"Crossing the Chasm"

Exploring RFID adoption characteristics in South African industries

Bas Korteweg
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Picture: T.L. Fischer- 'Ravine'

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Preface

This report is the result of a research on behalf of the Master Innovative Entrepreneurship and Business Development at the University of Twente. Innovative Entrepreneurship and Business Development is one of the specialization tracks of the study Business Administration.

My background starts as a chemical engineer, but along the road I felt a gap between the technological and business side of organizations. In order to cross this gap, knowledge not only on the economic factors but also the entrepreneurial process and business development site of organizations was the missing link that could connect these two playing fields. The master innovative entrepreneurship and business development could fulfill this need.

While looking for opportunities to cross that gap, I traveled the globe in Asia and Oceania to experience other cultures in this fast moving world. During this journey my interest in other countries and especially emerging economies started. It was fascinating to see the innovativeness and drive of people in order to keep their head up, while seeing businesses in emerging economies struggling with innovation and new technologies to keep up with the western world. The interesting part of the business environment in emerging economies is the social view of entrepreneurs, a view that I did not see in the 'west', the need to take care for their whole family.

It was during the master track that I came in contact with South Africa, and especially the Innovation Hub, which has a strong relationship with the University of Twente. The Innovation Hub is South Africa's growing pool of new businesses and ideas in a strong emerging economy. It was interesting to see the progress South Africa achieved and activities it had initiate to keep pace with the Western world. While the African culture gives it a special touch.
Techsolutions Pty (Ltd), who gave me the opportunity to experience the African business culture during my research, is a tenant of the Innovation Hub and a leading RFID solution provider. During the research for Techsolutions I experienced the different views of companies on new things that affect their organization, their resistance or their enthusiasm. Especially the interviews I held with executives was a pleasant and an interesting way of experience business cultures of different companies in a different country.

While visiting the African continent and especially South Africa, I was surprised by the modernism in the country. I had the perception of South Africa as an undeveloped country, with wild animals everywhere and people riding horses instead of cars. Instead huge shopping malls, business centers, and research organizations were part of the sky-line. The passion and the drive of the people in this country to make business work in a difficult environment have been amazing. In this case this research did not only develop me in an academical way but also on a personal field.

This report could not have been written without the contribution of several people. At first I want to thank Dr P. van der Sijde and Dr. S.J. de Boer for giving me guidance on the academical path. Mr. E. de Koker for his guidance in the RFID world and the opportunity he gave me to investigate 'the' technology of the future. The Innovation Hub, to give me the opportunity to be a part of the vibrant entrepreneurial environment, besides a learning experience it was also an interesting look at entrepreneurial processes and views. EPCglobal South Africa and Fiona van der Linde in particular, for arranging the interviews. To conclude I want to thank all organizations who contributed to this research and cooperated with the interviews.

Enschede, February 2007
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Executive Summary

Radio Frequency Identification or RFID has sprung into prominence in the last five years with the promise of providing a relatively low cost means for connecting non electronic objects to an information network. In particular, the retail supply chain has been established as a key sector for a major deployment of this technology.
RFID is a technology used to track assets throughout the supply chain. Very small RFID transponders or tags containing a unique identifier are placed on assets (pallets, cases, or individual items), and these tags communicate with RFID readers. The RFID readers then associate this unique identifier with information about the product to which the tag is attached. The next generation of inventory management technology and supply chain efficiency hinges on broader adoption of RFID technology for tracking and tracing. RFID has the potential to materially change how inventory is managed in the supply chain, in warehouses, in transit, in distribution centers, and on store shelves and check out counters, by improving visibility of that inventory in near real time and, importantly, at an economically feasible cost.
Although the relative advantages of RFID have been seen by industries the innovation is seen as complex, which resulted in hesitation, South Africa is no exception. In order to initiate mass adoption, a transition is necessary to cross the chasm from the early adopters towards the early majority. This leads to the following problem formulation:

Which adoption characteristics influence RFID in South African industries?

Research on RFID adoption in industries is very limited, certainly in South Africa no empirical support is found in order to determine the adoption characteristics of this technology. Therefore this research explores the influencing RFID adoption characteristics in South African industries in order to bridge the chasm towards the early majority. Six industries are included in this research, Retail, Pharmaceutical manufacturers, Food and beverage manufacturers, Automotive manufacturers, Telecommunication and the Transport industry. Interviews were held among all industries. In this research two different data collection methods are used. On one hand a literature study has taken place to identify RFID competitors and the adoption characteristics in the US. On the other hand interviews were held to identify the adoption characteristics perceived by the South African industries. The interviews were held in cooperation with EPC Global South Africa, who has the required contacts in the South African sectors, and are interested in the results of the research. Techsolutions acts a client in this research and is one of the members of EPC Global South Africa and participate in the developing and marketing of RFID in South Africa.

The exploration of the adoption characteristics of RFID in South Africa has as starting point the framework of Tornatzky and Fleisher (1990). Tornatzky and Fleischer (1990) stated that adoption is influenced by three aspects; Technological, Organizational and Environmental aspects. In order to determine the influencing characteristics of the adoption of RFID, these aspects are explained by using a specific model for each aspect. The technological aspects are explained by Rogers (1995), Rogers defined five innovation characteristics what explain the adoption from a technological perspective. The EiN model (NIKOS, 2005) explains the organizational aspects. The model stated that to be successful an enterprise need sufficient capital in four dimensions; Strategic, Economic, Cultural and Social. These four capitals explain the organizational aspects that influence the adoption of RFID. The external environmental aspects will be determined by the framework of Deuten *et al.* (1997), who argue that the environment exist of three parts business environment, regulatory environment and wider society. Those three parts explain the environmental aspects of the RFID adoption characteristics.

Whereas retail is initiating RFID adoption in the US and Europe, the pharmaceutical manufacturing is leading in South Africa. Retail in South Africa is reserved the technology and takes a following position. Mandates faced by the pharmaceutical industry are driving the adoption. It appears that the main barrier for RFID adoption in South Africa is the underlying lack of sufficient understanding of RFID within organizations. This understanding is required to identify opportunities which can be translated into strong business cases. In result external sources are needed for introduction and implementation of a business case.
In South Africa four competitors can be distinguished, Barcode, GPS, Magnetic stripe card and Manual handling. Barcode and Manual handling are most common competitors in the research population. RFID gives although the complex nature of the technology strong business advantages and therefore considered important for industries.

In conclusion, in a technological perspective the relative advantage of RFID are seen within supply chain applications which result in improved visibility, reduced out-of-stocks, better traceability and identification. The focus is mainly at open loop applications of the technology, while largely overlooking the opportunities for

closed loop applications. Maturity of the technology is seen as a barrier towards these advantages, the evolving character of the technology called for hesitation. South African industries require a business case and ROI. It is a requirement in order to convince senior management and to increase the awareness in the whole organization.

Many companies stated that RFID costs are prohibitive and that implementation will postpone until costs decreases. While some of the companies surveyed are ready to start exploring RFID internally, the market readiness in general is not at an appropriate level. Trade partners are still struggling with bar-coding, which slowing down the adoption process. In a regulatory perspective global standards are a main requirement, a focus (as previously remarked) on global open loop applications. In this case global standardization is obliged in order to create global adoption and efficient usage of the technology. On social grounds the economic situation of the country plays a role. In the adoption process community poverty is a factor which companies need to take into account. Especially businesses to consumer organizations where company image plays a role social responsibility is a factor of importance. The privacy concerns that exist in the US and Europe regarding RFID are unlikely to play a role in South Africa. All industries argued that privacy is not a factor of importance among the South African population.

Awareness and knowledge about RFID is the major challenge in the South African market. While many companies have heard about RFID and in some cases have appointed personnel to investigate the potential of the technology, a substantial knowledge gap exists for understanding the technology. This gap is hampering companies in being able to identify potential applications of the technology and to be able to build credible business cases. Many of the above mentioned issues can be explained by the way RFID is marketed. Currently RFID is marketed as an IT solution while it is in essence an operational solution. By moving it in the domain of IT, it substantially limits the opportunities in establishing a business case. If RFID was marketed as an operational solution more understanding and commitment towards the technology will be created.

Has RFID crossed the chasm? When looking at the current status of the industries hesitation seen as the trend and business cases sporadically appear. Which can conclude that the transition has not took place. Initiatives are coming up, more supply chain members are sitting around the table, and awareness is growing and gives a positive sound for the future. Organizations still need a strong business case to get convinced by the technological benefits. Business cases are in some industries planned for the near future and can give a positive influence to other industries to initiate a business case. When awareness and understanding is increasing, it is a matter of time before the first industries get a full roll out, what could lead to initiate the chasm crossing.

In line with the conclusions recommendations are given. A distinction can be made between recommendations towards the industries and recommendations towards Techsolutions.

Recommendations for South African Industries

- Increase the internal RFID knowledge and awareness, in order to see the organization benefits and correct decision making;
- Cost is one aspect of the whole technology. Facing the cost issue on its own gives misconceptions and place the technology an unnecessarily negative perception. The relative advantage justifies the investment in all cases;
- Start a business case within in a close loop environment. This allows organizations internally experience and explore the implications and benefits of the technology
- When decided to consider a business case in an open loop environment, collaboration between trade partners and departments has sufficient advantages. Even if RFID is being employed in a very limited scope to solve a specific business challenge, the implications of the technology in other parts of the organization and outside the enterprise should not be ignored;
- An organization must ask herself the question, does RFID whether besides the barriers directly contribute to improvement of the business processes. If that is the case, do not wait any longer and become a driver of the technology.

Recommendations for Techsolutions

- Market RFID as a business solution, to create awareness and commitment among non-technical people and managers. When presented as a business solution, more people can see the benefits and understand the results;
- Facilitate knowledge programs in order to bridge the knowledge gap of the industries, to increase awareness;
- Give companies' guidance and assistance in formulating businesses cases which can positively contribute towards understanding the technology and gaining commitment within the organization;

Contents

1. Introduction

Radio Frequency IDentification (RFID) is an emerging technology intended to complement or replace traditional barcode technology to identify, track, and trace items automatically. RFID is at the beginning of a wide spread global introduction. According to the technology adoption life cycle of Moore (1998), RFID is in a stage that has to cross the chasm between the early adopters (visionairs) and the early majoritiy (the pragmatists) in order to initiate mass adoption. Crossing the chasm brings the technology in a transition, from a visionairs view to a pragmatic use. Where early adopters are often product focussed, the early majority is process focussed. Pragmatists seek improvements in business performance, lower cost, lower inventories, increased sales, faster cycle times and improved customer satisfaction (Regan *et al.*, 2005). In order to have a steady growth of RFID where mass adoption takes place, this chasm needs to be crossed. While South Africa is a follower in the RFID market[1], the transition of the technology towards a pragmatic usage needs to take place, also in this emerging economy. The way the transition process in South Africa will take place can be similar to the process in Europe and the United States (US) where the technology introduction is in a further stage (FtC, 2005) and the economy is on a higher level. The question rises in what way this transition will take place in South Africa, and in which way play the cultural differences and economical situation a role.

1.1 Background

RFID is an automated data-capture technology which can be used to electronically identify, track, and store information about groups of products, individual items, or product components (DoC, 2005). RFID fundamentally consist of four elements: the RFID tag, RFID readers, the antennas and choice of radio characteristics, and a computer network (Garfinkel *et al.*, 2006). RFID tags are small or miniaturized computer chips programmed with information about a product or with a number that corresponds to information that is stored in a database. The tags can be located inside or on the surface of the product, item, or packing material. RFID readers are querying systems that interrogate or send signals to the tags and receive the responses. These responses can be stored within the reader for later transfer to a data collection system or instantaneously transferred to the data collection system. Lastly, data collection systems consist of computers running data processing software, which typically are networked with a larger information management system (DoC, 2005).

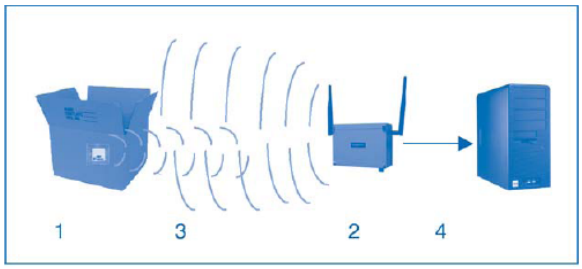


Figure 1 Components of RFID (Source EPC NL, 2006)

A real world RFID application will typically make use of many RFID-tags. When one of these objects comes into proximity with the RFID-reader, data from the associated tag can be read. This may and can be used to identify that specific object, or to provide information about the object. Similarly, real applications of RFID often make use of several RFID-readers, in order to identify the tagged objects in different locations (AudioIDLAB, 2005). The reader sends the data of the tag into a computer network, where the information would be visible for use (Finkenzeller, 2003).

The technology itself offers several improvements over its predecessor technologies, the barcode and magnetic stripe cards. The central data feature of RFID is the Electronic Product Code (EPC), which is viewed by many in the industry as the next generation barcode or Universal Product Code (UPC).

01	0004Y7	0002B9	000622CA
Header	EPC Manager	Object Class	Serial Number

Figure 2 Example Electronic Product Code (Source Manhattan Associates, 2006)

[1] http://www.epcza.org

This EPC code can carry more data, than the UPC code and can be reprogrammed with new information if necessary. Like the UPC, the EPC code consists of a series of numbers that identify the manufacturer and product type. The EPC code also includes an extra set of digits to identify unique items. RFID allows easy and when needed uninterrupted access to data on the tag. Unlike the barcode where identification is limited by line-of-sight, RFID and its reliance on radio waves does not require a line-of-sight for identification nor a straight-line alignment between the tags and readers. RFID tags are also sturdier than barcodes, allowing use in adverse conditions, and tags can be affixed or embedded on the product packaging or inside the item (DoC, 2005).

RFID is not a new technology, it was first introduced in World War II, to identify own aircrafts by the allies. The technology relies on the transfer of packets of information through radio waves or electromagnetic waves. However, it has been the exponential growth in information and communication technologies coupled with the expansion of global production and trade. That has resulted in RFID becoming useful for managing and tracking large shipments and product sales, and as a means of identification for security purposes and supply chain management. The RFID system allows manufacturers, retailers, and suppliers to efficiently collect, manage, distribute, and store information on inventory, business processes, and security controls. RFID will allow retailers to identify potential delays and shortages; grocery stores to eliminate or reduce item spoilage; toll systems to identify and collect auto tolls on roadways; suppliers to track shipments; and in the case of critical materials RFID will allow receiving authorities to verify the security and authentication of shipped items. These uses are seen as only the beginning. When RFID is deployed across different sectors and services, to increase efficiency and visibility, benefits may arise. This can be seen in the forecasted sales of the technology (figure 3).

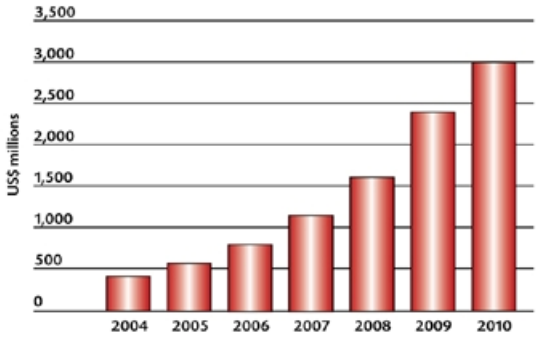


Figure 3 Forecast market grow of RFID (Source Gartner, 2005[2])

Given the robust tracking capability relative to bar coding, RFID is capable of offering significant incremental benefits associated with operational improvement and market intelligence. Among organizations, a supply network characterized by rich information exchange, which can be enabled by RFID, increases the feasibility of implementing alliances of firms that exchange information to coordinate production and distribution, outsource functions and services, and partner with suppliers and intermediaries (Lee, Padmanabhan *et al*., 1997; Straub, Rai *et al*., 2004). RFID has sprung into prominence in the last five years with the promise of providing a relatively low cost means for connecting non-electronics objects to an information network (OECD, 2004).
Given the mandates rolled out by large US retailers, usages of the technology increase and as a result prices decrease. The lowering price and the many possibilities of RFID mean an increase in market opportunities[3].

1.2 Problem formulation

RFID developments are following each other up rapidly, and the popularity of this technology is increasing. This results in new possible markets and technological possibilities, where RFID can be applicable. While the decreasing price of the RFID is promising for adoption, hesitation still remains among industries. Besides RFID gives many advantages towards organizations, it has also some difficulties. The implementation of the technology into the existing Information Technology (IT) infrastructure obtains huge technical challenges (Bear-Stearns, 2003). The even more substantial organizational changes required by the adoption of RFID such as the changes in the business processes and organizational structure (Gerst *et al.*, 2005). RFID, by its nature, touches a wide variety of areas of the enterprise. This means that for companies to fully reap the benefits of RFID, they must involve multiple functions (Deloitte, 2004), thus creating a multi divisional environment.
Enormous progress is being made on the commercial applications of the technology that make the entire industry supply chain visible, efficient, and collaborative. However, some challenges and barriers to a broad

[2] http://www.information-age.com/.../69176/item65327.jpg
[3] http://www.rfidjournal.com/article/articleview/796/

implementation of RFID still exist. What are the reasons that companies do not adopt this technology? Is it the lack of sufficient knowledge about RFID[4], or is it the negative media attention RFID is facing nowadays? Violations of privacy, radiation illnesses are reports from the media (Garfinkel, 2006). Uncertainty plays a role in the adoption process, people do not want to be the first to use an 'unproven technology' (Choi, 1997). The perception that RFID is a complex innovation and take effort of the whole organization, changing the organizational structure to a multidisciplinary level (Bear-Stearns, 2003; Gerst *et al.*, 2005) can give several constraints towards the technology.

Some US/European companies are leading the way with the technological applications and pilot testing of RFID tags attached to items, cases, and pallets. The lessons learned from these early adopters acknowledge these challenges and barriers, but also point to benefits already proven in these piloted tests and to those benefits alluded to by the tremendous promise of this initiative.

When comparing South Africa with the situation in the US, an interesting point of view is if South Africa is following the international trends, and what is the current status of the technology? Are the same adoption characteristics applicable for South Africa as for the US? In order to cross the chasm to reach the early majority and initiate mass adoption, these factors have to be determined. The problem can therefore be formulated as follows:

Which adoption characteristics influence RFID in South African industries?

This problem formulation will be further explained in chapter three (research methodology) in several research questions.

1.3 Objective

RFID gives many advantages towards organizations, although it is also a complex and multidivisional product (Bear-Stearns, 2003; Gerst *et al.*, 2005). Because of these obstacles, there are several uncertainties within the market concerning RFID which effect the adoption (Rogers, 1995). In the US these uncertainties are identified, nowadays there is no sufficient insight in the uncertainties of the South African market. The objective of this research is to give an overview of the influencing adoption characteristics for RFID in South African industries.
In order to get a sufficient overview of the RFID market and their abilities, this research can be combined with research by Wilm van Aken (Master student of the University of Twente). Van Aken research explores RFID opportunities in South African markets. Together with the RFID opportunities and the adoption characteristics of this technology, an overview of the South African RFID market will be presented. In this context will refer to the joint report of Aken and Korteweg (2006) where the views of the industries in this context are presented.

This research is contributed to the interest of the following parties:

Techsolutions;
Techsolutions acts as a client in this research. The research gives an overview of the adoption characteristics of the South African industries and their limitations in order to have insight in the market approach towards them. According to this overview a strategic plan can be developed to tackle the uncertainties of the industries towards RFID. Expansion of the companies' activity scope could lead to an increase in market share and improved market position.

[4] http://www.rfidjournal.com/article/articleview/612/1/2/

1.4 Practical and theoretical relevance

In practical respect, this research has a contribution to the market approach, changeable perception, and (possible) adoptability of markets, as it is currently pursued with regard to RFID. While the industries are restrained towards the technology (Bear-Stearns, 2003; Gerst *et al.*, 2005), it is of interest which barriers and drivers these industries view for implementation. This leads to a better understanding of the industries demand, and encourage collaboration in the chain (Choi, 1997).

This research contributes to the existing literature about RFID in South Africa. On national level, in South Africa research on adoption characteristics of organizations and their perception towards this technology does not exist. Although several studies mentioned RFID adoption (Gerst *et al.*, 2005; Accenture 2003; Sharma *et al.*, 2005), there is a lack of substantial research to determine these adoption characteristics in South Africa. Where existing research is indicating *that* there are general adoption characteristics for technological and IT innovations, this research is determining *which* RFID adoption characteristics exist, and which factors influence the perception of RFID in the South African industries.

1.5 Structure report

The report is structured as follows; the theoretical framework will be presented in chapter two. It will go further into the concepts of innovation (§2.1), afterwards the theoretical framework will be outlined (§2.2), three theoretical aspects of RFID adoption framework will be discussed with their theoretical models where the adoption process will be determined (§2.3, §2.4, §2.5).

Central in chapter three is the used research methodology. The central problem formulation will be set out in three separate research questions (§3.1). In succession it will go further into the industry selection method (§3.2), and the data collection method (§3.4). The chapter will be finished with a description of the operationalization (§3.5).

The present situation of RFID competitors in South Africa, and the reasons why RFID is considered important for development will be outlined in chapter four. Chapter five explains the adoption characteristics in the United States. The findings of this process will be used to determine the process in South African sectors.

The adoption characteristics in South Africa are presented in chapter six, where the respondents and interview sample survey population will be presented (§6.1), and the three aspects of RFID adoption will be explained, technological aspects (§6.2), organizational aspects (§6.3), and the environmental aspects (§6.4).

In the end of the report, the conclusions will be presented in chapter seven, with which an answer will be given on the central problem formulation (§7.1). A reflection of the research process is outlined (§7.2). Several strategically recommendations will be made towards Techsolutions and the industries (§7.3). Suggestions for further research (§7.4) are made at the end of the report.

2 Theoretical framework

2.1 General Innovation theory

'There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new order of things…Whenever his enemies have the ability to attack the innovator, they do so with the passion of partisans, while the others defend him sluggishly, so that the innovator and his party alike are vulnerable.
Niccolò Machiavelli, The Prince (1513)

Two roads diverged in a wood, and I –
I took the one less traveled by,
And that has made all the difference.
Robert Frost, The Road not taken (1920)

RFID is a globally emerging innovation, the implementing the technology is in the US in a breakthrough stage in several sectors. The adoption process is in this continent in a further stage, compared to South Africa which is in an early stage of adoption. The early majority in US is more and more enthusiastic about the technology, while in South Africa the early adopters are exploring the field. RFID is a new innovation for the adopting organizations. Adoption is stated as an internally generated or purchased device, system, policy, program, process, product or service that is new to the adopting organization (Daft, 1982; Damanpour & Evan 1984; Zaltman, Duncan, & Holbeck, 1973). Or as Rogers (1995) argues, adoption is a decision to make full use of an innovation as the best course of action available. The adoption of innovation creates changes in the structure and functioning of an organization (Damanpour, 1991). The adoption of innovations is conceived, according to Damanpour (1991), to encompass the generation development, and implementation of new ideas or behaviours. The adoption of innovation is generally intended to contribute to the performance or effectiveness of the adopting organization. Innovation is a means of changing an organization, whether as a response to change in its internal or external environment, or as a pre-emptive action taken to influence an environment. When new technological innovations are introduced, and especially the information technology, they transform the society (Guideria, 2000). McClure (1997) argued that organizations that fail to adopt or support these changes in technology will be ill prepared to function in current and future environments. This has a great affection in South Africa through the increasing globalization of businesses. A RFID standard is growing in the 'Western world'.

