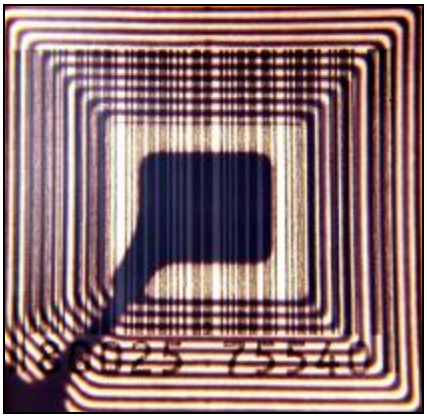
Master Thesis

RFID Adoption in Bookstores

A study on factors that explain adoption intention



Cover photo: RFID tag

Source: http://elproyectomatriz.wordpress.com/2008/02/04/microchips-en-humanos-una-realidad/

Author:	**Ward Jeurissen**
University:	**University of Twente** **School of Management and Governance** **Business Administration – *Innovation Management***
Company:	**Intres Media B.V.**
Graduation Committee:	**Dr. P.C. van der Sijde (University of Twente)** **Dr. A.H. van Reekum (University of Twente)** **Mr. A. Guliker (Intres Media)**
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I Management Summary

Intres Media was interested in studying the opportunities of RFID technology for their Libris bookstore chain. With this study, Intres Media wanted to find out what intention the bookstore entrepreneurs had to adopt RFID technology. From a scientific point of view, it was relevant to study what factors explain the level of RFID adoption intention with these bookstore entrepreneurs.

A case study was made to compare the opportunities for RFID technology to the current barcode technology. It appeared that RFID offered some o*perational improvements in* the ordering process, the stock reliability and shrinkage insights. RFID also *improves store turnover* by providing an increase in custom orders and a decrease in the shrinkage levels and 'Out of stock sales'. Finally, RFID *improves the shopping experience and customer satisfaction* by offering self-service facilities, enhancing the traceability of stock and making the custom order process more advanced.

However, RFID adoption also involves a number of negative aspects. The case results show that the technology is to some degree still in development. In spite of the positive adoption results in this case, the technology appears not to be 100% reliable yet. In addition, the attitude of store personnel towards RFID technology can have negative effects on RFID adoption. The success of RFID implementation depends for a large part on the commitment and discipline of store personnel.

To measure adoption intention among bookstore entrepreneurs, a theoretical model has been developed that was tested on a population of bookstore entrepreneurs by a survey. The Adoption Intention Model (AIM) measures *RFID Adoption Intention* and is based on the existing UTAUT model for determining acceptance and use of new technology. The AIM model introduces two additional factors that originate from literature and the preceding case study. According to the results of the survey, three factors were able to explain the level of adoption intention significantly. The additional factors *RFID Facilitating Conditions* and *RFID Technology Trust* are of significant influence on the level of RFID Adoption Intention. The strongest factor in predicting RFID Adoption Intention is *RFID Performance Expectancy*. Analysis of the survey results shows that the average respondent has an above-average intention to adopt RFID technology. It appears that two groups of respondents have a significant higher level of adoption intention. The first one is entrepreneurs operating in multiple branches. The second one is entrepreneurs of the male sex. These two groups have a significantly higher level of adoption intention than the other entrepreneurs who only operate a single store or entrepreneurs that are of the female sex.

II Management Summary (in Dutch)

Intres Media heeft opdracht gegeven om te onderzoeken welke kansen RFID technologie biedt voor haar boekhandelsketen Libris. Daarnaast was er de vraag welke intentie de boekhandelaar heeft om RFID technologie te adopteren. Vanuit wetenschappelijk oogpunt was het relevant om te onderzoeken welke factoren van invloed zijn op de mate van RFID adoptie intentie.

Om de kansen van RFID technologie, ten opzichte van bestaande barcode technologie voor de boekhandel te onderzoeken, is er gebruik gemaakt van een case studie. Uit de case resultaten blijkt dat RFID *operationele verbeteringen* biedt door het verbeteren van: de voorraad betrouwbaarheid; de inzichtelijkheid in derving; en het bestel- en leveringsproces. Daarnaast blijkt dat RFID *de winkelomzet verbeterd* door: een toename van klantorders; afname van 'nee verkopen' en vermindering van derving. Ten slotte blijkt dat RFID *de koopbeleving* en *klanttevredenheid verbeterd* door: geavanceerde zelfservice faciliteiten; verbeterde vindbaarheid van titels en geautomatiseerde bestel mogelijkheden.

RFID adoptie brengt echter ook een aantal negatieve aspecten met zich mee. Uit de case resultaten is gebleken dat RFID technologie in zekere mate nog in staat van ontwikkeling verkeerd. Ondanks de goede resultaten die in deze case behaald zijn is de technologie nog niet 100% betrouwbaar gebleken. Daarnaast blijkt dat de houding van de winkelmedewerkers ten opzichte van RFID technologie een negatief effect kan hebben op RFID adoptie. Het succes van RFID adoptie hangt sterk af van de betrokkenheid en discipline van winkelmedewerkers.

Om de mate van adoptie intentie onder boekhandel ondernemers te meten is een theoretisch onderzoeksmodel ontwikkeld dat getoetst is door middel van een enquête. Het Adoptie Intentie Model (AIM) meet het intentie niveau voor RFID adoptie en is gebaseerd op het bestaande UTAUT model voor het vaststellen van acceptatie en gebruik van nieuwe technologie. Het AIM model biedt twee additionele factoren die zijn voortgekomen uit literatuuronderzoek en de case studie. Naar aanleiding van de resultaten van de enquête kan gesteld worden dat er drie factoren zijn die de mate van adoptie intentie significant beïnvloeden. Het blijkt dat de additionele factoren *RFID Faciliterende Condities* en *RFID Technologie Vertrouwen* van significante invloed zijn op de mate van RFID adoptie intentie. *RFID prestatie verwachting* blijkt de sterkste voorspeller van RFID adoptie intentie. Analyse van de resultaten laat zien dat de gemiddelde respondent een bovengemiddelde mate van RFID adoptie intentie heeft waarbij onderscheid kan worden gemaakt tussen twee groepen. Ondernemers met meerdere filialen of van het mannelijke geslacht blijken een significant hogere mate van adoptie intentie te hebben dan de ondernemers met 1 filiaal of van het vrouwelijke geslacht.

III Preface

In order to accomplish my study in Business Administration, I accepted a research assignment at the Dutch retail organisation Intres. When I first heard about the assignment at Intres Media, I was immediately interested. To study an innovative technology like RFID and all of its adoption aspects in a bookstore context, I became aware of a close fit to my master specialisation Innovation Management. Because I was convinced that conducting the assignment as an intern would offer me better research facilities and organisation insights, I left Enschede and moved to the city of Amersfoort at the beginning of this year. Besides the research assignment, Intres offered me a part-time job as assistant with the buying department for two days a week. This job had no particular links with the assignment but got me involved with the "*books business*" and helped financing my costs of living.

My time at Intres was a very informative and enjoyable experience. During the research and work it felt like I became part of the organisation. Looking back I can say that the Intres Media team consists of very dedicated and professional people that really provide the retail formula's Blz. and Libris of distinct added value. In this context I would like to acknowledge my company supervisor Andries Guliker for his trust and support during my research. I would also like to thank Andries for sharing his office with me and for reflecting all my 'Retail ideas', which was really good fun. Next I would like to thank Jan van Schoot as he was my manager at the buying department. I have experienced working with Jan, and my direct colleague Harold Bouwman, as very refreshing and will not soon forget the realization of the 'Spring market catalogue' under difficult circumstances. Finally I would like to thank Caroline Damwijk, CEO of Intres Media, for her trust in my research.

Performing this thesis would have been a completely different story when I did not have my team of supervisors at the university. Both Peter van der Sijde and Rik van Reekum were of great help to me and it was very pleasant working with them. The meetings with Peter and Rik provided me with useful suggestions and stimulated me to get more out of this research. After each meeting I was driving home, realizing I had new insights and a sound overview of my research again!

Next I would like to thank Joris van Hoof and Pieter Terlouw for their help with SPSS and feedback on the statistical analysis of the survey results. I also have to acknowledge Tiemen Strijk for reviewing my concept and helping me out with the thesis lay-out.

At last, but certainly not the least, I am very grateful to my parents. They supported me in every way during my college years. Looking back, I almost cannot believe their level of patience and trust in me. Thanks a lot.

Ward Jeurissen

Enschede, October 12, 2008

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1. Introduction

This research thesis concerns the adoption of new technology in a retail environment. Innovations are necessary for companies to enhance their market position and improve their business operations. However, acceptance and use of new technology is not a self-evident process. Innovations will not diffuse by themselves, but depend on various adoption factors. Technology adoption depends on the level of adoption intention of the prospective adopter. Within this research, adoption intention is the subject of study. The innovation regards to RFID technology and the research context is the independent bookstore.

1.1 Research initiator

Intres Retail B.V. is one of the largest non-food retail organisations in the Netherlands. 1250 associated entrepreneurs exploit 1900 specialty stores, department stores, fashion malls and megastores in Fashion, Living, Sports and Media. They represent a sales total of more then 2 billion euro. The organization offers entrepreneurs a wide range of retail expertise and various cooperation possibilities within three core business units: Intres Retail Collaboration; Intres Retail Services and Intres Retail Formula's. Intres Retail head office is located in Hoevelaken and employs 300 FTE.

Intres Media is a subsidiary of Intres Retail and comprise the organisation and support of two independent bookstore formula's. The formula Blz. consist of a chain of 85 bookstores situated in smaller cities, often less then 50.000 inhabitants. Blz. has a moderate assortment of books that is complemented with magazine's and office equipment. The formula Libris consists of a chain of 105 bookstores often situated in cities of more then 50.000 inhabitants. Libris bookstores are top market bookstores with an extensive assortment of literature and non fiction titles. Both formula's have a combined market share of 27% on the Dutch market. This makes Intres Media the largest book retailer in the Netherlands.

1.2 Research motive

In order to maintain a strong competitive position on the Dutch market, Intres media works with advanced purchase automation systems. 95% of all associate entrepreneurs use branch specific store automation and take advantage of efficient purchase tactics of the head office. This result in better margins and lower distribution costs. In order to keep ahead of the competition and remaining an innovative disposition, Intres media deliberate on further automation activities. The organisation follows the developments of RFID applications in retail with particular interest. RFID technology is seen as a radical innovation, or even as the successor of barcode, that offers new opportunities for bookstore

retailers. RFID also entails many questions and uncertainties about the maturity of the technology and the fit within the independent bookstore. In the last couple of years there have been many pilot projects setup concerning RFID applications in retail. The results of the projects often looks promising but are very dependent of the type and level of RFID technology applied. In 2007, one specific RFID project became very famous. Dutch book retailer BGN rolled out RFID in their new Selexyz bookstore. BGN took RFID beyond the pilot stage and adopted the technology on item level, representing the whole store inventory. At the end of 2007 they announced to roll out RFID in all of their branches in the next years.

1.3 Research goal and relevance

Practical research goal

RFID applications may become an important strategic instrument to obtain a strong competitive position in the book retailing market. Researching the RFID case in the Netherlands is from this point of view very desirable. In order to provide the initiator of relevant RFID adoption insights, a case study is performed concerning RFID adoption in a bookstore context. At the same time, the initiator wants to have insight into the attitude of the associate entrepreneur concerning RFID adoption and their level of adoption intention. Determining the adoption factors and measuring behavioural intention results in conclusions in respect to RFID adoption in the independent bookstore.

Scientific research relevance

The Unified Theory of Acceptance and Use of Technology (UTAUT) combines existing theories about technology adoption into one unified model. A literature study did not uncover earlier empirical research about the examination of the UTAUT model in a bookstore context. From a scientific perspective it is interesting to know to which extend the UTAUT concept is applicable. In this study, a new model has been developed based on UTAUT constructs and additional adoption factors. The new model illustrates what factors explain RFID adoption intention.

1.4 Research questions

Four research questions have been formulated to accomplish the research goals. All questions concern the adoption of RFID technology by the independent bookstore entrepreneur.

RQ 1) Does RFID offer added value to the independent bookstore entrepreneur?

RQ 2) What factors explain adoption intention of RFID technology?

RQ 3) What is the level of adoption intention of the independent bookstore entrepreneur?

RQ 4) What are the effects of adopter characteristics on adoption intention?

1.5 Thesis overview

Chapter 2 of this research will provide a brief *introduction of RFID* principals. In this chapter, the technology and the design of an RFID system are explained. Chapter 3, *theoretical framework* introduces, and motivates, the theoretical research model. Chapter 4, *research methods*, explains the chosen research methods. Chapter 5 consists of the *research results*. The first part of this chapter consist of the research results concerning RQ 1 and the second part consists of the results concerning RQ 2, 3, and 4. In chapter 6, *research conclusions*, all RQ's are answered. Chapter 7 *discussion,* discusses the research model and the external validity of the research results.

2 RFID technology

The following chapter explains the operations of an RFID system. Because the origin of RFID technology dates back to world war II, a brief history of the technology is presented before RFID technology in retail is explained.

2.1 Historic origin and retail application

In world war II there were a lot of uncertainties. The allied forces were often not sure of strategic actions undertaken because of a lack of information. One specific problem arose and needed a very effective and reliable solution. Radio Detection and Ranging technology (Radar[1]) made it possible to recognize fighter airplanes from over large distances. It had one major disadvantage: it was not able to distinguish Friend-or-Foe. The need to identify own aircrafts on the battlefield was of great importance for the overall strategy to conquer the enemy. During the war the British developed a Radio Frequency Identification (RFID[2]) technology that was based on existing radar systems. RFID existed of transponders build-in allied planes that made it possible to identify an airplane as Friend-or-Foe. RFID technology had, without doubt, a positive outcome on the war strategy of the allied forces and, eventually, the ending of the war.

The above prologue has some remarkable common features with today's retailing challenges. In western retail; the battle is between retailers that try to reach the customer in order to enhance their sales and increase customer satisfaction. To create a customer focus strategy in which long term relationships with customers are desired, companies need information from suppliers, products and customers. A lot of companies find it difficult to gather such information and subsequently the strategy is not based on the right data or the strategy is executed without relevant data input.

Data collection in a retail environment mainly focuses on warehouse management and financials and less on supply chain and Custom Relationship Management (CRM) information. The gathering of information has to do with the movement and storage of materials within the store or warehouse and includes data about shipping, receiving, storage and picking of goods. Collected information is often automated in some kind of Electronic Resource Planning (ERP) system. In order to reach the customer, companies try to design their businesses in such a way that their product or service meets the demands of the customer in the most effective and efficient manner. Since the 1980's a store or warehouse management system utilizes Auto ID Data Capture technology (AIDC) like barcode technology and computers to monitor the flow of products. Barcode technology was developed in the 1960's and is diffused among a variety of industries. These days,

[1] Radar was invented by Watson Watt in 1935
[2] RFID was developed by the RAF in world war II

barcode is very mature but has its limitations. Because of the limitations, companies seek for other AIDC technologies that can improve or replace barcode in order to add more value to the product and service. From the beginning of the 21st century, retail companies are experimenting with the RFID technology as AIDC in pilot projects. A comparison between barcode and RFID functionality is provided as appendix III.

2.2 RFID system

An RFID system is used to identify unique products, animals or humans without the need of a direct "line of sight" between the reader and the product. The basic technology, illustrated in figure 1, exists of RFID tags, readers and special software. In the following sub paragraphs, these elements will be clarified in more detail.

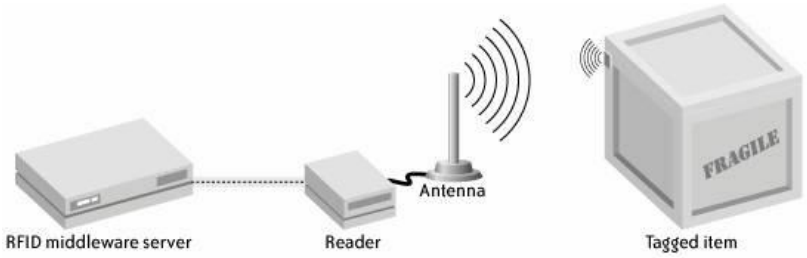

Figure 1: RFID system (Bhatt, 2006)

The RFID tag

Each RFID tag consists of a silicon chip, an antenna, and some kind of housing. The size depends on the application type. RFID tags can be as large as a paperback book and smaller then a grain of rice. The data on the tag can be either fixed or rewritable. When an RFID chip is scanned, it provides specific information, often in the form of a unique, fixed, code that serves as a key to unlock information from a central database about the identity of the chip. This unique identity in combination with the place and time the identity is scanned, provides the information to track movements through an RFID environment. RFID tags can be distinguished in two classes: Active tags and passive tags. Active tags contain batteries while passive tags use the static energy from the radio frequencies used to read the tag.

