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2009

Investment Evaluation Of RFID Technology Applications: A Real Options Perspective

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INVESTMENT EVALUATION OF RFID TECHNOLOGY APPLICATIONS: A REAL OPTIONS PERSPECTIVE

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Abstract

The majority of previous studies on investment evaluation of RFID technology ignore the flexibility and the Real Options that this kind of investment can lead to. However, studies on the evaluation of other Information Systems have acknowledged the importance of these options as they create future business opportunities or give to managers the opportunity to take actions that could favorably influence the future direction of an investment in response to external or internal events. Drawing on literature from the Financial Field (Real Options theory) and Information Systems (IT investment evaluation), this paper has the aim to apply the Real Options approach to the RFID context through a case study example. This study shows how and why this approach is applicable to the case of RFID technology, underlining its necessity for the RFID investment evaluation.

Keywords: *RFID, Investment Evaluation, Real Options*

1 INTRODUCTION

Radio Frequency Identification (RFID) is the generic name for technologies that use radio waves to automatically identify individual items that carry such identification tags (Jones et al. 2004). This technology dramatically increases the ability of an organization to obtain an enormous amount of data about the location movement and properties of any entity that can be physically tagged and wirelessly scanned (Curtin et al., 2007). Supply chain management, anti theft systems, asset tracking, airline baggage handling, electronic tolling, and facilities management (ex. libraries) are examples of areas where RFID can be applied to. Widespread adoption of this technology is observed in the retail industry. In this environment, RFID can support a range of applications from upstream warehouse and distribution management to retail-outlet operations including shelf management, promotions management and innovative consumer services, as well as applications for the whole supply chain such as product traceability (Pramatari et al. 2005).

As it happens with all novel technologies, studies for the evaluation of investment in RFID technology have been conducted. However, the majority of these studies ignore during the assessment the flexibility and the different kind of options that the investment in RFID technology can encompass. These options coming from the field of Finance are called “Real Options”. They refer either to the business future opportunities that one initial investment can lead to or to the opportunities that they give to a manager to take actions, based on emerging events, that could favorably influence the attributes (ex. timing) of an investment, such as deferring, expanding or abandoning an investment (Benaroch, 2001). Several studies for the investment evaluation of other information technologies, except for RFID, have acknowledged the importance and the vale of these options. Ignoring the embedded options can seriously understate the value of an investment (Benaroch, 2001).

One kind of option that has been neglected by the literature on RFID investment evaluation is the growth option, referring to the future business assets that an initial investment can lead to. That is due to the fact that the majority of the studies assess RFID projects as stand-alone and independent, ignoring the common

characteristics, namely synergies that these projects can have. According to the literature on the evaluation of information systems, exploiting these synergies can result to the decrease of total expenditures and increase of benefits (Santhanam and Kyparisis, 1996). These synergies can be the basis for the generation of growth opportunities ("Growth options") of an investment. The importance of this option has been highlighted by the literature for the evaluation of other information systems. However, research on RFID investment evaluation has neglected this issue.

This study has the aim to identify the kind of options that an RFID investment can encompass. The need for this research idea has been highlighted by the literature (Curtin et al. 2007). Under the same perspective, this study has the aim to consider RFID applications rather as interrelated that can result to follow-on investments than as independent. The above issue has been highlighted as further research by Curtin et al. (2007). According to them: "Researchers could test the notion that infrastructure technologies (such as RFID) may not be the primary drivers of business value themselves but rather create real options for additional follow-on investments".

The rest of the paper is organized as follows. The first section provides a literature review on RFID technology. The following section contains an analysis and a critical review of previous research on RFID investment evaluation. The paper continues with the research aims and the followed research design. In the next part of the paper, the Real Options approach is applied to the RFID context and then to a real case example. The following section offers concluding remarks. The last part of the paper presents the limitations of the study and directions for future research.

2 RFID TECHNOLOGY

2.1 RFID system and applications

The basic trait of RFID technology, which involves the automated and wireless unique identification of a tagged item, is essential in environments such as supply chain management, anti theft systems, asset tracking, airline baggage handling, electronic tolling, and facilities management (ex. libraries), where a non-line of sight system is required to extract information about object movement. Retail supply chain is an area where RFID is mainly adopted. In this environment, RFID can serve a range of applications from upstream warehouse and distribution management to retail-outlet operations including shelf management, promotions management and innovative consumer services, as well as applications for the whole supply chain such as product traceability (Pramatari et al. 2005).