Through the relatively newness and complexity, RFID entails the market several uncertainties, which holds back a global adoption of this technology. The newness of an idea gives the diffusion its special character it creates uncertainty within the process. Diffusion is defined as the process in which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1995). While uncertainty is the degree to which a number of alternatives are perceived with respect to the occurrence of an event and the relative probability of these alternatives. Uncertainty is influencing adoption, it prevails the true value of the technologies (Choi, 1997). The nature of the uncertainty is such that the values of the technologies can be ascertained only by actually using them (Rosenberg, 1982; Zeira, 1987). As a poet once wrote:

"One must learn by doing the thing, for though you think you know it, you have no certainty until you try" (Sophocles, 400B.C.).

Technological innovations involves the introduction of knowledge derived tools and devices, which extend the interaction of humans with their environment (Tornatzky *et al.*, 1990). These innovations imply information and therefore potentially reduce uncertainty (Rogers, 1995), once someone uses a technology, the value of it becomes public knowledge, thereby creating informational externalities. In the presence of network externalities, once a technology is adopted and its true value is revealed, it has a significant advantage over another technology whose value is uncertain in the subsequent technology adoption process. The consequence of handicapping the adoption of the other technology is the prevalence of herd behaviour in the technology-adoption process (Choi, 1997). Technology consists of both its characteristics and the social processes and behaviours that determine the manner and extent of usage (O'Sulivan, 2000). Herd behaviour is a result of the social system in organizations, or as Parsons (1964) defines:

"A social system consist in a plurality of individual actors interacting with each other in a situation, which has at least a physical or environmental aspect, actors who are motivated in terms of a tendency to the "optimization of gratification" and whose relation to their situations, including each other, is defined and mediated in terms of culturally structured and shared methods".

Herd behaviour is driven by the fear of being stranded. Experimentation with new innovations is avoided because of the informational consequences accompanying the adoption of an untested technology. Consequently, each decision maker is concerned with the number of future subscribers who can act upon new information that the decision can create. All subsequent movers adopt the same strategy of 'let someone else be the guinea pig,' which resulted in a failure to experiment with the new technology (Choi, 1997). This behaviour is seen in the adoption process of RFID, organizations hesitate to implement the technology before all uncertainties are solved. Another form of behaviour what is required for an innovative character is within the context of the economics of localized technological change. In this context adoption is viewed as a complementary component of a broader process of adjusting the technology when unexplained events in the product and factor markets push the firms towards a creative reaction (Antonelli, 2006). It is seen as an active process, it requires, instead, the active participation of users not only in terms of the search and eventual choice among a range of existing products, but also and mainly in terms of a specific and dedicated activity of adoption of available products, either brand new, just introduced, or existing ones, to the localized and idiosyncratic needs and constrains of users, as shaped by irreversibility, routines and switching costs (Bianchi, 1998; Metcalfe, 2001; Witt, 2001), in other words it requires an entrepreneurial focus for new opportunities.

Behaviour among innovations is an aspect of interest, but on a holistic view, adoptions of innovations can not be generalized. In order to determine the specific adopter criteria of the technology it has to be distinguished in industries. Damanpour (1991) argues, type of organization should be a primary contingency variable in the adoption process. These types can be identified by industry, sector structure (Mintzberg, 1979), strategy (Miles and Snow, 1978; Miller, 1986). Distinguishing types is crucial, as the variance in environmental opportunities and the threats for organizations of different types can influence their degree of innovativeness (Butler, 1988; Pavitt, Robson & Townsend, 1989; Tushman & Anderson, 1986).

While innovations differ in the rate of complexity and changes, each kind of innovation has a different adoption process. The distinguishing of types of innovation is necessary for understanding organizations adoption behaviour and identifying the determinants of innovation in them (Downs & Mohr, 1976; Rowe & Boise, 1974). According to Daft (1978) distinguishing between administrative and technological innovation is important because it imply potentially different decision-making processes. While technological innovations pertain to products, services, and production process technology (Damanpour and Evan, 1984; Knight, 1967), RFID can be seen as an administrative innovation, because it involves organizational structure and administrative processes. It is indirectly related to the basic work activities of an organization and directly related to its management (Damanpour & Evan, 1984; Kimberly & Evanisko, 1981; Knight, 1967).
The difference between the kind of innovation, radical versus incremental, is another distinguishing in the adoption process. Incremental innovations create less uncertainty than radical innovations, therefore more equally adopted (Rogers, 1995). The more radical the innovation, indexed by the amount of knowledge that organization members must acquire in order to adopt, the more uncertainty it creates and the more difficult its implementation. Etile *et al.* (1984) define an innovation as radical if it is both new and introduces a magnitude of change. Sharma *et al*. (2005) defines radicalness of technology as having two key dimensions 1) the degree of new knowledge required for its adoption and 2) the extent of changes it mandates to existing practices and infrastructure for adoption and subsequent implementation to occur. RFID may be perceived as radical because it may 1) require learning new skills and acquiring new infrastructure, 2) provides unforeseen strategic benefits, 3) bring about changes to an organizations internal structure and functioning and 4) change supply chain partners interactions (Sharma *et al.*, 2005). In this way the adoption of RFID cannot be seen as an equally adoption process, and must be seen as a discontinuous process.

In order to identify the influencing adoption characteristics of RFID, the existing adoption models could not totally apply. Through the discontinuously of the adoption, other variables should be included to have a total view on the influencing adopting characteristics.

2.2 Technological innovation adoption

The extensive writings on adoption and diffusion of innovation (Rogers, 1995), and the adoption of new and emerging technologies with unique characteristics are still not well understood. Adoption of special technologies with adopter interdependencies (Katz and Shapiro, 1986; Markus, 1987), technologies that impose heavy knowledge burdens on adoption (Attewell, 1992; Cohen and Levinthal, 1990), and adoption of Electronic Data Interchange (EDI) (Iacovou *et al.*, 1995)) are all instances where generalization could not be directly applied (Sharma *et al.*, 2005). While RFID is an emerging technology with unique characteristics, imposing knowledge burdens and could be used in an EDI environment, the adoption can not be explained with a generalized model. Tornatzky and Fleischer (1990) developed a framework to explain intra- and inter-organizational factors that influence the adoption of technological innovations, the Technological, Organizational and Environmental framework (TOE). The TOE framework identifies three aspects of a firm's context that influence the process by which it adopts, implements, and uses technological innovations: (a) *Technological context* describes both the existing technologies in use and new technologies relevant to the firm. (b) *Organizational context* refers to descriptive measures about the organization such as scope, size, and the amount of slack resources available internally. (c) *Environmental context* is the arena in which a firm conducts its business—its industry, competitors, and dealings with government (Tornatzky and Fleischer, 1990). This framework is consistent with the innovation diffusion theory of Rogers (1995), which emphasizes technological characteristics, and both the internal and external characteristics of the organization, as drivers for technology diffusion. The TOE framework has consistent empirical support in various Information Systems (IS) domains, such as EDI, open systems, and material requirement planning (e.g., Iacovou *et al.*, 1995; Chau and Tam, 1997; Thong, 1999). As a generic theory of technology diffusion, the TOE framework can be used for studying different types of innovations (Zhu *et al.* 2005). While a general model can not determine the adoption characteristics of RFID, the framework of Tornatzky & Fleischer (1990) (figure 4) gives a good basis to explain the adoption characteristics of RFID in South Africa.

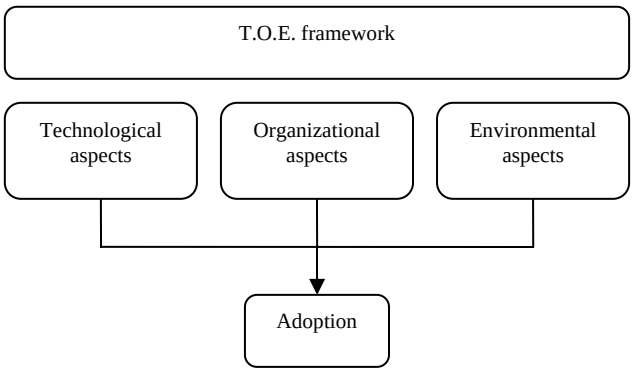


Figure 4 T.O.E. framework (Source Tornatzky & Fleischer, 1990)

Each of these aspects has specific characteristics each aspect will be explained by a model in order to have a total overview of the influencing adoption factors.

2.3 Technology aspect

To explain adoption of new innovations, several theories exist. There are two theories that are widely used for technological innovations: The Diffusion of Innovations (Rogers, 1995) and specifically developed for inter-organizational information systems the Electronic Data Interchange (EDI) Adoption Model (Iacovou *et al.*, 1995). These two theories explain the technology adoption characteristics, and in some way external environmental influences that can affect the adoption process.

Rogers (1995) developed the 'perceived innovation characteristics theory', a general model that sees adoption as a process through which an individual or other decision making unit passes from first knowledge of an innovation, to an attitude towards the innovation, to a decision to adopt or reject it, to the implementation of the new idea and to the confirmation of this decision. Rogers (1995) defined innovation as an idea, practice, or object that is perceived as new by an individual or unit of adoption. Rogers postulates that 'subjective evaluations of an innovation, derived from individuals' personal experiences and perceptions and conveyed by interpersonal networks, drive the diffusion process (Rogers, 1995).

The EDI adoption model (Iacovou, *et al.*, 1995) stated that factors that influence the adoption and impact of EDI, depends on the perceived benefits, organizational readiness and external pressure. Iacovou *et al.* (1995) refer to adoption as 'the process during which a firm becomes capable of transaction via EDI' and refer to integration as 'the process during which a firm alters its business practices and applications so that they can interface with its EDI applications'. Integration can be both internal (variety of applications) and external (number of trading partners). While the EDI model approaches the adoption with a holistic view over the whole supply chain, the focus of this research is on individual level. Determining the influencing adoption characteristics of industries at individual level fits better than the holistic approach. The innovation characteristics of Rogers (1995), what explain the technical implications of the innovation on adoption are more suitable for this research to explain the technological aspects.

Central to Rogers' model are the innovation characteristics as perceived by the adopter. Innovation characteristics are used in this research to determine the technological aspects of the innovation. In the second stage Rogers, the persuasion stage, the individual forms a favourable or unfavourable attitude toward the innovation (Rogers, 1995). Attitude is defined as a relatively enduring organization of an individual's belief about an object that predisposes his or her actions. In this stage the innovation characteristics as perceived by the adopter are of importance. By understanding the persuasion stage of the South African industries, anticipation can take place in the approach to these industries to give support in their struggles towards RFID. Rogers (1995) investigates five perceived innovation characteristics:

- *Relative advantage*. The degree to which an innovation is perceived as being better than the idea it supersedes. The nature of the innovation determines what specific type of relative advantage is important to adopters, although the characteristics of the potential adopters may also affect which specific sub-dimensions of relative advantage are most important.
- *Compatibility*. The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. An idea that is more compatible is less uncertain to the potential adopter and fits more closely with the individual situation. An innovation can be compatible or incompatible with 1) socio-cultural values and believes, 2) previously introduced ideas, and 3) clients need for information.
- *Complexity*. The degree to which an innovation is perceived as relatively difficult to understand and use. A new idea may be classified on a complexity-simplicity continuum. Complexity may be not as important as relative advantage or compatibility, but for some new ideas complexity is a very important barrier to adoption.
- *Trialability*. The degree to which an innovation may be experimented with on a limited basis. The trial of an innovation is one way of an individual to give meaning to an innovation and to find out how it works under one's own conditions. Trials can in this way dispel uncertainty. Relatively earlier adopters of an innovation perceive trialability as more important than do later adopters (Gross 1942; Ryan, 1948).
- *Observability*. The degree to which the results of an innovation are visible to others. Some ideas are easily observed and communicated to others, whereas other innovations are difficult to observe or to describe to others.

According to Rogers (1995) most (49 to 87 percent) of the variance in the rate of adoption of innovations is explained by these variables. The attributes of the innovation at hand as perceived by the adopter have proven to be significantly instrumental in predicting adoption (Tornatzky & Klein, 1982). These five variables are used to explain the technological aspects of the adoption according to the framework of Tornatzky and Fleischer (1990).

2.4 Organizational aspect

The model of Rogers (1995) explains the technology aspect of the adoption, in the framework of Tornatzky and Fleischer (1990). In order to explain the organizational aspect, the Entrepreneurship in Networks (EiN) (NIKOS, 2005) model is used. While the EDI model (Iacovou *et al.*, 1995) also includes organizational aspects, this model is rejected because it focuses on the collaboration between chain members, while the focus of this research is based on an individual level. The EiN model has an entrepreneurial view, which is similar to the adoption process. While the model is based on micro level, it is applicable on meso-level. The meso-level refers to actors who have the same role for many micro-level actors because of their equivalent position in the network of those micro-level actors (Groen, 2005).

The EiN model is a compilation of the entrepreneurial process (Van der Veen and Wakkee, 2004) and the social system theory (Parsons, 1977). Entrepreneurship can be seen as a process, directed by the entrepreneur (individual or organization), in which opportunities are recognized, prepared and exploited. The process is supported by four capitals; economic, strategic, cultural and social, in which each capital need to be presented in

order to create a sustainable enterprise. This can be directly related towards the opportunity recognition of RFID, the entrepreneurial process is of less importance in this context, while the supporting capitals have a strong influence on the organizational aspects of the adoption. The EiN model has four capitals that are important for the survival of an organization.

1. *Economic capital*; process to adapt the business processes to the goals and make them more efficient than the concurrent, it is the financial resources in cash and kinds, a venture has available and access to;
2. *Strategic capital*; process of setting goals, is the way a venture positions itself in the market, and attains and uses power;
3. *Cultural capital*; process of pattern maintenance. Particular patterns of behaviour that fits better to the strategic goals are set down in shared values and norms, methods and managing particular situations. It is the knowledge, know-how, experience, and values a venture puts into practice as well as how it organizes this.
4. *Social capital*; the relations an entrepreneur and his venture have with their environment, and the position of the venture within the network.

The central hypothesis of the model that on each of those four dimensions entrepreneurs, within network embedded enterprises will need sufficient capital in each of the dimensions to create sustainable enterprises (Groen, 2005). This can be translated to the adoption and implementation of RFID, where on all four dimensions a sufficient capital is needed in order to create a smooth and efficient adoption and implementation process. These four capitals are used to explain the organizational aspects of the adoption according to the framework of Tornatzky and Fleischer (1990).

2.5 Environmental aspects

External environmental aspects influence the adoption and diffusion of new technologies because of their unique features and characteristics (Sharma and Citurs, 2005). This corresponds with the 'environmental aspect' explained in the framework of Tornatzky and Fleischer (1990). Classically there has been an assumption of a clear boundary between the organization and the environment, in which the environment has been defined as "anything not part of the organization itself" (Miles, 1980). Environmental aspects in this context are the aspects organizations face within the environment. The last decades the boundaries between organizations and their environment began to dissolve (Astley, 1984), and therefore the perspective changed from an independent individual organization to one of an organization interacting with its perceived environment (Pfeffer, 1987). While from an efficiency standpoint, many companies stand to gain from the use of RFID, certain impediments to the broader adoption of RFID still remain (Bear-Stearns, 2003). RFID has been commercially available for over two decades, the rate of adoption for most applications has been slow as the relative benefits of the technology have been outweighed by several key barriers, including lack of standards, relatively high cost, weak education, technology hurdles and privacy concerns (Baird, 2004). Organizations and other technology actors are increasingly confronted by issues of ecological soundness, public acceptability and other aspects of 'societal quality' (Deuten *et al.*, 1997). Many entrepreneurial failures can be attributed to the fact that a would-be entrepreneur failed to consider the relevant conditions of interdependence between the component with which he happened to be preoccupied and the rest of the larger system (Rosenberg, 1979). It is important for organizations to reflect their experiences and avoid the potentially damaging consequences of innovation, for themselves, their organization and the world beyond (Thomas, 1996), in other words creation of 'social embedding'. The nature of the environment in which an innovation has to survive is essential for its getting embedded. Deuten *et al*. (1997) developed a model which divides the environment in three parts:

- Business environment; Actors in the business environment have input-output relations with the organization. Innovations have to be integrated in relevant industries and markets. Embedding in existing practices and cultural repertoires of users is required. Suppliers and customers have to adjust themselves to innovations, in the sense that it affects their processes, and/or allows them new combinations;
- Regulation environment; Actors are local, regional, national and international governments and other regulatory bodies (including standard setting bodies). Innovations have to be admissible according to the rules and standards set by government agencies or the sector. A complicating factor is that in many cases appropriate regulation for innovations based on new technologies is not available;
- Wider society; Actors are consumer organizations, environmental groups, animal protection organizations and also public opinion leaders, media and independent scientists. Innovations have to be accepted by the public. Public resistance can cause the failure of an innovation.

An innovation is accepted according to Deuten *et al.* (1997) when three conditions are fulfilled: societal concern is not overly large, there has been sufficient articulation of the pros and cons so that choices can be made consciously and the innovation is actually used.

This model looks from within the organization and sees the different parts as layers around the organization. The first layer is the business environment, the second layer is the regulation environment and the third layer is wider society. The businesses environment is the most familiar one for the organization, while the wider society is unfamiliar (Deuten *et al.*, 1997). All three layers influence the organization on new technological innovations (see appendix I for more details).

2.6 Overview

The exploration of the adoption characteristics of RFID in South Africa has as starting point the framework of Tornatzky and Fleisher (1990), figure 5. Tornatzky and Fleischer (1990) stated that adoption is influenced by three aspects, Technological, Organizational and Environmental aspects. In order to determine the influencing characteristics of the adoption of RFID, these aspects are explained by using a specific model for each aspect. The technological aspects are explained by Rogers (1995), Rogers defined five innovation characteristics that explain the adoption from a technological perspective.

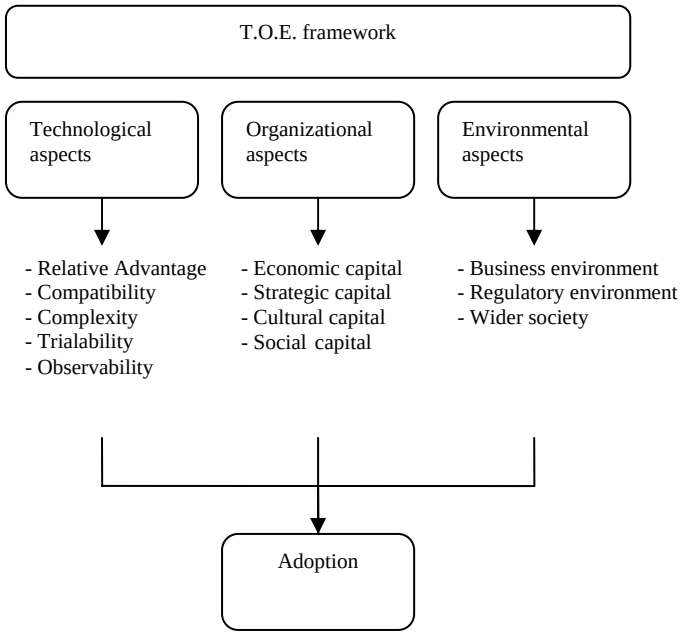


Figure 5 Research variables

The EiN model (NIKOS, 2005) explains the organizational aspects. The model stated that to be successful an enterprise need sufficient capital in four dimensions; Strategic, Economic, Cultural and Social. These four capitals explain the organizational aspects that influence the adoption of RFID. The external environmental aspects will be determined by the framework of Deuten *et al.* (1997), they argue that the environment exist in three parts business environment, regulatory environment and wider society. Those three parts explain the environmental aspects of the RFID adoption characteristics. These three aspects explain the influencing characteristics of the RFID adoption in South African industries.

3 Research methodology

3.1 Research questions

The problem definition can be categorized as a strategic objective, since it requires the analysis and combination of both the technology as well as the environment. Considering the development that takes place in RFID and changing environmental variables, this research had focused on strategic opportunities in the future. Segmentation of the national RFID market leads to a better understanding of different customer groups and enables a better future approach. As Van de Ven (1986) argues organizational factors may unequally influence innovation in different types of organizations, as extra organizational context and the industry or sector in which an organization is located influence innovativeness.

In order to achieve this objective a research model was developed which analyses RFID from a meso-perspective. The analysis will identify the influencing RFID adoption characteristics in the several South African market segments. In order to gain a proper conclusion of the problem, three research questions have been formulated. These research questions have individually an input in answering the problem and are therefore determined in a parallel research design. These answers are to be used to determine the key-issues that should be taken into account when approaching the South African RFID market.

In order to investigate the overall problem, stated in section 1.4, the following main research questions have been formulated.

1. ***What are the RFID competitors in South Africa and what are the reasons that RFID is considered important for development?***

   Explore the technology competitors, in applicable RFID areas.

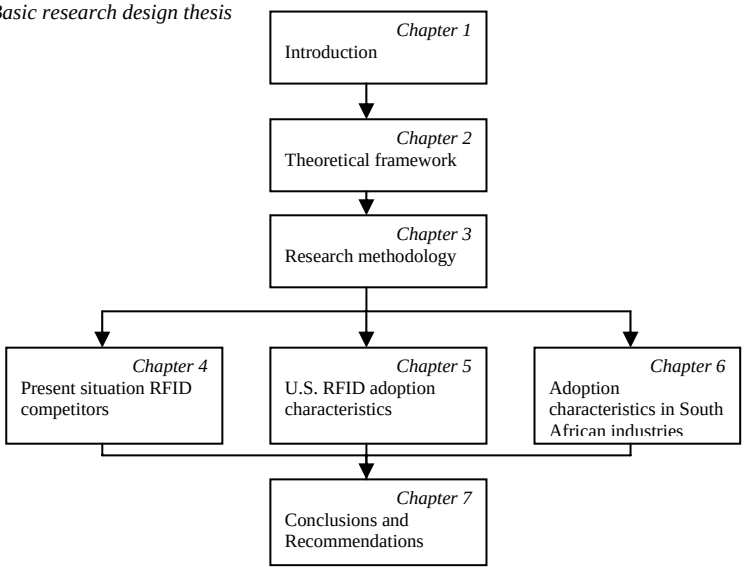
2. ***Which adoption characteristics were of importance for RFID in the United States and could be of use in South Africa?***

   The United States is in further stage of RFID adoption compared to South Africa. An exploration of their adoption process can give insight in the influencing adoption characteristics. Trends can be seen as well as a future path for the adoption in South Africa.

3. ***Which adoption characteristics support or inhibit RFID in South African industries?***

   Exploration of the adoption in South African market segments, and determining which adoption characteristics is influencing RFID.

Figure 6 Basic research design thesis



3.2 Industrial selection method

In the time frame of this research, six South African industries are selected. According to the Department of Trade and Industry of the Government of South Africa (DTI), ten sectors can be distinguished. In order to select six appropriate industries, the selection is based on three criteria.

- RFID suitability
- Gross Domestic Product (GDP)
- Political/social implications

The RFID suitability is an underlying criterion that will not be mentioned separately but will influence the other criteria (see appendix II for details).

Gross Domestic product
This selection criterion for industries is based on the highest percentage value added GDP on the national economy. Data are collected from the Statistics South Africa department (2006). Industries that are chosen on GDP are automotive manufacturing, food and beverage manufacturing, retail, transport and telecommunication.