The RFID reader

The reader sends RF signals to the tag in the form of radio energetic pulses and then 'listens' to the response of the tag. The tag senses the radio energetic pulse from the reader and will send a response to the reader that contains the unique serial number of the tag. The reader can also switch the tag on or off and read or write the memory in the tag.

The range in which a tag can be used differs. It depends on the tag's class; antenna type; type of tag reader; software; and the radiofrequencies used.

RFID middleware

RFID middleware manages the RFID readers and passes the read data from the tags to its database system. The information from the RFID tag is processed with special software that defines the information, status and location of the tags.

2.3 Bookstore context

When individual products are fitted with RFID technology, they have a unique identity and can be recognized in real time over large distances. The advantage of real-time track and trace of products does not only offer solutions concerning warehouse management but also offers improvements for the value chain and the customer relationship strategy of the company. Many large retailers like Wall Mart and METRO experiment with RFID technology on pallet, carton and item level (Garfinkel, 2005), (Flederus, 2005).

In Dutch retail some pilots with RFID have looked very promising and revolutionary. In 2005, Dutch bookstore retailer BGN set up a pilot project to tag every book in their new chain store with RFID (Ammelrooy, 2006). Because of the results of this pilot BGN decided to roll out the technology to the rest of their stores in 2007. Because they were the first retailer on the globe to apply RFID on all their products, a lot of media attention followed. In 2007 the Portuguese bookstore chain Byblos follows with a full roll out of RFID in their flagship store in Lisbon (RFID Journal, 2008). It seems that RFID is very interesting for implementation in bookstores. The character of bookstores and books as a product, derive interesting opportunities to adopt the technology, but there is still a lot of uncertainty about the adoption strategy. The next chapter will explore the theory about technological innovations; how they are diffused among a social system; and what factors are of relevance in case of explaining the intention to adopt RFID technology.

3 Theoretical framework

This chapter provides an overview of existing theories about technology adoption and innovation diffusion. Exploring the diffusing process of innovations creates more understanding about the adoption process of new technologies. Because the diffusion theory involves adoption of innovations on macro level and between adopter groups, insights in individual decision making are considered necessary. Within this research thesis the Unified Theory of Acceptance and Use of Technology (UTAUT) is used for explaining individual use behaviour and behavioural intention. The chapter starts with an introduction of the innovation concept and explores how innovations are diffused. In the second part of the chapter the UTAUT model is introduced and analyzed. In the last paragraph the design of a revised model for RFID adoption intention is motivated.

3.1 Innovation

Although there are various definitions of the concept innovation, literature shows that they all share common principals in a way that innovation is about the successful introduction of something new (or altered) and useful in the appearance of a process, service or product. According to Miller (1999) "*innovation is the process of transforming an idea or invention in something that has useful commercial applications".* According to Rogers (2003) "*An innovation is the idea, practise, or object that is perceived as new by an individual or other unit of adoption".* The innovation diffusion theory of Rogers (2003) also says that "*it matters little whether or not an idea or invention is 'objectively' new as measured by the laps of time since its first use or discovery*". Often innovations can be seen as radical or incremental changes to products, processes or services. By adding value, innovation has the purpose to improve or overcome an existing problem related to a product, process or service. In this context Huizingh (2008) stated that "*innovation should lead to increased value, user value and producer value*". In order to distinguish between invention and innovation Fagerberg (2004) formulate: "*An invention is considered to be the first occurrence of an idea for something new and Innovation is the first attempt to carry it out in practice".* In addition: the word 'innovation' is often used as a synonymous for new technology in research literature because most new ideas or inventions seem to be of a technological kind.

Technological innovation

According to the dictionary, technology is defined as: "*the domain of knowledge that deals with the creation and use of technical means and their interrelation with life, society and the environment, drawing up on such subjects as industrial arts, engineering, applied science and fundamental science*". In short: Technology is the systematic and practical application of knowledge.

As mentioned earlier, most innovations are in some extend of a technological kind. An *technological invention* is the process of creating new technology. (The innovation explicitly concerns the technological aspect of a new product, process or service.) *Technological innovation* is seen as the perceived newness of the technological invention by members of a social system. (individual or other decision-making-unit). The newness is about the uncertainty and the level of knowledge, persuasion or decision to adopt the innovation. The uncertainty level depends on the information seeking process in which advantages and disadvantages are considered by the individual or decision making unit.

3.2 Diffusion of innovations

The adopter population can be seen as a social system in which individual members make a decision to adopt or not. When a new technology is adopted by members of a social system, often several steps has been taken before the decision for adoption has been made. Diffusion relates to the communication and mutual understanding between the involved participants about the innovation in order to clarify uncertainties. The diffusion of a (technological) innovation is represented in figure 2 and concerns the process by which *an invention (1) is considered as an innovation (2) and via certain channels (3) is communicated (4) over time (5) among members of a social system (6) in order to make an adoption decision (7).*

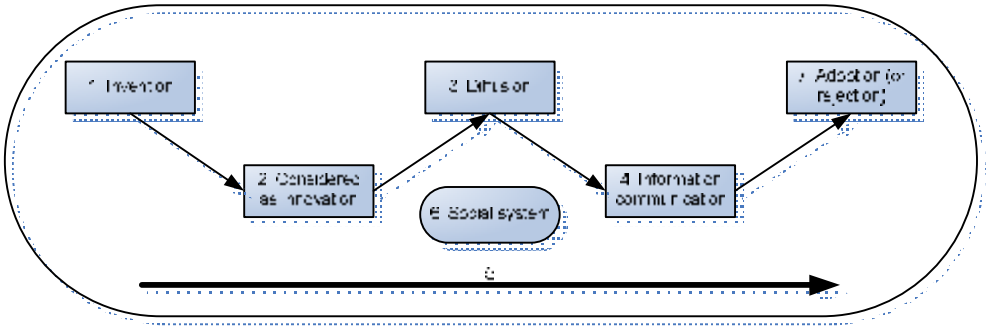

Figure 2: Diffusion process of innovations

Rogers (2003) studied the diffusion speed of innovations among a certain population. In his research, Rogers differentiated 5 adopter classes depending on the moment that a member of a social system adopts an innovation. *Innovators* or lead users represent the first 2.5% of the population and are the first ones to adopt an innovation. These group is characterized by their venturesome, risk taking and educated characteristics. They often function as change agents as they are part of the development and application of the innovation. 13% of the population can be seen as e*arly adopters* and are visionaries because they recognize advantages of the innovation in an early stadium. They are often social leaders within their market and dare to take risks involved with the usage of new

technologies. The *early majority* (34%) are the next group of individuals that adopt the innovation. They accurately review the pro's and con's of an innovation and often decide to adopt the innovation within subgroups at the same moment. The *late majority* (34%) is characterised by a more sceptical attitude towards innovations This is a sensible group of adopters that is motivated to adopt the innovation just to keep up with the competition in the market. The final 16% consists of *"laggards".* Laggards are very traditional and tend to be very aversive against adoption because of a disbelieve in the advantages of the innovation. They block adoption as long as possible or do not adopt at all (non-adopter).

3.2.1 Adoption rate of innovations

The innovation diffusion theory has produced an S-shaped distribution curve that illustrates the cumulative adoption rate of an innovation over time. The process of adopting a new technology within a certain social system has got two important dimensions: The adoption rate and the diffusing time. These two dimensions are positively related to each other as can be noticed in figure 3. The *adoption percentage* represents the level of adopters within a certain social system. *Time* represents the diffusion time that is needed for adopting the innovation over time among the different individuals within the social system. The relationship between adoption and time, is the relative speed in which the innovation is diffused. An important distribution indicator is distinguished in the 'point of critical mass'. At this point about 13% of the population has adopted the new technology. Reaching this rate of adoption implies further and faster diffusion of the innovation. Variations in the slope of the S-curve are possible because the diffusion process differs per innovation type. Strong steepness of the curve indicates a fast diffusion process.

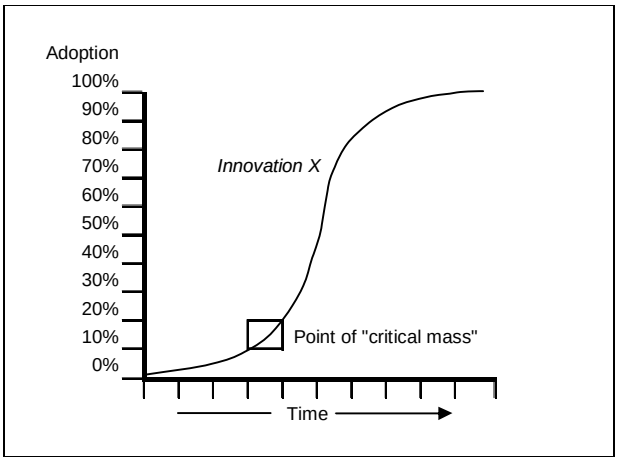

Figure ***3: S-shaped diffusion curve*** **(Rogers, 2003)**

3.2.2 Attributes of innovations

The adoption rate of innovations is determined by a variety of factors. These factors did not received equal attention from diffusion scholars. The type of innovation decision, the type of communication channels diffusing the innovation at several states in the innovation-decision process, the extend of change agents and their promotion efforts in diffusing the innovation, the nature of the social system in which the innovation is diffusing and the perceived attributes of innovations explain differences in adoption rates. It is this last factor, the perceived attributes of innovation, that have been investigated extensively and appear to play an significant role in explaining the rate of adoption. In his fourth edition of *Diffusion of Innovations*, Rogers (2003) discovered that 49% to 87% of the variance in the rate of adoption of innovations is explained by the perceived attributes of innovations. Rogers differentiated five characteristics of innovations that help to explain differences in adoption rates. *(1) Relative advantage* is the degree to which an innovation is considered as better than the idea it supersedes. *(2) Compatibility* is the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of potential adopters. *(3) Complexity* is the degree to which an innovation is perceived as relatively difficult to understand and to use. *(4)* Trialability is the degree to which an innovation may be experimented with on a limited basis. *(5) Observability* is the degree to which the results of an innovation are visible to others. Rogers (2003) emphasized on the importance of the individuals' perceptions of the attributes of an innovation and not on the objectively classification of the attributes by experts or change agents.

3.3 Individual technology acceptance

In extension to the innovation diffusion theory, the acceptance and adoption of new technology has to do with individual perception of the characteristics of the innovation and the individual decision to adopt or not. The last couple of decades various research models concerning technology adoption and use behaviour have been developed. Most of these theories describe behavioural intention as an important determinant of use behaviour. Eight prominent theories in this research area became fundaments for a unified theory concerning acceptance and use of new technology. This unified theory was developed in 2003 by Venkatesh et al and was called the "Unified Theory of Acceptance and Use of Technology [UTAUT]. The UTAUT model is used as point of departure for studying adoption intention.

3.3.1 UTAUT model

The UTAUT model presented in figure 4 is based on eight behavioural explaining theories; the Innovation Diffusion Theory; IDT (Rogers; 1962), Theory of Reasoned Action; TRA (Fishbein & Ajzen, 1975), Social Cognitive Theory; SCT (Bandura, 1986), Technology Acceptance Model; TAM (Davis, 1989), Motivational Model; MM, Theory of Planned Behavior; TPB (Ajzen, 1989), Model of PC Utilization; MPCU (Thompson, Higgins & Howell, 1994), Combination of TAM and TPB; C-TAM-TPB (Tyler & Todd, 1995).

The research of Venkatesh et al demonstrates that the UTAUT model is a strong instrument to explain the individual's acceptance and use of new information technology within organisations. In their research, the UTAUT model was able to explain 70% of the variance of use behaviour.

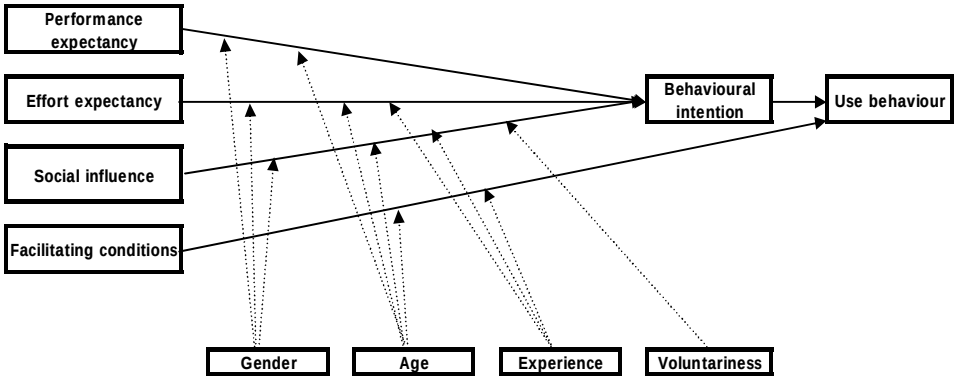

Figure 4: UTAUT model

The dependent variable in the model is called Use Behaviour. Use Behaviour is predicted by two variables. *Behavioural Intention* and *Facilitating Conditions*. Behavioural Intention is the intention of an individual to use new technology. There are three independent variables that predict Behavioural Intention. These variables are *Performance Expectancy*, *Effort Expectancy* and *Social Influence*. The fourth independent variable, Facilitating Conditions, is a direct determinant of Use Behaviour. The moderating variables within the model are *Gender, Age, Experience* and *Voluntariness of Use*. These independent variables describe the individual's characteristics that appeared to moderate the effects of the independent variable on the dependent variable. If an individual has a high level of behavioural intention towards a new technology, and possess over sufficient facilitating conditions, it is likely that this individual will adopt (use) the new technology.

3.3.2 UTAUT adoption factors

Behavioural intention

The UTAUT model consists of three independent variables that explain the intention to adopt an innovation (Behavioural intention). The constructs *Performance Expectancy, Effort Expectancy* and *Social Influence* are defined and accompanied with their root concepts from preceding technology adoption theories.

Performance Expectancy is defined by Venkatesh et al as *the level to which an individual believes that using the technology will help to attain gains in job performance.* In the UTAUT model Performance Expectancy appeared to be the strongest construct in case of predicting behavioural intention. The determinants of behavioural intention from the original theories that capture this UTAUT construct are: Perceived usefulness (TAM I, II, II and C-TAM-TPB), Extrinsic motivation (MM), Job-Fit (MPCU), Relative advantage (IDT) and Outcome expectations (SCT).

Effort Expectancy is defined by Venkatesh et al as *the level of ease that is related when using the technology.* The determinants of behavioural intention from the original theories that capture this UTAUT construct are: Perceived ease of use (TAM I, II, III), Complexity (MPCU), and Ease of Use (IDT).

Social Influence is defined by Venkatesh et al as *the level to which an individual perceives that important others, in their social network, believe he or she should use the technology.* The determinants of behavioural intention from the original theories that capture this UTAUT construct are: Subjective norm (TRA, TAM II III, TPB/DTPB, C-TAM-TPB), Social factors (MPCU), Image (IDT).

Use behaviour

The UTAUT model consists of two independent variables that explain innovation usage (Use behaviour). The constructs F*acilitating conditions* and *Behavioural Intention* are defined and accompanied with their root concepts from preceding adoption theories.

Facilitating Conditions is a direct determinant of use behaviour. Facilitating Conditions are defined by venkatesh et al as the level to which an individual believes that an organizational or technical environment exists that supports the technology. The determinants of behavioural intention from the original theories that capture this UTAUT construct are Perceived behavioural control (TPB/DTPB, C-TAM-TPB), Facilitating conditions (MPCU), Compatibility (IDT).

Behavioural Intention although behavioural intention is explained by Performance expectancy, Effort expectancy and Social influence, the variable itself is not defined in the model. Venkatesh et al (2003), state that there is a positive linear relation relation between intention and use behaviour. Within this research we use the definition of Fishbein and Ajzen (1975) that intention is *'the subjective probability of behaviour'*.

Gender, Age, Experience and Voluntariness of Use are key moderators within the UTAUT model. These variables have the ability to modify the effects of the adoption factors on the level of adoption intention and adoption use.

3.4 Revised model

A specific model that is able to determine the level of RFID adoption intention in a retail setting is desired because behavioural intention is a strong predictor of forthcoming RFID usage. Distinct knowledge about the determinants of RFID adoption intention, and how they are related, enables in example the development of practical instruments that are capable to influence the effects of these determinants.