An RFID system is composed of three layers as it is depicted in the Figure 1: (i) a tag which is attached to or embedded in a physical object to be identified, (ii) a reader and its antennas which allow the tags to be interrogated and (iii) a software equipped with a middleware application that controls the RFID equipment, manages the data and interacts with other enterprise applications such as ERP, CRM or WMS (Asif and Mandviwalla, 2005 ; Wamba et al. 2008). An RFID reader identifies any tagged item within its interrogating field. The reader extracts data (ex. the price or the location of the product) from the identified tag and transmits it to a computer which filters and manages this data and all necessary information for providing specific business services. The difference among RFID and barcode technology is the fact that the readers can identify tagged items from a distance, automatically without requiring a line of sight. In addition, each item can be identified (separately from other items) having a unique identity. Furthermore, a high number of tagged items can be simultaneously identified, without the need of checking them one by one.

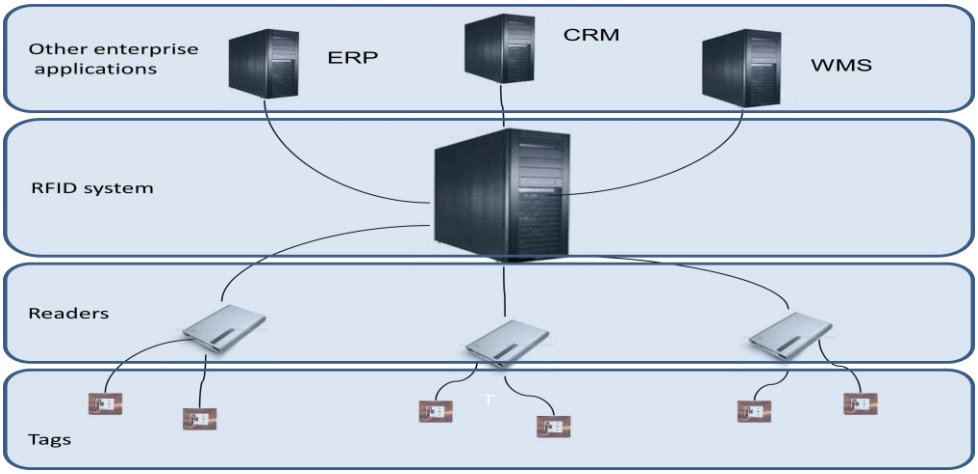

Figure 1. An RFID system and its components (based on Chen et al. 2007)

2.2 What makes RFID different/unique compared to another technology investment which can make the application of option analysis more relevant?

RFID technology is comprised of specific attributes that make investment unique among other technology investments. One of the main attributes of RFID derives from the fact that this technology can support not only "closed-loop" but also "open-loop" applications which lead to several investment options. Closed-loop applications refer to the use of RFID solely by an organization to achieve specific goals and resolve certain business problems. One example of this application is the utilization of the RFID technology to improve access control. For instance, an employee's RFID tagged card is identified by a reading device which allows the access of the employee to a store. This application can be utilized solely by one company and it is common with other technology investments as they require the investment by one business entity internally. On the contrary, open-loop applications based on a more complicated infrastructure require a tight and complex cooperation among different stakeholders. One example of an open-loop application is Collaborative Promotion management. In this case, a retailer and a supplier can collaborate based on RFID technology to offer enhanced promotion offerings to the consumers of a retailing store. In contrast to other technology systems, RFID technology investment decisions are contingent on the collaboration among different organization partners which may stimulate issues of data sharing and ownership. In particular, several investment questions such as the following occur: Is the retailer or the supplier going to pay for the tagging of the products? Who is the owner of the RFID system? Is the value derived from an RFID system differentiated between different stakeholders? Who will receive the higher benefits? Why? These questions yield many different options for an investment.

Other aspects of RFID that differentiate it from other technology investments are based on the components of an RFID system, described above. Modification of these components can lead to a variety of different business alternatives and choices, creating flexibility for an investor. For instance, tagging is a new attribute which can take several forms. Cases or individual items can be tagged leading to a "Case" or an "item" level of tagging, respectively. This different level of tagging supports different types of applications. In addition, in contrast to other technology investments, this attribute creates a new type of cost for the investor which is parametric and dependent on the number of the products that are tagged. This cost can reach very high points as this number increases or when individual products are tagged ("item-level tagging). This type of cost in contrast to other types of investments is a follow-on cost during the whole life of an RFID investment. Except for the tags, an investor can be in front of many business alternatives based on the number, the type or the location of the second RFID component which is the reading devices. These alternatives result to the creation of a type of cost which is again parametric and contingent on the number of the reading devices. In addition, the third component of an RFID system which is the software can

stimulate the generation of multiple business applications. Applications of this technology based on a common infrastructure can operate simultaneously (Violino, 2005) and support a variety of business aims and processes.