Political and social implications
Political and social issues play an important role in certain RFID solutions. The industry Pharmaceutical manufacturing is selected through this criterion, through the Federal Drug and Administration (FDA) mandate. The FDA in the US has mandated to all pharmaceutical manufactures to trace electronically their medicine in order to prevent counterfeit drug. This mandate influences the pharmaceutical manufacturing in South Africa through export to the US. See appendix II for detailed explanation.

Conclusion:
The following industries will be assessed in this research: Automotive manufacturing, Pharmaceutical manufacturing, Retail, Transport, Telecommunication, Food and beverage manufacturing.

3.3 Data collection method

In this research two different data collection methods are used. On one hand a literature study took place to identify RFID competitors and RFID adoption characteristics in the US. On the other hand interviews are held to identify the adoption characteristics perceived by several industries.

At first a literature study took place to describe the first and second research questions, RFID competition and the adoption characteristics in the US rd.. Hereby mainly were used Internet, scientific articles and books, consultant reports and governmental sources.

Secondly, interviews were held among the selected industries in South Africa in order to determine the third research question, the South African RFID adoption characteristics. The interviews were constructed along the theoretical framework, described in chapter two. In order to give an answer to the research questions a longitudinal[5] research design would be appropriate. Perceptions can change in time, if determine this changes a prognoses can be given. However, seen the available time for the research this was not possible.

The type of interview held can be categorized as a semi-structured (Saunders *et al*., 2004). A semi structured interview categorizes itself by a list of themes and questions that need to be covered. Although these may vary from interview to interview, additional questions can be omitted, in order to specify topics. The interviews were held in cooperation with EPC Global South Africa, who has the required contacts in the South African sectors, and are interested in the results of the research. Techsolutions act as a client in this research and is one of the members of EPC Global South Africa and participate in the developing and marketing of RFID in South Africa. The interview consists of combined questions from this research and the research of Van Aken about RFID opportunities. The data for each research are filtered out the answers.

[5] Longitudinal research: The study of a particular phenomenon over an extended period of time

3.4 Operationalization

The operationalization of the research variables is divided in three parts, as seen in table I. The three parts are related to the three aspects that influence technological adoption founded by Tornatzky and Fleischer (1990). The first aspect describes the technological aspect of how organizations face the innovation explained by the variables of Rogers (1995). The second part the organizational aspects of companies explained by the EiN model (2005).The third part are the external environmental aspects that innovations face explained by the framework of Deuten *et al.* (1997). Most of the items are adapted from Van der Veen (2004) who has pioneered a similar adoption model. Other items are derived from Rogers (1995) and a meta-analysis of Damanpour (1991).

Table I Operationalization of the research variables

Technological aspect (based on Rogers, 1995)	
Variable	*Tested on*
Perceived relative advantage	- Perceived solutions
Perceived compatibility	- Exposure
Perceived complexity	- Maturity of the technology - IT infrastructure
Perceived trialability	- Business case
Perceived observability	- Image
Organizational aspects (based on EiN model, 2005)	
Variable	*Tested on*
Economic capital	- Annual turnover - Amount of employees
Strategic capital	- Importance of innovation in the company - International mandates - Senior management commitment
Cultural Capital	- RFID knowledge in the organization - RFID knowledge about internal changes / challenges
Social Capital	- Usage of external social network for searching new ideas/solutions
Environmental aspects (based on Deuten *et al.*, 1997)	
Variable	*Tested on*
Business environment	- Perceived cost - Perceived market readiness
Regulation environment	- Perceived standardization need
Wider society	- Perceived privacy issue - Perceived social responsibility

All variables were asked in a semi structured interview, see appendix III for overview of interview questions. The questions are not in all cases asked literally, but in context of the conversation changed in a way it suited the situation. In addition some variables are asked in an additional question list, to cover all variables in the limited interview time. The variables in the additional questions were measured on a five point Likert scale, and used to determine the cohesion between the industries.

4 Present situation RFID competitors

Several RFID applications groups can be distinguished; tracking, tracing, identifying and control (see appendix IV), an estimate is determined of current technologies in these groups. These technologies are the RFID competitors. A comparison of these technologies with RFID gives insight in the relative advantage of RFID for potential adopters. Therefore the first research question is formulated as follows.

***What are the RFID competitors in South Africa and what are the reasons that RFID is considered important for development*?**

4.1 Competitors

The current status of tracking and tracing, identifying and control in South Africa can be categorized in four groups of RFID competitors, Bar Coding, Global Positioning System, Magnetic Stripe Cards, and Manual. These groups are the main sources of technologies which are used in applications where RFID can be applicable.

Bar coding
Currently the main technology companies' use for tracking and tracing, identifying and control is bar coding. Bar codes have successfully held their ground against other identification systems over the past twenty years. The bar code is a binary code comprising a field of bars and gaps arranged in a parallel configuration (Finkenzeller, 2003). Barcodes can be read by optical scanners called barcode readers or scanned from an image by special software. The dimensions of bar codes vary with the application. They can be as small as approximately 20 millimeter (mm) by 10mm when used to identify small retail items. In chemical process and manufacturing industries, large components, tanks, or packages of product can be labeled with bar codes as large as 300mm by 200mm in size (*Howlett et al., 1997).*

Global Positioning System
Another technology used for tracking and tracing is Global Positioning System (GPS). GPS is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations[6], allowing to accurately determine the location (longitude, latitude, and altitude) of objects, in any weather, day or night, anywhere on earth (Garmin, 2000). Since GPS communicates via radio waves which travel at a known speed (the speed of light), GPS is also a means of determining a user's position in time. It comprises three functional areas referred to as segments: satellites (space segment), GPS receivers (user segment) and ground station (control segment) (Moore and Crossley, 1999).

Magnetic stripe cards
A magnetic card (MSC) is a plastic card resembling a traditional credit or debit card that contains a built-in integrated circuit chip used for identification and authentication purposes. MSC's use a serial interface and receive their power from external sources like a card reader. The processor uses a limited instruction set for applications such as cryptography[7].

Manual
In applications like asset control, manual registration is used frequently. Manual registration of an object and authorized persons occurs every time a person/object enters a premises or building and repeats when leaving. It is time consuming, increased human errors, and is inconvenient. There are more examples of manually identification within other categories.

[6] http://www.trimble.com
[7] http://www.smartcard.co.uk/smartlinks.html

4.2 Analysis competitors in view of T.O.E. framework

The framework developed in paragraph 2.6 will be used to answer the first research question. The three aspects of the framework, technological, organizational and environmental, are used to explore the competitors of RFID.

4.2.1 Technological aspects

Bar coding
Barcodes are widely used to implement Auto ID Data Capture (AIDC) systems that improve the speed and accuracy of computer data entry *(Finkenzeller, 2003)).* Bar codes are often used to provide a product with a numeric identification. The information supplied by the code can be used for stock control and pricing in a retail environment, or for tracing through a production process used in manufacturing *(Howlett et al., 1997*). Bar codes are found with increasing frequency in a range of applications. Frequently they are used as an identification method for products on sale in retail outlets, often in conjunction with electronic point of sale (EPOS). Bar codes are also used in manufacturing as a means of labeling components, sub-systems and finished products for automated recognition (*Howlett et al., 1997*). Conceptual, bar coding and RFID are similar: both are intended to provide rapid and reliable item identification and tracking information. The primary difference between the two technologies is that bar coding scans a printed label either with an optical laser or imaging technology, while RFID scans, or interrogates, a semiconductor tag using radio frequency (wireless) technology (Baird, 2004).

Global positioning system
Applications of GPS are mainly navigation, for boats, aircrafts and vehicles, nowadays used for tracking people. Timing applications include power systems uses but also encompass uses by local and wide area network providers through to cellular phone operators (Moore and Crossley, 1999). A GPS system is excellent for tracking vehicles on a road, but it is not accurate enough to track a vehicle on premises. In a typical GPS application, a "geofence" is drawn around a premise. Vehicles are assumed to be on the premises if they are within the 'geofence'. In the case of RFID, a time stamped event is generated when the vehicle enters the premises, creating a record to reflect the change of ownership of goods and/or liability. The item can be located with RFID within a 9 meter radius[8].

Magnetic stripe card
Applications are access control, were data carriers are used to automatically check the access authorization of individuals to buildings, premises, or individual rooms. Other applications are in the public transportation sector, ticketing, and electronic payments (Finkenzeller, 2003). The advantage is the ease of use, magnetic stripe cards has to be wiped a reader, while the contactless smart card (smartcard with RFID) automatically is read within the range of a reader. It speeds up the process of identifying and gives users more convenience.

Manual
Applications for manual use are unlimited. All supply chain activities can be manually done.

4.2.2 Organizational aspects

Bar coding
On security level the bar code is vulnerable to copying and reading. RFID-tags contain a unique number, where item level identification is sufficient. Copying RFID-tags is almost impossible and for reading the tags, very expensive equipment is needed[9].
Unlike bar coding scanning, RFID does not require line-of–sight to read the tag information, as the radio frequency signal is capable of traveling through most materials (Baird, 2004). Environmental influences, dirt, and rain decrease the readability of barcodes. RFID-tags are not influenced by environmental sources and are always readable[10]. Barcode scanning relies on the human operator. At a point of sale where the customer purchases more than one of an item, the operator saves time by scanning the same item many times instead of scanning each item. This allows errors to be introduced. RFID-tags can be scanned automatically and simultaneously without human intervention, preventing human error. Only one bar-coded item can be scanned at a time, while up to 200 RFID-tags can be scanned simultaneously. The distance of scanning a bar code is generally around 1 meter, were RFID-tags can be read up to approximately 9 meters. For item level

[8] http://www.techsolutions.co.za
[9] http://www.techsolutions.co.za
[10] http://www.techsolutions.co.za

identification, a barcode is insufficient. The barcode number is not unique it only contains a product code. While RFID-tags contain an item code, each product/item has its own code and in this case easily to identify.
These examples of usage of barcodes give changes in organizational structure and processes in order to bridge the effectiveness gap. The barcode is integrated in the society, most end chain members have implemented the technology, external sources control the applications, internal process change, and internally the organizational structure remains the same.

GPS
Is used in a specific nice market, and is expanding towards more markets. External sources are used for implementation, and GPS implies internal process changes.

Magnetic stripe card
Contactless smart cards (smart card with integrated RFID) have tremendous advantages over the magnetic stripe cards. Smart Cards differ from magnetic stripe cards in their capability to process data 'on-card', their increase in security, and their greater capacity to store data (Elliot *et al.*, 1998). They are able to execute cryptographic logarithms locally on their internal circuitry, means that the user's secrets (PIN-code, keys) never have to leave the boundaries of the tamper-resistant silicon chip, which increases the security level (Garfinkel, 2006). The magnetic stripe card is integrated in society, most end chain members implemented the technology, external sources control the applications, internal process change and internally the organizational structure remains the same.

Manual
Organizational aspects are no issue, investments are not necessary, an increased knowledge level is not applicable and external sources are not needed for implementation. One organizational aspect that occurs is time consuming. Every manual control check and registration demands human intervention, it is inconvenient and time consuming. This procedure is automatically by RFID, no human intervention is required and human error avoided, resulting in increasing convenience. A tag will be installed in an item and a reader will automatically read the item and identify the person who it belongs to, it is an identification and security system in one[11].

4.2.3 Environmental aspects

Generally all technologies are embedded in the environment. Wider public has accepted the technology and it is widely used among them. Regulatory bodies have standardized the technologies and are globally used. The business environment has accepted more or less the technologies.

Bar coding
The technology is globally standardized, and though the widely use costs are low, public awareness is huge and gives no implications. The market, in most cases, has implemented the technology.

GPS / Magnetic stripe card / Manual
Are fully embedded in the society, and gives no environmental implications.

[11] http://www.techsolutions.co.za

4.3 Conclusion

Four types of competitors can be distinguished, Barcode, GPS, Magnetic stripe card and Manual. In table II a comparison of the competitors is presented. In the research population barcodes and manual are the two most common competitors of RFID. GPS and the magnetic stripe card are more applicable in other industries.
Manual handling has advantages in terms of complexity and economic capital, yet it is inefficient and time consuming. Nevertheless in South Africa manual handling is a common thing as a result of the cheap labour prices. Compared to RFID the barcode is not efficient in item tracking, environmental influences and security level. Advantages of the bar code are minimal complexity and due to the global acceptability less costly than RFID. While the advantages of RFID towards current competitive technologies are clear, hesitation is still the main characteristic of the South African industries, this implicates the focus on the RFID implications instead of the advantages.

Table II RFID competitors

	Barcode	**GPS**	**Magnetic card**	**Manual**	**RFID**
Technological aspects					
Relative advantage	Tracing Stock control Pricing	Navigation Tracking	Access control Electronic payments Ticketing	All kind of applications	Tracking, Tracing, Identification, Control
Compatibility	Not needed	None	Yes	None	Not needed
Complexity	IT infrastructure	IT infrastructure	IT infrastructure	None	IT-infrastructure Multidivisional organization structure
Trialability	Yes	Yes	Yes	None	Yes
Observability	Yes	Yes	Yes	Yes	Depends on position in chain
Organizational aspects					
Economic capital	None	Depends on stage in adoption life cycle	Depends on stage in adoption life cycle	None	Depends on stage in adoption life cycle
Strategic capital	International mandates	Depends on the application	Standard in financial environment	None	Senior management commitment issues
Cultural capital	Medium knowledge level	Medium knowledge level	Medium knowledge level	Low knowledge level	High knowledge level
Social capital	Yes	Yes	Yes	None	External sources needed
Environmental aspects					
Business environment	Low cost High market readiness	Depends on stage in adoption life cycle	Depends on stage in adoption life cycle	None	High costs Low market readiness
Regulatory environment	International standards exist	International standards exist	International standards exist	None	Limited standardization
Wider society	None	None	None	None	Social responsibility is an issue

5 Adoption characteristics in the United States

5.1 Introduction

In June 2004 Wal-Mart (largest US retailer) announced that it would require its top hundred suppliers to put RFID-tags on shipping crates and pallets by January 1st 2005, and that it will expand its RFID efforts to its next two hundred largest suppliers by January 1st 2006. Wal-Mart in one decision changed the strategic foundation of many companies[12]. Before the announcement of Wal-Mart, the adoption of such technology had been somewhat scatter-shot. Within any given company that use the technology, it may be used only for some types of supply chain operations, or is used only with some types of customers, its adoption had been a relatively immature "hit-or-miss." Through the mandated request for RFID in the supply chain, a more matured adoption process occurred. The Wal-Mart announcement is often seen as the starting point of the commercially exploitation of RFID. Following the mandate of Wal-Mart, other large retailers in the US, Target, Tesco, mandated the same of their suppliers. These retailers lead the way in retail IT innovation, and hold a commanding lead in RFID adoption (Deloitte and Touch, 2005).

Besides the mandates of the largest retailers, the widespread interest in RFID appears shallow. Industry members are anxious to get in the pool, but they do not want to dive into the deep end (Deloitte, 2004). The large investment and the involvement of a variety of functions are constrains small and medium companies face. Larger companies are more likely to have created cross functional teams to develop RFID programs. In this way large companies have more power to implement and demand the RFID (Deloitte, 2004). In Europe, large retailers, like Metro, have also mandated suppliers to use the technology, but there exist a difference in the two continents. An Accenture (2004) study found that a little more than half of US companies were under mandate to implement the technology, while only 22 percent of European counterparts reported likewise. The difference could be explained by marketplace dynamics. In the United States, mandates from retailers like Wal-Mart are clearly outlined and have definitive deadlines for compliance; in Europe, there appears to be “room for interpretation” from companies like Metro, that are phasing in mandates to key suppliers.
The mandate of Wal-Mart and others brought several strategic implications in the RFID market. The volume of RFID tags increased enormously through the mandate, in relation the cost of these tags decreased. As the cost per tag decreases, smaller and smaller companies will be able to afford incorporating RFID into their operations. In addition, it will enable new kinds of innovative applications and applicability to new markets[13].
The adoption of RFID in the US is in a far stage, some characteristics of their adoption could contribute to the South African adoption. In order to identify specific characteristics of the adoption, an exploration of the RFID adoption in the United States is determined. Therefore the second research question is formulated as follows.

Which characteristics were of importance for the RFID adoption in the United States and could be of use in South Africa?

The characteristics of the US adoption are determined through the TOE framework of Tornatzky and Fleischer (1990). In below the three aspects, technological, organizational and environmental are outlined.

5.2 Analysis US adoption characteristics in view of T.O.E. framework

The framework developed in paragraph 2.6 will be used to determine the second research question. The three aspects of the framework, technological, organizational and environmental, are used to explore the RFID adoption characteristics in the United States.

5.2.1 Technology aspects

Relative advantage: Supply chain members acknowledge the true value of the relative advantage of RFID in their organization, and in cooperation with trade partners there will be even more advantages (Accenture, 2004).

Compatibility: The question if RFID fits within the image, values, and beliefs of the organization does not play an important role in the US. Each of the initiating organizations has a strong innovative character and in that case

[12] http://www.eweek.com/article2/0,1895,14922
[13] The Strategic Implications of Wal-Mart's RFID Mandate, Directions magazine, 29 July 2004

the technology would fit in. Overall the advantage of RFID counts more than the question if it will fit within the companies values[14].

Complexity: The complexity of the technology is a barrier which companies face. End users consider the fact that they must read RFID-data and at the same time perform error correction. Staggering amounts of parallel data is generated, which means data systems must refer to previous events. The sheer volume of data involved only exacerbates these daunting computational challenges (Persinos, 2006).

Trialability: In order to face the advantages and the implications the technology gives, an experimentation period always proceeded before the total implementation. The trialability of the technology, in a form of a pilot project, are introduced in most of the companies in the Accenture research (2004), this is an important step for a total implementation. Through the difficulties of RFID, a pilot project can identify aspects of important before deciding to totally implement the technology.

Observability: The visibility of RFID towards others in the market is not an influencing factor for choosing this technology. Internal advantages are more important than the image they want to expose. In an environment were the public opinion is rather important, observability is a subject what is tried to be avoided (FTC, 2005).

5.2.2 Organizational aspects

Economic capital: Looking at the early adopters of RFID in the US, large retail organizations were the ones who started the implementation of the technology. Through their size, they could demand the whole supply chain to implement the technology. Currently the large retailers are in a far stage of implementing the technology. As a result growing numbers of organizations in a wide variety of vertical niches are adopting RFID. The technology is seen as a "paradigm-shifting" innovation[15], which is generating operational efficiencies and strategic advantages within supply chains. It becomes a more wide spread adopted technology, even middle and small organizations have the ability to invest in this technology. Costs are decreasing, childhood diseases are tackled, and it is more accepted in the markets. Through this move from early adapter to early majority, governments find their way to RFID and try to tackle social problems with the technology.

Strategic capital: The strategic focus of the early adopter retailer is consumer focused, binding the consumer to the organization is their goal, innovation is one way they will try to accomplish this goal[16, 17, 18]. Through the mandates of large retailers towards their trade partners, a force of introducing RFID in organizations is established. Trade partners are forced to adopt the technology and as a result optimalization of the supply chain will occur.
Besides mandates of retailers, the US government also acknowledges the advantage of the technology. Numerous domestic and international regulatory bodies have issued strict guidelines for product labelling, tracking and tracing. Products coming under these regulations range livestock to prescription drugs to tires. The US Food Drugs Administration (FDA), demands of all pharmaceutical manufactures an electronic tracing system for their produced drugs, and the recommend RFID therefore (FDA, 2006). Primarily, for improved anti-counterfeiting but there will be great improvements in theft deterrence and improved stock control and recalls[19]. Food safety legislations provided by the European Union, FDA, and the Food Standard Agency (FSA), demand traceability of all supply chain members. Electronic tracing is mandated and RFID is recommended. Several other mandates are placed by the US trade act, to require tracking of tires in order to facilitate streamlined recalls, and in the war against terrorism, the Custom Trade Partnership Against Terrorism (C-TPAT has mandated container secure initiatives and smart and secure trade lines, which could be implemented with RFID (Deloitte, 2005). Such guidelines serve to accelerate RFID adoption as the preferred viable solution to meet these requirements.

Although the above stated mandates have a positive influence on the adoption and implementation process, organizations which are not in the scope of these mandates are still hesitating. One reason is the support of management, while this might be a bit of an exaggeration, there is no doubt that getting management commitment is not an easy task. As with any new business innovation, many companies are reluctant to be "the first." They choose a wait-and-see strategy, holding off until other industrial leaders adopt the technology.

[14] The Strategic Implications of Wal-Mart's RFID Mandate, Directions magazine, 29 July 2004
[15] The Strategic Implications of Wal-Mart's RFID Mandate, Directions magazine, 29 July 2004
[16] Annual report Target 2005
[17] Annual report Tesco 2005
[18] Annual report Wal-Mart 2006
[19] IDTechEx, may 08, 2006

Another challenge is change resistance. Many companies believe "if it ain't broke, don't fix it." But these companies end up playing a frantic game of catch-up, while their competitors who embraced change capture market share[20].

Cultural capital: Besides the larger retailers (early adopters) who have a deeply understanding of the technology and their benefits, the majority of the organizations who are using the technology are far behind and see only the negative aspects instead of the huge opportunities[21]. While the early adopters in the beginning, made use of external consultants to assist with the exploration of the technology, nowadays departments within the organization exist to guide in the implementation process. In general, companies do not believe there is a sufficient "pool of talent" in RFID technology to guide in the implementation process. As the Computing Technology Industry Association (CTIA) say "RFID is a complex and still evolving technology and expertise is absolutely required for its usage to be a success"[22].

Social capital: External sources are the main resources for information and support for most organizations, RFID bodies like EPC Global and consultants like IBM and Accenture play an important role in providing information and guidance.

5.2.3 Environmental aspects

***Business environment*:**
Costs: For many companies, tag cost and supporting RFID equipment (e.g. readers and IT hardware) remains a barrier to adoption. Advances have been made in hardware, but the market place is still in the early stage of development. The ability of many middleware systems to process tag data and interconnect efficiency to legacy systems without significant effort remains unproven (Deloitte, 2004).

Market readiness: Looking to the mandate of Wal-mart, the trade partners are in most cases ready to implement RFID. In case the economic situation of the trade partner does not allow that kind of investment, Wal-mart supports their market[23]. In industries where those mandates were not been faced, waiting is the trend till cost decreases, standardization takes place.

Regulatory environment:
Standards: Concerns over market stability and standards are perceived as important factors for adoption, where the pressure to comply is bigger. Furthermore, standards need to be established around Electronic Products Codes (EPC), which are used by RFID. The International Standard Organization (ISO) and EPC have recently developed a standard for RFID, and this is seen as the beginning of the globally standardization[24]. While these standards are coming closer to reality through the efforts of several well known oversight organizations, they remain an unsolved topic. With suppliers and customers at present are forced to choose one standard over the other. These issues will be magnified as wholesaler-distributors and are presented with the challenge of meeting multiple customer mandates (Deloite, 2005).

***Wider Society*:**
Privacy: There is a lot of media attention, regarding RFID. Through this negative media attention several companies are forced to delay or cancel the implementation of RFID (Benneton, Gillette rd.). Consumer organizations are prosecuting against the possible tracing of consumer behaviour by retailers. Although consumer perceptions and privacy issues receive a great deal of media attention, the companies did not see these issues as significant barriers to implementation (Accenture, 2004). According to Benneton it is the result of a lack of understanding of the public. Through educating the public they will try to overcome this issue[25].