UTAUT Fundaments

The UTAUT model is used as a fundament to develop an adjusted model for RFID adoption intention. The decision to use the UTAUT model as an explanatory model for RFID adoption intention is based on three arguments. First the UTAUT model suits the RFID context very well because the original UTAUT research context concerned IT related innovations. Second the UTAUT model has to do with individual decision making in an organisational context. This is the case for the bookstore and the decision authority of the entrepreneur. Third, the UTAUT model has proven to establish a higher explaining variance concerning use behaviour then all preceding technology adoption theories.

Limitations of the UTAUT model

The UTAUT model is designed to explain the degree of use behaviour. Therefore the original model is only of relevance in situations were the innovation is already adopted, which is not the case. The variable Facilitating Conditions is presumed to be a direct determinant of use behaviour and does not influence the behavioural intention. This is questionable because Facilitating Conditions are indeed a necessary factor in case of adopting an innovation, but they might also have a direct influence on the behavioural intention. For example in case there are poor facilitating conditions it is presumable that the level of facilitating conditions are of influence on the overall behavioural intention. Also facilitating conditions might be correlated with other variables in the model that explain adoption intention. Venkatesh et al did not involve the knowledge aspects in the UTAUT model. Never the less, adoption of new technology often requires knowledge resources. The level of these knowledge resources is

of relevance on facilitating conditions and might influence the intention to adopt. At last the model lacks the aspect of subjective technology trust. The level of trust in, for example, the maturity of a new technology, might be of influence on the intention to adopt the new technology. Research has demonstrated the importance of trust and is explained in more detail in paragraph 3.4.2 *RFID adoption factors*.

3.4.1 AIM model

In respect to research question 3 '*What is the intention of the entrepreneur to adopt RFID*?' the UTAUT model has been adjusted to the RFID context and the independent bookstore entrepreneur. The dependent variable within the Adoption Intention Model [AIM], presented in figure 5, is Adoption Intention of RFID (*Behavioural intention in the original UTAUT model)* Adoption intention is the behavioural intention of the entrepreneur to use RFID applications and technology. Actual RFID adoption (*Use behaviour in the original UTAUT model*) is left behind in the new model because the technology has not been adopted in this case and thus it cannot be measured. Based on the original UTAUT model, four variables are applied and one new variable, technology trust, is added to the model. The new variable Technology Trust is a complement to the variables Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions.

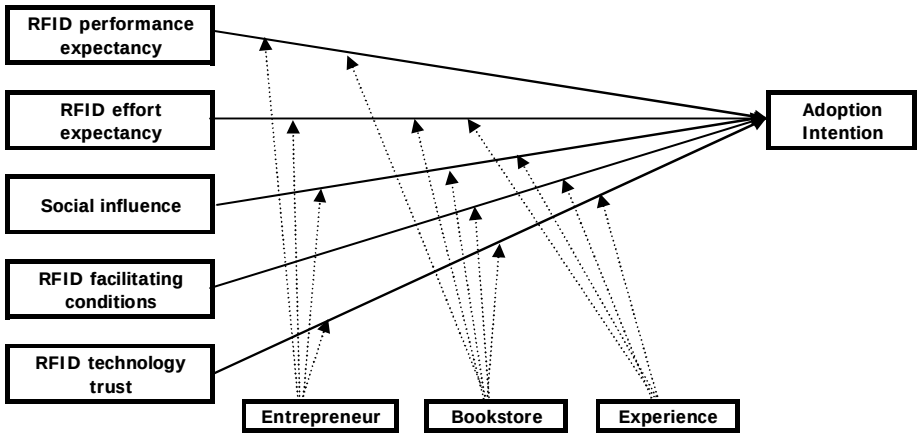

Figure 5: AIM model

3.4.2 AIM adoption factors

The AIM model consists of five independent variables that explain adoption intention. The constructs RFID Performance Expectancy, RFID Effort Expectancy, Social Influence, RFID Facilitating Conditions and RFID Technology Trust are defined and placed in historic context with their root concepts from preceding adoption theories.

Adoption intention is the dependent variable within the adjusted model and is defined as the subjective purpose of the bookstore entrepreneur to adopt RFID technology. RFID adoption intention is considered to determine actual RFID implementation in the bookstore.

RFID Performance expectancy is defined as the belief of the bookstore entrepreneur that RFID technology improves the performance of bookstore operations compared to present status of automation. The determinants of RFID performance expectancy projected on the original adoption theories are Perc*eived usefulness of RFID technology (TAM I, II, II and C-TAM-TPB), Extrinsic RFID motivation (MM), RFID Job-Fit (MPCU), Relative advantage of RFID compared to present automation (IDT), Outcome expectations of RFID technology (SCT).*

RFID Effort expectancy is defined as the level of ease concerning RFID usage in the bookstore compared to the present status of automation. The determinants of RFID effort expectancy projected on the original adoption theories are *Perceived ease of RFID use (TAM I, II, III),Complexity of RFID (MPCU), Ease of RFID use (IDT).*

Social influence is defined as the level of influence on the bookstore entrepreneur by their social environment (colleagues, competitors, head office, counsellors, etc.) about RFID adoption. The determinants of Social influence projected on the original adoption theories are *Subjective norm about RFID (TRA, TAM II III, TPB/DTPB, C-TAM-TPB), Social factors of the entrepreneur (MPCU), Image of the entrepreneur (IDT).*

RFID Facilitating conditions is defined as the level to which the bookstore entrepreneur believes that their organizational, entrepreneurial and technical environment has enough knowledge or expertise to support RFID implementation. The determinants of Facilitating conditions projected on the original adoption theories are *Perceived RFID operational control (TPB/DTPB, C-TAM-TPB), Facilitating RFID conditions (MPCU), RFID compatibility (IDT).*

RFID technology trust is expected to be related to technology adoption. A unified definition of trust that is useful among different situations does not exist. However, according to different dictionaries, two factors play a significant role in the concept trust: *Uncertainty* and *Vulnerability*. When some kind of uncertainty for a new technology exists, a degree of vulnerability is created for the potential adopter. Often the environment in which the potential adopter is operating consists of uncertainties. In case of the independent bookstore context, the evaluation of the environment includes perceptions and proficient knowledge about RFID technology and their suppliers. A lack of trust creates uncertainty with the potential adopter, and therefore trust is necessary for the adoption of a new technology.

Van der Geest et al (2005) also states that "*trust is relevant in determining the acceptance of new technologies*". Bhamanziari et al (2003) states that the factors "*Perceived usefulness*" and "*Ease of use*" (operated as RFID Performance expectancy and RFID Effort expectancy in the AIM model) are necessary for the adoption of new technology. Just as important however is "*subjective trust*" in the new technology and its supplier which might be the decisive factor for the adoption decision. The results of the research of Bhamanziari et al (2003) suggest that trust is an important predictor of adoption intention of new technology. It should therefore be incorporated in future research models that focus on technology acceptance.

In the AIM model, Technology Trust is defined as the level of confidence that the entrepreneur has in RFID technology, their RFID business partner and the supplier of RFID technology.

The moderating variables Entrepreneur, bookstore and Experience may influence the effects of the independent variables. The variable Voluntariness of Use is excluded from the model because the entrepreneurs are independent and cannot be mandated to adopt RFID. Adoption or rejection of RFID is therefore a freedom of choice. The moderators of the original UTAUT model are by it self not adequate enough. Therefore, compulsory attributes are needed in order to describe the independent entrepreneur and his bookstore. A distinction is made between the characteristics of the entrepreneur and the characteristics of the bookstore. The intervening variable Experience remained in the model but concentrates on automation experience.

The next chapter describes the research methods that are needed in order to study these adoption factors empirically.

4 Research methodology

The previous introduction of RFID, the theoretical framework and the new model for explaining RFID adoption intention are the impetus for two specific research methods in order to answer the research questions. The first method consists of a case study that answers the first research question. The second method consists of a survey, based on the AIM model, in order to give answer to the subsequent three research questions.

4.1 Case study

A case study can be defined as empirical research about a contemporary phenomenon within its real-life context when; the boundaries between the phenomenon and context are not clearly evident; and in which multiple sources of evidence are used. Malhotra and Birks (2003, p.140) define a case study as a "*detailed study based upon the observation of the intrinsic details of individuals, groups and organizations*". From these perspectives it seems clear that the 'case' is the level of analysis and that it has to be studied intensively and detailed and from more then one point of view. According to Yin (1989, p.23) a case study is grounded on some conditions. The overall research question is based on the presumption why or how something is working that way. A second argument to use a case study is when the researcher has very little control over the research situation. A third reason might be if the phenomenon is very rare.

Case study goal

The purpose of this case study is to acquire knowledge of the RFID adoption process in a bookstore context. Because the phenomenon is rare and consists of unique conditions, in which no other examples around the world are operational, a single case study is used to analyze the adoption process of RFID at Dutch bookstore retailer "*Boekhandels Groep Nederland*" [BGN]. BGN's top market bookstore chain '*Selexyz*' consists of 16 stores located in large cities all over the Netherlands. Besides the large consumer stores, there are several sub-branches on university campuses. The Selexyz Bookstore chain is the second largest bookstore chain in the Netherlands and the first retailer in the world that adopted RFID on item level and on full-scale in three of their bookstores. Full-scale means that every book (item) in stock is equipped with RFID technology.

The case study is supposed to answer the following research questions: "*Does RFID offer added value to the bookstore entrepreneur?*". And: *What factors explain the level of RFID adoption intention?* To answer these questions the case study examines the functioning of RFID technology in a bookstore environment and takes a closer look at the implementation details of the technology The case study will have an explorative character in which the case is explored in it's depth and at same time will have an descriptive

character in which the phenomenon is described and documented by adoption factors from the theoretical model of adoption intention.

Case study instruments

Three instruments are selected to gather data: *Secondary Research, Interviewing* and *Observational research. Secondary research* consists of acquiring information about the case by studying existing resources like scientific articles and other publications. *Interviewing* provides more background information and confirmation in exploring the case. An unstructured and open interview reveals insights in what people are doing and why they do so (Emans, 1990). In this context interviewing is used as a strategic instrument for exploring the future marketplace of the bookstore in an RFID environment. *Observational research* consists of information gathering about the RFID system and the usage of the system by consumers and store personnel. Observational research in this case means gathering of information by mystery shopping, product testing and by means of guided tours.

4.1.1 Case study procedure

Secondary research

Preceding the expert interviews and observational research, the secondary research was performed on January 2008 and was meant to produce fundamental know-how of RFID technology implementation within a bookstore environment. In the course of the desk-research the focus shifted from a general study of the applied RFID technology, towards a more profound study on the adoption process of the technology at BGN/Selexyz. Articles were found via scientific research data bases and through searching the internet. The secondary research provided the required knowledge to conduct the interviews involved in this case.

Interviews

In order to conduct the interviews, the case was divided in three sections. *Section one* consists of interviews with people from within the organization. The first interview in this field was conducted on February the 15th 2008, with Mr. Vink, CIO of BGN/Selexyz. As the information technology director, he was responsible for the introduction of RFID into the organisation. The secondary research has produced many articles in which Mr. Vink has been cited concerning RFID adoption. The open interview with Mr. Vink took place at the head office of BGN in Houten and took about two hours. The second interview that took place was with Mr. Harmes, store manager of Selexyz Dominicanen Maastricht. In 2006 it was the first Selexyz store equipped with RFID technology and drew a lot of global

publicity. The interview took place on April the 24th 2008 in Maastricht. *Section two* consists of interviews with companies that were involved in this particular adoption case because of their supplying technological expertise or related business operations. The first interview in this field was with Mr. Stephen Leferink, Business Unit Manager Retail at Progress software. Progress software was already the supplier of the software infrastructure at BGN/Selexyz. The interview took place at Progress main office in Rotterdam on the 8th of February 2008. The purpose of the interview was to find out about the software architecture and the role of progress software in this case. The next BGN partner in this project was CaptureTech. CaptureTech designs, installs and supports RFID systems. For this case they designed a custom made scan device for application in a bookstore environment. The interview with innovation manager Mr. Anderson took place on 22th April 2008 in Nieuw Vennep. The one hour interview was preceded with a presentation of in-house designed RFID systems at the R&D lab of Capturetech. The third interview that took place was with CIO Mr. ir Ronald Janssen of Central Bookhouse. Central Bookhouse [CB] is the largest distributor of books in the Netherlands. They were closely involved in the RFID case at BGN/selexyz as supplier of the RFID labels on books. At the CB, every book is equipped with an RFID tag before the book is sent out to the Selexyz bookstore. The interview took place at the CB main office on Monday the 18th of February 2008. *Section three* concerned expert interviews with people that are considered to have fundamental knowledge or experience with RFID in retail but were not directly involved with the case itself. The first interview was with Mr Silvan Lucke of GS1 the Netherlands. GS1 is an international accredited organisation for Global Standardisation. GS1 is accredited to develop an international Electronic Product Code (EPC) that can be applied as a standard RFID product code on RFID tags. EPC is supposed to succeed the barcode and the temporary required Universal Product Code (UPC). GS1 cooperates with the central bookhouse in developing an EPC for the book industry. The interview took place on the 17th of April 2008 by telephone and by e-mail. Second interview was with Mr. Gerard DeCock of TiteLive, a Belgian company that develops bookstore resource software. The TiteLive organisation is well informed about the latest developments in RFID and was interviewed on the 21st of May by telephone about the application of RFID technology in bookstores.

Observational research

To study the implementation of RFID technology within the bookstore and experience the application of RFID labelled books, three observational actions were carried out. The first action was performed on the 6th of February 2008 when visiting the branch of Selexyz Almere. The visit was not announced to the store personnel and the researcher was able to search for book titles by using the RFID search system in the store. The second visit was planned on the 24th of April 2008 in Maastricht. The store manager gave an instructed store tour and was able to demonstrate the administrative and logistical aspects of the

RFID system. The researcher was able to operate the technology itself. The third visit was at the Selexyz bookstore in Nijmegen. The announced visit on may the 16th 2008 was aimed to derive opinions from store personnel. Because the store appeared not yet operational on the same level as the Almere and Maastricht stores, the visit was considered not very representative and a revisit of the Selexyz Almere store on June 3th was needed in order to gather additional opinions of store personnel.

Case analysis

All information derived from the secondary research, interviews and observational research is captured into one comprehensive document that illustrates RFID adoption at BGN/Selexyzis. The document is enclosed as appendix II 'Case Report BGN/Selexyz'. The document describes the adoption process, the technology, the business partners and the pro's and con's of implementation. The document ends up with a present RFID investment overview. Subsequently, the results of the case study are analyzed by the adoption factors from the AIM model. This is done to understand to which extent the theoretical model explains adoption intention in practise. The results of this analysis are presented in chapter 5.1 Case study results.

4.2 Survey research

A survey is considered as a quantitative research method in the social science. According to Babbie (2004) a survey is used in exploratory and explanatory research. The purpose of a survey is to collect data from individual units to describe characteristics, attitudes or opinions within a certain population.

Survey goal

The goal of the survey is to provide answers to research questions 2,3 and 4. The survey results should provide knowledge about the importance of five adoption factors that explain adoption intention and about the level of adoption intention. Next, the survey is used to determine the characteristics of the entrepreneur, bookstore and the level of automation experience.

Respondents

The units of analysis in this study are independent bookstore entrepreneurs that operate top-level bookstores in the Netherlands. The population is distinguished from other populations of bookstore entrepreneurs for the reason that they operate their business independently but, on the contrary, also cooperate under a common bookstore label in which they merge, to some extent, their marketing and purchasing activities. The population consists of a homogeneous group of 70 entrepreneurs that operate 110 stores in total. Because of the relative small population size, all units are approached to cooperate in the survey.

Instrument

A digital questionnaire was developed as a survey instrument. The questionnaire was divided in three parts and consists of 53 items in total. Special software (thesistools.com) was used for developing and publishing the questionnaire on the internet. The first part of the questionnaire exists of statistical questions concerning the personal characteristics of the respondent. The second part invites the respondent to answer questions about their specific enterprise. The final part enquires the opinion of the respondent concerning the constructs of RFID adoption.

Operated survey constructs

The adoption factors of the AIM model are operated in survey constructs. Each construct exists of at least three items to measure the underlying concept. The level of adoption intention is measured by a separate construct in the survey. The greater part of items are operated on a five point scale of which 1 is "*most disagree*" and 5 is "*most agree*". The respondent is able to select between these 5 values on each question. The survey constructs and the related research questions are presented in table 4-1 and exists of the independent variables and the dependent variable of the model. The constructs are operated in survey questions and are enclosed as appendix I: Operated survey constructs.