Altering the form of the above RFID traits can lead to different business functions and applications. For instance, assume that a reader is located in an inventory room at a store to identify automatically the stock of the products. If a manager decides to place an additional reader at the check out points of the store in order to identify the sold products, then another business function occurs. Through the automatic identification of the sold products and the necessary software adjustments, the inventory of the store can be updated and decreased automatically by the number of the purchased products. This is a result of adjusting the location of the readers and the software of the system. Thus, modifying the basic components of the RFID system can result to different implementation options and RFID enabled applications. "Whenever an IT project has flexibility about which applications and functions to implement and when or how to implement them real options are present (Fichman et al. 2005)". The paper will analyze the Real Options approach and explain why and how this approach can be applicable to the RFID setting.

3 RFID INVESTMENT EVALUATION AND ITS CRITICAL REVIEW

As it happens with all novel technologies such as RFID, projects and studies assesses their business value. The majority of the empirical studies on RFID evaluation have focused on back office operations such as inventory and warehouse activities. Studies based on several tools such as mathematical or simulation models (Doerr et al., 2006; Fleisch and Tellkamp, 2005; Kok et al., 2008; Rekik et al. 2008; Wang et al. 2008), assess the impact of the technology on inventory management and more specifically on inventory replenishment, inventory inaccuracies, product misplacement errors and shrinkage. In addition, research based on financial, simulation or hybrid approaches (Bottani and Rizzi, 2008; Karagiannaki et al. 2007; Kim et al., 2008; Subirana et al. 2003; Wamba et al. 2008) has evaluated the use of RFID for warehouse and logistics operations such as shipping, orders receiving and put away processes, concluding that RFID can lead to labour, material and transportation cost savings. In addition, little empirical research (Lee et al., 2008; Tzeng et al. 2007) has anticipated the impact of RFID technology on customer facing activities such as customer service.

In the above literature some issues have been ignored. Previous literature on RFID evaluation rarely does it take into consideration the flexibility and the different kind of options that an RFID investment can yield. However, studies for the evaluation of other information systems through a financial approach which is called "Real Options" (Benaroch, 2001, 2002; Benaroch and Kauffman, 1999, 2000; Kumar, 2002; Wu et al. 2008), have acknowledged the importance of these options, as they give managers the opportunity but not the obligation to adjust the future direction of a project in response to external or internal events (Tiwana et al. 2006). Examples include: deferring the investment of a project to an optimal timing period, changing the scale of a project, implementing it into sequential stages or exploiting it as a platform for future projects (Tiwana et al. 2006). These types of options entail value for an investment. If not considered, then the evaluation may lead to ambiguous results. However, the literature on RFID investment evaluation disregards this perspective. The need for identifying the kind of options that an investment in RFID can entail is underlined by Curtin et al. (2007) as an idea for further research.

One kind of option that has been neglected by the literature on RFID investment evaluation is the growth option, referring to the future business assets that an initial investment can lead to. This is a consequence of the fact that the RFID projects in the literature are mostly considered as independent and stand-alone. However, synergies among these applications exist as they share common characteristics, such as the implementation cost resources. Previous literature (Iniestra and Gutierrez, 2008; Lee and Kim,

2000; Santhanam and Kyparisis, 1996; Verma and Sinha, 2002; Liesio et al. 2008) has supported the importance of exploiting these synergies among IT projects, as they can result to sharing valuable resources, the decrease of total expenditures and the increase of benefits (Santhanam and Kyparisis, 1996). Exploiting synergies, investment projects can be considered as a 'bundle' of interrelated investment opportunities, the earlier of which are prerequisites for others to follow (Panayi and Trigeorgis, 1998). However, this perspective is neglected by the literature on RFID investment evaluation. As Curtin et al. (2007) argue, interesting opportunities for research on RFID emerge: "Researchers could test the notion that infrastructure technologies may not be the primary drivers of business value themselves but rather create real options for additional follow-on investments".

4 RESEARCH AIMS AND RESEARCH DESIGN

The aim of this research is to apply Real Options thinking to the RFID investment evaluation. The goal of this research is to use Real Options as a tool to understand better the flexibility that is yielded for a company which decides to invest in this technology. In contrast to the previous studies, this research considers RFID technology as an infrastructure which can work as a basis for follow-on investments. The main goals of this research are to:

- Analyze and identify the types of options that an RFID investment can yield
- Identify and justify the variables of the RFID setting that lead to these options
- Analyze the flexibility and the value that these options can include in the case of the RFID.
- Justify the applicability of the Real Options approach to the RFID setting and analyze its importance

In order to fulfill these aims the following research design is followed. One of the first steps is to exploit the Real Option types from the literature (Trigeorgis, 1996; Brach 2003; Fichman, 2005) and explore if these are related to the case of RFID. The applicability of these types of options to other kind of information technologies (CRM/ERP) as it is described by the literature is used as a guide. In addition, the taxonomy of these types of options as it is discussed in the literature (Trigeorgis, 1996; Benaroch, 2001) is used as a guide. The identification of the Real Options for the case of the RFID is based on Benaroch's (2001) methodology. According to this, one of the first steps for the Real options approach in order to evaluate an investment in a technology is to recognize the shadow options that this investment encloses.