Social responsibility: Social responsibility does not play any role in the US. Cooperate governance is important, but responsibility for the community plays no role in this. The standards of living and the unemployment rate is not at a level where it affects decision making.

[20] http://www.rfidjournal.com/magazine/article/2767
[21] http://www.rfidjournal.com/article/articleview/612/1/2/
[22] Computing Technology Industry Association (CompTIA), March 9, 2006
[23] Annual report Wal-mart, 2006
[24] http://www.rfidjournal.com/article/articleview/2481/1/1/
[25] http://www.cioinsight.com/article2/0,1540,1780794,00.asp

5.3 Conclusion

Although the mandates have catalyzed the adoption of RFID in the US, companies still face problems with actually executing the technology (Table III). A trend which is visible in the US and more or less in Europe is the initiative of adoption of RFID by the retail sector. This sector is leading in RFID adoption and forcing other industries by mandates to implement. While mandates in South Africa are a rare phenomenon, currently this can be a factor that will catalyze the process in South Africa. South African retailers are very conservative with regard to RFID and are waiting for the business case to be proven by "someone else". Their view is that their trade partners are not ready for RFID and there is no business pressure to implement RFID. The RFID implementations in South Africa will most likely be driven by the pharmaceutical industry. The pharmaceutical manufacturers realize that the FDA mandates are likely to affect them. This brings them on a high level of urgency to explore the possibilities and look for business cases.

The advantages of the technology are seen in US organizations, but the surrounding complexity is not well understood. IT related issues are obstacles for companies, the current costs and standards are not promoting to step in. Initiating of a business case in order to try the technology and convince the organization of the benefits is important for organizations. Through the lack of internal knowledge there is a hesitation to adopt, while with a business case this hesitation can turn around to a positive attitude, by viewing the opportunities and advantages of RFID. The privacy issue in a huge barrier in the US, social pressure towards banding RFID is the issue of the day, it can be explained by the lack of public knowledge. Through education companies will try to overcome this. In respect to South Africa, with a low average education level, and a majority living in poverty, this problem with the wider environment is not viewed by the industries.

The RFID adoption model of the US is not directly applicable to the South African market. Several factors that do not occur in the US play an important role in the South African industry sectors. Social and economic factors are barriers slowing down the adoption while market readiness is a factor that influences the adoption rate. While individual organizations might be ready for implementation, their trade partners are in some cases far away from adoption. This can be related towards the current situation of RFID competitors (chapter four), in the research population barcodes and manual are the two most common competitors of RFID. GPS and the magnetic stripe card are more applicable in other industries. While the advantages of RFID towards the current technologies are clear, hesitation is still the main characteristic of the South African Industries, what could be the push they need to step into this technology. The step from manual handling to RFID can be complicated for some trade partners, through the lack of an IT-infrastructure. While bar code implementation also is a point of concern. In case of US industries where those technologies are further developed and automation is introduced in many organizations, and manual handling does not existing anymore, the country has a big advantage over South Africa. The step for the US industries to implement RFID is smaller than for South African businesses.

Table III Characteristics of importance in the US

Model	US	Implications SA
Technological aspect		
Relative advantage	Applications in the supply chain are seen and explored; other applications in other areas are coming up.	In which area are RFID applications seen?
Compatibility	All companies pretend to have an innovative character; in that case RFID should fit within the organization.	Does business culture affect the introduction of new technology?
Complexity	IT implications are a concern.	Is the IT level and maturity level of technologies at a stage that it is suitable for RFID?
Trialability	A pilot project or business case is important for a total adoption.	Is a business case needed in South Africa, after the Wal-Mart role out?
Observability	Plays no role	Needs RFID to be visible in South Africa?
Organizational aspect		
Economic capital	Retail is leading the adoption	Which industry leads the adoption in South Africa?
Strategic capital	Mandates by government and retailers are a catalyst for the adoption of RFID. For areas without those mandates, senior management commitment is a barrier that influences the adoption.	Can South African organizations put an mandate in the market, like Wal-Mart?
Cultural capital	Awareness is at the initiating organizations very high, the rest of the industries deals with a knowledge gap.	How does the low education level affect the awareness?
Social capital	External consultants and information sources are important to bridge the knowledge gap.	Is an external information network available in South Africa?
Environmental aspects		
Business environment	The perceived costs are a huge barrier, especially for smaller organizations with less financial resources.	Is the harrowing economical situation for many organizations influencing the adoption?
Regulatory environment	Initiatives for global standardization take place.	Is global standardization a need for South African industries?
Wider society	Lack of public awareness leads to critic and protest, what has a negative influence on implementations. Social responsibility plays not a role in the adoption process.	In what way do the undeveloped and poor communities and a role in the decision process around RFID?

6. Adoption characteristics South African industries

While the characteristics of importance in the US are determined, it is of interest to see which characteristics influence the RFID adoption in South Africa. Are the same adoption characteristics similar in the US as in South Africa, or are different characteristics of more importance? Therefore the third and last research question is formulated as follows.

Which adoption characteristics support or inhibit RFID in South African industries?

The characteristics of the adoption of RFID in South African industries will be outlined in this chapter. The framework of Tornatzky and Fleischer (1990) explains these characteristics. Each aspect will be outlined with the variables connected to the used model. The variables are generally outlined, in succession discussed by industry.

6.1 Respondents and interview sample population

A total of fourteen companies in six industries have been interviewed. Due to the fact all interviewed companies are leading in their market segment, the results can be generalized over the whole industry. In table IV the characteristics of the respondent companies are shown. Table V gives an overview of the interviewees and their position within the company. Each respondent is interviewed for an hour until two hours. Interviews took place by phone or face to face.

Table IV Characteristics of respondents

Respondent characteristics						
	Retail	Transport	Pharmacy	Food & Beverage	Automotive	Tel. Communication
Number of interviewed organizations	3	2	3	2	2	2
Percentage of the population (%)	21	14	21	14	14	14
Turnover (Rmil[26])	25077	19877	1774	6600	1570	39587
Fte[27] (average)	24983	13363	1517	4550	3897	15517
Fte/turnover (average)	0,99	0,99	1,52	1,5	0,4	3,79
Total market share (%)	49	36	39	40	20	73

Table V Positions interviewees

Positions interviewees						
	Retail	Transport	Pharmacy	Food & Beverage	Automotive	Tel. communication
IT Director	2	1		1		
Supply Chain Director				1		
Customer Logistics Manager			3		2	1
Systems & Technology Executive	1	1				
Executive Operations						1
Total	**3**	**2**	**3**	**2**	**2**	**2**

The position of the interviewees within the companies is on executive level. This position has an influencing role in the decision about RFID. This is a requirement in order to get reliable data from the interviews. All companies determined in this research were leading companies in the South African market. The target of this research was to achieve a total market share per industries above 50 percent, due to the fact that arranging interviews on executive level is difficult, this target has not been reached in all industries. While some industries have a lower total market share, the findings are still relevant because the participants were leading companies in their market and have a strong influence on the competition and trade partners.

[26] Rmil = Million Rand, 1 Euro is approximately 9,39 Rand
[27] Fte is fulltime-equivalent

6.2 Technological aspects

Technological aspects describe both the existing technologies in use and new technologies relevant to the company. These aspects viewed by the industries comprise their current technological situation and the implications implementation of RFID is going to bring. According to Rogers (1995) five variables affect the technological aspects towards adoption. In below these variables are discussed by industry.

6.2.1 Relative advantage

Awareness of RFID applications in the organizations is a factor that influences perception. Awareness of applications gives direct insight in the relative advantage of the technology. Each industry has different views of which applications they perceive as suitable. Figure 7 shows the perceived driving forces for RFID for problems that South African industries organizations face. In the paragraph below the RFID applications viewed by the industries are outlined.

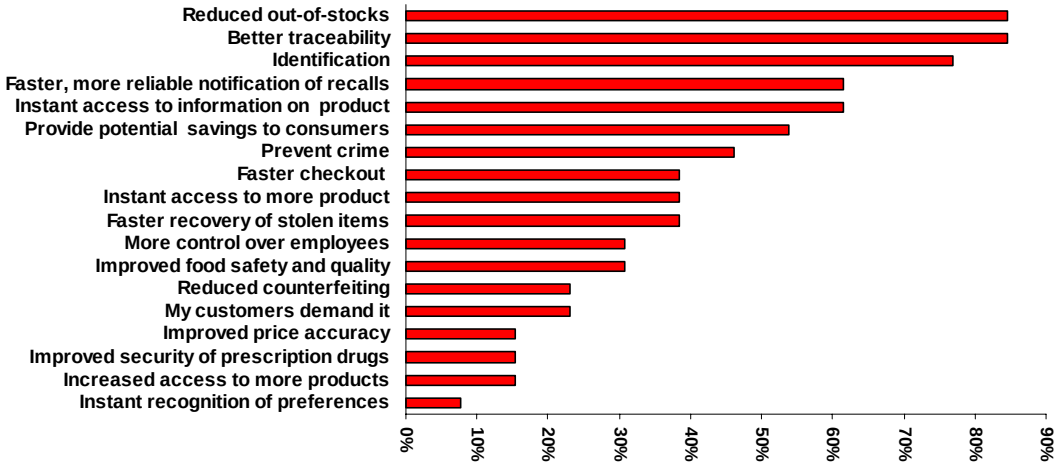


Figure 7 Perceived driving forces by South African industries for RFID (Source Aken van and Korteweg, 2006)

Retail
The retail industry is aware of applications for RFID. On-shelf availability and poor visibility in the supply chain are important business arguments for considering RFID in an open loop application, which result in the reduction of out-of-stocks and shrinkage. The application is focused on the tracking and tracing of goods through the supply chain by tagging at container, pallet and/or case level. Item level is currently not appropriate and according to the retail industry is far in the future. In a close-loop application, warehouse management and tagging of returnable assets, like containers, trolleys, cases, etc. is a major opportunity for the retail industry to reduce the operational costs. Another opportunity in the returnable asset tagging is adding temperature/humidity sensors, to control the 'cold chain'. More control over their personnel is also an advantage that was identified by retailers.

Pharmaceutical
The pharmaceutical sector is in the early stages of their awareness about RFID. They are aware of the possibilities and the opportunities RFID can create. Traceability is an important application to prevent counterfeiting and tracking through the supply chain.

Food and beverage manufacturers
Food and beverage manufacturers are in the early stage of exploring RFID. They face problems in shrinkages and security but are not able to translate this towards RFID applications. The unawareness of the possibilities is forcing them to wait for other parties to identify the ways in which they can implement RFID technology.

Transport
Applications are mainly in the asset tracking, specifically for tracking and tracing vehicles and loads, in order to increase the efficiency in their operations. For some organizations, implementation of RFID started several years ago, and the use of applications is expanding.

Telecommunications
The telecommunications sector identified the application of tracking and tracing of high value assets, equipment and goods for the purpose of better asset management and within the internal supply chain of the organization.

Automotive
Within the automotive sector, many applications could be identified, including reduction in shrinkage, security, tracking and tracing components and distribution. At this stage the sector is exploring the advantages of RFID for various applications.

6.2.2 Compatibility

The way RFID fits within the organizational culture and the image it wants to expose is according to the industries very suitable, figure 8. While every industry sees the technology as an innovation what suits within the organizational values, there is a distinction between organizations that exploit the technology and organizations which explore RFID.

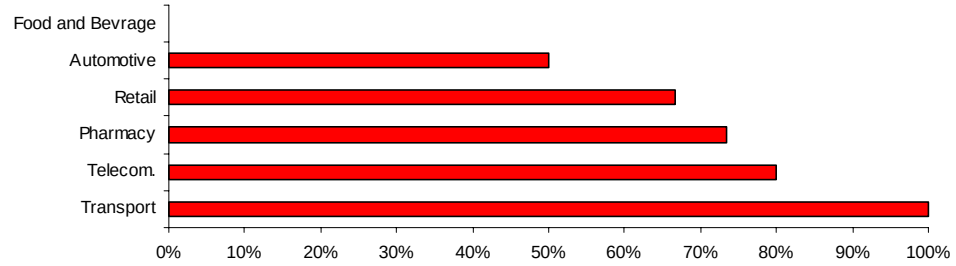


Figure 8 RFID fit within external exposure (Source own research, 2006)
(The Food and beverage industry did not answer the question for compatibility, this results in an empty bar)

The transport industry identify themselves with RFID, it suits in their image to the outside. As a result the strategy of the transport industry includes RFID recently. They use it as a strategic technology in order to create added value. The Telecommunication industry and pharmaceutical manufactures are in a far stage of deciding when to implement RFID this is seen by the high rate of the exposed image. While the retail and automotive are on a low level of deciding to implement RFID and exposure is not an important issue.

6.2.3 Complexity

According to Rogers (1995) complexity is defined as the degree to which an innovation is perceived as relatively difficult to understand and to use. During the interviews this variable is distinguished in two aspects, Maturity of RFID and the IT-infrastructure. While RFID is an emerging technology it is not totally mature, there are still issues and the technology is evolving. This makes it a moving technology and makes it complex and difficult. The IT-infrastructure what is behind the hardware part (tags and readers rd.) faces some implications for fully functioning.

Maturity
Maturity of the technology is an important issue regarding RFID. A common question by organizations is whether RFID is now sufficiently mature to deliver value. The views of the industries towards the maturity of the technology are presented in this section.

Retail
Retailers have a divided view on the maturity of the technology. The readability of tags at item level is for some retailers a barrier. Some has the perception that RFID only becomes usable if all items are tagged. Other retailers remark that the technology can already deliver sufficient value to them. One retailer posed the question if RFID is really the 'next' technology that supersedes the bar-code and suggested that another technology might be found that would overtake RFID. Interoperability is a requirement of all the retailers: RFID components (tag, reader) should be transparent as for example the bar code reader. Reader or tags from different vendors should have the same standards to initiate interaction.

Pharmaceutical
Pharmaceutical manufacturers are divided: The more conservative view is that they want to see RFID work see some visible gains before moving forward. The other view is that, as they are planning for the future, they need to consider the advantages of the technology and explore how they can benefit from using it.

Food and beverage manufacturers
The recent developments and decreasing costs are reasons to be skeptical about the technology. The lack of a proven business case is a factor that makes them wait.

Transport
In the transport sector, the maturity of the technology is suitable for the close loop applications they use at the moment. While they benefit internally from the use of the technology, their clients have not yet made the first steps towards adoption.

Telecommunications
Their perception is that the technology in its current form can provide value for their internal use. The adoption of the technology by their suppliers will add further benefits in the future.

Automotive
The maturity of the technology is currently not an issue for the automotive industry. They are currently exploring the potential of the technology and are identifying potential applications that will support the business case.

IT-infrastructure
In order to maximize result from RFID technology, the technology needs to be supported by adequate data processing and networks. The various industry sectors have different infrastructures and therefore different views on the subject as discussed below:

Retail
Maintaining data flow and storage requirements is a concern of the retail industry. Currently, retailers battle to maintain the data flow and are uncertain what will be the impact of RFID technology. Other areas that might be affected are operating systems, communication networks and operational systems. In general there is concern with the additional complexity which RFID is perceived to add to current systems. Further, it is a challenge to optimize their business processes for the use of RFID. The translation of the raw data into real world events is a further challenge retailer's face. One retailer said: "How can this be done in order to get the real benefits out of the technology because what is the advantage of RFID when the translation can not be made?"

Pharmaceutical
Data storage is important for pharmaceutical manufacturers and they are convinced that their current systems can handle it. The interpretation of data is also not an issue for pharmaceutical manufacturers. A property of RFID they are looking forward to utilize is the ability to obtain sensor data from RFID tags, as it enables them to obtain information about the environmental conditions in which products are stored and transported.

Food and beverage manufacturers & Transport
Both industries have no concerns over the impact of RFID on IT-infrastructure. While the food and beverage industry are not at a stage where data interpretation is an issue, the transport sector is preparing customer demands.

Telecommunications
The current data flow and storage will be affected by RFID technology, not only internally but also at their suppliers and vendors. Another concern is the multiplicity of systems that is currently used, which will require integration of RFID data with many different systems. Within mobile the telecommunications industry, where already tracking at serialized item level by using the IMEI number, the move to RFID can easily be made. The improvement by doing so would be marginal in their view.

Automotive
Due to the global nature of automotive manufacturing, the manufacturers already use extensive IT systems with global connectivity and JIT (Just in Time) delivery to the many suppliers. IT systems are not foreseen at this stage as barriers. Further, opportunities are seen within operations that are independent of the supply chain.

6.2.4 Trialability

The lack of a RFID business case is a common reaction from the organizations who were interviewed. This is the main reason why implementation of RFID has not already started (figure 9) in South Africa. Examples of implementation in the US and Europe are not necessarily applicable to South Africa. This also indicates a need for information and business cases which can prove the advantages of the technology in South Africa. The trialability of the technology is an important factor in the decision process of the industries. A pilot project or business case has to be the first action for a fully implementation. In this case the benefits for the company are visible and the senior management can be convinced.

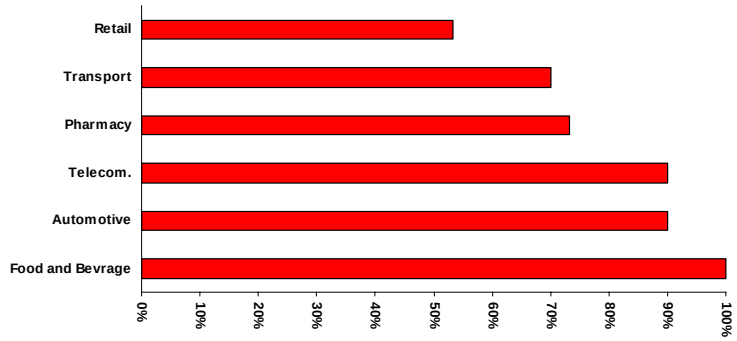


Figure 9 Need for a business case (Source own research, 2006)

Retail
Wal-mart is of course one of the well known examples of using RFID in the retail sector. South African retailers have difficulties in finding a compelling business case. A further point was made that there is no real pressure to move towards RFID. As a result, all retailers have decided to wait.

Pharmaceutical manufacturers
The pharmaceutical industry is not yet affected by global requirements on traceability of pharmaceutical goods. While they agree that there is scope for using the technology and benefits to be gained, there does not appear any sense of urgency to do so.

Food and beverage manufacturers
Food and beverage manufacturers are struggling to find a business case. In many cases the products are low cost and packaged in ways making it difficult to tag at item level. The general perception is, as they are already using batch management (although manual), they perceive limited gains until it becomes viable to track at item level. Further, most of these manufacturers have international parents, who guide and direct in the utilization of technology. These parent companies have not yet indicated their intention to use the technology. A further issue is that many manufacturers are exporting from South Africa to African countries, which are not in a position to use RFID technology.

Transport
The transport sector views RFID technology as a value-add and product differentiator. The industry is preparing to offer the technology to clients, bundled with the current offerings. Currently, they are find take-up by clients to be slow and are likely to use the technology first within their own operations. One of the organizations has already proven the business case by making substantial savings. The transport industry is a link in the supply chain and is waiting of clients in manufacturing and retail to take the initiative and drive implementation.

Telecommunications
The telecommunications industry sees the potential for tracking goods and assets within the internal supply chain and is actively exploring the possibilities. A good business case can be made and they are currently developing one. Within the distribution of mobile telecommunications, due to the fact that serialization is currently used, the business case for RFID is not clear for them.

Automotive
Within the automotive sector, companies have seen the potential of the technology but are not clear about the business case. A number of potential applications have been defined and are being investigated further.

6.2.5 Observability

The variation in the views on observability is salient but on the other hand logical explainable. The transport, pharmacy and telecommunication industry have a strong need for exposing the technology towards competitors and customers. This can be explained by the value added strategy behind it. In the transport industry it can be explained by the strategic function of RFID, it has to be seen by other to show the value added services. The pharmacy industry has the mandate by the FDA for electronic tracking and tracing, exposure of usage of the technology is needed to sustain export. Telecommunication industry sees the technology as value added service towards trade partners in supplying spare parts and high value items. The difference is in the retail industry, there is no interest in observability, which can be a result of the privacy issues in the US or the unawareness of the community. The automotive manufacturers have seen only internal RFID applications and see no advantage in exposure to the external environment.

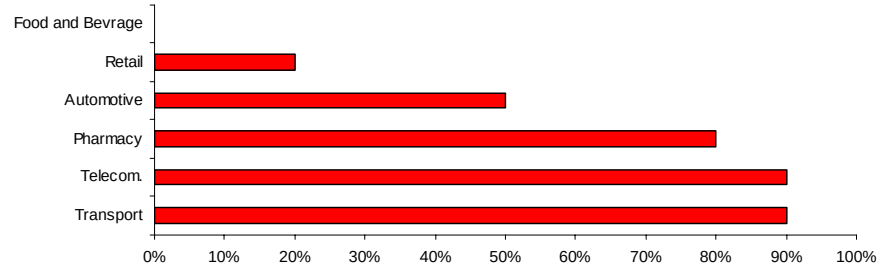


Figure 10 Importance of observability (Source own research, 2006)
(The Food and beverage industry did not answer the question for observability, this result in an empty bar)

6.2.6 Conclusion

In conclusion, most industries view the relative advantage of RFID to be within supply chain applications which result in improved visibility, reduced out-of-stocks, better traceability, and identification. Their focus is mainly at open loop applications of the technology, while largely overlooking the opportunities for closed loop applications. This is in contrast with global trends, where benefits of closed loop implementations were identified and exploited first. Starting with closed loop implementations gives organizations the opportunity to learn and explore the technology, resulting in insight and understanding of the benefits and implications. Awareness and support from management and other staff increases. Organizations become prepared for the challenges faced by implementing open loop systems improving the ability to overcome obstacles.
In contrast with closed loop applications, open loop applications are much more challenging and complex as it require cooperation between multiple trading partners and integration between multiple systems. It also requires adherence to global standards and/or requirements for interoperability. Some risk is involved in implementing an open loop system before having gained experience using closed loop systems. The level of awareness and understanding within the organization and/or its trading partners might not be sufficient to identify the best opportunities for utilizing RFID technology, or to assess the impact on business processes. Such a project might be expensive and management might perceive it as too risky to support.

While from a compatibility perspective the technology does not always fit within the exposure of the image of the organizations, it differs with respect to strategic focus. Organizations that see RFID as added value and placed it on the strategic agenda, have a positive response on the compatibility.

The maturity of the technology affects all industries in terms of cost and readability performance. While some sectors already see potential benefits at the current level of maturity, other industries have the perception that RFID will only be viable once all items can be tagged cost effectively. In contrast with their international counterparts, local retailers hold the latter view. With regard to the IT-infrastructure, the various industry sectors have different views. Some are confident that their current infrastructure is sufficient while other have the opinion that significant changes will be required. The different viewpoints can be explained by the different levels of knowledge of the technology and the different intended applications involving different levels of integration.