Table 4-1: Overview survey constructs

Survey constructs	Research Question
What is the level of performance expectancy concerning RFID?	(2)
What is the level of effort expectancy concerning RFID?	(2)
What is the level of social influence on the independent entrepreneur?	(2)
What is the level of trust in RFID technology?	(2)
What is the level of facilitating conditions concerning RFID?	(2)
What is the level of adoption intention of the bookstore entrepreneur?	(3)

The moderating variables within the AIM model are operated in the survey as separate constructs. These moderating constructs are presented in table 4-2 and are enclosed as appendix I: Operated survey constructs.

Table 4-2: Overview moderating constructs

Survey constructs	Research Question
What are the characteristics of the entrepreneur?	(4)
What are the characteristics of the bookstore?	(4)
What is the level of automation experience?	(4)

4.2.1 Survey procedure

Preliminary test

In advance to the construction of the final questionnaire, a preliminary test was desirable in order to check if items were relevant to the research model and if the questions were properly formulated. 4 Entrepreneurs were invited to fill out the pre test. Also 2 managers from within the initiating company were invited to test the questionnaire. As a result of the pre test, the last segment of the questionnaire was redesigned to five point scale items only. This would be of advantage for the analysis of the results in retreat. Besides a few minor changes on a couple of other questions, the concept survey was approved to publish.

final version

On May 26th 2008 the final version of the survey was published on the internet. The survey was double checked to be sure that everything was functioning alright. After this check, the respondents were invited by e-mail and by phone to cooperate in the survey. They received an e-mail letter that contained a direct link to the online questionnaire and a clear instruction that stimulated collaboration. After one week the response was measured and those who had not responded yet received a reminder e-mail. After another week, the response was measured again and all of those who did not responded to the survey were contacted by phone. The reason for calling the respondent was twofold. A person to person conversation crosses barriers and is a suitable instrument for giving assistance to those that administer problems with the online fill-out of the questionnaire. Second reason was to convince the respondent of the importance of cooperation to the survey for reliable results. Respondents encounter the phone call as reminding them of the questionnaire in their mail box and motivated them again to join the survey. Because it became very difficult to contact all respondents, it took two weeks to reach enough respondents to close the survey application.

The results of both empirical studies are described in subsequent paragraphs in the next chapter.

5 Results

5.1 Case study results

The Case Study results are described in two sections. The results of RFID implementation at BGN/Selexyz are analyzed and summarized in the first part. In the second part the case study results are compared to the adoption factors from the AIM Model. This is done in order to see the relevance of the adoption factors on RFID adoption intention in this case.

RFID implementation results

The case study described the adoption of RFID technology at BGN/Selexyz. The management of BGN/Selexyz has been very satisfied with the implementation of RFID into three of their stores so far. According to the management the adoption process was deliberately oversimplified in stead of looking at obstructions. They were surprised that implementation of RFID progressed smoothly. Never the less, the case shows that implementation of RFID technology was still a great challenge because nobody had taken item level tagging to this scale yet. User acceptance of RFID technology was in this case important for two groups of users. Internal acceptance by store personnel and external acceptance by customers. The usability level of the technology and the trust towards the technology were important factors that explain use behaviour of personnel and customers in this case.

Positive and negative results concerning the implementation can be noted and are summarized below.

Implementation results:

- **+Supply chain operations: RFID results in better insights in the supply chain by giving it more transparency and control. Major advantage of RFID: Improved time efficiency and effectiveness at the order intake; Improved order delivery and reliability.**
- **+Stock control: The case showed an increase in control over stock. Without RFID the stock reliability was only 100% the day after inventory was done (once a year). Afterwards, the reliability slipped back to 60-65%. With RFID technology implemented, the reliability stayed at 97.5%.**
- **+/-Search Kiosks: The self-search kiosk fulfilled customer service and demand more than was expected. However, the kiosk self-search function did not perform 100%. The kiosk appeared not as reliable as expected. Not every kiosk search effort resulted in reliable outcomes.**
- **+Inventory efficiency & accuracy: Whole store was 100% inventoried within 2-4 hours by one employee in stead of a whole day shutdown of the store and employment of 4-5 staff members.**

- **+/-Custom orders: The custom ordered books increased due to the kiosk. The notification of the customer is automated and prevents that a customer is notified too late. Notification system appeared not 100% reliable yet.**
- **+Shrinkage: RFID makes it possible to see which specific item is lost because every item has its unique identity. Shrinkage can be traced very fast.**
- **+Labour: RFID showed dramatic decreases of employee hours on several business operations. This offers the possibility to operate the store with a smaller staff.**
- **+Sales: Increase in direct sales and custom orders. +5% sales increase due to a decrease of out of stocks and increase in customer orders from the kiosks.**
- **+Security & Privacy: Full EAS detection is integrated within the RFID system. Because the tag is killed at the point of sale, no privacy issues are involved.**
- **+Customer satisfaction: It can be assumed that the customer satisfaction increased. There is more time for service to the customer, also the stock reliability increased and the kiosk self service component offers satisfying customer search service and comfortable custom ordering options.**
- **+/-Personnel: Resistance among the Selexyz personnel towards RFID was larger than expected. The personnel is suspicious about the supposed efficiency and control advantages but did not encounter major problems with operating the technology.**
- **+Cooperation: The associate partners in this RFID project are mainly suppliers of technology or knowledge and appeared to be very cooperative and flexible concerning the implementation of the system.**
- **+/-Investment: The case concerned a period of 2 years of RFID adoption. The financial figures that were published in the media were based on the first investments. Meanwhile the present financial investment is significant less expensive then the initial investment in 2005 and 2006. On the contrary, the return in cash flow is debatable because profit can be computed in multiple ways and depends on which financial measures are involved.**

Case study and the adoption factors

Because those factors that explain adoption intention will explain actual RFID adoption in the end, a comparison between the theoretical adoption factors and the case study is performed. The case has been compared to the adoption factors of the AIM model in order to see in which extend the factors are of relevance in practice.

RFID Performance Expectancy *is defined as the believe of the bookstore entrepreneur that RFID technology increase the performance of bookstore operations compared to present status of automation.* The case study illustrate that the management of BGN/Selexyz was convinced that the bookstore performance would increase when adopting RFID technology. According to the management the RFID performance expectation was the most important driver in case of deciding to adopt or not. The promises in performance

improvement compared to the present barcode technology resulted in a business case approval by top management.

RFID Effort Expectancy ***is defined as the level of ease concerning RFID usage in the bookstore compared to the present status of automation.*** **RFID effort expectancy appeared not an important factor in this case. The management, store managers and project partners, deliberately did not look to effort issues concerning RFID adoption. They were convinced that problems would arise anyway and that the operation of the RFID technology itself could work out problematic in some extend.**

Social Influence ***is defined as the level of influence on the bookstore entrepreneur by their social environment (colleagues, competitors, head office, counsellors, etc.) about RFID usage.*** **In this case social influence was very little (internal criticasters only) and did not effect the decision to adopt or not. Everybody who was involved in the project was exited and even competition was curious about the implementation. Only few store personnel were suspicious on beforehand when they heard about the ideas, but did not influence the adoption decision.**

RFID Facilitating conditions ***are defined in the adjusted UTAUT model as the level to which the bookstore entrepreneur believes that the organizational, financial and technical environment is enough supportive for RFID implementation.*** **According to the case study, facilitating conditions happens to be an important adoption factor. The organizational environment in the way of a complete new, yet to be opened bookstore, were perfect conditions for an RFID pilot. Financing the project was crucial but not a problem because sufficient budget for the business case was available from head office. The technical knowledge and support was also available through the supplier, and other partners, of RFID technology.**

RFID technology trust ***is defined as the level of confidence that the entrepreneur has in RFID technology, their RFID business partner and the supplier of RFID technology.*** **Confidence in the technology appeared a very relevant adoption factor. The speed and risk taking on this operational scale by the management in the case study, is regarded as having a high level of trust in the basic technological applications and stage of development. The confidence in RFID technology in general, only became larger with the company after their first acquaintance in 2005. The management considered RFID technology mature enough for application and implementation in a bookstore context.**

5.2 Survey results

This chapter provides insights in the results of the survey. Within the research model RFID adoption intention is predicted by the independent variables RFID Performance Expectancy, RFID Effort Expectancy, Social Influence and RFID Technology Trust. These variables were operated in constructs of multiple items and examined in the RFID questionnaire that was distributed among a population of independent bookstore entrepreneurs. The answers of the respondents on items in the questionnaire were analyzed for each construct. Preliminary, the internal consistency of the constructs was measured, as was the correlation between each construct and the causal relationship between the independent variables and the dependent variable.

Sample size and survey response

The survey sample size consisted of the whole population of 70 independent bookstore entrepreneurs. These entrepreneurs possess all 110 bookstores operating under the same bookstore label. Because one entrepreneur was not able to cooperate in this research, the net sample size exists of 69 entrepreneurs. Finally, 52 respondents were collected. Because one respondent did not answered any items which explained RFID adoption intention, the respondent was excluded and making the total net response set at N=51 representing 72% of population total.

Respondent characteristics

One of the research questions was to describe the independent bookstore entrepreneur. In separate items the respondent was asked for his or her characteristics.

Demographic results

The Dutch retail representative organisation in the Netherlands (Hoofd Bedrijfschap Detailhandel) has calculated that the proportion of older entrepreneurs (above 50) in the bookstore sector has increased from 21% to 40% between 1994 to 2008. The group of young booksellers (under 30) decreased from 13% to 5%. The survey results about the age distribution of bookstore entrepreneurs are in tone with these trends. Table 5.1 illustrate that off all respondents, of which 75% is male and 25% is female, the average age ranges between 40 and 60 (88,3%). This matches the national trend that booksellers are relatively old compared to other entrepreneurs across the retail sector. The average age is 48 years while retail mean is 45.3 years. The average age is consistent with the average entrepreneurial experience. Of all respondents, the largest group has an entrepreneurial experience of between 15 and 25 years (37,20%). The most experienced group has an entrepreneurial experience of more then 25 years (23,5%). There were no respondents in this survey younger then 30 years. Most regions (77%) in the Netherlands

were represented in this survey. Table 5-2 shows that only Flevoland, Limburg and Groningen were not represented of which Limburg was expected because the population did not have members in this region.

Table 5-1: Respondent characteristics

Characteristic	*Number (n)*	*Percentage (%)*
Sex		
Male	38	74,5
Female	13	25,5
Age		
<30	0	0
30<39	3	5,9
40<49	24	47,1
50<59	21	41,2
>60	3	5,9
Experience		
<5 years	5	9,8
5<9 years	9	17,6
10< 14 years	6	11,8
15<19 years	13	25,5
20<25 years	6	11,8
>25 years	12	23,5

Table 5-2: Bookstore regions

Location bookstore	*Number (n)*	*Percentage (%)*
Region		
Friesland	5	9,8
Drenthe	3	5,9
Overijssel	2	3,4
Gelderland	5	9,8
Utrecht	5	9,8
Noord Holland	12	23,5
Zuid Holland	9	17,6
Brabant	7	13,7
Zeeland	3	5,9
Groningen	0	0
Limburg	0	0
Flevoland	0	0

The entrepreneur

Table 5-3 illustrate the characteristics of the entrepreneur. Respondents describe their entrepreneurial nature in terms of progressive or traditional entrepreneurship as mainly progressive (67%). 23,5% of this group thinks he or she is medium progressive while 43,1% thinks that he or she has an obvious progressive nature. Almost 33% of the respondents describe themselves as traditional of which 28% has a modest traditional nature and only 6% has an absolute traditional nature. When the entrepreneur is asked for his or her attitude against technological innovations, 69% consider themselves as

prospective early adopters of which almost 12% consider themselves as future lead users of new technology. 31% of all respondents regard themselves as members of the early majority concerning the adoption of new technology. Within the survey, none of the respondents consider themselves as members of the late adoption type or laggards. In the questionnaire the respondent was asked for his or her familiarity with the term RFID. 82% was familiar with RFID, 18% was not familiar.

Table 5-3: Entrepreneurial characteristics

Characteristic	*Number (n)*	*Percentage (%)*
Nature		
Traditional	3	5,9
More traditional	14	27,5
More progressive	12	23,5
Progressive	22	43,1
Innovation attitude		
Lead user	6	11,8
Early adopter	29	56,9
Early majority	16	31,4
Late majority	0	0
Laggards	0	0
Familiarity RFID		
Familiair	42	82,4
Non Familiair	9	17,6

Automation experience

94% of all respondents make use of store automation. This means that 3 respondents did not use store automation at all. Off all software packages Tite-Life (63%) is most used followed by Des Bouvrie (14%) and Van der Valk (8%). Nearly 8% uses software packages from other suppliers. Since 1990 the population started with adopting store automation in combination with barcode technology. In 5 years (from 1997 till 2001), 50% off all respondents adopted store automation. The modus appeared in 1998 when an adoption rate of 12,5% was established. The respondent's average automation experience is 10 years. The respondents considered the adoption of store automation as a positive process (71%) of which 27% was very positive about store automation. 19% was not negative nor positive about the adoption process and 10% responded that they had a negative experience concerning the adoption of store automation.

The respondents were asked to describe important obstacles concerning store automation adoption. Technical problems within the software package was most recognized by the respondents (27%) The high costs of automation was also frequently noticed (24%) as was the workload of barcode scanning of the store supply when installing store automation (21%). About 18% of the respondents referred that their personnel was aversive against the new technology in their work environment and complicated the adoption process of store automation. Finally, about 12% of the population experienced

operational problems or limitations of the system as an obstacle. One item measured the use of customer cards by the respondent. 6% of the respondents make use of a customer card to collect customer information. 75% indicated they would like to make use of a customer card system in their store.

The bookstore

Most bookstore entrepreneurs exploit one bookstore (73%). But a substantial group exploits 2 till 4 stores (21%) and a small group exploits a chain of 5 till max 8 stores (6%). About 65% of all bookstores employed 1-9 full time employee (FTE). 16% employed 10-19 FTE and 20% of the respondents employed 20 or more FTE. The customer potential of the bookstore is measured by the customer population. 24% of the population is located in an area with a customer potential of max 30.000. Most respondents (33%) are located in an area with a customer population between 30.000 and 70.000 inhabitants. 20% has a customer population of between 100.000 and 110.000. 10% operate their store in an area between 110.000 and 150.000 and 14% are located in a place with a customer population more then 150.000.

The stock supply is calculated by the number of copies that are in stock per bookstore. The stores with a stock supply of less then 20.000 copies is about 33%. The largest group are bookstores with a supply between 20.000 and 30.000 copies (43%) The third group has a stock supply between 30.000 and 40.000 copies (12%). The remaining group of 12% has an average stock supply of over 40.00 copies. Stock turnover is consistently distribute among stock supply. 25% of the respondents reported an annual turnover (in copies) of max 30.000. The next group reported an annual turnover between 30.000 and 70.000 (35%) About 16% achieve a turnover of between 70.000 and 110.000 and 24% achieve a yearly turnover larger then 110.000 copies.

Electronic Article Surveillance (EAS) exists of anti theft magnetic or radio frequency labels applied in books and detection gates at the store's exit. The respondents were asked if they used EAS. 55% said they operate such a system. 78% of this group has equipped their stock supply for utmost 50% with an EAS label.

The adoption factors

This subsection takes a closer look to the survey constructs that represent the adoption factors. The AIM model is used as a navigator in this analysis. This model is presented in figure 5 of chapter 3. According to the research model there are five independent variables that should explain the level of adoption intention at the bookstore entrepreneur. The independent variables are operated in five constructs: RFID performance expectancy; RFID effort expectancy; Social Influence; RFID facilitating conditions and RFID technology trust.

Reliability Analysis of the survey constructs

In order to achieve reliable conclusions from the survey results, the internal consistence of each construct is tested for their reliability. The items that are operated in the constructs all measure the same underlying concept. The Cronbach's alpha is conducted as a statistical measure for the internal consistence. In table 5-4 are all constructs presented with their average score, standard deviation and Cronbach's alpha.

Table 5-4: Reliability analysis of the constructs

Construct	*Mean (M)*	*Standard deviation (SD)*	*Cronbach's Alpha (α)*	*Number of items*
RFID performance expectancy	3,36	0,73	.92	11
RFID effort expectancy	3,35	0,75	.90	5
Social influence	3,08	0,86	.79	3
Facilitating conditions	2,98	0,96	.82	3
RFID technology trust	3,33	0,71	.96	3
RFID adoption intention	2,90	0,79	.66	4

All items were measured on a 5 point Lickert-scale. The results produce a Cronbach's alpha between .66 and .92 and are recognized as reliable. This means that all items within the constructs measure what they need to measure and there was no need to delete any items.

