 157 Italian CIOs this study presented IT decision makers' views of RFID across industries and companies of varying sizes in two countries. The respondents indicated that RFID diffusion is very low. Many IT decision makers have heard about, taken an 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 the experience with RFID, company size and perceived potential of the technology. Results revealed that the potentials attributed to RFID differ significantly in different cultures. A desire for quality improvement, reduction or automation of manpower, reduction of counterfeits as well as an improvement of customer service were characteristics that most attracted German CIOs to RFID; whereas Italian CIOs mostly associated a reduction of inconsistencies in stock, optimization of stock keeping, and an improved customer service with RFID. A major finding was also the fact that due to little experience among Italian CIOs, this factor hardly influenced the perception of strategic relevance of RFID.

As expected, a higher perception of strategic importance correlated positively and strongly with a higher willingness to invest in the technology in both cultural contexts. However, RFID is not (yet) a topic of high priority on a company's IT agenda. 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 RFID visions. A large number of respondents did not indicate that it was necessary to define a vision. On the other hand, virtually all participants stated that the importance of tracking & tracing and RFID will rise significantly over the next years. The technology might well turn out to be a sleeping giant.

Analyzing the innovation leaders in RFID in the German market in follow-up interviews and case studies (Metro and DHL) our findings were in accordance with those of previous research (Loebbecke & Palmer, 2006). For example, if RFID is considered strategically, it can help to increase process efficiencies and provides a significant competitive advantage from the use of RFID data as claimed by consultants in the context of the real-time enterprise. Furthermore, responses indicated that companies were very interested in building up and improving technical and management skills to be able to redesign infrastructures, processes and organizational structures in order to leverage the potential of real-time infrastructures. Furthermore, they stated (as also reported in other related research (Khosla & Pal, 2002; Leimeister, Knebel, & Krcmar, 2007) that migration to a real-time enterprise requires a continuous migration process and they are convinced that these RFID-enabled RTE systems have all necessary attributes of IT-dependent strategic initiatives (Piccoli & Ives, 2005) to be able to deliver a sustainable competitive advantage.

Based on the results of the research, the following insights can be derived:

- RFID is a logical next step in enterprise computing and extending corporate boundaries.
- There is nothing really new about RFID.
- RFID can create a competitive advantage.
- The degree of experience with RFID is still low among IT decision makers.
- In the current status of RFID company size does not make a difference on the perceived strategic importance attributed to RFID.
- The interplay of perceived strategic importance of RFID and the willingness of IT decision makers to invest in this technology is strong.
- Potentials of RFID are diversified and also perceived differently in different cultures and according to a different level of experience with this new technology.

9.1. 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.

9.2. 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. Our study showed that the potentials and benefits associated with RFID differ significantly in cultural contexts. A clear and adapted market communication is thus necessary to address target users and their needs appropriately.

9.3. Further research

Future research should analyze the diffusion of RFID and the corresponding strategic paradigm shifts towards real-time enterprises 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 as we found first antecedents of such cultural differences. 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

Table 7
Indicator and construct reliability for both data samples.

Construct	Item	Sample Germany ($n = 463$)				Sample Italy ($n = 157$)			
		Load./Weight	Sign.	CR	AVE	Load./Weight	Sign.	CR	AVE
Company size: *Reflective*	S14Q14	1.00	–	1.00	1.00	1.00	–	1.00	1.00
RFID experience: *Reflective*	S02Q01	1.00	–	1.00	1.00	1.00	–	1.00	1.00
Perceived potentials: *Formative*	S09Q08	0.448	0.001			0.273	>0.1		
	S09Q09	0.279	0.05			−0.258	>0.1		
	S09Q10	0.098	>0.1			0.125	>0.1		
	S09Q11	0.256	0.05			−0.210	>0.1		
	S09Q12	−0.018	>0.1			0.415	0.05		
	S09Q15	0.027	>0.1			0.416	0.05		
	S09Q16	0.429	0.001			0.406	0.1		
Strategic importance: *Reflective*	S07Q06	0.861	0.001	0.910	0.771	0.887	0.001	0.919	0.792
	S07Q07	0.917	0.001			0.899	0.001		
	S07Q08	0.856	0.001			0.884	0.001		
Willingness to invest: *Reflective*	S08Q01	0.803	0.001	0.901	0.694	0.892	0.001	0.935	0.782
	S08Q02	0.847	0.001			0.891	0.001		
	S07Q09	0.796	0.001			0.876	0.001		
	S07Q10	0.881	0.001			0.878	0.001		

Table 8
PLS cross-loadings of reflectively measured constructs for sample Germany.

Item	Construct			
	Strategic importance	Willingness to invest	Experience RFID	Company size
S14Q14	0.218	0.211	0.320	*1.000*
S02Q01	0.296	0.269	*1.000*	0.320
S08Q01	0.622	*0.804*	0.202	0.232
S08Q02	0.711	*0.847*	0.315	0.246
S07Q09	0.664	*0.796*	0.153	0.053
S07Q10	0.706	*0.882*	0.232	0.174
S07Q06	*0.860*	0.723	0.235	0.186
S07Q07	*0.917*	0.739	0.274	0.200
S07Q08	*0.856*	0.677	0.264	0.185

Table 9
PLS cross-loadings of reflectively measured constructs for sample Italy.

Item	Construct			
	Strategic importance	Willingness to invest	Experience RFID	Company size
S14Q14	−0.043	0.001	0.101	*1.000*
S02Q01	0.353	0.408	*1.000*	0.101
S08Q01	0.758	*0.892*	0.384	0.105
S08Q02	0.800	*0.890*	0.290	0.036
S07Q09	0.611	*0.877*	0.314	−0.078
S07Q10	0.688	*0.879*	0.440	−0.086
S07Q06	*0.888*	0.794	0.349	−0.129
S07Q07	*0.899*	0.708	0.312	0.120
S07Q08	*0.884*	0.666	0.261	−0.107

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 real-time enterprise are needed.

Appendix A

See Tables 7–9.

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