The requirement for a business case and ROI applies to all industries. This is approached differently by each industry sector. In one extreme senior management supports the technology and is prepared to fund the exploration. In the other extreme, senior management requires a proven business case in their specific sector but is not prepared to fund the exploration. The personnel involved in establishing the business case are finding it

difficult: 1) in most cases they do not have senior management support; 2) they do not have sufficient knowledge or skills to identify the opportunities. They are focusing more on open-loop supply chain applications and are using the requirements for item level tracking as a valid reason to wait. Further, they seem to be overlooking the fact that most of the successful business cases today started as closed loop applications. As indicated previously, such applications are much cheaper and easier to implement while allowing the whole organization to learn about the technology and experience the benefits. For example, most industries sectors indicated that they are struggling with high levels of theft and shrinkage, but none of the companies interviewed have yet considered a business case for RFID to address this problem.

Observability is in some cases important, through the international exposure and strategic goals of value added service, in other cases it is of less importance because of the fact that unawareness of communities and the possibility of arisen issues. Industries that face mandates for having an electronic track and trace system are eager to have observability of the technology, same as the industries who have RFID as a strategic tool.

Table VI Technological aspects

	Retail	**Transport**	**Pharmacy**	**Food & Beverage**	**Automotive**	**Tel. communications**
Relative advantage	Tracking & tracing	Tracking Control	Control Tracking & tracing	Tracking & tracing Identification Control	Identification Tracking & tracing	Tracking & tracing
Compatibility	Fits within the beliefs	Fits within the beliefs	Fits within the beliefs	None	None	Important
Complexity	IT infrastructure Maturity	None	None	Maturity	None	IT infrastructure
Trialability	Need for a business case	Important	Need a business case	Need for a business case	Need for a business case	Important
Observability	Not important	Important	Important	None	Not important	Important

6.3 Organizational aspects

Organizational aspects refer to descriptive measures about an organization. One question which arises is how a new technology like RFID affects the internal organization. Organizational aspects will be described by the four capitals of the EiN model (1995). These capitals are outlined underneath for each industry.

6.3.1 Economic capital

All interviewed companies are major players in their market. There is a variance in the average turnover, see §6.1, but generally speaking all companies have an important influence in the market and can change the adoption rate of RFID. Looking towards these markets and with respect towards the US, the large organizations have to drive the technology, as they have the resources and capital to initiate the technology and further expand it. They can use their position in the supply chain to role out RFID over other industries and markets.

6.3.2 Strategic capital

Every industry, in more or less the same way, pays attention to new opportunities to be more competitive and more innovative (figure 11), which results in a positive attitude towards investing in new innovations that can have a contribution towards these goals. While in a strategic perspective RFID is not seen as a strategy tool for market exposure, in some cases where fully adoption is accomplished the technology is shifted form a ‘nice to have technology’ to a strategic tool to compete in the market. Two aspects, international mandates and senior management commitment, of strategic capital are determined, in this section these findings are presented.

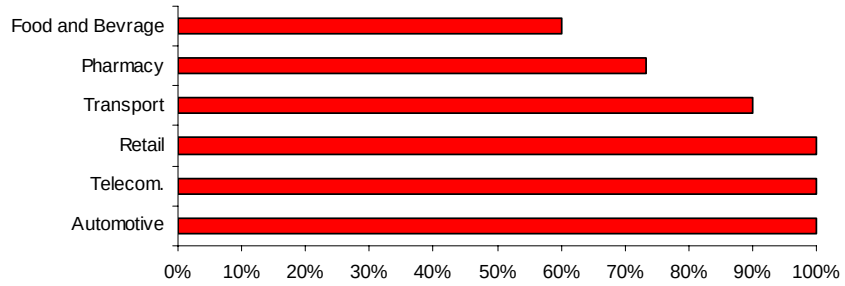


Figure 11 Attention towards new opportunities to be a step ahead on the competition (Source own research, 2006)

International mandates

Internationally, mandates by Wal-Mart, other large retailers, and the U.S. Department of Defense (DOD) and Metro requiring their top suppliers to use RFID tags on cases and pallets have spurred the recent uptake of this technology. In all cases of mandates, compliance dates and deadlines have been set according to a phased program over two to three years, increasing from a limited number of shippers and distribution centers to all shippers, materials, and distribution centers or warehouses. In addition, the FDA has also mandated electronic tracking and tracing for drugs through e-pedigrees. Do these mandates affecting South African industries and what are the views of the different industry sectors in this regard?

Retail

As the retail sector does not export goods, they are not directly affected by the above mentioned mandates. Local retailers are divided in their view of whether they would, in following their overseas counterparts, also introduce mandates. One local retailer mentioned the case of bar-coding, where sunset dates were set, and which would most likely also be done with regards to RFID.

Pharmaceutical

As mentioned above an important driver for implementing RFID within the Pharmaceutical industry is the FDA mandate for tracking and tracing off drugs in the US. Companies exporting to the US have to comply with this mandate. South African pharmaceutical manufacturers are aware but have not taken any steps. The perception exist that, if they decide to implement the technology it would be for their own benefit.

Food and beverage manufacturers

This sector has not yet been affected by international mandates and they hold the view that it is unlikely that they will be affected by mandates from local retailers anytime soon. Decision making from the parent company can influence this through a company wide role out.

Transport

This sector is not affected by any mandates. Face requirements from customers to implement RFID.

Telecommunications

This sector is not affected by international mandates. However, as end-users, they would consider mandating their suppliers to comply.

Automotive

There are no mandates on the automotive industry, and unlikely to be in the near future. The parent company can influence this through a company wide role out.

Senior management commitment

The success of implementing new innovations is largely influenced by the commitment of senior management. In several studies is noted that senior management commitment is critical to the success of ongoing technological process innovation (Farhooman *et al.*, 1990; Voss, 1988; Vrakking, 1989). Their commitment provides access to the required funds and resources to execute an implementation. The level of commitment by senior and top management is influenced on the one hand by the perceived risk in supporting new and untested innovations, while on the other hand it provides an opportunity to take leadership and claim success.

Retail

As no local business cases have been proven yet, senior management is not supporting RFID implementation. Top management require that a successful business case needs to be proven first in order to show the benefits of

the technology as well as the Return of Investment (ROI). However, they are not prepared to establish such a business case themselves. The fact that many business cases have been proven overseas does not seem to make any difference.

Pharmaceutical
The pharmaceutical industry has two views on this issue. Currently there is no commitment of the senior management to do anything regarding RFID. No strategy for RFID exists. At the moment, there is no real drive to support RFID and it is not on the priority list of the senior management. However, awareness about the FDA mandate is present and predicts implications in the near future.

Food and beverage manufacturers
While their parent companies are committed to the implementation of RFID, their South African senior management is not convinced that it would have any impact in the short or medium term. They fully rely on the parent company to indicate how the technology could be used.

Transport
Senior management is committed to the implementation of RFID and has identified the business cases. Some implementations have already brought benefits.

Telecommunications
The senior management of the companies is supporting the technology and is prepared to fund pilot implementations to assess the business case.

Automotive
Senior management has given commitment to evaluate the technology and to become involved in the pilot testing of identified opportunities.

6.3.3 Cultural capital

The cultural capital is determined on the internal knowledge industries have about RFID. Resulting two areas of knowledge can be distinguished, 1) knowledge about the applications and benefits of the technology and 2) knowledge about the internal implications of the technology. In below these two areas are outlined.

RFID knowledge
Consumer's fears in the area of RFID are sparked by a lack of understanding of the limitations of RFID. Education is the key here, as people learn more about when and how the technology works and what exactly is stored on the tag, these fears may lessen (Accenture, 2003). While innovations being a relatively new phenomenon, potentially posing considerable changes for organizations operations, considerable learning will have to take place. A greater knowledge and understanding of the requirements are needed for successful adoption and the implications of implementation (Munro and Noori, 1988). How well do industries in South Africa know the technology and what actions do they apply do understand it? This issue is crucial in the adoption process, without the right knowledge about the technology a negative perception can arise and eventually a rejection of the innovation can be the result.
Organizations that have appointed a responsible person to research RFID seem to be more aware of the technology and its potential applications. Organizations not having appointed a responsible person are struggling more with understanding the technology and have many misconceptions about the technology. In some cases they fully rely on the international parent companies to guide them in the application of the technology.

In all cases, there is found that companies do not have a clear strategy regarding to RFID and are unsure of the environmental impact in the operating area, except one transport organization. In some cases, companies expressing a strategy without having gained sufficient knowledge to do so.

Need for more RFID information is a necessity for all industries, specifically business cases and case studies within similar market sectors as their own.

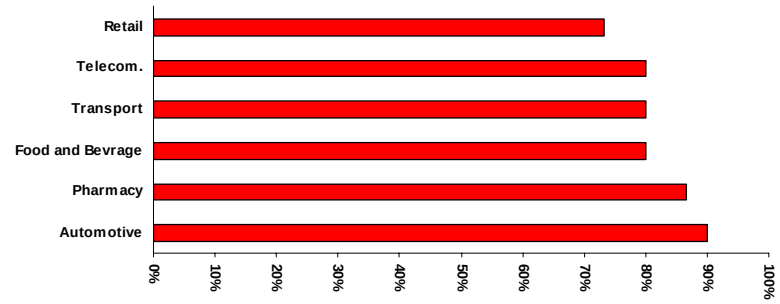


Figure 12 Needs for external consultant (Source own research, 2006)

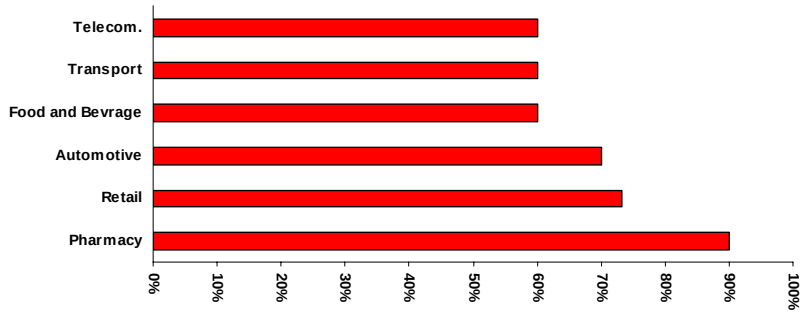


Figure 13 Need for knowledge (Source own research, 2006)

Retail
Each of the retailers has one or more people responsible for watching the RFID developments. The level of knowledge within this group, according to a retailer, is 'not as high as it should be', while others argued that there is sufficient understanding. Information is gathered through conferences and forums. One of the retailers remarked that, in a growing market such as RFID there are many offering from many companies and that they will be cautious by only working with reputable companies having established track records.

Pharmaceutical manufacturers
Pharmaceutical manufacturers have allocated the responsibility for RFID to internal resources, to keep the organization informed about developments in RFID. The senior management does not have RFID on the hit list and it is therefore not a priority. The internal knowledge level can be classified as low and when the organization decides to start a pilot, consultants will be used as an external source of knowledge.

Food and beverage manufacturers
There are people within the company with some understanding of RFID. They do not have the requirement to get involved further and will take their lead from their international parents.

Transport
Companies have a team of consultants, who are knowledgeable about RFID. Some companies, who have embraced RFID technology, are using it successfully in their own business processes and promoting its use to their clients. Other companies have not yet found business cases for themselves or their clients. In this sector, companies will not develop RFID solutions themselves but will rely on external parties.

Telecommunications
Within the telecommunications sector, there is a difference in RFID knowledge. In one of the companies, they have realized the potential and are developing the business case, while at the other companies the exploration for a business case has not started. In this sector, there is no sufficient understanding of the technology at a technical level. The level of knowledge is growing through research and case studies.

Automotive
The approach from the companies interviewed is different. Although all companies have international parents, one company relies on direction of its parent while others see the opportunity to innovate and improve independently of its parent. In both cases the internal knowledge of RFID is low at this stage, but companies have recently formed project teams to explore the potential of RFID technology. This is likely to increase their level of knowledge substantially within the near future.

Internal changes / challenges
RFID applications, by its nature, touch a number of areas within the enterprise. In many cases, changes to business processes and organizational structure are required to optimize the use of RFID technology. This also implies that, for companies to fully reap the benefits of RFID, they must involve multiple departments (Deloitte, 2004), thus creating a multi divisional environment. To what extent are the South African industries aware of these internal challenges and changes?

Retail
There is an understanding that changes in the internal processes are needed to benefit the optimal use of the technology. It is unclear at this stage as to how many internal processes would have to be changed or how many departments and applications would be affected.

Pharmaceutical
The impact on the organization is not yet clear. The general feeling is that they would consider starting a business case in the very near future.

Food and beverage manufacturers
The view is that the impact of RFID could be substantial, but the details are uncertain. The use of RFID technology scanners by low skilled labour also has to be investigated.

Transport
Within the transport sector, they do not foresee a problem with adapting internal processes or structure to optimize RFID applications. They foresee that their clients' business processes will be affected more than their own.

Telecommunications
The typical size of the organizations in the telecommunications sectors makes it challenging to implement interdepartmental cooperation. It is therefore more likely that the technology will initially be used within one or more departments.

Automotive
The requirements for internal cooperation do not appear to be viewed as problematic. Further, due to the large buying power of automotive manufacturers, they are in a stronger position to influence suppliers to change or adapt the required processes. Within the organization, they appear to be confident that the required changes can be incorporated.

6.3.4 Social capital

RFID is a new innovation that creates knowledge burdens in the organization. As Munro and Noori (1988) argue, greater knowledge and understanding of the requirements are needed for successful adoption and the implications of implementation. It means that this knowledge gap needs to be crossed. In which way are South African industries crossing this gap, which external social network do they use, and even more important how do they use these gathered information? Resulted from the interviews, all industries have a need for external sources of information (figure 14), which is not surprisingly because no one has the knowledge of all.

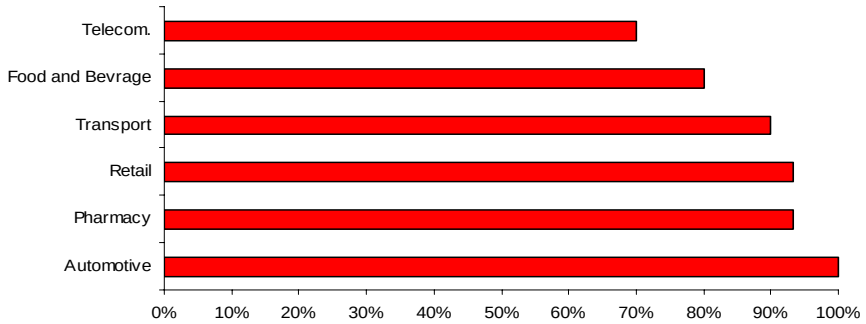


Figure 14 Need for external sources for searching for new ideas/solutions (Source own research, 2006)

Retail
While the retail do not want to get involved in RFID, a close look is held at the developments in the US and Europe. They looking at case studies and attends conventions over the world. They are active in RFID bodies like EPCglobal South Africa and AfriTag and present findings on conferences.

Automotive
There is a strong relationship with automotive body, try to get more knowledge through them. Visiting presentations, attending seminars, and recently getting more involved in the EPC network.

Pharmacy
Assistance of consultants is used to gather information and guiding in the process. Information gathering through reading articles and newspapers is also an information source.

Food and Beverage
Information gathering is not yet started with them, besides some presentations no information sources is used.

Telecommunication
Seek opportunities through consultants, gather information through them. Visit workshops and made some decisions there.

Transport
Data is gathered through consultants and internal research. Own case studies are used to innovate and as a marketing tool. Visiting seminars around the world to update and expose the expertise about RFID and being a member of EPC helps to be involved in the latest developments and stories.

6.3.5 Conclusion

From an economic point of view, the trend of large organizations initiating RFID adoption is seen in South Africa as well. Large leading companies in each sector have the most capabilities, in terms of economic capital and resources, to successfully roll out the technology.

Mandates are viewed as having a potential impact on the pharmaceutical manufacturing industry, due to FDA mandates. Other industries do not face pressure for implementation. In case RFID is decided to be implemented, all industries indicated that a similar roll out will be followed as Wal-mart.
All companies interviewed agreed that commitment of senior management is crucial for successful implementation of the technology. In some cases senior management is actively involved and supporting the introduction of the technology. In other cases, personnel are finding it difficult to establish business case required to convince senior management. In most cases, middle management sees the benefits for the organization and is driving it. However, without convincing senior management with a compelling business case, support in funds and resource is unlikely.

It appears that the main barrier to the adoption of RFID in South Africa is the lack of sufficient understanding of RFID within organizations required to allow them to identify opportunities which can be translated into strong business cases.
In some cases, strategic decisions are being made without the required understanding. It is ironic that, while the technology has the ability to resolve a number of problems which are high on the list of senior management, they have not been able to make the connection yet. This typically results in a decision to wait, as there is no perceived pressure for further exploration or implementation of the technology. This can be the case of gathering wrong or insufficient information, believing newspaper articles instead of trusting RFID bodies causes decision making without required knowledge. In order to achieve a positive ROI in an RFID initiative depends greatly on the business problem, the approach taken, the commitment of the organization to leveraging the technology, and the ability of the enterprise to turn RFID data into business intelligence (Aberdeen, 2006). For the majority of industry sectors, the internal changes that could be required as a result of the implementation of RFID solutions are not well defined or understood. However, it is recognized that some changes might be required in the business processes.

All industries need external sources for assistance or information for RFID implementation. Participation in conferences, RFID bodies and attending global seminars are sources that are used. Interesting is all attended network activities are abroad, national network activities are rising. The search for information is based on a lack

of knowledge and results in insufficient information gathering. In order to implement all interviewees argued that there is a need for assistance, in terms of a consultant or solution provider.

Table VII Organizational aspects

	Retail	Transport	Pharmacy	Food & Beverage	Automotive	Tel. communication
Economic capital	Largest retailers	Largest transport organizations	Largest pharmaceutical manufacturers	Largest F&B manufacturer	Large automotive manufacturers	Largest organizations
Strategic capital	Senior management commitment issue	Senior management commitment	FDA mandate Senior management commitment	Head quarter driven	Head quarter driven	Senior management commitment
Cultural capital	Low knowledge level	Deeply understanding	Low knowledge level	Very low knowledge level	Very low knowledge level	Low knowledge level
Social capital	Active in information gathering	Active in information gathering	Low in knowledge gathering	Active in information gathering	Low in knowledge gathering	Active in information gathering

6.4 Environmental aspects

Environmental aspects characterize the arena in which a company conducts its business - its industry, competitors, and relationship with government (Tornatzky and Fleischer, 1990). External environmental aspects influence the adoption and diffusion of new technologies because of their unique features and characteristics (Sharma and Citurs, 2005). As a result, these characteristics have kept RFID from becoming being widely adopted. The environmental aspects are explained through the framework of Deuten *et al*. (1997), who divided the environment in three parts; Business environment, regulatory environment and wider society. The perspective of the South African industry sectors regarding the mentioned environmental issues are discussed below.

6.4.1 Business environment

As a result from the interviews two aspects in the business environment are of importance, costs and market readiness. Those variables are outlined below.

Perceived costs
While tag costs used to be one of the main barriers in the past, prices have shown a steep downward trend since the ratification of the EPC Gen2 specification, as production volumes increased and more producers are entering the market. Recent price indications for large volumes are set to decrease further according to Moore's law. See appendix I for detailed explanation. What is the view of the South African industry sectors regarding RFID costs?

Retail
For some retailers, cost is still the main barrier which results in postponing all RFID initiatives. For other retailers costs are not a barrier when decreasing, making it increasingly easier to adopt it.

Pharmaceutical
The pharmaceutical industry views the tag issue correctly as part of the business case which needs to be established.

Food and beverage manufacturers
Food and beverage manufacturers view both tag and IT infrastructure costs as barriers, resulting in them postponing implementation until it reduces to an appropriate level. However, they are unsure about what this level would be.

Transport
The transport sector correctly views tag and other costs as part of the business case, which needs to show sufficient ROI. They do not perceive tag costs as a barrier. One of the companies perceives the support of RFID to be of a strategic nature as it allows differentiating from the competitors and is therefore prepared to pay a premium.

Telecommunications and Automotive
Technology and implementation costs are not seen as barriers. They will move forward if the business case is justified.

Market readiness
Economical and technological status of trade partners and other actors in the implementation of RFID is an important factor. Readiness of trading partners affects the adoptability in the chain, appendix I gives a more detailed explanation. In which way does this characteristic influence the industry on the adoptability?

Retail
The retail industry is skeptical about their readiness for applying RFID in their supply chain. They commented that suppliers nowadays still have problems with implementing and operating bar-code systems. It has also taken a long time to get their suppliers on board with bar-coding and in some cases there are suppliers who have not implemented bar-coding. Another issue mentioned was that smaller retailers and suppliers might not be able to implement RFID due to economic considerations. Other retailers see no problem in introducing mandates to suppliers over a period.

Pharmaceutical
It will take some years before the technology is fully adopted by the pharmaceutical industry. Some companies will follow the strategy of the head office abroad while others will begin to explore RFID within its own operations.

Food and beverage manufacturers
The food and beverage manufacturers in South Africa believe that the market is not yet ready for RFID. Trade partners still have difficulties with implementing bar-coding and a mandate for RFID in the future will cause a lot of resistance.

Transport
While some companies are already using RFID internally, other indicated that their clients are not yet ready for RFID technology.

Telecommunications
While the companies do see opportunities for RFID within the closed loop environment, they do not see their suppliers adopting the technology within the near future.

Automotive
Within the automotive industry, the perception is that the companies are ready to evaluate opportunities for RFID technology for closed loop applications. They do not perceive the market to be ready for open loop applications in the near future.

6.4.2 Regulatory environment

In the current scope of RFID the standardization of several component functions fills within a regulatory framework. Several bodies and organizations are active in this field, industries try to coordinate and initiate those standards.

International standardization
In today's global business environment, standardization of systems, products and interfaces is important in running efficient businesses. For many years, RFID lacked sufficient global standards. It is only with the publishing of the EPCglobal specifications in 2004 that this barrier started to be given attention. Earlier this year in June 2006, history was made as the ISO accepted the EPC Gen2 specification, making it a truly global standard. This is the first initiative in which both standards organizations cooperated. In many countries including South Africa, the necessary frequency spectrum to support RFID is not available yet. This also acts as a barrier as companies are unable to purchase and/or use equipment which complies with international standards. While global standards are mandatory for open loop systems, it is not the case for closed loop systems. The views of the leading industry sectors on this issue are presented below.

Retail
Standardization is important for the retail industry because of the global importation. Standards are mandatory for interoperability. They are not concerned about which standard, as long there is a global standard.

Pharmaceutical
Standardization is important to the pharmaceutical industry. They perceive that it is necessary to wait until a globally accepted stands exists.

Food and beverage manufacturers
Food and beverage manufacturers believe that global standards are important as they operate on a global scale.

Transport
They view international standards as critical for global adoption in open loop environments. For closed loop applications, they believe that the current scenario is sufficient.

Telecommunications
While they do see benefits in using closed loop applications, these benefits will be enhanced if the imported goods are already tagged in compliance with international standards.

Automotive
The automotive sector operates globally: raw materials are imported and end products are exported. When they implement RFID, they believe that it is important to comply with an international standard. In their case they will most likely support the EPCglobal standard.

6.4.3 Wider society

Although RFID is currently not that evolved that it interferes in the personal lives of consumers several issues arise around the technology, privacy, and social responsibility rd.. In below these two factors of influence in the society are outlined.