Correlation Analysis

It is useful to conduct a correlation analysis to see if the constructs are mutually related and if this relationship is positive or negative. Table 5-5 presents the correlation among the independent and dependent variables.

Table 5-5: Correlation between the constructs

Construct	Intention	Performance	Effort	Social	Facilities	Trust
Intention	x	-	-	-	-	-
Performance	,717***	x	-	-	-	-
Effort	,366***	0,439***	x	-	-	-
Social	,402***	0,574***	0,036	x	-	-
Facilities	,494***	0,449***	0,639***	0,042	x	-
Trust	,550***	0,543***	0,423***	0,142	0,374***	x

Correlation significance *** = P<.01 (2-tailed).

The data from the correlation table illustrates that all constructs from the AIM model have a positive relationship with Adoption Intention. The presented data illustrate a significant strong relation ship between the construct Performance Expectancy and Adoption Intention. Also the construct Trust has a strong correlation with Adoption Intention. A closer look at the independent variables confirms that the construct Performance Expectancy is positively related to all other independent constructs. The correlation between Social Influence and Effort Expectancy; Facilitating conditions; and Trust is less strong and not significant on the P<.01 level.

Regression analysis.

A regression analysis is used to estimate the regression coefficient (R2) between the independent and the dependent variables within the research model. The dependent variable Adoption Intention is predicted by the independent variables that are operated in constructs. The performed data analysis prove that the model explains Adoption Intention for 55% (Adjusted R2 = 0,547)

The data in *table 5-6a* demonstrate positive and negative effects on Adoption Intention. This regression analysis indicates that there is a relative strong linear influence of Performance Expectancy on Adoption Intention. This linear relationship is significant on p<.01. Also the construct Facilitating Conditions implicate a significant linear relationship with Adoption Intention (p<0.05). The complement variable Technology Trust illustrate a significant relation ship with Adoption Intention (p<0.10). Technology Trust is regarded as a significant factor because the construct produces a beta of .197 which is almost 20% of the regression coefficient. The constructs Effort expectancy and Social influence illustrate less stronger relationships.

Table 5-6a: Regression analysis of the AIM model (R2= .55)

Construct	*Beta*	*Sig.*
Performance expectancy	**0,513**	**0,00*** **
Effort expectancy	-0,123	0,37
Social influence	0,084	0,52
Facilitating conditions	**0,264**	**0,05** **
Technology trust	**0,197**	**0,10***

Significance levels *** = P<.01 ** = p<.05 * =.p<.10

Second test

The data has also been tested in the original UTAUT setting, in which adoption intention is predicted by the constructs Performance Expectancy, Effort expectancy and Social influence. This is done in order to see if the new model produces a higher explaining variance (R2) compared the original UTAUT setting. The performed data analysis demonstrate that the UTAUT model explains Adoption Intention for 46% (Adjusted R2= 0,457). The data of the second test in table 5-6b shows that only Performance expectancy has a strong linear relation with Adoption Intention.

A partial F-Test has been performed to compare both regression outcomes. This test is performed to see if the contribution of the added variables of the AIM model compared to the existing variables of the UTAUT model is significant. Unless the high correlation of the added variables with adoption intention, the difference between both outcomes is not significant. Nonetheless, the AIM model represent a better insight in the underlying adoption factors which improved the level of explaining variance (figure 6).

Table 5-6b: Regression analysis of the UTAUT factors for Adoption Intention. (R2= .46)

Construct	*Beta*	*Sig.*
Performance expectancy	**0,645**	**0,00*** **
Effort expectancy	0,080	0,53
Social influence	0,029	0,83

Significance levels *** = P<.01 ** = p<.05 * =.p<.10

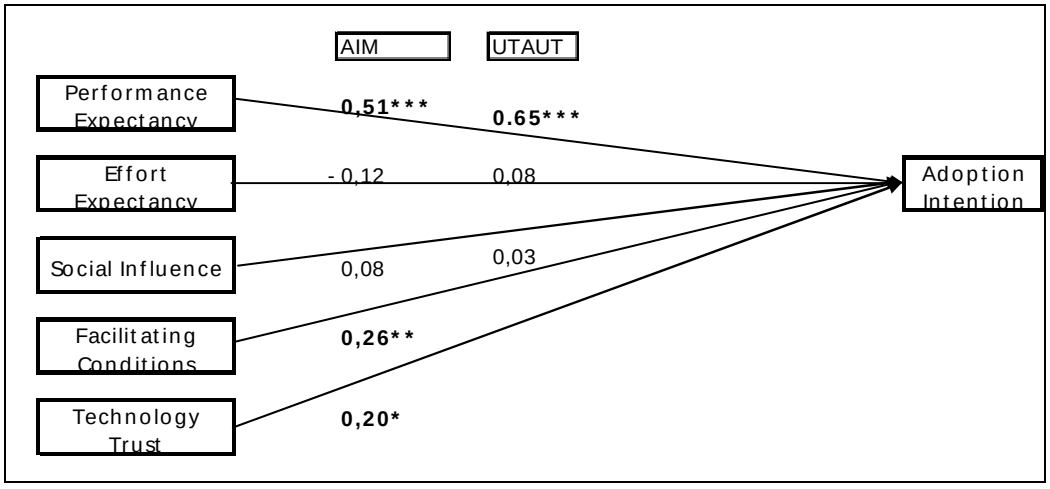

Figure 6: Explaining variance AIM (R2 0.55) compared to UTAUT (R2 0.46)
Significance levels ***= P<.01 **= p<.05 *=.p<.10

Consequence of groups

Among the population of respondents, different groups of respondents can be distinguished. The intervening variables entrepreneur, bookstore and experience with store automation can decrease or increase effects of the independent variables on the level of adoption intention. To study differences between groups of respondents an independent sample T-test is executed.

The moderating construct Entrepreneur.

To observe if characteristics of the entrepreneur can be of influence on the constructs, the variables sex, age and nature are tested to see if there are (significant) differences.

Table 5.7 represent the mean (M) differences between gender, age and nature of the respondent. Sex appears to be of influence on all constructs within the model. Men offer more weight to all constructs then women do. Of these differences there is a significant difference concerning the construct Adoption intention. Men score significant higher on this construct then women. Another construct that appeared to have a significant difference, is Performance Expectancy. Men scores higher then women on this construct. Because of the small portion of female respondents within the sample population, a Mann-Whitney U test has been performed in order to confirm the results of the independent T-test or to see if there are differences between both test results. Table 5-8 represents the result of the Mann-Whitney test. The results correspond for a large extend with the results of the independent T-test. In this test only Adoption Intention is significant on p< 0.01 and Performance Expectancy is not. A distinction between respondents above fifty and under fifty does not produce significant different scores on any construct. A comparison between

progressive and traditional respondents does not result in significant different scores on the constructs.

Table 5-7: Results of independent sample T-test for the variables Sex, Age and Nature of the entrepreneur

Construct	Men		Women			Age <50			Age >50			Traditional			Progressive		
	M	SD	M	SD	T	M	SD	T	M	SD	T	M	SD	T	M	SD	T
Performance	3,47	0,72	3,03	0,70	**1,90***	3,42	0,70	3,29	0,77	0,66	3,26	0,80	-0.68	3,41	0,70	-0.68
Effort	3,39	0,69	3,22	0,93	0,70	3,29	0,71	3,41	0,79	-0,53	3,45	0,86	0,69	3,30	0,69	0,69
Social	3,14	0,86	2,92	0,90	0,76	3,17	0,82	2,99	0,91	0,76	2,90	1,01	-1.07	3,18	0,78	-1.07
Facilities	3,07	1,01	2,69	0,77	1,19	2,94	1,03	3,01	0,91	-0,25	3,17	1,22	0,96	2,89	0,81	0,96
Trust	3,38	0,76	3,21	0,55	0,73	3,21	0,84	3,46	0,54	-1,25	3,41	0,67	0,52	3,29	0,73	0,52
Intention	3,08	0,74	2,37	0,72	**3,02*****	2,89	0,74	2,91	0,87	-0,08	3,03	0,91	0,83	2,83	0,74	0,83

Significance levels *** = P<.01
**** = p<.05**
***** = p<.10**

Table 5-8: Results Mann Whitney U test for the variable Sex

Construct	Men	Women	*Mann-Whitney*	
	M	M	U	Z
Performance	27,64	21,19	184,50	-1,35
Effort	25,26	26,25	219,00	-0,21
Social	25,96	22,04	186,50	-0,84
Facilities	25,89	20,33	166,00	-1,20
Trust	25,74	22,96	207,50	-0,61
Intention	**29,41**	**16,04**	**117,50*** **	**-2,82**

Significance levels *** = P<.01 ** = p<.05 * =.p<.10

The moderating construct Bookstore

Table 5-9 represent differences between respondents on construct scores. It appeared that respondents that operate a multiple branch business, score significant higher on the construct Performance Expectancy, Facilitating Conditions, Trust and Adoption Intention. These group of respondents also score slightly higher on other constructs in the model. The amount of copy turnover does influence the score on the construct Performance Expectancy. Respondents with an annual turnover of ≥50.000 copies score significant higher on this construct. The amount of copy turnover does not produce significant differences on the other constructs in the model.

Table 5-9: Results independent sample T-test for the variable Branch and Turnover

Construct	<1 Branch		>1 Branch			Copie turnover <50.000		Copie turnover >50.000		
	M	SD	M	SD	T	M	SD	M	SD	T
Performance	**3,24**	0,72	**3,69**	0,68	**-2,04****	**3,17**	0,81	**3,54**	0,61	**-1,86***
Effort	3,24	0,65	3,63	0,91	-1,69	3,34	0,77	3,35	0,73	-0,44
Social	3,01	0,83	3,26	0,94	-0,92	2,92	0,92	3,24	0,78	-1,32
Facilities	**2,73**	0,88	**3,60**	0,89	**-3,10*****	2,81	1,03	3,13	0,89	-1,16
Trust	**3,21**	0,63	**3,63**	0,82	**-1,93***	3,38	0,66	3,28	0,76	0,50
Intention	**2,72**	0,77	**3,36**	0,67	**-2,70*****	2,81	0,87	2,98	0,72	-0,77

Significance levels *** = P<.01 ** = p<.05 * =.p<.10

The moderating construct Automation Experience

There does not emerge any significant differences on the constructs when the respondents are divided in groups that have been automated before 1998 and after 1998. Table 5-10 shows that groups automated before 1998 do score slightly higher on all constructs then groups that are automated after 1998.

Table 5-10: Results independent sample T-test for the variable Automation Experience

Construct	Automated ≤1998		Automated ≥1999		
	M	SD	M	SD	T
Performance	3,46	0,63	3,26	0,81	0,95
Effort	3,42	0,68	3,34	0,83	0,37
Social	3,15	0,87	2,99	0,88	0,64
Facilities	3,26	0,87	2,84	0,94	1,54
Trust	3,45	0,66	3,25	0,78	0,96
Intention	2,95	0,71	2,82	0,89	0,54

Significance levels ***= P<.01 **= p<.05 *=.p<.10

6 Conclusion

Explaining the behavioural intention to adopt RFID technology was the central subject of research in this thesis. The research resulted in comprehensive understanding about RFID technology and RFID adoption in a 'bookstore context. Moreover it provide a deeper understanding of what factors are of relevance when explaining RFID adoption intention. A theoretical model was developed in which the adoption factors were compared with the results of the case study. Empirical research in the form of a survey tested the adoption factors on a population of bookstore entrepreneurs. The following paragraphs answers the research questions based on the research results.

6.1 General conclusion concerning RFID adoption

RQ 1) Does RFID offer added value to the bookstore entrepreneur?

The results of RFID adoption in a bookstore context are twofold. The case study proofs that RFID adoption on item level can be attainable and can result in added value to existing business processes. On the other hand, adoption in the case study took place at a 'lead-user' and therefore the technology is still in stage of development (learning by doing). The consequences of the development stage are that the effects of RFID adoption over time might change due to improvements in technology or different system settings. However, according to the research results, one can conclude that the technology is fitting a retail environment and especially in case of adopting in a bookstore context. The bookstore with its large assortment of books, relative high average price per product, complex traceability of stock, predetermined supply chain and poor inventory reliability, suits the implementation conditions of RFID very well. Compared to barcode technology, RFID can offer significant efficiency and accuracy improvements. RFID is superior above barcode technology in case of: determining the ordering moment, the order intake process, determining the stock levels, providing up to date location information and insights in shrinkage type. These effects result in an increase of sales due to lesser out of stock articles; increase in custom orders due to the self service kiosks and a decrease in shrinkage rates due to better control. Besides these direct effects of implementation, RFID can result in an increase in customer service because business processes run more efficient, store personnel have got more time for service related tasks to the customer and for furnishing the store. The customer also benefits of RFID applications in the bookstore. The demand of the customer is more likely to be fulfilled. There are lesser out of stock experiences, several self service facilities for location of titles and efficient custom order applications. The consequence of being the first adopter of RFID was noticed already in the beginning of this paragraph. However some effects may not be under estimated because they are important to all 'early adopters' of this technology. Not all components of the technology have matured yet. The case showed not to underestimate the running-in period of the technological environment and effects of technology adoption on store personnel.

RFID adoption in a bookstore is not 'plug and play'. In this case, evolution is the key word after the implementation took place. It will take several months before the store personnel has ease and convenience in using the technology and the RFID processes to operate error free. The adoption success depends heavily on the devotion and discipline of store personnel. The case illustrates the important role of store personnel in the elementary functioning of the system. Regular inventory scanning and stock controlling is essential for almost all RFID related processes and services. Observational research proofed that RFID is not perfect in a sense that the inventory reliability reaches a 100% level. A 98-99% reliability level however, should be realistic but only when the inventory is scanned very accurate and on regular basis. The case has illustrated that the self service kiosks underperformance was caused by lack of inventory scanning. Concerning the customer expectations that were shaped by the search and information kiosks, achieving maximum reliability is imperative. However, it is questionable if this is a realistic goal in the present system design. Thus when high reliability is pursued, improvement of this application is needed. According to the research one can conclude that some RFID components are not considered essential for RFID operations. The electronic article surveillance (EAS) component is optional. The use of smart shelves are not required for system functioning and are considered luxurious and expensive. RFID adoption requires significant financial investments. The return on investment and determining the break-even point in an RFID case is discussable because the ratio's can be estimated with dissimilar financial components and variable operating figures. In this way the ROI and BEP can be calculated more or less profitable. Besides, a realistic calculation also depends on store performance and variable future costs of RFID components which make things in some extent unpredictable.

6.2 Determining adoption factors

RQ2) What factors explain adoption intention of RFID technology?

The theoretical Adoption Intention Model (AIM) consists of five variables that explain the Adoption Intention level of the bookstore entrepreneur. Empirical research confirms that the level of adoption intention is explained by three constructs: *Performance Expectancy*, *Facilitating Conditions* and *Technology Trust*. The level of *Performance Expectancy* is the strongest predictor of adoption intention. The constructs *effort expectancy* and *social influence* have no significant power in case of explaining the intention to adopt RFID. A second test confirmed the non-influence of these factors also in the original UTAUT setting. One can conclude that the two additional factors presented in the AIM model are of significant influence on adoption intention.

6.3 Determining adoption intention

RQ 3) What is the level of adoption intention of the independent bookstore entrepreneur?

There is an above average intention to adopt RFID among the respondents. Trust in RFID technology and RFID Performance Expectations are considered as above average to nearly high. Concerning Facilitating Conditions, entrepreneurs are convinced that they posses over sufficient facilities to adopt RFID. The opinion and behaviour of their social environment is important to the entrepreneur but does not have significant effects on the level of adoption intention. That is also the case for RFID Effort Expectancies. The entrepreneur is convinced that operating the system would not be a problem, but that does not affect the intention level to adopt RFID at all.

6.4 Determining adopter characteristics

RQ 4) What are the effects of adopter characteristics on adoption intention?

Results from the empirical study indicate the high level of entrepreneurial experience which includes the adoption process of barcode technology and store automation in the 1990's. The average entrepreneur experienced the adoption process as positive and considered the adoption results as added value to their store operations. Besides the level of entrepreneurial experience, the average entrepreneur possesses a progressive nature; considers themselves as 'early adopters' of new technology; and are already highly familiar with RFID technology. These characteristics are considered to be important drivers in case of prospective RFID adoption.