Privacy
The privacy issues in the US and Europe is nowadays a major topic in RFID with media reports on privacy violation and misuse of the technology (EPC.NL, 2005). In the US a major protest has arisen against RFID due to privacy issues. (Big research, 2004). These issues include the use of personal information by third parties, tracing of consumer habits through their purchases, reading of the tags over long distances, and the increase of direct mailing[28]. Consumer privacy advocates are calling for regulation, codes of best practices, and technological methods that can provide a measure of control over the use of RFID. In addition they are attempting to slow down the rollout of this transformative technology, so that the public can get involved in the dialogue. What are the views of the South African industry sectors on this issue?

Retail
The retail industry does not see any real problems regarding consumer privacy issues relating to RFID technology.

Pharmaceutical
The pharmaceutical manufacturers do not believe that tracking of consumer consumption will happen any time soon. However, they believe that, should it become necessary, it is important to convince the customers that the technology has advantages by addressing the negative concerns and highlight the advantages.

Food and beverage manufacturers, Telecommunications & Automotive
At this stage, consumer privacy is not an issue.

Transport
In some companies, senior management expressed concern about consumer privacy issues that were raised abroad. However, they are unable to assess whether it would have any impact on the local market.

[28] http://www.ecp.nl

Social responsibility
Within the process of adoption, social responsibility plays an important role in South Africa. The social environment differs from the US and Europe. Communities and culture play an important role in decision making process. Local industries are also more labour intensive. Some of the business cases for RFID in manufacturing and distribution are due to savings in labour costs. This could be translated into job losses. On the other hand, labour intensive processes can be more prone to be inefficient due to human error, which can be reduced by using RFID technology. The views of the various industries are discussed:

Retail
Retailers have the social responsibility to create jobs. When mandate suppliers to use RFID, some suppliers might not be able step in on an economic point of view. Closure of suppliers could lead to job losses and indirectly affects the communities and therefore consumers. Retailers view their relationship with their communities as being symbiotic.

Pharmaceutical
The pharmaceutical manufacturers do not believe that social responsibility is relevant. There is a possibility for job losses, this is generally true when efficiency is improved through using technology.

Transport & Food and beverage manufacturers, Telecommunications & Automotive
They do not view social responsibility as having an important impact on their decision to implement RFID technology.

6.4.4 Conclusion

Many companies stated that the costs of RFID are prohibitive and will postpone implementation until costs have come down. A viable cost level could not be given by industries, it appears that costs are being used as an excuse for not exploring the technology any further and is based on a misconception. While companies state that they require a justifiable business case, the costs issue per se is not important. These companies are more inclined to look at the trends in cost reduction.
While some of the companies surveyed are ready to start exploring RFID technology internally, the market in general is not ready for RFID, because some industries are still struggling with bar-coding. From an economic point of view, obstacles exist for small enterprises which cannot afford the technology at this stage. They would not be able to comply with any mandates given. This can be resolved by only mandating the 20% suppliers making up 80% of the volume.

While many companies stated their requirement for global standards, they seem to focus (as previously remarked) on global open loop applications. In this case global standardization is obliged in order to create global adoption and efficient usage of the technology. While these standardization process takes a while, it is more efficient to begin (as previously remarked) with a close loop and make the step towards open loop when the standardization process is finished.

On social grounds the economic situation of the country plays a role. Poverty is a factor that companies need to take into account, especially in businesses-to-consumer organizations where company image plays a role in the marketing and sales. In the retail sector social responsibility plays an important role, whereas all industries have programs on social responsibility and decision making in the retail is influenced by the communities. Unemployment and customer care are factors what plays a role. The privacy concerns that exist in the US and Europe regarding RFID are unlikely to play a role in South Africa. All industries argued that the population currently does not have an interest in these issues, which could be a result from the low level of education.

Table VIII Environmental aspects

	Retail	**Transport**	**Pharmacy**	**Food & Beverage**	**Automotive**	**Tel. communication**
Business environment	Cost Market readiness	None	None	Cost Market readiness	None	Market readiness
Regulatory environment	Important	Important	Important	Important	Important	Important
Wider society	Social responsibility	None	None	None	None	None

6.5 Conclusion

The technology aspects of the industries can be generalized over all industries. Tracking and tracing are seen as the general relative advantage. As a result of the unawareness, trialability of the technology is an aspect that is required by all industries. Complexity is seen differently by the industries. RFID maturity is seen as a barrier in the retail supply chain which can be explained by the requirement of item level tagging. IT infrastructure by the retail and telecommunication industry gives implications in the current infrastructure.

Organizational aspects which affect the adoption characteristics are especially in strategic and cultural capital. Senior management commitment is an issue that is faced by all industries. Through the lack of a business case, commitment of senior management is seen as a barrier. The food and beverage manufacturers and automotive manufactures are international companies and are guided and depended, of strategic decisions from the head quarters. Mandates are only faced by the pharmaceutical manufacturers, the FDA mandate rd.. Cultural capital is within all industries a barrier, although not always seen as one. The low knowledge level affects all adoption characteristics.

The business environment plays an important role, especially for the retail and food and beverage industry. Trade partners are in their view not at a sufficient level to incorporate RFID in their businesses and therefore face a barrier towards them. Cost plays a barrier for these industries as well, which need to see a decrease before stepping in. The regulatory environment in terms of standards, play an important role for all industries, global standardization needs to occur. Industries that are delivering directly towards consumers are facing a barrier in social responsibility. There is an obligation to help and support communities, which could be negatively influenced by introducing RFID in their organizations.

Table IX Overview industry adoption characteristics

	Retail	**Transport**	**Pharmacy**	**Food & Beverage**	**Automotive**	**Tel. communication**
Technological aspects						
Relative advantage	Tracking & tracing	Tracking Control	Control Tracking & tracing	Tracking & tracing Identification Control	Identification Tracking & tracing	Tracking & tracing
Compatibility	Fits within the beliefs	Fits within the beliefs	Fits within the beliefs	None	None	Important
Complexity	IT infrastructure Maturity	None	None	Maturity	None	IT infrastructure
Trialability	Need for a business case	Important	Need a business case	Need for a business case	Need for a business case	Important
Observability	Not important	Important	Important	None	Not important	Important
Organizational aspects						
Economic capital	Largest retailers	Largest transport organizations	Largest pharmaceutical manufacturers	Largest F&B manufacturer	Large automotive manufacturers	Largest organizations
Strategic capital	Senior management commitment issue	Senior management commitment	FDA mandate Senior management commitment	Head quarter driven	Head quarter driven	Senior management commitment
Cultural capital	Low knowledge level	Deeply understanding	Low knowledge level	Very low knowledge level	Very low knowledge level	Low knowledge level
Social capital	Active in information gathering	Active in information gathering	Low in knowledge gathering	Active in information gathering	Low in knowledge gathering	Active in information gathering
Environmental aspects						
Business environment	Cost Market readiness	None	None	Cost Market readiness	None	Market readiness
Regulatory environment	Important	Important	Important	Important	Important	Important
Wider society	Social responsibility	None	None	None	None	None

7 Conclusion

This section concludes the problem definition formulated in Chapter 1.

Which characteristics influence the adoption of RFID in South African industries?

In this research the central theme is the influencing RFID adoption characteristics in South Africa. At the same time the adoption characteristics of the US are compared with the situation in South Africa. Around this central theme a central problem formulation is formulated, with three research questions (chapter 3).
The first paragraph gives the conclusion of the influencing RFID adoption characteristics in South Africa (§7.1). The second paragraph (§7.2) reflects on the research process and obstacles that came along. In the third paragraph (§7.3) recommendations toward Techsolutions and South African industries are stated. Paragraph §7.4 discusses subjects for further research.

7.1 Conclusions

Awareness and knowledge about RFID technology is the major challenge in the South African market. While many companies have heard about RFID and in some cases have appointed personnel to investigate the potential of the technology, a substantial knowledge gap exists in the understanding of the technology. This gap is hampering companies in being able to identify potential applications of the technology and to be able to build credible business cases. In some cases, the lack of understanding gives way to misconceptions which leads to incorrect decisions being made in terms of strategy. Typical misconceptions relate to issues such as costs and standardization when discussed out of context. When looking at the business case, cost is only one component and standards only become mandatory within open loop applications. An influencing factor within the organization is the commitment of senior management and which has a direct impact on the decision of a company to implement RFID. It is therefore important that senior management has sufficient understanding of the technology to support it. While middle management is driven the technology, translation of the technical advantages towards financial and operational benefits is needed.

Many of the above mentioned issues can be explained by the way RFID is marketed: currently RFID is marketed as an IT solution while it is in essence an operational solution. By moving it in the domain of IT, it substantially limits the opportunities in establishing a business case. If RFID will be marketed as an operational solution, more understanding and commitment towards the technology will be created. It will more likely gain the support of senior management. As argued by Gagnon *et al.* (1996), technologies must be presented more in terms of relevant opportunities for managers in order to achieve the desired increase the level of technology adoption. When RFID is marketed as a business solution and focusing on opportunities where organizational benefits are presented, it will yield more commitment to technology adoption than technical/IT solution marketing.

Is RFID, in the perspective of adoption, crossing the chasm in South Africa? When looking at the current status of the industries there can be concluded that it is not. Hesitation has the overhand and business cases sporadically appear. Although initiatives coming up, and more supply chain members are sitting around the table, awareness is growing and gives positive sounds for the future. Although organizations still need a strong business case to get convinced by the technological benefits, business cases are in some industries planned for the near future and can have a positive influence on other industries to also start a pilot. When awareness and understanding is increasing, it is a matter of time before the first industries get a full roll out. That could be the start of the chasm crossing.

7.2 Reflection

While the objective of the research population was stated 50 percent of the market per industry, this objective is not achieved in all industries. This can be explained by several factors 1) appointment making on executive level gives constraints in a certain timeframe, 2) willingness of organizations to participate, 3) late decision for qualitative research instead of quantitative. Although not all interviewed industries have a market share of 50 percent, the finding can be generalized due the fact of; 1) all interviewed organizations are leading in the industry or have a strong influence in the industry; 2) The interviewees have positions at executive level within the organizations, which gives the data from the interviews a highly trustworthy character.

In hindsight, this has been a labour intensive process that might have been shorter if I did not have to cope with the change in research approach at a far stage within the process. Where a quantitative approach was scheduled, a qualitative approach was conducted in order to overcome the possible lack of sufficient knowledge about the technology, when looking back at this decision it was a wise thing to do.

The primary data collection has been carried out in South Africa. We, Van Aken and myself, have spent six month in Pretoria, South Africa. We are grateful for this experience and we are convinced that it has contributed much to our findings. However, due to the African mentality we were not the most effective in terms of contacting people. The advantage is that we were more or less independent and have learned therefore rapidly to deal with local circumstances.

With regard to the results versus the objectives I do believe this assignment has produced the desired results. Based on the research on the influencing adoption characteristics of RFID in South Africa industries, insight is given in the adoption views of the industries.

Overall I have concluded that the research process ran smoothly. After the theoretical framework was developed it has been clear to me what kind of information was needed in every phase of the research. The theoretical research framework has been easy to use and has functioned as a proper manual.

In succession of the interviews conducted for the research, EPCglobal South Africa asks to produce a report about the views of the interviewed companies. This report is produced and published and is currently promoted and used by EPCglobal South Africa at presentations and workshops.

Some extra curriculum activities have been done during the research and stay in South Africa, a survey is conducted within the Innovation Hub. The purpose was to survey the support of a joint tenant forum, for stimulating cooperation between tenants to develop business relationships as well to address common problems. The feedback from tenants have been processed and prioritized and presented to the general management of the Innovation Hub who has pointed this at their agenda.

Most important Techsolutions CEO, Mr. de Koker, has showed his appreciation for the results. Due to the conducted interviews new business projects occurred and collaboration ships arises. The promotion and publication of the additional report by EPCglobal South Africa, gives in this way an additional marketing for Techsolutions and enlarge the familiarity in South Africa. Some of the recommendations in this report are currently implemented and some will be implemented on the short run.

7.3 Recommendations

In the line of the conclusions some recommendations are given. A distinction can be made in recommendations towards the industries and recommendations towards Techsolutions.

Recommendations towards South African Industries

- *Bridge the knowledge gap*
  In order to make correct decisions in terms of strategy, awareness and knowledge are needed. In case of RFID a gap exists, and organizations need to bridge this gap in order to know the potential for their organization. Through current unawareness misconceptions arise and incorrect decisions will be made. Compiling a multidivisional project team, who investigate the technology, participating in RFID bodies, and attending in global conferences, is a starting point to increase the knowledge level. This results in a business case what can be translated towards the senior management in terms of business advantage and increases commitment.

- *Let the costs not be the barrier*
  Costs are one aspects of the whole technology, facing the cost issue on its own gives misconceptions and place the technology in an unnecessarily negative perception. Face the whole business case with the investments and the relative advantage together. The relative advantage justifies the investment in all cases. Through the absence of relevant ROI studies, those figures are hard to present, while the cost are easily presentable in financial figures. Looking at the multiple divisions RFID is touching it gives in that way multiple advantages and in financial terms more results.

- *Closed loop applications*
  When decided to start with a business case, put the scope in a close loop environment. This allows organizations internally to experience and explore the implications and benefits about the technology. It increases awareness and support from management and other staff. The organization will be more prepared and can fully rape of the benefits when RFID implementation will be expand.

- *Encourage collaboration between departments and with trading partners*
  When decided to consider a business case in an open loop environment, collaboration between trade partners and departments has sufficient advantages. Even if RFID is being employed in a very limited scope to solve a specific business challenge, the implications of the technology to other parts of the organization and outside the enterprise should not be ignored. Meaningful conversations among line of business managers and the IT groups in partner organizations can yield valuable long–term strategies for improved enrolment of the technology. The economical and resource aspects of the business case have benefits, costs reduction and increased cultural and social capital, and more exploitation of the technology benefits are examples. Increasing awareness in a part of the supply chain in the implications and advantages of the technology gives a better basis for fully adoption in the chain.

- *Be a driver of the technology*
  The hesitation in adopting the technology, in order not to be the 'guinea pig', is a passive approach what is not in line with most strategies of the organization. Innovation is a key principle of most industries, in order to be a step further than the competition. Why in this context wait till the rest of the market adopt RFID and be a follower of the market. An organization must ask herself the question, does RFID besides all the barriers directly contribute to improvement of my business processes. If that is the case, do not wait any longer and become a driver of the technology.

Recommendations towards Techsolutions

The gaps that are faced by the industries as mentioned above can be overcome through the following recommendations. These are entrepreneurial opportunities Techsolutions face, when exploited the chasm can be bridged. These recommendations must be seen as a package, facilitating all three action points' results in bridging the industries gaps. When facilitating one or two points, this does not give the desired result for Techsolutions and the desired confidence for the industry.

- *Different marketing approach*
  As stated in the conclusion, RFID is marketed as an IT solution. It is limited to the domain of opportunities and creates a negative perception around stakeholders. RFID is in essence an operational solution, the marketing around the technology should focus on this fact. Present the technology more in terms of relevant opportunities for managers in order to achieve the desired increase the level of technology adoption. While seen it as a technical solution it is difficult to convince non-technical people within the organization, because of the lack of understanding. When presented as a business solution, more people can see the benefits and understand the results.

- *Facilitate knowledge programs*
  In order to bridge the knowledge gap of the industries, facilitate and organize workshops, give presentations, creation of a RFID database, in order to make the businesses aware of the technology and it benefits. In order to reach the right people, participation in conferences of supply chain bodies or technology bodies could give the attention towards RFID. Sufficient and reliable information will be given in order to avoid misconceptions. Workshops or participation in research projects are other way to increase awareness and stimulate organizations for own initiatives.

- *Compile a business case*
  Companies require guidance and assistance in formulating businesses cases which can positively contribute towards understanding the technology and gaining commitment within the organization. Compile a business case for organizations and assist them in executing the project. By offering the resources, in terms of University students and RFID test-centre, organizations can do their own pilot projects with the advantage of low cost, sufficient knowledge sources and assistance in exploitation in the business environment.

7.4 Further research

Exploration of stage three and four of the Innovation decision process (Rogers, 1995)
The diffusion of innovation model of Rogers (1995) exists of five stages, knowledge, persuasion, decision, implementation and confirmation. This research was focused on the second stage of the model, the persuasion stage. When organizations formed an attitude toward the technology the other stages of the model are of use. Exploring the other stages of the model gives insight in the whole adoption process and results in insight and support towards the South African industries. The stages, decision, implementation and confirmation could be of use in the scope of activities of Techsolutions. Techsolutions could broader the scope from a solution provider towards a turnkey player who assist in the whole process form opportunity recognition towards the implementation and after sales.

Exploration of the opportunity preparation and opportunity exploitation stages in the EiN model (Nikos,2005).
The entrepreneurial process according to the model of NIKOS (2005) consists of three stages, opportunity recognition, opportunity preparation and opportunity exploitation. This research was focused on the fist stage, the opportunity recognition. When adoption takes place the other two stages of the model are of use. In order to determine the characteristics of these stages an exploration of the transition form opportunity recognition towards opportunity preparation and in a further stage the transition of opportunity preparation to opportunity exploitation, are fields for further research. These transition phases, where industries face barriers and drivers, could give Techsolutions new opportunities for business expanding.

Implications through the inter organizationally of the technology
RFID is a technology what gives the optimal advantage when used in a chain. The focus of this research was on individual level, due to the fact that the adoption and implementation of the technology is currently not at a stage where inter-organizationally is appropriate. Exploration of the impact of inter-organizationally of the technology for industries could give insight in the implications it may bring.

References

- Aberdeen Group (2006), *ROI in RFID a Benchmark report*, Boston Massachusetts .
- Accenture (2003), *Auto-ID on the Line: The value of Auto-ID Technology in manufacturing*. Audio-ID center, Cambridge.
- Accenture (2004), *High performance enabled through radio frequency identification, Accenture research on manufacturer perspective*, High performance delivered series.
- Anderson, J.C., Hakånsson, H. and Johanson, J. (1994), *Dyadic business relationships within a business network context*, Journal of Marketing 58, p. 1-15.
- Antonelli, C. (2006), Diffusion as a Process of Creative Adoption, Journal of Technology Transfer 31, p211-226.
- Aken van, W. and Korteweg, B. (2006), *RFID beyond infancy, a future perspective; Views of leading South African companies in six major industries*, EPCglobal South Africa.
- Astley, W.G.(1984), *Toward an appreciation of collective strategy*. Academy of management review 9 (3), p526-535.
- Attewel, P. (1992), *Technology diffusion and organizational learning: The case of business computing*. Organizational Science 3 (1), p1-19.
- AutoIDLabs (2005), *Radio frequency identification; technology, applications and impact*, white paper series 1st ed.
- Alfonsi, B.J. (2004), *Privacy debate centers on Radio frequency Identification*, IEEE security and privacy, March.
- Baird, R.W. (2004), *RFID explained, a basic overview*, equity research, United Kingdom.
- Bear-Stearns (2003), *Supply chain technology, track(ing) to the future*, Equity research.
- Bianchi, M. (1998), *The Active Consumer*, London, Routledge.
- Brown, I. Cajee, C., Davies, D. and Stroebel, S.(2003), *Cell phone banking: predictors of adoption in South Africa- an exploratory study*, International journal of Information management (23), p 381-394
- Butler, J.E. (1988), *Theories of technological innovation as useful tools for corporate strategy*. Strategic management journal 9, p15-29.
- Cadbury, C. (1999), *Corporate governance overview*, World Bank report.
- Chau, P.Y.K, and Tam, K.Y. (1997), *Factors affecting the adoption of open systems: an exploratory study.* MIS Quart 21 (1), p1-21.
- Choi, J.P. (1997), *Herd Behavior, the "penguin effect", and the suppression of informational diffusion: an analysis of information externalities and payoff interdependency*, The RAND journal of economics 28 (3), p407-425
- Christensen, C.M. (1999), *Het innovatiedilemma; Kansen en risico's an nieuwe technologie*, Amterdam, Contact.
- Christo-Baker, E.A. (2004), *Distance Education as a catalyst for change in higher education*, ASCUE conference.
- Cohen-Levinthal (1990), *Absorptive capacity*, administrative science quarterly 35, p 128-152.
- Daft, R.L. (1978), *A dual core model of organizational innovation.* Academy of management journal 21, p193-210.
- Daft, R.L. (1992), *Bureaucratic versus nonbureaucratic structure and the process of innovation and change.* Research in the sociology of organizations vol. 1, p129-166.
- Damanpour, F. (1991), *Organizational Innovation: a Meta-analysis of effects of determinants and moderators*, The academy of management journal 34 (3), p 555-590
- Damanpour, F. & Evan, W.M. (1984), *Organization innovation and performance;the problem of organizational lag*. Administratve Science Quarterly 29, p392-409.
- Davidsson, P. (2005), *Researching Entrepreneurship*, NewYork, Springer.
- Deloitte Retail system alert group (2004), *RFID: How far, how fast, a view from the rest of the world*. Deloitte Touch Tohmatsu report.
- Deloitte Technology, media and telecommunications (2005), *TMT trends, prediction 2005, a focus on the mobile and wireless sector*, Deloitte Touch Tohmatsu report.
- Department of Commerce (2005), *Radio Frequency Identification; Opportunities and implications in implementation*, Washington D.C.
- Deuten, J.J., Rip, A. and Jelsma, J. (1997), *Societal embedding and product creation management*, Technology Analysis and Strategic management 9 (2), p. 131 - 148.

- Downs, G.W., and Mohr, L.B. (1976), *Conceptual issues in the study of innovation*, Administrative Science Quarterly 21, p700-714.
- Elliot, S. and Loebbecke, C. (1998), Smart card based Electronic Commerce: Characteristics and Roles. IEEE1060-3425/98.
- EPC.NL (2005), Privacyrechtelijke aspecten van RFID, Efficienta Offsetdrikkery BV.
- EPC.NL (2006), RFID en privacy voor managers, Efficienta Offsetdrikkery BV.
- Ettile, J.E. and Vellenga, D.B. (1984), *Organization strategy and structural differences for radical versus incremental innovation*. Management science 30, p682-695.
- The Dti (2005), *South Africa Business guide book 9th ed*. WriteStuff Publishing cc, Sandton.
- Farhooman, A.F. *et al* (1990), *Mangers perceptions towards automation in manufacturing*. IEEE Transactions on Engineering management 37, p228-232.
- Food and Drug Administration (2006), *Counterfeit drug task force report*, Rockville.
- Fielt, E. (2005), Design factors contributing to the acceptance of electronic intermediaries, Telematica Instituut.
- Federal trade Commission, Radio Frequency Identification; Applications and implications for consumers, 2005.
- Finkenzeller, K. (2003), *RFID Handbook, Fundamentals and applications in contactless smart card and identification 3rd ed.*, Chichester, Wiley & Sons Ltd.
- Gagnon, Y. and Toulouse, J. (1996), *The behavior of business managers when adopting new technologies*, Technology forecasting and social change 52, p. 59-74.
- Gagnon, Y.C. & Toulouse, J.M. (1996), *The behavior of business managers when adopting new technologies*, Technological forecasting and social change (52), p59-74
- Garfinkel, S and Rosenberg, B. (2006), *RFID, Applications, Security and Privacy*, New York, Addison-Wesley.
- Garmin Corporation (2000), *GPS guide for beginners*, Olathe, Kansas.
- Gefen, D. Rose, G.M., Warkentin, M. and Pavlou, P.A. (2005), *Cultural Diversity and Trust in IT Adoption: A comparison of potential e-Voters in the USA and South Africa*. Journal of Global Information Management 13 (1), p54-78.
- Gerst, M., Bunduchi, R. and Graham, I. (2005), *Current issues in RFID standardization*, workshop 22nd February.
- Geurts, P. (1999), *Van probleem naar onderzoek*, Bussum, Coutinho.
- Grix, J. (2004), *The Foundations of Research*, New York, Palgrave MacMillan.
- Groen, A.J. (2005). *Knowledge Intensive entrepreneurship in networks: towards a multi-level/multi dimensional approach*. Journal of Enterprising Culture 13 (1): p69-88
- Gross, N.C. (1942), The diffusion of a culture trait in two Iowa Townships. MS thesis, Iowa State College, Ames.
- Habets, T., Voordijk, H. and Van der Sijde, P. (2006). *Adoption of alternative transport technologies in the construction industry*. Twente University.
- Howlett, R.J. and Awcock, G.J. *et al* (1997), Determining the location of industrial bar codes using neural networks. IEE Conference publication No. 443.
- Iacovou, C.L., Benbasat, I. and Dexter, S. (1995), *Electronic data interchange and small organizations; adoption and impact of technology*, MIS Quarterly 19 (4), p465-485.
- Katz-Shaprio (1986), *Technology adoption in presence of network externalities*, Journal of political economies 94.
- Kimberly, J.R. (1981), *Organizational innovation, the influence of individual organizational and contextual factors on hospital adoption of technological and administrative innovations*. Academy of management journal 24, p689-713.
- Knight, K.E. (1967), *A descriptive model of the intra firm innovation process*. Journal of business 40, p478-496.
- Lee, H.L., Lee, H.L., Padmanabhan, V. and Wang, S. (1997). *"The bullwhip effect in supply chains."* Sloan Management review 38 (3), p93-102.
- LogiaCMG Industry, Distribution and technology (2004), *RFID benchmark study*, Hoofddorp.
- Markus (1983), *Power, Politics, and MIS implementation*, Communication of the ACM 26 (6).
- McClure, D.L. (1997), *Improving federal performance in the information era; The information technology management reform Act of 1996*. Government Information Quarterly 14 (3), p255-269/
- Metcalfe, J.S. (2001), *Consumption preferences and the evolutionary agenda*, Journal of evolutionary economics 11, p37-58.