According to the research results, it can be stated that men are more likely to adopt RFID then women. Women appeared to have a mediocre intention to adopt RFID while men have a substantial higher intention to adopt RFID. This is caused by the fact that men have higher expectancies of the performance of RFID and believe to have more sufficient facilities to adopt RFID then women.

Entrepreneurs that operate more then one bookstore also have a significant higher intention to adopt RFID technology then those who operate one bookstore. This difference is explained by the given fact that these entrepreneurs posses over better facilities, have a higher level of technology trust and a higher level of performance expectancies.

The level of automation experience of the bookstore entrepreneur has no significant effect on the level of adoption intention. It can be concluded that entrepreneurs with less then 10 years of automation experience have the same level of intention to adopt RFID then those with more then 10 years of automation experience.

7 Discussion

In this chapter the relevance and the results of the research are discussed in respect to existing theories about technology acceptance and technology use. The chapter starts with discussing the quality of the constructed model and subsequently the operations of the model. Finally, the chapter discusses the relation of this research to the future research agenda of RFID and discusses the 'fit' of the model in other settings then RFID adoption in a bookstore context.

7.1 Quality of the research model

Explaining power of the AIM model compared to UTAUT model

Until recently there did not exist much scientific literature that focussed on RFID adoption at item level specifically. Literature about RFID adoption mainly focus on RFID pilots on 'pallet' or 'carton' level. In contrast, there has been much scientific research performed concerning the adoption decision process of new technologies over the past couple of decades. Venkatesh et al (2003) constructed the UTAUT model that was based on existing technology adoption theories in order to measures the level of adoption intention and use of new technology. The UTAUT model was, compared to all preceding technology acceptance models, able to achieve an considerably higher explaining variance (R2= 0.70. The past several years, the UTAUT model has been widely accepted for technology acceptance research of IT related innovations. The high explaining power of the UTAUT model and the IT context of the model was the driving force to develop a more specific model for explaining RFID adoption intention: the AIM model.

Based on literature about Technology Trust and the results of the case study, it was expected that the factors Technology Trust and Facilitating Conditions would be valuable determinants of adoption intention. The construct Facilitating Conditions was added to the AIM model as a direct determinant of adoption intention. This is an important modification compared to the function of the construct in the UTAUT model. In the UTAUT model, facilitating conditions was operated as a direct determinant of use behaviour instead of being a determinant of adoption intention. There does not exist much literature that recognizes the relevance of the factor Technology Trust as added value for explaining adoption intention. Van der geest et al (2005) and Bhamanziari et al (2003) discovered the explaining power of the factor trust in relation to technology adoption and those findings are confirmed in this study. Both Facilitating conditions and Technology Trust appeared of significant influence in case of explaining adoption intention. Compared to UTAUT, the AIM model is 20% more powerful and is able to explain 9% extra variance in adoption intention. (AIM 55% vs UTAUT 46%). Despite the relative high level of explaining variance in both the UTAUT and AIM setting, the results differs from the first research results that

Venkatesh et al (2003) found in their study in 2003. A closer look to the explaining variance of the original UTAUT of Venkatesh et al (2003) show a variance of 70%. However, the explaining variance of 70% was established by merging the datasets of three measuring moments. According to their results, Venkatesh et al (2003) measured the same population (N=133) three times, resulting in 399 units of analysis. When the results of each dataset are studied separately, the results display that the variance of each measuring moment varies between 36% and 48%. In that way the results of Venkatesh et al (2003) are consistent with the results of this research. From this perspective it could be very well possible that a larger group of respondents result in a higher explaining variance because of the relative amount of errors is lower compared to smaller group of respondents. Another explanation for the discrepancy between the research results and the results of the former studies might be explained by cultural differences in relation to the research setting. The research of Venkatesh took place in the united states and this study in the Netherlands.

Non- explaining factors discussed

Two factors of the AIM model did not increase the level of variance in adoption intention significantly. This was not expected because the construct Effort Expectancy and Social Influence were important determinants for adoption intention in the research of Venkatesh et al (2003). A second test confirmed the non-influence of these factors also in the original UTAUT setting. The construct Social Influence was operated in the same manner as in the original UTAUT model, but the construct Effort Expectancy changed. In the original UTAUT context, Effort Expectancy was operated as a negative related construct towards adoption intention. In the AIM model, this construct is operated as a positive determinant, in line with the other constructs in the model. This was done to prevent analytical errors and for model design purposes. It did not change the essential meaning of the construct. Probably both these factors are of low importance in this specific context but might be of relevance in other settings like cases with different technology or with a different adoption environment. For this reason the constructs should remain in the Adoption Intention Model.

Model operations

The operated scale in the questionnaire was constructed on a five point Lickert scale and was chosen because of the sound discrepancies between each scale value. However, it might be the case that respondents could have been avoiding the scale extremes 'totally agree' and 'totally disagree' and answered more towards average. This could influence the results of the survey because respondents might answered different if the scale was broader. However, the chance that this effect has consequences for the explaining power of the research model is small because the dependent variable Adoption Intention was also operated as a construct and therefore it is presumable that respondents handled each Lickert-scale question in the same manner. The amount of construct validity was high

enough and did not have negative effects on the level of explaining variance because all items operated in the questionnaire measured their interdependent concept more then sufficient.

7.2 Research relevance

Adoption of RFID among different industries is rising. Corporations and governments are interested in RFID because they think that this technology helps them build a better business or policy and eventually improve our daily lives. When the industry's adoption of RFID increases, the interests of researchers increases at the same time. Curtin et al (2007) studied the research agenda of RFID and differentiated three broad research questions for academic researchers. 1: How is RFID developed and adopted by organisations? 2: How is RFID used, supported, and evolved in organizations and alliances? 3: How does RFID impact individuals, business processes, organizations, and markets?

This research thesis mainly focus on: the adoption factors of RFID; the application of the technology; and the impact of RFID on the organization and its business processes. In respect to the research questions of Curtis et al (2007), it would be interesting to explore what RFID adoption in bookstores entails for other retail organisations. The AIM model for determining RFID adoption intention could be very well applicable in other retail settings like a hypermarket or a tackle store. If the AIM model is applied in an other context, the constructed model can be further improved and additional factors could increase its explaining power.

The adoption of RFID would not be the first technological revolution in the book retailing sector. A radical change exists in the 1970s when bar code technology was introduced in retail. From the 1990s, till now Barcode diffused among bookstore entrepreneurs in the Netherlands. According to the Dutch marketing report bookstores (Van Es Marketing services, 2008), approximately 47% of all bookstores in the Netherlands has adopted barcode technology at the end of 2007. Of all bookstores, the cooperating bookstores possess over a significant higher barcode adoption rate of 72% at the end of 2007. Because of the future diffusion process of RFID technology, it is very interesting to study if the adoption factors of the AIM model are applicable on barcode adoption intention. In that way predictions concerning the diffusion time could be made for RFID technology.

Concerning the public effects of RFID adoption in bookstores and RFID adoption in general, much research lies ahead. In 2006, the Dutch Ministry of Economic Affairs, has published a report called '*Notitie RFID in Nederland*' and explores the present status of RFID adoption in the Netherlands. One of the major conclusions of this report comprise the importance of innovation for the economy and the opportunities of RFID adoption in the Netherlands. In this context, the government tries to stimulate entrepreneurs to adopt RFID by providing subsidies and grants. The report also mentions that the government is financing scientific research programs concerning RFID technology and is considering more RFID research facilities. These provisions are important for future RFID developments but it

is questionable if this approach is sufficient to stimulate RFID adoption at this present moment. After all, entrepreneurs will use subsidies and grants only after a decision for adoption has been made. The stimulation of fundamental RFID research is important, but this research thesis has demonstrated the importance of research on adoption factors that influence the level of adoption intention of the entrepreneur, before the decision for adoption is made. In order to achieve more innovation and more diffusion of RFID technology, as mentioned in the report, it is recommendable to perform further research on the adoption factors in order to create more comprehension and influence on the level of adoption intention of the entrepreneur.

A final remark considering the role of RFID costs within this research. The AIM model was able to provide a more comprehensive understanding about those aspects that explain the level of RFID adoption intention. The role of RFID costs was operated within the construct RFID adoption intention. It would be interesting to see if the explaining role of costs changes if it was operated as an independent variable. Further research in the area of subjective costs could improve the model and consequently the level of explaining variance on adoption intention.

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www.rfidkenniscentrum.nl
www.zebra.com
www.rfid-asia.com
www.hightechsrategies.com
www.idtechex.com
www.aimglobal.org
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Appendix I: Operated survey constructs

Question	Concept	definition	Item (5 point Lickert-scale)	Code
2	Performance expectancy	**Performance Expectancy** is defined as the believe of the bookstore entrepreneur that RFID technology gains the performance of bookstore operations compared to present status of automation.	Processes are more efficient with RFID applications	22-2
			RFID offers better in store-stock insights	22-3
			RFID offers more control over the received orders	22-4
			With RFID, product localization is more accurate	22-5
			With RFID, the stock reliability increases	22-6
			The store stock-taking is more efficient en more effective with RFID	22-7
			RFID declines the potential of administrative (human) faults	22-8
			RFID offers effective anti-theft functions	22-9
			With RFID, turnover increases due to lesser "not-in-stock" sales	22-10
			RFID offers new commercial opportunities like the self-service Kiosks	22-11
			With RFID there is more time and attention to customer service and or store presentation	22-12

Question	Concept	definition	Item (5 point Lickert-scale)	Code
2	Effort expectancy	**Effort Expectancy** is defined as the ease of RFID usage in the bookstore compared to the present status of automation.	The practises for RFID usage will not be a problem for me	23-1
			The practises for RFID usage will not be a problem for my personnel	23-2
			Frequent inventory scanning will not be a problem within my store	23-3
			It will not be a problem for me to develop system competences	23-4
			It will not be a problem for my personnel to develop system competences	23-5

Question	Concept	definition	Item (5 point Lickert-scale)	Code
2	Social Influence	**Social Influence** is defined as the level of influence on the bookstore entrepreneur by their social environment about RFID usage.	If my colleque bookstore entrepreneurs would adopt RFID, it would influence my decision to adopt RFID	24-1
			I would consider the adoption of RFID if others recommend it	24-2
			If others disadvice the adoption of RFID, then this would influence my decision	24-3

Question	Concept	definition	Item (5 point Lickert-scale)	Code
2	Facilitating conditions	**Facilitating Conditions** is defined as the level to which the bookstore entrepreneur believes that their organizational and technical environment has enough expertise to support RFID implementation.	I have sufficient knowledge and experience concerning automation	25-2
			I have sufficient knowledge about RFID technology	25-3
			If necessary, I can possess over knowledge or expertise concerning RFID	25-4

Question	Concept	definition	Item (5 point Lickert-scale)	Code
2	Technology Trust	**Trust** is defined as the level of confidence in RFID technology and the supplier of RFID technology.	I believe that RFID is enough mature for adoption in my bookstore	26-2
			I believe that my software distributer is a reliable partner for the adoption of RFID	26-3
			I believe Intres can provide me of reliable RFID adoption advice	26-4

Question	Concept	definition	Item	Scale	Code
4	Gender	Male/Female entrepreneur	Select your gender	Multiple choice (max. 1)	1
	Age	Age of the entrepreneur	Select your age	Multiple choice (max. 1)	2
	Experience	The experience of the bookstore entrepreneur	How long have you been a bookstore entrepreneur?	5 point matrix	3
	Nature	Attitude towards innovations	Describe your nature in terms of progressive and traditional entrepreneurship	Multiple choice (max. 1)	19
			Choose your attitude against innovations	Multiple choice (max. 1)	20
	Familiarity	*Familiarity with RFID*	*Are you familiar with RFID?*	*Multiple choice (max 1)*	*21*

Question	Concept/construct	definition	Item	Scale	Code
4	Bookstore name	Name of the bookstore	What is the name of your bookstore? (Elective)	Open ended	4
	Location	Location of the bookstore	In which district is your bookstore situated?	Multiple choice (max. 1)	5
			How large is your customer potential?	Multiple choice (max. 1)	17
	Branches	Amount of branches of the store	How many branches does your business have?	Multiple choice (max. 1)	6
	Employees	Characteristic of the employees	How many employees does your business have	Multiple choice (max. 1)	7
			What is the age classification of your employees	Matrix	8
	Store automation	Software adoption, Electronic Article Surveillance and customer card	Who is the supplier of your software?	Multiple choice (max. 1)	9
			Do you make use of anti-theft Electronic Article Surveillance?	Multiple choice (max. 1)	13
			Could you make an estimation of the percentage of EAS labels in your store?	Open ended	14
			Do you want to make use of customer cards to collect customer information?	Multiple choice (max. 1)	18
	Stock	Information about the stock level in the store	How many copies do you have in stock?	Multiple choice (max. 1)	15
			How many copies do you sell per year?	Multiple choice (max. 1)	16

Question	Concept/construct	definition	Item (5 point Lickert-scale)	Scale	Code
4	Automation experience	Experience of the entrepreneur with the adoption of bookstore automation	Since what year is your store automated?	Multiple choice (max. 1)	10
			How did you experienced the adoption of store automation?	5 point Lickert Scale	11
			What were barriers to overcome when implementing store automation	Open ended	12

Question	Concept	definition	Item (5 point Lickert-scale)	Code
3	Adoption intention	The level of intention to adopt RFID technology	I predict that RFID will be usefull in my bookstore	22-1
			I predict that RFID will be important in my bookstore	26-1
			I have financial resources to invest in RFID in my bookstore	25-1
			What is your RFID adoption intention level in terms of an economic investment threshold?	27

Appendix II: Case report BGN/Selexyz

This document concerns the study of RFID adoption at BGN bookstore chain "Selexyz". The table below presents the setup and content of the case study.

Case	
Subject	**Adoption process of RFID technology at BGN/Selexyz**
Researcher	**Ward Jeurissen**
Date	**February; March; April; and June 2008**
Geography	**The Netherlands; Almere; Maastricht and Nijmegen**
Environment	**Bookstore**
Setting	**Secondary Research, Interviews, observational research, demonstration and mystery shopping**
RFID	
Function	**Identification and track and trace on item level (books)**
Application	**Application of RFID as smart labels on books**
Technology (infrastructure)	**Use of Gen-2 passive UHF RFID tags with a unique serial number merged with the Book information Label of the Central Bookhouse that is commonly applied on books. RFID Readers in the form of custom made scan tunnels and portable hand terminals are form CaptureTech. RFID middleware is from VUE technologies distributed by Capturetech. The software from Progress consists of Sonic, a Enterprise Server Bus which is the intelligent backbone that connects all applications. And ATLAS, an application designed to track locations and stock.**
Maturity	**Operational system**
Users	**Customers, Store personnel, supplier and head office**
Adoption level	**Lead user/innovator**
Case instruments	
Secondary Research	**January 2008; Desk research, preparation**
Interviews	**February 2008: CIO BGN/Selexyz February 2008: Business Unit Manager Retail, Progress Software February 2008: CIO Central Book House April 2008: Innovation Manager CaptureTech April 2008: Store manager Selexyz Dominicanen April 2008: Advisor GS1 the Netherlands May 2008: Manager TiteLife**
Observational research	**February 2008: Selexyz Scheltema, Almere April 2008: Selexyz Dominicanen, Maastricht May 2008: Selexyz Dekkers, Nijmegen June 2008: Selexyz Scheltema, Almere**
Case report	
RFID Motive	**§1** ***pg 61***
RFID Functions	**§2** ***pg 62***
RFID Adoption	**§3** ***pg 63***
RFID Results	**§4** ***pg 69***
RFID Investment	**§5** ***pg 72***

Case study BGN/Selexyz

This report provides information about the case, structured in 5 paragraphs. §1 contains the motive for RFID adoption in the case. §2 is about the application type in the case. §3 describes the adoption process successively in 6 subparagraphs: the implementation process in the bookstore; RFID Tagging; RFID & point of Sale; personnel experience; and customer experience. §4 Describes the adoption results according to BGN/Selexyz. §5 captures the financial investment of RFID for 2008.

§1 RFID Motive

The following information is based on case related articles and an in-depth, unstructured, interview with Mr. Vink, CIO of BGN/Selexyz.