- Miller,D. (1986), *Configurations of strategy and structure; towards a synthesis*. Strategic management journal 7, p233-250.
- Mils, R.E. and Snow, C.C. (1978), *Organizational strategy, structure, and process*. New York; McGraw-Hill Book co.
- Mils, R.H. (1980), *Macro organizational behavior*, Glenview IL; Scott Foresman and company.
- Mintzberg, H. (1979), *The structuring of organizations*, Engelwood Cliffs, NJ; Pressence Hall.
- Moore, G.A. (1998), *Crossing the chasm, marketing and selling technology products to mainstream customers*, Capstone Publishing Limited, Oxford.
- Moore, P. and Crossley, P. (1999), *GPS applications in power systems*. Power engineering journal, Feb 1999.
- Munro, H. and Noori, H. (1988), *Measuring Commitment to New Manufacturing Technology: Integrating Technological Push and Marketing Pull Concepts.* IEEE Transactions on Engineering Management 35 (2), p63-70.
- NIKOS; Groen A.J. and Sijde, v. d., P.C. (2005*). Nikos Progress Report 2001-2004*. Enschede, University of Twente
- OECD (2004), *The Security economy*, OECD Publications, Paris.
- Parsons, T. (1964) *The social System*, New York; The Free Press.
- Parsons, T. (1977), *Social systems and the evolution of action theory*, New York, The free press.
- Pavitt, K., Robson, M. and Townsend, J. (1989), *Technological accumulation, diversification and organization in UK companies, 1945-1983*. Management science 35 (1), p81-99.
- Persinons, P. (2006), *RFID the future is now; a special report on RFID*, Larstan Business Reports, Potomac.
- Pfeffer, J. (1987), Bringing the environment back in; the social context of business strategy. The competitive challenge; strategies for industrial innovation and renewal, Ballinger Publishing, p119-135.
- Regan, Jacobs and Sydney (2005), *Has RFID "crossed the chasm"?*, ReganJacob&Sydney
- Rogers, E.M. (1995), *Diffusion of Innovations 5th ed*., New York, Free Press.
- Rosenberg, N. (1979), *Technology interdependence in the American Economy*, Technology and Culture, January 1979.
- Rosenberg, N. (1982), *Inside the black box: Technology and Economics*. New York: Cambridge University Press, 1982.
- Rowe, L.A. and Boise, W.B. (1974), *Organizational innovation; current research and evolving concepts*. Public administrative review 34, p284-293)
- Ryan, B. (1948). A study in technological diffusion. Rural sociology 13, p273-285.
- Saunders, M., Leis, P. and Thornhill A. (2004), *Research Methods for Business Students 3rd ed*., Prentice Hall.
- Sharma, A. and Citurs, A. (2005), *Drivers and rationales in RFID adoption and post adoption integration: an integrative perspective on IOS adoption*, DIGIT document review system.
- Sohal, A.S. (2001), Adoption of AMT by South African manufacturers, Integrated manufacturing systems 12 (1): p15-34.
- Straub, D. and Rai, A. (2004), "*Measuring Firm performance at the network level: A Nomology of the business impact of digital supply networks."* Journal of management information systems 21 (1), p 83-115.
- Sumarsono (1995), Compresses natural gas as a fuel for motor vehicles: adoption and marketing policy; a case study in Indonesia, proefschrift, Den Haag.
- Thomas, P. (1996), *The devil is in the detail; revealing the social and political process of technology management*. Technology analysis & strategy management 8, p82.
- Thong, J.Y.L. (1999), *An integrated model of information systems adoption in small businesses*. Journal of management information systems 15 (4).
- Tornatzky, L. G. and Klein, K.J. (1982). *"Innovation Characteristics and Innovation adoption implementation: A meta-analysis of findings."* IEEE Transactions on Engineering Management 29(1): p28-44.
- Tornatzki, L. G., M. Fleischer. 1990. *The Processes of Technological Innovation*. Lexington Books, Lexington, MA.
- Tushman, M.L. and Anderson, P. (1986), *Technological discontinuities and organizational environments*. Administrative science quarterly 31, p439-465.
- Van de Ven, A.H. (1986), Central problems in the management of innovation. Management science 32, p590-607.
- Van der Veen, M. (2004). *Explaining e-business adoption: Innovation & entrepreneurship in Dutch SMEs*. Enschede, M. van der Veen.

- Van der Veen, M. & Wakkee, I.A.M. (2004), *Understanding the entrepreneurial process*. In review of progress in entrepreneurship (In D. Watkins ed., Wol. 2, p144-152) Brussels; ARPENT.
- Visser, D.J., Coning, T.J. de and Smit, E.v.d.M. (2005), *The relationship between the characteristics of the transformational leader and the entrepreneur in South African SMEs*, South Africa Journal of Business Management 36 (3), p 51-64.
- Voss, C. (1988), *Implementation: a key issue in manufacturing technology: the need for a field of study*. Research Policy 17 (2).
- Vrakking, W.J. (1989), *Consultants role in technological process innovation*. Journal of management consulting 5, p17-24.
- Witt, U. (2001), *Learning to consume, a theory of wants and the growth of demand*, Journal of evolutionary economics 11, p23-36.
- Yang, G and Jarvenpaa, S.L. (2005), *Trust and Radio Frequency Identification (RFID) Adoption within an Alliance*, Proceedings of the 38th Hawaii International Conference on System Sciences.
- Zaltman, G. Duncan, R. and Holbeck, J. (1973), *Innovations and organizations*, New York; Wiley.
- Zeira, J. (1987), *Investments as a process of search*, Journal of political economy 95, p204-210.
- Zhu, K & Kraemer, K.L. (2005), *Post-Adoption Variations in Usage and Value of E-Business by Organizations: Cross-Country Evidence from the Retail Industry*, Information System Research Vo 16 (1).

List of abbreviations

AIDC	AutoID Data Capture
CEO	Chief Executive Operations
C-TPAT	Custom Trade Partnership Against Terrorism
CTIA	Computing Technology Industry Association
DOC	Department of Commerce
DOD	Department of Defense
DTI	Department of Trade and Industry
EDI	Electronic Data Interchange
EiN	Entrepreneurship in Networks
EPC	Electronic Product Code
EPOS	Electronic Point of Sale
ETSI	European Telecommunication Standards Institute
FCC	Federal Communications Commission
FSA	Food Standard Agency
FDA	Food and Drugs Administration
FTC	Federal Trade Commission
GDP	Gross Domestic Product
Gen2	Generation 2
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
IMEI	International Mobile Equipment Identity
IOS	Inter organizational systems
ISO	International Standard organization
IT	Information Technology
JIT	Just in Time
MSC	Magnetic Stripe Card
PIN	Personal Identification Number
RFID	Radio Frequency IDentification
ROI	Return on Investment
TOE	Technology, Organizational Environment
UHF	Ultra High Frequency
UPC	Universal Product Code
US	United States

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Appendix I Environmental aspects

External environmental aspects influence the adoption and diffusion of new technologies because of their unique features and characteristics (Sharma and Citurs, 2005). This corresponds with the 'environment aspect' explained in the framework of Tornatzky and Fleischer (1990). Classically there has been an assumption of a clear boundary between the organization and the environment, in which the environment has been defined as "anything not part of the organization itself" (Miles, 1980), environmental aspects in this context are the aspects organizations face within the environment. The last decades the boundaries between organizations and their environment began to dissolve (Astley, 1984), and therefore the perspective changed from an independent individual organization to one of an organization interacting with its perceived environment (Pfeffer, 1987; Pfeffer and Salancik, 1978). While from an efficiency standpoint, many companies stand to gain from the use of RFID, certain impediments to the broader adoption of RFID still remain (Bear-Stearns, 2003). RFID has been commercially available for over two decades, the rate of adoption for most applications has been slow as the relative benefits of the technology have been outweighed by several key barriers, including lack of standards, relatively high cost, weak education, technology hurdles and privacy concerns (Baird, 2004). Organizations and other technology actors are increasingly confronted by issues of ecological soundness, public acceptability and other aspects of 'societal quality' (Deuten *et al.*, 1997). Many entrepreneurial failures can be attributed to the fact that a would-be entrepreneur failed to consider the relevant conditions of interdependence between the component with which he happened to be preoccupied and the rest of the larger system (Rosenberg, 1979). It is important for organizations to reflect their experiences and avoid the potentially damaging consequences of innovation, for themselves, their organization and the world beyond (Thomas, 1996), in other words creation of 'social embedding'. The nature of the environment in which an innovation has to survive is essential for its getting embedded. Deulen et al (1997) divided the environment in three parts:

- Business environment; Actors in the business environment have input-output relations with the organization;
- Regulation environment; Actors are local, regional, national and international governments and other regulatory bodies (including standard setting bodies);
- Wider society; Actors are consumer organizations, environmental groups, animal protection organizations and also public opinion leaders, media and independent scientists.

This model looks from within the organization and sees the different parts as layers around the organization. The first layer is the business environment, the second layer is the regulation environment and the third layer is wider society. The businesses environment is the most familiar one for the organization, while the wider society is unfamiliar (Deulen *et al.*, 1997). All three layers influence the organization on new technological innovations, in below the variables in the three layers will be outlined to explain the environmental aspects RFID is facing.

Appendix I Environmental aspects
Continued

Business environment

As a result from the interviews two aspects in the business environment are of importance, costs and market readiness. Those variables are outlined below.

Costs
RFID-tags are the most frequency cited cost component in RFID implementation. This is partly true. The costs of tags are of importance, because of the needed amount. Tags, readers antennas, controllers, middleware, operations and maintenance all contribute to the total cost of ownership (figure 7)[29], especially the last two cost factors makes the total cost of RFID implementation transparent (Gerst *et al.*, 2005).

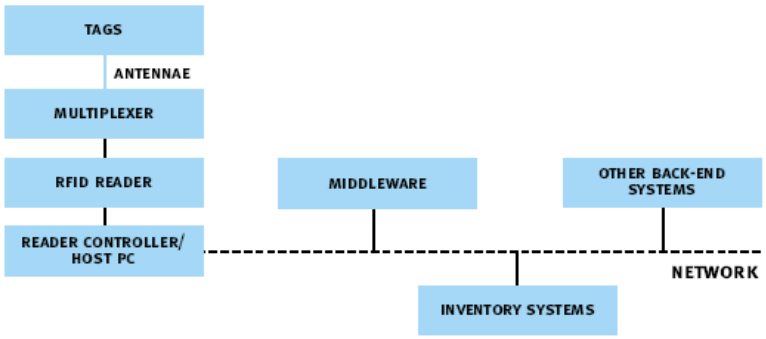

Figure 6 Representative RFID implementation (Source Accenture, 2003)

The tag cost is one of the biggest issues nowadays, they vary within the variants of the tag and the volume of production. The time for broader adoption is at hand because the price of RFID-tags is finally approaching levels where placing tags on individual items is not far from being economically feasible. Through RFID is still at a minimum rate of adoption the volume of tag productions is still low, what higher the price. Predictions for decreasing tag prices in the future are estimate by several research organizations (Accenture, 2003; AutoID-Labs, 2005). In case of mass adoption, and the result of mass volume production of tags, the price decreases. This positively influences the adoption process. Costs are in this context sited as external costs, these are the investments organizations has to make in order to implement the technology, these costs can not be included in the economic capital of the EiN model (NIKOS, 2005) because these costs are defined as external instead of the defined internal cost of the EiN model (NIKOS, 2005).

Market readiness
In today's South African business, maturity on technical levels is in some cases very low. Introducing new technologies takes to fully integrate in the current market conditions a while. Cultural and economical aspects have an influence in the quick adoption towards new introduced technologies. Especially in the quick changing market of today, where technologies follow each other up rapidly, for most organizations it is economically not feasible to follow, even as they face a demand from major clients. In this perspective the adoption of RFID can be classified as an innovation that influence the cultural and economical capitals of the organization and therefore can in that way be a major barrier for organizations to adopt even if mandatory.

[29] http://www.accenture.com

Appendix I Environmental aspects
Continued

Regulation environment

In the current scope of RFID the standardization of several component functions fills within a regulatory framework. Several bodies and organizations are active in this field, industries try to coordinate and initiate those standards.

The use of standards in RFID technology, applications development, and deployment is a multi-tiered issue. For example, standards are needed to specify performance of tags (whether passive or active) to ensure that tags meet intended designs, such as single-write/multi-read tags, multi-write/multi-read, or for potentially sensitive applications requiring a built-in disable function as in single write/ single-read tags. Standards also cover the air-interface operational requirements, i.e., the parameters for interaction between a tag and the tag reader such as transmission and receiving frequencies; algorithms by which the tag reader can communicate with the tag; and in case of active tags, when the tags would respond to a reader query. Another set of standards is required for the software that supports the readers and the tags, and for the data obtained from the tags. Likewise, standards would also cover systems for coding information contained in the RFID tags, for handling the estimated terabytes of data generated from the information contained in the tags, and for ensuring the adequate protection of data for both security and privacy concerns.

The number and use of standards within RFID and its associated industries is quite complex, involves a number of bodies and is in a process of development. There are several standards bodies involved in the development and definition of RFID technologies, International Standard Organization (ISO), EPCglobal Inc, European Telecommunications Standards Institute (ETSI), and Federal Communications Commission (FCC)[30]. At the moment there are existent and proposed RFID standards that deal with the air interface protocol, data content, conformance and applications, issues by the different involved bodies.
EPCglobal began developing a second-generation protocol (Gen2). The aim was to create a single, global standard that would be more closely aligned with ISO standards. RFID vendors that had worked on the ISO Ultra High Frequency (UHF) standard also worked on Gen 2. Gen 2 was designed to be fast-tracked within ISO[31]. ISO has developed RFID standards for automatic identification and item management. This standard, known as the ISO 18000 series, covers the air interface protocol for systems likely to be used to track goods in the supply chain. They cover the major frequencies used in RFID systems around the world. EPCglobal's Gen 2 standard is submitted to ISO under 18000-6, the first cooperation between these organizations is with this standard a fact[32].

Cooperation between the several standardization bodies is going to be established, what has a positive influence to the aim for global standards for RFID. This gives a good perspective for the future. When all bodies are now around one table, the global standards are just a matter of time before been established and one barrier for global adoption of RFID, in this international business environment, is overcome.

[30] JISC Technology and Standard watch, May 2006; RFID; Frequency, standards, adoption an innovation
[31] http://www.rfidjournal.com/article/articleview/1335/3/129
[32] http://www.rfidjournal.com/article/articleview/248

Appendix I Environmental aspects
Continued

Wider society

Although RFID is currently not that evolved that it will interfere in the personal lives of consumers several issues arise around the technology. In below two factors of influence in the society are outlined.

Privacy
The privacy issue is nowadays a major topic in RFID, media reports privacy violation and misuse of the technology (EPC.NL, 2005). In the US a major protest has arisen against RFID in the privacy area (Big research, 2004). Important issues for rejecting the technology by the public are the use of personal information by third parties, tracing of consumers' trough their purchases, reading of the tags over long distances, and the increase of direct mailing[33]. Privacy and consumer advocates are calling for regulation, codes of best practices, and technological fixes that give a measure of control over RFID, in the mean while they try to slow down the rollout of this transformative technology, so that the public can get involved in the dialogue (Perrin, 2006). Privacy is difficult to define, because of the fact that the concept of privacy is only defined when referred to a complex area of social, cultural, politics, law and philosophy factors were it depends on (Gutwirth, 1998). Privacy has traditionally been discussed along two vectors (Perrin, 2006):

- As a fundamental human right, including the right to be free from unreasonable search and seizure or intrusion;
- As a protection of personal information.

People react negatively to the loss of control over their own personal information, believing they have a right to present their unique face to the world, in their own terms. This may be in denial of the facts of the twenty-first century, as pointed out by the CEO of Sun Micro Systems, "You have zero privacy anyway, get over it"[34].

There are three privacy threats concerning RFID. First is profiling, a reader network can seamlessly collect RFID information from belongings, documents, etc. and easily add it to the profile of the person. Second threat is surveillance, RFID can locate its target in space. If a target is carrying a tag, a RFID reader network can locate the target and identify it. Action is the third threat. After reading a tag when entering a geographic area, al information is visible about the object. People or devices associated with the reader network can take actions, ranging from arresting, to show targeted ads (Weinberg, 2006).

The unique properties of RFID could cause, with careless or unlawful use of RFID an infringement of privacy and individual freedom of civilians. Invisibility of RFID-tags is seen as one of the major privacy concerns. While all these issues rise, it is not proven that with using of RFID systems a privacy risk arise. RFID knows many applications forms that have no risk for privacy (ECP/NL, 2005). According to Bear-Stearns (2003) the key to controlling privacy, related to RFID, lies in educating consumers about this technology and its limitations. The lack of knowledge about the technology influences the perception of the privacy violation of RFID. Bear-Stearns (2003) also argues that the consumers 'acceptance' of RFID will increase, when there is a legislative proposal that required RFID-tags to be turned off after purchase. The ability, and the feeling, to trace items after purchase in a persons house will be neglected. Overall, the use of RFID triggers the same privacy concerns as other commonly used techniques, such as credit cards, cell phones, and the Internet. In case of adoption of RFID it is an important variable, what can influence the decision for adoption.

Social responsibility
"Socially responsible business" has become a buzz-phrase in corporate circles - and companies in South Africa may have to reach beyond the chequebook philanthropy of the past if they want to walk the talk of sustainable business (Finlay, 2004[35]). Within the process of adoption, social responsibility and the thereby include corporate governance plays an important role in South Africa. Corporate governance is concerned with holding the balance between economic and social goals and between individual and communal goals…the aim is to align as nearly as possible the interests of individuals, corporations and society (Cadbury, 1999). The social and economical environment in South Africa differs from the US and Europe. Communities and culture play an important role in decision making process. Local industries are also more labour intensive. Some of the business cases for RFID in manufacturing and distribution are due to savings in labour costs.

[33] http://www.ecp.nl
[34] http://wired.com/news/politics/0,1283,17538,00.html
[35] http://www.southafrica.info/doing_business/economy/development/socialindex.htm

Appendix I Environmental aspects
Continued

This could be translated into job losses. The other hand, labour intensive processes can be more prone to be inefficient due to human error, which can be reduced by using RFID technology. While decrease of operational costs gives benefits, the damage in the communities is dramatically increasing through the unemployment, and as a result the decreasing economical position of those people who are on the other hand consumers of the industry. In a line with the global trends in corporate governance a list is developed were companies have to apply to criteria such as: a business's commitment to black economic empowerment, tackling HIV/Aids in the workplace, labour policies and environmental practices. In which way is the involvement in the communities of influence in the adoption of RFID?

Appendix II Industry selection

The selection of the industries is based on three criteria, RFID suitability, Gross Domestic Product (GDP), and social/political implications. The first criterion, RFID suitability, is an underlying factor in the selection process. With attention to the time frame of the research, a maximum of six industries will be included in the research.

Gross Domestic Product
This selection criterion is based on the highest percentage value added Gross Domestic Product (GDP) on the national economy. Data are collected from the Statistics South Africa department (2006).

Table 1; Sector overview on contribution to the GDP

Sector	Value added (% of GDP)
Agriculture, forestry and fishing	2,6
Mining and quarrying	6,3
Manufacturing	16,4
Electricity, gas and water	2,2
Construction	2,8
Whole share and retail trade, hotels and restaurants	13,8
Transport, storage and communication	9,9
Finance, insurance, real estate and business services	19,5
General government services	12,4
Personal services	5,2
Total value added	91,1
Taxes less subsidies on products	8,9
GDP at market prices	**100,0**

Source: Statistics South Africa; Gross Domestic Product Q1 2006

In this criteria, a top five of the highest value added in GDP, sectors will be selected. The selected sectors are Manufacturing, Whole share and retail trade, Transport and communication, Finance and General governmental services.

The financial, insurance, real estate and business service sector has the highest GDP contribution, but looking separately at the four divisions, the financial division has only one RFID application, the credit card. The credit card and therefore the contactless smartcard application is not in the current and future scope of the Techsolutions strategy, therefore this division is left out. Business service contains two sub divisions, accommodation and catering. Accommodation is not suitable for RFID and catering contains only the food tracing application. Because South Africa currently and in the coming future has no regulation for food tracing, catering is left out of the research. The real estate division has two major applications, asset and access control. These are nice markets that are not the early adopters of the technology, and therefore left out. Insurance applications are linked to other applications, toll port payment for example, and are not stand alone applications and therefore left out the research.
The general governmental services are not the most suitable sectors for RFID, document tracing and access control are the only applications that suit this sector and are still a nice market in the RFID. In this case it will be left out the research.
Concluded, the sectors that are chosen on GDP are Manufacturing, Whole share, and Transport/communication.

The manufacturing sector is divided in ten divisions, in order to select the most promising and economical thrived division, a selection is made on behalf of the contribution (%) of the total manufacturing sales.

Table 2; Manufacturing divisions on contribution to the total sales

Manufacturing division	Contribution (%) to total manufacturing sales
Food and beverages	18,3
Textiles	4,9
Wood, paper, publish and printing	9,0
Petroleum, chemical products, rubber and plastics products	19,6
Glass and non-metallic mineral products	2,9
Basic iron and steel, non-ferrous metal products, metal products and machinery	21,5
Electrical machinery	2,4
Radio, TV and communication apparatus and professional equipment	1,3
Motor vehicles, parts and accessories and other transport equipment	15,5
Furniture and other manufacturing division	4,6
Total	**100,0**

Source: Statistics South Africa; Manufacturing Production & Sales, April 2006

Appendix II Sector selection
Continued

The best four divisions are selected and in this view Food and beverages, Petroleum and chemical products, Basic iron and steel, and Motor vehicles are chosen.

Petroleum, chemical products, rubber and plastics products division, and the basic iron and steel, non-ferrous metal products, metal products and machinery division, are divided in sub divisions (table 4).

Table 3; distinguishing of divisions

Manufacturing division	Contribution (%) to total manufacturing sales
Petroleum, chemical products, rubber and plastics products	**19,6**
Coke, petroleum products and nuclear fuel	6,5
Basic chemicals	3,8
Other chemical products	5,5
Rubber products	1,1
Plastic products	2,6
Basic iron and steel, non-ferrous metal products, metal products and machinery	**21,5**
Basic iron and steel products	7,7
Basic precious, non-ferrous metal products	2,9
Fabricated metal products	4,9
Machinery and equipment	6,0

Source: Statistics South Africa; Manufacturing Production & Sales, April 2006

These subdivisions have each a very small contribution to the total manufacturing sales. In this way these two divisions will be left out of the research. Therefore automotive manufacturing and food and beverage manufacturing divisions are added to the research.

Social/Political Implications
Due the fact that political and social issues play an important role in certain solutions, several future actions mandated by the government are possibly influencing the implementation of RFID.

Pharmaceutical division
Drug counterfeiting has become a global problem. Although the number of drugs affected is relatively small, the consequences of administering a compromised pharmaceutical can be catastrophic (Garfinkel *et al.,* 2005). The pharmaceutical division deals with counterfeit and stolen medicines and drugs. Up to 20% of the medicines sold in South Africa are stolen or counterfeit and are almost impossible to distinguish from the real thing (Sunday Times, November 2002). Counterfeit drugs are defined as medicines produced by fraudulent pharmaceutical laboratories that often contain incorrect amounts of the active ingredients, if any at all, or contain the incorrect active ingredients - making them potentially lethal or completely useless. The total sales of drugs in South Africa is about 14.5 billion Rand (1,7 billion Euro) a year, 2 billion Rand (235 million Euro) is earned by the illegal drugs trade (Business Day, August 2004).

The Food and Drug Administration (FDA) in the US stated in her 'Counterfeit drug task force report (2006) that all pharmaceutical manufacturers are obligated to electronically track and trace their drug through the supply chain. As a solution for this obligation, the FDA argued that RFID is the most promising technology for implementing electronic track and trace in the drug supply chain. The FDA does not mandate RFID use within the pharmaceutical industry. However, it does recommend that the industry move quickly to implement this technology. This action of the internationally accepted administration has impact on the South African counterfeit drug legislation. In this case it is important to determine the adoption process of this division.

Conclusion:

Six industries are incorporated in this research: Transport, Retail, Pharmaceutical manufacturing, Communication, Food and Beverage manufacturing and Automotive manufacturing. These industries were interviewed in order to determine their supporting and inhibiting factors against RFID.

Appendix III Interview questions

Interview RFID ***Date:*** **/ /**

Organization: _____
Name interviewee: _____
Function: _____

This interview has two focus areas, one area is the strategic focus of your organization. The other area is the perceived use of RFID in your organization. This interview should take approximately 30 minutes. Information provided in this interview will be kept confidential.

1. Introduction (basics)

a. Are you using RFID in your organization?

If yes, what kind of RFID-applications are you using? And what are the prospects?

If no, do you have plans to use RFID in the future in your organization? What possible RFID-applications? In which timeframe?

b. In which way is your organization working with RFID-applications?
   a. Is there one person responsible for RFID?
   b. What is the level of knowledge of RFID within the organization? Is it sufficient, and if not, what to do to overcome it?
   c. Have you looked at case-studies or been overseas for RFID-knowledge?
   d. Is there a budget for RFID-implementation? What is the budget?
   e. What are the targets for RFID-applications?

c. What is your view on the following topics regarding the RFID-implementation process?
   a. Do you think that there is a need for an assessment to determine ROI?
   b. What kind of training is required?
   c. Do you believe a pilot is important and what should be a preferable size and costs?

2. Related and supporting industries

a. Are you consulting organizations that can support you with your requirements or investigations regarding to RFID-applications?
b. What are your requirements for RFID-vendors / RFID-consultants, and have you find such a company?

3. Organization strategy and structure

a. In the process of implementing RFID, do you cooperate/ or willing to cooperate with trade partners?
b. What are the most important sources of information about RFID for your organization? What is the role of the EPC-global organization in this case?
c. What are the most important improvement projects in your organization?

Appendix III Interview questions
Continued

4. Innovation Characteristics

a) In which areas in your company are innovations important, and what kind of innovations are implemented in the past (NPD or incremental innovations)
b) How will RFID improve your current processes regarding to, reduction of operational cost, improved effectiveness/ efficiency/ reliability? *(perceived relative advantage*)
c) What constraints would you face when you implementing RFID? For example understanding the technology, use of the technology, constraints in IT structure or organizational structure, the complexity. (*Complexity*)

5. *Environmental aspects*

We are going to mention possible issues that RFID is facing at the moment. Indicate in which way these issues are limiting you in the process of choosing for RFID, and if it's limited, how do you think you can overcome these issues.
a. Privacy Issues
b. Current cost of RFID
c. The lack of global standards
d. What other issues, please define

6. Opportunities

a) Is your organization receiving some incentive schemes from external organizations for innovation? like RFID?

b) What is currently the most important trend in the national market in your opinion? (Demand)

c) What could you describe as an opportunity in the <u>current</u> situation of your organization? And in the near future?

Appendix III Interview questions
Continued

Additional questions

1. The following refers to the external orientation of your company. Indicate in which way each is valid in your company.

		Totally disagree				Totally agree
a.	Our company pays a lot of attention on searching for opportunities, to be a step ahead on the competition.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b.	When searching for new ideas / solutions, external sources are important.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c.	Our organization needs reputable consultants for implementing RFID projects	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d.	Our organizations needs training and workshops to learn more about what RFID can do for our company	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

2. The following indicates the possible uses of RFID within your business processes. Indicate in which way each of these is of use in your company.

Use of RFID		Totally disagree				Totally agree
a. (ca)	RFID fits within the companies' culture and image we want to expose to our clients.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b. (ca)	RFID will be mandatory in the future by external parties (clients/suppliers/government).	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c. (ob)	In the companies image view, it is important to us that the RFID-application itself is visible to others.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d. (tr)	When a pilot project is implemented, it can improve my personal perception positively about the technology.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
e.	RFID has to become more mature (cheaper, no privacy issues, global standardization, etc.), before my perception will change positively.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

Appendix III Interview questions
Continued

3. RFID is an emerging technology that will be used in various sectors. Please answer the following regarding your company:

The following issues regarding RFID are the perceived constraints for my organization:

		Totally disagree				Totally agree
a.	Current costs of tags	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b.	Current costs of reader infrastructure	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c.	Current costs of implementation	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d.	Public opinion	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
e.	Safety	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
f.	Technical implications	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
g.	No standardization	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
h.	Not enough knowledge within the organization	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
i.	Privacy issues	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
j.	Other :	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

4. The reasons why I have/will implement RFID in the organization is: (driving forces)

- ☐ Better traceability
- ☐ Identification
- ☐ My suppliers demand it
- ☐ My customers demand it
- ☐ Instant recognition of preferences
- ☐ Faster recovery of stolen items
- ☐ Prevent crime
- ☐ Reduced counterfeiting
- ☐ Instant access to more product information
- ☐ Instant access to information on product availability
- ☐ Reduced out-of-stocks
- ☐ Increased access to more products
- ☐ Improved security of prescription drugs
- ☐ Improved food safety and quality
- ☐ Provide potential savings to consumers
- ☐ Faster, more reliable notification of recalls
- ☐ Faster checkout
- ☐ More control over employees
- ☐ Improved price accuracy
- ☐ Other reason

If other specify:

Appendix III Interview questions
Continued

5. Do you want to know more about RFID technology?

☐ Yes
☐ No

Evaluation: Do you have any remarks or comments on this interview?

Thank you for your time.

Appendix IV RFID applications

RFID knows many application possibilities, through the wide variance of readers and tags, a wide variance of applications can be applicable. In order to get insight on the possibilities of this technology and the benefits it brings for an organizations, it is of importance to give an overview of these applications.
The applications of RFID can be divided into three groups, control applications, identifying applications and tracking and tracing applications. Below these groups will be explained.

Control applications

Control is a result of RFID, while every tagged item/person can be identified, it can also be controlled. Amounts of inventory, fleet, assets, etc. are known at any time, and can be regulated. Below several control applications will be explained.

Access control
Electronic access control systems using data carriers are used to automatically check the access authorization of individuals to buildings, (commercial or event) premises, or individual rooms. With the unique code on the tag, only authorized tags gain access towards specific areas. Manual checking of the person/item/vehicle is not necessary, it is time saving and prevents inconveniences (Garfinkel, 2006).

Quality control
In modern production lines the quality of products is tested at test points located at a number of stations. When a product is inspected at the end of a production process, it must be possible to unambiguously attribute the quality data gathered earlier to the correct object. With writable transponders (tag) that travel with the product, it can be achieved, because all quality data obtained during the production process is carried with the object (Finkenzeller, 2003).

Asset control
With the controlling of assets, information about the assets in the supply chain is visible, and where assets are needed, the management of inventory can be more efficiently. Through the integration of real-time data captured by RFID the extension dynamically optimizes the inventory and utilization of supply chain assets[36]. A relation can be made between the asset and a person, in this case only authorized persons may take the asset (a laptop for example). An extension of asset control is fleet control, on a real time basis the location and status of the vehicles on the premises are known, and supports the optimizing of the fleet and fleet activities[37].

Tracking and tracing applications

Tracking and tracing can be described as the process of retrieving information about the movement and location of goods, especially in the supply chain where RFID can contribute to better visibility of the products, goods or other. The uniqueness of RFID tags means that a product may be individually tracked as it moves from location to location, finally ending up in the consumer's hands. This may help companies to combat theft and other forms of product loss. Moreover, the tracing back of products is an important feature that gets well supported with RFID tags containing not just a unique identity of the tag but also the serial number of the object. This may help companies to cope with quality deficiencies and resulting recall campaigns, but also contributes to concern over post-sale tracking and profiling of consumers. (*Wikipedia encyclopedia)* The technology is typically used to track products at three levels: pallet, case and unit.

Identifying

Identifying can be described as serving to distinguish or identify a species or group. RFID can improve the process of identifying in a broad field. The unique identity in any case is a mandatory requirement for RFID tags, despite special choice of the numbering scheme. RFID tag data capacity is large enough so that any tag will have a unique code, while current bar codes are limited to a single type code for all instances of a particular product. (*Berns, 2003)* The function of identifying can be used in a widely determined setting since the developments of RFID follow up rapidly. Examples of the usage are in the field of productmanagement and the recent usage in passports.

[36] http://www.rfidjournal.com/article/articleview/602/1/1/
[37] http://www.rfidjournal.com/article/articleview/2231/1/1/

Appendix V Interview data

Industry: Retail			
Variables:	**Company**		
	I	**II**	**III**
Technological aspects	**(Pick and Pay)**	**(Mass Mart)**	**(Edcon)**
Relative advantage	On-self availability Returnable assets Shrinkage Traceability Recalls	Visibility Shrinkage Control over staff Security Traceability Out-of-stocks	Shrinkages Out-of-stocks Visibility Traceability
Compatibility	Fits within the beliefs of the company	Fits within the beliefs of the company	Does not fit within the beliefs of the company
Complexity	When implemented it is easy, before that it gives implications. Maturity is a barrier in terms of standards.	Maintenance of the data and optimize the IT-infrastructure are challenges. And the maturity of the technology in terms o readability is an issue.	The IT infrastructure behind it is very complex to adjust to RFID and integrate it into the current systems. The multidivisional touch of the technology gives some challenges.
Trialability	The barrier is a compelling business case	Important, due to the costs it has no business pressure.	Not that important, internal adjusting is more important.
Observability	Not important	Not important	Not important
Organizational aspects			
Economic capital	Top 3 of largest retailers in SA	Top 3 of largest retailers in SA	Top 3 of largest retailers in SA
Strategic capital	Senior management commitment is a barrier as a result of the lack of a business case. When implemented gives mandates towards trade partners.	Facing no mandates, want to mandate trade partners when start implement. There is currently no Senior management commitment, through the lack of a business case and the status of the technology now a day.	There is commitment of the senior management, but through complexity and environmental issues they are not ready.
Cultural capital	No sufficient knowledge because the lack of business pressure	Small group of people have deeply understanding. Sees the changes in internal processes.	Small group of people have very deep understanding.
Social capital	Visit conventions and are active in RFID bodies, going to make use of consultant when the time is there, but first internal awareness has to be improved.	Visit conferences oversee. Participate in RFID bodies. Not make use of consultants.	Active in RFID bodies. Visiting seminars and conferences.
Environmental aspects			
Business environment	Cost are not a barrier while the costs decreases Market readiness is not a problem, force them to use RFID, if not then use another trade partner.	Costs are a barrier, they have to drop before step in Market readiness; some trade partners still having problems with barcode, thus with RFID it is going to be even worse	Costs are not an issue Market readiness; trade partners have not the capability what is required
Regulation environment	Mandatory for global/national interoperability It is not an barrier	Very important, there is a need for a global standard.	Global standardization is needed
Wider society	Privacy is not an issue Social responsibility has a high priority in the company, very involved in the communities.	Privacy is not an issue Social responsibility has a high priority in the company, very involved in the communities.	Privacy is not an issue Have a social responsibility to create jobs in South Africa and to take care for the communities.

Appendix V Interview data
Continued

Industry: Pharmaceutical manufacturers			
Variables	**Company**		
	I	**II**	**III**
Technological aspects	**(Aspen)**	**(Johnson & Johnson)**	**(Adcock Ingram)**
Relative advantage	Prevention of theft Expiry dates Preventing counterfeiting Out-of-stocks	Brand protection Shrinkage Expiry dates Track and trace	Out-of-stocks Security Shrinkage Asset control Tracking and tracing Preventing counterfeit
Compatibility	Does not really fir within the companies' beliefs and culture.	Fits within the beliefs of the company	Fits within the beliefs of the company
Complexity	Sees not issues in the ease of use. IT wise and maturity wise it should be not a problem for them.	It is complex, but not everyone has to be the expert.	Complexity is not important, the benefits justify the rest. IT infrastructure can give implications.
Trialability	Looking for a business case, but is difficult to find a suitable one.	Closed loop pilot projects are important to start.	Very important to have a business case to see the benefits and the implications, as a start for this technology it is needed.
Observability	Very important, especially in the export	Not that important	Is important, especially for export.
Organizational aspects			
Economic capital	Top 3 pharmaceutical manufacturers	Top 3 pharmaceutical manufacturers	Top 3 pharmaceutical manufacturers
Strategic capital	FDA mandate will be of use. While the senior commitment is not convinced for further implementation, needs to see a business case.	Senior management commitment is not there, because of lack of awareness and no business pressure, they want to wait and see the others first. Mandate will come from head quarters. Are not falling under the FDA mandate.	Senior management is aware of the need for this technology. Need to comply with the FDA mandate.
Cultural capital	Lot of people involved, but understanding is low. It is in an infancy stage in the organization.	Very low understanding.	There is a low understanding about RFID, they are not involved in any kind of RFID body, and through information gathering they try to get the deeply understanding.
Social capital	Cooperation with trade partners and use of external networks will be used.	Cooperation is important internally and externally. Not active searching for information.	External sources are needed in order to understand and implement the technology. Information gathering though reading articles and newspapers is also an information source.
Environmental aspects			
Business environment	Costs are high, but these costs will go down and the issue will resolve. Market readiness; within the export, were the FDA mandate is applicable, the market has to be ready for it.	Gives concerns, costs has to drop down in order to step in. Market readiness; the export market oversees is ready and that should not give any problems.	Not an issue, the benefits will justify the investment. Market readiness; the export market oversees has to comply as well with the FDA, that should not be an issue.

Regulation environment	Global standardization has to take place.	Without global standards, we would not step in.	With close loop applications this is currently not a problem, but global standards need to take place soon.
Wider society	Social responsibility is important, but does not influence the decision around RFID. Privacy is not an issue in the near future.	Social responsibility is important, but does not influence the decision around RFID. Privacy is not an issue	Social responsibility is important, but does not influence the decision around RFID. Privacy is not an issue

Appendix V Interview data
Continued

Industry: Food and Beverage manufacturers		
Variables	**Company**	
	I	**II**
Technological aspects	**(Nestle)**	**(Unilever)**
Relative advantage	Traceability Shrinkage Security Counterfeit Identification (Can not make the link between issues and RFID solutions)	Warehouse Traceability
Compatibility	Have no idea.	No idea
Complexity	Have no insights in the complexity.	No idea about the implications of RFID
Trialability	Important to see the implications and the benefits.	No idea
Observability	Have no idea.	No idea
Organizational aspects		
Economic capital	Top two F&B manufacturer	Top two F&B manufacturer
Strategic capital	RFID is driven by head quarters, we wait till they decide. Senior management commitment is not there as a result of unawareness.	Head quarter is driving the technology, but SA does not follow.
Cultural capital	Very low knowledge level about the technology and its implications	There is no/very little knowledge about the technology.
Social capital	Participating in RFID body. Use of external sources is used to gather more information.	Attending conferences and presentations.
Environmental aspects		
Business environment	Cost is an issue, has to come down. Market readiness; think that the trade partners do not really care about RFID.	Costs are too high, but do not know the current price of tags. Market is not mature enough to drive RFID, still facing problems with barcode.
Regulation environment	Is important for us as an international company.	Maturity of the standards is a barrier
Wider society	Social responsibility is important, but does not influence the decision around RFID. Privacy plays a role, but through the low knowledge level what is the meaning of this answer.	Social responsibility is important, but does not influence the decision around RFID. Privacy is not an issue

Appendix V Interview data
Continued

Industry: Transport		
Variables	**Company**	
	I	**II**
Technological aspects	**(Cargo Carriers)**	**(BarloWorld)**
Relative advantage	Reduction operational costs Efficiency Productivity Tracking	Sees advantage in a lot of applications in the transport sector, they have an advisory role towards clients, act as a 4PL player.
Compatibility	Fits within the companies believes.	Fits within the companies believes.
Complexity	Depends how it is packaged, each level need it own information level. Close loop applications are not that complex to implement.	Ease of use is not an issue, it has benefits, and the rest is of no importance.
Trialability	Very important	Not that important, they try it out at the client.
Observability	Very important, it is a marketing tool and a strategic tool for added value.	Important, is use as a marketing tool and value added service.
Organizational aspects		
Economic capital	Small but influencing player in the transport sector.	Top two in transport sector.
Strategic capital	Senior management have great commitment, it is part of their strategy.	Senior management has commitment, it is in their strategic plan. Mandates are not applicable here.
Cultural capital	Knowledge within the organization is high.	There is awareness, but no deeply understanding.
Social capital	Visit seminars and conferences to expose their own experiences, member of a RFID body. Use consultants to assist them in implementation.	Make use of consultants when implement.
Environmental aspects		
Business environment	Cost is a matter of low awareness, the ROI of the technology is often forgotten. RFID is seen as a strategic tool and no costs can compete that. Market readiness; use only for own projects, market readiness is not an issue in this case.	Cost plays not a role, if the customer wants it, they do it. Clients face cost as a barrier. Market readiness; the clients awareness is low, and therefore not a top priority for them. In that case the market for Barloworld is not ready.
Regulation environment	Standardization is critical for mass adoption.	Standardization is no issue for them, but clients can see it as a barrier.
Wider society	Privacy issue is a matter of low awareness. While knowing the technology, this issue plays no role. Social responsibility does not play any role for implementing RFID if the client wants RFID they give, decision about social responsibility for RFID lay with them.	Privacy is not an issue Social responsibility does not play any role for implementing RFID if the client wants RFID they give, decision about social responsibility for RFID lay with them.

Appendix V Interview data
Continued

Industry: Telecommunication		
Variables	**Company**	
	I	**II**
Technological aspects	**(Telkom)**	**(Vodacome)**
Relative advantage	Asset tracking Visibility Stock taking	Sees no benefits
Compatibility	Very important	Does not really fit in the beliefs of the company.
Complexity	Front door is resource light, back door is resource intensive. IT-infrastructure and data maintenance going to be a challenge.	Has no idea, is not interested in the technology, no deep understanding about the complexity of the technology.
Trialability	Very important, have set a scope for a pilot.	Important to see the benefits, first on a small scale, later expanding towards the whole organization.
Observability	Very important	Important
Organizational aspects		
Economic capital	Top 2 telecommunication organization.	Top 2 telecommunication organization
Strategic capital	Commitment of senior level is there. No mandates are faced.	There is support and commitment of senior management.
Cultural capital	Small group of people involved, there is understanding about RFID. Internal changes are known.	No knowledge, because of the lack of advantage of the technology.
Social capital	Cooperation with consultants is a must in our organization. Attending workshops, conferences.	Did not search for information, because RFID is not a technology for them.
Environmental aspects		
Business environment	Costs are not an issue, when benefits are clear. Market readiness; keep it internally, market is not necessary for them.	Costs are not an issue. Money plays not a role if the technology gives benefits for the organization. Market readiness; at the moment the retail industry is not ready for RFID, there are still conflicts with the current way of scanning.
Regulation environment	Global standards are needed, because of their global import.	No idea
Social responsibility	Privacy is not an issue Social responsibility is important, but does not influence the decision around RFID.	Privacy is not an issue Social responsibility is important, but does not influence the decision around RFID.

Appendix V Interview data
Continued

Industry: Automotive manufacturers		
Variables	**Company**	
	I	**II**
Technological aspects	**(BMW)**	**(General Motors)**
Relative advantage	Returnable assets Shrinkages Visibility Security	Returnable assets Asset tracking Security
Compatibility	Not important	Not important
Complexity	No idea of the working or implications	Is no idea about implications, although they see problems with some applications in their environment.
Trialability	Very important, although they have no idea what kind of business case should be applicable in their organization.	Business case is very important for the first step, in order to convince senior management.
Observability	Not important	Not important
Organizational aspects		
Economic capital	Top 5 player in the automotive industry	Top 3 player in the automotive industry
Strategic capital	Head quarters is driving it, in SA there is not that commitment, need to see a business case first. Face no mandates.	There is no commitment of the board to support RFID, they are technology redundant.
Cultural capital	Very low understanding, head quarters have one person who has deeply understanding, SA is a follower of their strategy.	Level of knowledge is very low, they are willing but have no clue.
Social capital	Read the logistics news, participating in conferences also presenting there. Is a link with the AIDC and RFID body.	Visiting seminars and conferences.
Environmental aspects		
Business Environment	No issue	Cost issue, very low financial resources Market readiness; within the industry they are ready, but without the knowledge of implications, they are not sure.
Regulation environment	Need a global standard, but does not know which or what kind of standard.	A global standard for the industry, but head quarters needs to take the lead in this.
Wider society	Do not know the RFID implications for social responsibility. But does not see problems in that. Privacy is no issue	Do not know the RFID implications for social responsibility. But does not see problems in that. Privacy is no issue