BGN/Selexyz

Boekhandels Groep Nederland (BGN) exploits a multiple bookstore business in the Netherlands and was founded in 1992 when they became an independent business unit of Wolters KLuwer Divisie Boekhandels. Untill 2006 BGN operated their bookstore chain under the name BGN*). A new business strategy was needed and BGN decided to invest in a brand new chain name: Selexyz bookstores. In that same year two new stores were opened: Selexyz Scheltema Almere and Selexyz Dominicanen Maastricht. Selexyz Scheltema is located in the basement of a large department store and Selexyz Dominicanen is situated in a renovated church from the 13th century (2). There are 16 large consumer stores exploited in total. Besides these regular stores, there are also 26 smaller, so called campus bookstores, exploited on Universities and Hogescholen. These stores focus on study books mainly. Furthermore a business oriented service label exists which provides books, annuals and other business services for the professional market. Besides the sales oriented focus of BGN with the Selexyz stores, a small publishing company, Adr. Heinen, is also part of the BGN group. BGN/Selexyz has less then 700 employees and over 11 million visitors each year. The stores carry between 25.000-275.000 books. Each day the chain is selling between 15.000 and 40.000 books. The annual turn over in 2006 was €175.000.000,- (4)(5).

The market share of BGN/Selexyz on Dutch market is approximately 18% (3). The new business strategy required fundamental financial investments in the marketing of the new brand name and enrolment of the new website. The internet site is also operating under the Selexyz label and must be considered as an extra bookstore outlet of BGN/Selexyz. This selexyz online portal is the largest Selexyz "store" and second largest internet store overall in the Netherlands (4)(2). All Selexyz stores have got a unified instalment and modern appearance. It is clear that the focus within the new strategy lies on autonomous growth, internet and acquisitions (4). The chain formula is defined on several aspects. Stores are situated in large cities and often located in historic buildings in the heart of the city centres. Stores are characterized by a high level of service, competent personnel and a broad assortment of books (1).

RFID strategy:

In order to comply to the new growth strategy the management searched for innovative business appendices. With a multi channel focus and internet technology in mind, the CEO Mr. van der Lely and CIO Mr. Vink of BGN/Selexyz went to an RFID convention at the end of 2005 and were surprised that not yet any retailer recognized the potential of RFID tags on item level application (3). They decided to develop an RFID business case and in sequence plan to set-up a 'pilot' for their new Selexyz Scheltema Store in Almere which opened in April 2006.

The presumed obligations by the management of BGN/Selexyz towards RFID originates from the believe that RFID:

- **Increases the efficiency of the order receiving process in the book store**
- **Improve the level of customer service**
- **Increase the volume of customer orders**
- **Improve the stock reliability of the book store**
- **Creates more detail and insight in (operational) costs**

§2 RFID functions

The following information is based upon, case related articles, specific literature and in-depth, unstructured, interviews with Mr. Vink, CIO of BGN Selexyz , Mr. Janssen, CIO of Centraal Book House and Mr. DeCock of TiteLive, developer and vendor of bookstore software.

RFID functionalities can be applied in subsequent retail area's:

- **RFID should improve retail supply chain effectiveness and efficiency. Orders, shipments and deliveries can be compared precisely and fast because every book has an unique identity (3) (6).**
- **RFID should improve retail stock control. With an RFID label, every book in the store can be traced exactly. There is nearly real-time insight in remaining stock supply and book inventory levels on the store floor. Stock reliability should rise. The replenishments of stock can be more accurate due to the RFID system that recognize out of stock items immediately (3) (6).**
- **RFID should improve the shrinkage rate. Causes of stock loss are more comprehensive with RFID. Shrinkage can be traced back on item level. The technology provides clear insights in the underlying causes of inaccurate and incomplete deliveries. At the same time missing of stock is very visible because of daily inventorying of stock (3) (6).**
- **RFID should reduce labour costs. RFID technology reduces labour time for receive and control of orders and the stock inventorying. The search effort of store personnel to**

specific items can be reduced. Labour time can be economized or allocated for other purposes (e.g. customer service (3) (6).

- **RFID should increase sales. RFID provides a richer customer experience. RFID enables store personnel to invest more time and expert knowledge in customer service. At the same time RFID encourage the customer to find their books in a far more effective and independent manner. This should result in less "not on stock sales" and increase of additional sales and increase in customer orders (3) (6).**
- **RFID may offer security solutions. RFID can offer effective anti-theft technology solutions 'build inside'. An RFID tag is able to function as identification label and as Electronic Article Surveillance (EAS) label. When an item has left the store without payment, the RFID-EAS alarm system exactly recognizes what item, and of what value has left the store (3) (6).**

§3 RFID adoption in practice

The following information is based upon case related articles, in-depth, unstructured, interviews with CIO of BGN/Selexyz Mr. Vink, CIO of Central Book House Mr. Janssen, Business Unit Manager Retail, Mr. Leferink of Progress Software, Innovation Manager Mr. Anderson of CaptureTech and observational research at Selexyz Scheltema Almere, Maastricht and Nijmegen.

Pilot Selexyz Scheltema Almere

In December 2005, the decision to set up a pilot for RFID was made by the management of BGN/Selexyz. Because they did not want a large and expensive consultancy company to function as system integrator, they decided to manage the adoption of the innovative technology them self. In consideration with their main supplier, Central Book house (CB), they decided to tag all books with an RFID tag before they send the first shipment to the store in Almere. The CB was well willing in participating this project. This was a crucial point because of efficiency reasons and costs, the tagging on item level should take place at the warehouse of the distributor. The next important partner in this pilot was Progress Software. Progress already supplied software applications for the BGN ICT department and was able to offer back-office solutions for the RFID infrastructure as well (8). The hardware solutions came from Capture-tech, a relative small, but RFID focussed, company that could offer innovative solutions concerning item level scanning. Capture-tech is also vendor of VUE technologies, an Californian company that designs smart shelves and RFID middleware (software for RFID scanning and reading) (9) (10).

Implementation

The adoption of RFID at BGN/Selexyz was at first instance conducted as a pilot project in combination with the opening of the new Selexyz Scheltema store in April 2006. Selexyz Scheltema opened in the city centre of Almere and was located in a bright and fancy

basement of a national department store. The 1,100-square-meter Selexyz Scheltema store holds about 38,000 books and receives at least 650 and sometimes more than 1,000 new books per day. The store displays their books on 800 shelving sections and a large number of displays and storage areas. The store is open for business 10 hours a day, six days a week. A store of this size normally operates with a staff of 18 or 19 members (7). There were only 4 months to set up the whole pilot. After an intensive testing phase, the RFID tag was provided by the CB in the form of a smart label that was hand applied to the cover of the book and alongside the existing Book Information Sticker (BIS). The label exists of a small stroke of sticky paper, an RFID inlay and a printed ID code on top of the label. Total costs of the label are less then €25ct each. Before the label was applied, a unique code was programmed on the RFID chip by an RFID printer. The printer is also able to print the code visible on the label.

Operations

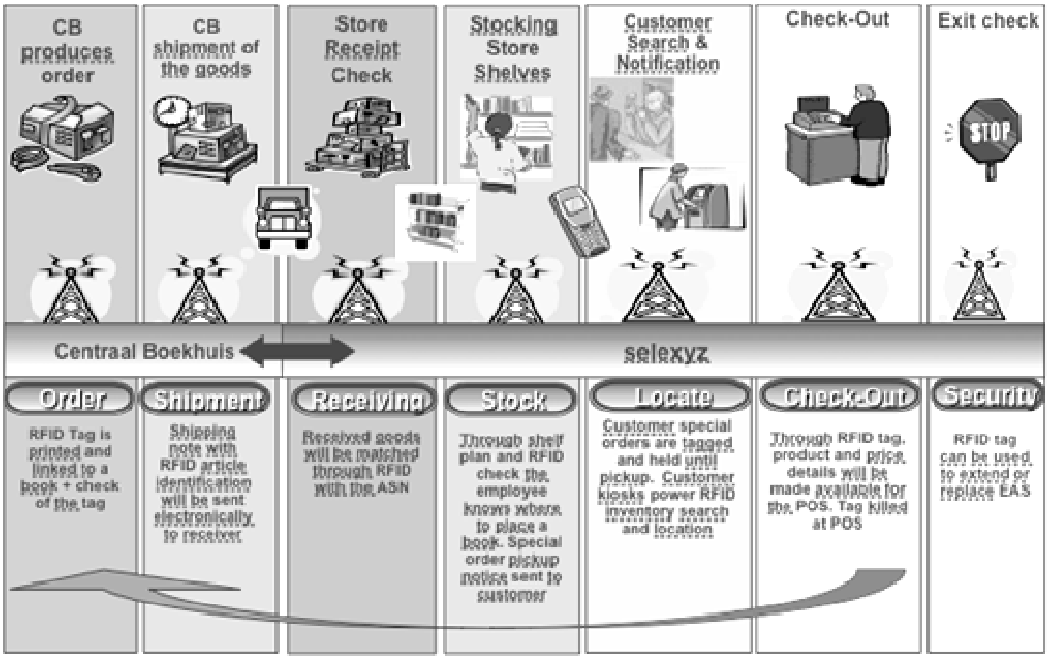

Figure 1: RFID supply chain BGN Selexyz

The store was loaded with 38.000 books that were all equipped with an RFID label. At the moment that CB ships the order, Selexyz Scheltema receives an advanced shipping note (ASN) in advance. The ASN tells the bookstore which books has left the warehouse. When the books arrive at the bookstore, the cartons are read with a so called RFID terminal. The terminal consists of a large scanning device that reads the RFID items within the carton. After that, a comparison can be made with the ASN, the original order and the physically arrived order. If there is a discrepancy between the order and ASN, action can be undertaken. The system tells the shop personnel which books are regular stock and which are custom order. Regular stock is then placed on the relevant store shelves and displays.

Custom orders are placed on smart shelves. These shelves are able to automatically identify what book is ordered by which customer. The system automatically sends an e-mail or sms to inform the customer his or her book has arrived. Regular scanning with portable terminals by store personnel provides a blue print of the bookstore inventory. Exact locations of books can be established and are visible for both personnel and customers. Customers can use self service terminals, the so called "Kiosks", for information about book titles, stock availability, exact location of, and navigation to, a specific book in the store. The kiosks exists of an network pc, lcd screen, a qwerty keyboard and a search interface. When the customer looks for a book, the interface functions like a navigator and selects relevant titles or alternatives depending on the type of search command. The kiosk provides extra background information of search results and can tell whether or not a title is in stock and where to find it in the store. If the title is not in stock, the kiosk functions as a digital order-form. The customer is able to custom order the book, decides were to deliver it and how to be notified (e-mail, sms, phone) when the book has arrived. The system also indicates at what date the book should arrive. When the customer finds the preferred book, payment is made at the Point Of Sale (POS) desk. Here RFID is not yet fully implemented. With a barcode scanner the price of the book is conducted and payment can be done. Because of the pilot nature, barcode and RFID are both operational. The RFID chip is 'destroyed' with special designed RFID 'killers' when payment is done to prevent privacy issues and to switch off the optional EAS alarm system. An RFID killer consists of a small desk object that scans the article and turns off the radio signal of the chip. When a book is returned, the store is able to re-print a new RFID label on the book. The unique number of the tag only needs to be linked with the right data from the book database and can be accomplished in the store. The store posses over an RFID printer to program the tag with the appropriate data and visible print.

<u>Second store: Implementation at Selexyz Dominicanen Maastricht.</u>

The following observation was established during a demonstration of RFID, a guided store tour and an in-depth*, unstructured, *interview with Store manager Mr. Harmes.

'The most beautiful bookstore in the world 2008' , according to British newspaper the Guardian in January 2008. Selexyz Dominicanen opened in November 2007 and is situated in an old monumental church in the old city centre of Maastricht, the Netherlands. The 1300 square meter bookstore holds about 25000 titles and 45000 copies on stock. The average daily supply is between 700 and 1000 copies, 5 days a week. A demonstration tour and interview with Store manager Ton Harmes provided extra information and experience in addition to the RFID observations at Selexyz Scheltema Almere and the previous interview with Mr Vink.

The process of receiving books in Maastricht happens to be the same as with Selexyz Scheltema Almere. The order is delivered by the CB at 08:30hr in the morning and the 24

cartons, with approximately 20-30 books each, are put through an RFID scan tunnel. Now the books are automatically compared with the Advance Shipping Note (ASN) of the CB and booked in the store's in-stock database. RFID preserves that the same item is booked in stock more then once (with barcode this can easily happen explained Mr Harmes). Next the cartons are unpacked and sorted by hand. Then the books are placed on the appropriate cabinet shelves in the store. After this task, the whole store needs to be re-inventoried and scanned with a custom designed mobile RFID scan terminal. This inventorying provides an up-to-date blue print of the books in store. Also, RFID inventorying give specific insights in the location of 'death' stock and optimum ordering moment. The stock data is renewed after inventory make up. The scan frequency of the store is at least once or twice a week. The mobile RFID scan terminal used in Maastricht looks like a table tennis bat that is connected to a computer and main battery in a small carriage. When scanning the items, it happens to be very important that all book covers are in the right position on the shelf. When a book is 'full-faced' it became more difficult to read the RFID tag. Also the Iron book cabinets in this particular bookstore caused some serious inference problems. The metal happened to be a source of inference between the reader and the tag, and a 90% reading accuracy is achieved in first instance. After resorting the books and multiple scanning of the shelves, the accuracy reaches 99-100%. (Wooden cabinets does not have this specific problem, but it is recommendable to place not to many books full faced on the shelf). Never the less, scanning a complete cabinet requires 2 till 3 minutes when the user is enough experienced. According to Mr. Harmes, inventory make up of this store with about 60000 Books took about 4 hours for one employee. The tags used in Maastricht are of a newer type then the ones first used in Almere. They are still working on the same Uhf frequency but are more comprehensive for usage on books because they are now integrated within the BIS label of the CB. The readability of the new tag has also improved a lot because lesser inference problems took place. Another advantage of the newer type is the integration of EAS. The RFID tag has full surveillance functionality. The Point Of Sale (POS) at Selexyz Dominicanen does not differ much with the POS of Selexyz Scheltema Almere. The killing procedure of the RFID tag and the barcode price scanning and other transaction information is exactly the same. When a chip is not killed and passes the surveillance exit, an alarm system at the entrance will be activated. In that case the item is on shrinkage and could be stolen. Costs of the tags remains the same because the antenna's are now printed with silver inkt, which makes the production of the tag cheaper.

<u>Third store: Implementation at Selexyz Dekker Nijmegen</u>

The following information was established during in-store observations and unstructured interviews with store personnel and Mr. Vink of BGN/ICT.

The board of BGN decided to enrol RFID in Nijmegen based on promising results of Almere and Maastricht. There is one major difference with previous implementations: Nijmegen is

an existing store in stead of Almere and Maastricht which were new stores. Nijmegen has been operational for several years and no adjustments to the assortment or store concept has took place till the implementation of RFID at the end of 2007. Operations: Before the first shipments with RFID tagged books arrived at the store in November 2007, all items that were already in the store needed to be relabelled with RFID tags. The whole process of relabeling the inventory took 3 days with full staff. After the relabeling process, the bookstore begun to use RFID within their ordering process and for inventory control purposes, like Selexyz Almere and Maastricht did. But on the contrary, BGN/Selexyz did not yet implement information kiosks for customers in Nijmegen. According to the personnel of Selexyz Dekker, there were some problems with the operational design of the system and because of that, there were no customer kiosks operational six months after adopting RFID technology. Also the EAS functionality of the RFID tag was not installed yet in Nijmegen. In Nijmegen, the technological infrastructure differs from Maastricht and Almere. At first the overall prices of the technology decreased dramatically in 2007 compared to technology prices in 2005 and 2006. Next, the scanning technology improved and became far more advanced and available in significant smaller, hand-held, sizes. Therefore the relative expensive RFID scan tunnel and mobile scan trolley became redundant and replaced with compact and economic RFID hand-held scanners (terminals) in Nijmegen. Because the search and information kiosks were not installed yet, no new insights about this component could be made.

Customer experience

According to Mr. Harmes, 30% of all customers does not plan to visit the bookstore in advance but enters the store when he or she walks by or just to take a look around. The other 70% have got specific buying intentions but often, due to all busy operations in the store and rush of the customer itself, no mutual communication between store personnel and customer takes place. To serve the customer in this situation, the interactive kiosk is an effective solution to communicate with this type of customer. Also, the customers seems to be very satisfied with the new kiosks, although they are often not aware of the underlying technology. Customers frequently use the kiosks in the store. They were surprised that also elderly people make use of the kiosks while these group of customers often have problems with interfacing new technologies. It seems to be that the kiosk's interface is very user friendly.

Using the search kiosks

One major advantage of the implemented RFID system at BGN/Selexyz is the self service kiosk for customers. Because the customer doesn't communicate with an employee when using the kiosk, excellent operation of the system is imperative. Therefore, some sample tests has been taken in order to check the functioning of the system and the current inventory update in the store. It appeared that the system did not worked out as expected.

The kiosk tells a title is on stock and subsequently were to find a particular copy. It turns out to be not on the described shelf location.

Next is described a sample search performance with the RFID system: According to the personnel, the store was inventoried two days earlier. A well known book title *-the 7 habits of Highly effective people by Stephen R. Covey-* was random selected at one of two kiosks. The kiosk explained that the title should be on stock and described at what cabinet the title could be found. Despite the exact description of the location where the book should be, it was not possible to determine the book on the described shelf. Also the check-up of every other book in the cabinet, did not result in finding the appropriate title. According to Ton Harmes, the book could probably be relocated by a customer or abusively misplaced by store personnel into another cabinet. In that case it was perhaps not scanned at inventorying. This test really emphasizes the need for regular inventory make-ups. Other tests were better but certainly not 100%. Mr. Vink and Mr Harmes explained that in 1 or 2 % the book is not on the right spot while the system says it does.

<u>Personnel</u>

The personnel of Selexyz Dominicanen appeared to have some resistance against the new technology and consequently the change in workflows. as Mr. Vink explained, a human been is naturally a bit conservative and seems to rely on standard procedures and a particular way of doing things. Because the success of the new RFID technology relies heavily on the effort and commitment of the personnel, training programs and demonstrations for the personnel were executed. The situation In Maastricht differed at some point with the situation in Almere were everything was new and there was no history to look back. In Maastricht there were besides the introduction of RFID two other issues that caused a cultural shock. First there was the transition from BGN*) to Selexyz. This was part of the new business strategy and conceived a new image for the bookstore and communication to the customer. Second, there was a major migration of the store to a new location and the consequence was that the expectations and pressure on personnel became heavier.

As underlined in the BGN annual report 2006 (4), *"time savings due to RFID adoption does not result in discharges of employees but the adoption must be seen as an opportunity to invest more time in customer service by store personnel"*. Despite this and all other internal communications, the staff has a sceptic attitude about RFID adoption. One staff member told what Mr. Vink and Mr. Harmes already explained: There were serious questions by the store personnel about the need for RFID and the advantages of implementing the new system. They did not see it as a huge improvement, but mainly as extra work, with little reward. The resistance also fulfilled the little confidence the personnel had about using their new internal search system, based on RFID. According to the employee, it happens frequently that a book was not on place while the system says it does. "*No big difference with the old system*". It seems to be that a lack of regular scanning causes failure in the RFID system in Nijmegen. Also the employee explained that

scanning the store did not happen very frequently yet, while the system is half a year in use already. In the store there is no communication to the customer about RFID usage on books which was also the case in Maastricht and Almere. An employee in Almere questioned the necessity of 'smart' shelves, as she did not make use of it. Orders from customers are placed at the customer service desk at special shelves with RFID technology build inside. In theory, a book can be placed at any spot on these shelves because a computer can always locate and track the book on the shelves precisely. In practice it appeared to be that store personnel still uses alphabetic categorizing to select a book when the customer order is picked-up. According to Mr. Harmes and some store personnel, the smart shelf technology does not always communicate very well with the computer and errors took place. Alphabetic paper categorizing appeared to be more reliable in case the smart shelf system fails to locate the order. On the other hand, the automated customer notification function seems to be very successful with no failures. The automatic notification of the customer by e-mail or sms, takes place when the order physically arrives on the smart shelf.

§ 4 Results

Implementation of RFID in books was a great challenge for BGN/Selexyz. Nobody had taken item level tagging to this scale yet. Large retailers in the U.S. like Wall Mart and Best Buy mandated their suppliers to use RFID on pallet and cartons but rarely on item level. These companies use RFID mainly for track and control purposes in the supply chain and way lesser on item level and shop floor management as BGN/Selexyz is doing. So there were no equal examples in retail to look at, the BGN/Selexyz business case was grounded on theories, premises, calculated capital investments and an estimated Break Even Point (BEP) of 22 months. Mr. Vink decided to deliberate oversimplify things in stead of looking at obstructions at the start of the pilots. He was convinced that RFID would work and problems anyhow would arise. Looking back to 1 year of RFID roll out at their first Selexyz Scheltema store in Almere, they were surprised that implementation of RFID progressed so smooth. Problems were determined during the running-in period and mainly regarded hardware and resistance issues.

Implementation and results

- **+Supply chain operations: RFID at BGN/Selexyz results in better insights in the supply chain by giving it more transparency and control. The advanced shipping note from Central Bookhouse is received in advance of the order and is already processed in the bookstore's database. When the order physically arrives in the store, the store personnel scans each carton at once by a scanning tunnel or hand reader. One carton contains between 30 and 40 books and is read in approximate 5 seconds. The system compares the shipment delivery with the order, recognize errors automatically and sent an alert to rectify the order. Major advantage of RFID: Time efficiency: Improved intake effectiveness: 100% checked < 10 minutes.**

Traditional time ,book scanned by hand: 650 books times 15 seconds = 1.5 hours (11). Orders are now 99% accurate according to Mr. Vink.

- **+Stock control: The case showed an increase in control over stock. At Selexyz Scheltema 38.000 books are tagged and could be traced exactly on store shelves and displays. When the staff has scanned the delivery, the books are stored on the appropriate shelves and display's. Once or twice a week the whole store is scanned with an RFID reader. First the shelf or display is scanned and second the books on that shelf or display. In this way, the system can determine exactly which books are available and where they are located in the bookstore. Without RFID the stock reliability was only 100% the day after inventory was done (once a year). Afterwards, the reliability slips back to 60-65%. With RFID technology implemented, the reliability stays at 97.5% (11).**
- **+/- Search Kiosks: The self-search kiosk is by it self a very innovative service. It happens to be an user friendly instrument for customers to search for a title and trace it's exact location in the store without any help from store personnel. However, the kiosk self-search function does not perform 100%. The kiosk tells a customer were to find a particular copy but testing the self-search kiosks appeared to be not as reliable as expected. Not every title was found on the location described, while the system says it should be.**
- **+Inventory efficiency: Whole store inventoried within 2-4 hours by one staff member in stead of a whole day shutdown of the store and employment of 4-5 staff members.**
- **+Custom orders: The custom ordered books increased due to the kiosks (6). The custom orders only need to be placed on the smart shelves after arrival at the store. The RFID system automates the notification process of the customer instead of searching and informing the customer by hand. This saves time and prevents that a customer is notified too late.**
- **+Shrinkage rate: Shrinkage consists of theft and administrative faults mainly. RFID provide good insights in the daily type of shrinkage. RFID makes it possible to see which specific item is lost because every item has its unique identity. Previously, only guesses could be made about which items might possibly be stolen or loosed during one yearly inventory made up. Shrinkage can be traced very fast because of the frequent inventory make ups by store personnel.**
- **+Labour: RFID showed dramatic decreases of employee hours on several aspects. This offers the possibility to operate the store with a smaller staff. BGN claimed that the amount of personnel remained the same as before RFID adoption so that sales and customer satisfaction could increase.**
- **+Sales: Selexyz Scheltema and Selexyz Dominicanen showed impressive results concerning increase in direct sales and custom orders. +5% sales increase due to a decrease of out of stocks and increase in customer orders from the kiosks (6). Note: Both are new stores and therefore other factors can be of influence.**

- **+Security & Privacy: In Maastricht EAS detection is operational. Because the tag is killed, no privacy issues are involved. Inside the stores, only in the beginning there were flyers that communicated about the RFID system usage inside the Store. During the pilots there were merely no question about privacy issues by the media or from customers says Mr. Vink.**
- **+Customer satisfaction: It is presumable that the customer satisfaction increased. Because of the equal amount of personnel, there is more time for service to the customer, also the stock reliability increased and the kiosk self service component offers satisfying customer search service and comfortable custom ordering options.**
- **+/-Personnel: Resistance among the Selexyz personnel towards RFID was larger then expected. Humans have a conservative nature and despite of the enthusiasm of the RFID initiators within BGN, and among the Selexyz storemanagers, the personnel is suspicious about the supposed efficiency and control advantages. It is important for the success of the technology to convince the personnel of the advantages because their commitment is essential. If the commitment is low, the advantages of adoption are not exploited.**
- **+Cooperation: The associate companies in this RFID project are mainly suppliers of technology and knowledge. They appeared to be very cooperative and flexible concerning the implementation of the system with BGN/Selexyz.**
- **+/-Investment: Taking the leading role in adopting RFID on item level, is not an easy job. The financial and human effort that is needed should not be undervalued. The case study concerned a period of 2 years of RFID adoption. The financial figures that were published in the media were based on the first investments in Almere and Maastricht and comprise an investment of 850.000 euro, The calculated break even point appeared to be 22 months. Note: the present financial investments in 2008 differs from the initial investment in 2005 and 2006.**

§ 5 RFID Investment

The total project costs of Almere and Maastricht (No figures were available from Selexyz Nijmegen) are approximately 850.000 euro (12). These costs are considered as relative costs for two stores, since the total investment for BGN is higher due to the fact that a large part of the investment is also relevant for future stores that adopt RFID. The investment will be break even some where between 19 en 22 months for both stores according to Mr. Vink. Because of the rapidly changing costs, the investments made for the Selexyz Nijmegen store are based on much lower priced hardware, and considered to be break-even in less then 18 months.

Financial investment overview

The fact that the RFID system at BGN/Selexyz had to be integrated in an existing, and extensive, Progress store and stock IT environment, clarifies the role of Progress and the extra costs of their software. The investment for an independent bookstore is based on actual hard and software prices (2008) and does not need to make use of Progress software as Maarten Anderson of CaptureTech explained. As mentioned earlier, CaptureTech develops and supplies RFID hardware and is exclusive vendor of Vue technologies, the leading company in design and development of RFID software and middleware. The Central book house is the supplier of the second generation RFID tags, special designed and combined with the Book Information Sticker. The tags on books are applied at CB before distribution to the bookstore. The adoption case at Selexyz provided all adoption related investments. Based on the information of CaptureTech, Central Book House and BGN/Selexyz the next investment overview is made for RFID adoption at one bookstore.

Hardware	Value	Costs
RFID Tags		
Price per tag	0,15	
Amount of tags needed	15000	
Total costs tags		2250
RFID terminal (reader)		
Price per terminal	3000	
Amount of terminals needed	1	
Total costs readers		3000
POS Killers		
Price per killer	1500	
Amount of killers needed	2	
Total costs killers		3000
Kiosk		
Price per kiosk	1500	
Amount of kiosks needed	1	
Total costs kiosks		1500
RFID printers		
Price per printer	3500	
Amount of printers needed	1	
Total costs printers		3500
EAS detection system		
Price per system	6000	
Amount systems needed	1	
Total costs systems		6000
Total hardware		19250

Software	Value	Costs
Middleware Licenses		
RFID sitemanager	6000	
Mobile RFID module	1500	
EAS Module	1500	
ERP/stock Module (interface)	1500	
Total software		10500

Installation	Value	Costs
Tagging 15000 tags		
Amount of tags p/h	150	
Amount of hours	100	
timewage	20	
Total tagging costs		2000
Installation costs (Hardware/software integration costs)		
Amount of hours	50	
Timewage	50	
Total system integration costs		2500
Training		
Amount of trainnees	8	
Costs of training	100	
Total costs of training		800
Project management		
Amount of hours	60	
Timewage	50	
Total expert costs		3000
Total installation costs		8300

Exploitation	Value	Costs
RFID Tags		
Price per tag	0,24	
Amount of items	15000	
Total costs of tags		3600
Maintanance		
Software maintanance 15%	1575	
Hardware Maintanance 9%	1530	
Total costs of maintanance		3105
Total exploitation		6705

Configuration	Value	Type
Parameter		
Personnel	8	employee
Turnover (year)	30000	unit
Labeling capacity p/h	150	unit
Tagging wage p/h (ex tax)	20	€
Stock	15000	unit
CB RFID tag net price	0,15	€
CB RFID tag inclusive price	0,24	€
Training courses	1	Course
Installation wage p/h (ex tax)	50	€
Management wage p/h(ex tax)	50	€

Figure 2: 2008 RFID investment overview

Budget interpretation

Figure 2 represent a €44.755,- RFID investment. The budget includes the adoption of anti-theft EAS detection functionality. Total costs of this component: € 7.500,- (€6.000,- + € 1.500,-). Although EAS detection is certainly an interesting option, it is not considered as a necessary investment and if desired, can be left out of the budget making the investment € 37.255,-. Considering the price of RFID tags within the investment budget, there is a price discrepancy between the RFID labels that are printed, applied and delivered by the Central Book House, and the tags that are printed and applied by the bookstore. The tags that are

applied when relabeling the inevntory are € 0.09 less expensive then the tags that are applied at the central book house because the coding, printing and appliance of the tags are a commercial service of the Central Book House. The maintenance of software is based as an percentage of the total software licences. The hardware maintenance is based as an percentage of all hardware (€ 17.000,-) except the RFID tags (€2.250,-). Considering the installation costs: the tagging can be done by store personnel or by external manpower, like students for instance. Costs are approximately € 20,- per labelling hour. Because the complete RFID system requires to be integrated with existing store-stock IT software, costs for installation and testing of the technology will be made. The estimation of 50 installation hours is budgeted for two partners: Capturetech: RFID Installation and Tite-Life: integration of store software and the new RFID system. The management of the adoption project can be done by the entrepreneur itself or by an external project manager. Estimated hours needed: 2 * 20 hours a week and 2 * 10 hours a week. In case of external project management, the entrepreneur can keep focus on the daily management of the bookstore while the RFID adoption project is guided and controlled by an external professional.

Return on RFID investment

As a supplier of RFID tagged books, the Central Book House (CB) has made an investment analysis for RFID adoption. They took an average independent bookstore as example and calculated the Return On Investment (ROI) and the Break Even Point (BEP) over a five year period. The investment analysis made by the CB consists of a balance sheet and a profit analysis but is considered confidential and therefore not included in this report. Because the reasoning in, and interpretation of, such analysis has, in a certain extend to do with assumptions, it is imaginable that misunderstandings or incorrect expectations about the adoption results appears. One premise that has been made in this analysis is discussed as example of a different interpretation: The assets side of the balance sheet of CB's investment overview, represents, among other assets, savings in personnel hours due to RFID adoption. This is only true if those hours are not paid anymore. In real life, the employee keeps employed and no direct money saving appears. Besides, extra employee hours are needed for regular inventory scanning. This different view influences the ROI and BEP significantly. Another point of discussion are the non financial benefits of RFID. In example: Improved working and shopping experience, new marketing and customer relationship opportunities cannot be measured directly.

Case references

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(11) Powerpoint presentation Beyond RFID by Jan Vink 24-04-2007

(12) RFID dient omzet en klantentrouw, Business Logistics Juni 2007

Appendix III: Functions of Barcode and RFID

Function	Barcode specific	RFID Specific
Identifcation of goods	Identification on SKU level	Identification on item level (serial)
Track and Trace of goods	static	Real time /automated
Reading / Writing	Light	radio waves
	One item per scan	Bulk reading of items (200 items in one sec)
	Direct line of sight necessary	No direct line of sight necessary
	Reading distance Max 50 CM	Reading distance varies from a couple of cm till several decades
	Static Label. Read only	Dynamic Label.Read and optional storage of information on chip.
Label capacity	Low. Limited information (max 50 bytes)	High. depending on chip approximately 2 megabits.
Standardisation of information	ISBN / EAN based	No standard yet, but in near feature the Gen2 EPC available via GS1
Durability	Depends on usage; relative short lifetime	Extensive lifetime, durable technology
Inactivate	Physical removal or destruction of the label	Digital destruction of the chip or removal of the tag
Costs of label	Low costs, cheap technology	Relatively high costs, expensive technology
Costs of Readers and infrastructure	Low	High
Security	Every reader is able to scan a barcode	The information can be secured via password or other encryptie technique.
Reliability	Scanrate is approximately 100%. The barcode is the critical point, when damaged or disquished, reading fails.	Scanrate is approximately 100% Reading reliability is becoming much better in recent years. Inference due to metal or water seems to overcome.
Hybrid function	No	Yes EAS compatibility function can be added on the tag
Assemble of the label	Often integrated in design of the package. Or stickers applied by hand or machine	Often integrated in design of the package. Or sticker tags applied by hand or machine(No need for replacement when information need to be corrected)