Previous literature on IT investment evaluation through RO and on RFID technology is utilized. Firstly, the above issues are applied to the RFID technology and at a second step to a real case study. The case study is used as the main objective is to improve understanding of the potential of the RFID technology to offer several investment options and value. Questions such as "how" or "why" corresponds to an exploratory research initiative and justify the use of the case study (Yin, 1994).

5 REAL OPTIONS APPROACH AND ITS APPLICATION TO THE RFID INVESTMENT EVALUATION

The approach that considers for the value assessment, the flexibility, the alternatives and the possible follow-on projects that an investment in an IT project can lead to, is the Real Options (RO) Analysis. This approach finds its origins in the financial management field. The main idea underneath this approach is the fact that an investment embeds several types of options that should be considered during the assessment of a project as they generate value. Enterprises invest in two types of technology options: a) "Growth options" which produce long-term payoffs in the form of future business opportunities and b) "Operating options" which give managers the flexibility to change the features of a base project by modifying its scale, timing or scope (Benaroch, 2001). The following table summarises the main studies on the IT investment

evaluation through the Real Option (RO) Analysis and it refers to the type of IT application that the authors evaluate and the type of option that they study.

Author	IT Application	Type of option
Dos Santos (1991)	integrated services digital network	Growth
Taudes (1998), Taudes et al. (2000)	ERP	Growth
Panayi and Trigeorgis, (1998)	Telecommunications IT infrastructure ("CYTA")	Multi stage-Compound growth /Expand/ Scale
Bardhan et al. (2004)	A portfolio of 31 IT projects	Growth
Benaroch et al. (2006)	Several IT projects (ex. data mart consolidation and CRM)	Growth-Nested
Jeffery, Shah and Sweeney (2003)	Data mart consolidation project	Compound (growth / Stage)
Fichman, (2004)	IT platform	Growth
Benaroch and Kauffman, (2000), (1999)	ATM banking network infrastructure ("Yankee")	Defer
Kumar, (2002)	IT software tool (hypothetical)	Expand, Defer, Abandon, Scale
Benaroch (2002), (2001)	Web-based sales channel	Operational (Defer, Abandon, Contract, Expand)
Wu et al. (2008),	ERP implementation	Compound (Expand Contract, abandon)
Fichman et al., (2005)	-Customer reservation system -ATM banking network -ERP implementation -Teleco/nications network -software for an airline -Starbucks	Stage ,Defer, Growth Scale, switch use

Table 1. Literature review on the IT investment evaluation through Real Options

5.1 RFID as an investment with growth options

One set of studies (Dos Santos, 1991; Taudes, 1998; Taudes et al. 2000, Panayi and Trigeorgis, 1998; Bardhan et al. 2004; Benaroch et al.2006) has evaluated investments in IT projects which lead to "Growth Options". This research field supports the notion that an early investment in an IT project such as a software platform can be seen as a prerequisite or a link in a chain of interrelated projects opening up future growth opportunities (Trigeorgis, 1996) and applications such as e-commerce, electronic data interchange (EDI). Thus, the cost of the initial investment is viewed as the premium that a company have to pay to buy the option to invest in other related investments in the future. The growth and follow-up options are viewed in some parts of the IS literature (Taudes et al. 2000, Bardhan et al. 2004, Benaroch et al. 2006) as sequential multi-stage options, called as "nested options", where the value of each project consists of its own asset and the value of the option that it leads to (Benaroch et al. 2006).

Based on the Real Options thinking, all the infrastructure investments can be considered as a sequence of interrelated applications (Trigeorgis, 1996). If RFID technology is considered as an infrastructure technology, initial investments in one initial application type can lead to related follow-on investments. Thus, not considering this kind of option would undervalue the initial investment. RFID technology can

support simultaneously many applications (Violino, 2005) with common characteristics, goals and synergies. Exploiting these synergies an investor can consider how an initial investment can lead to a future related application and create value. The employment of these synergies can offer business benefits and cost decrease (Santhanam and Kyparisis, 1996). An example of this option for the RFID case is the following. An initial investment in the RFID infrastructure for the automatic identification of the products received in a backroom store can work as the basis for a follow-on RFID enabled application for the stock management. These applications have synergies as they share the implementation cost resources and the development of the second project requires the development of the first one.

5.2 RFID as an investment with operational options

The second set of the studies (Benaroch and Kauffman, 1999; Benaroch and Kauffman, 2000; Benaroch, 2001; Taudes et al. 2000; Kumar, 2002; Wu et al. 2008; Benaroch 2002) evaluates IT investments measuring the value of their "Operational options". These options refer to the actions that managers can make to reduce the potential for losses or increase the potential for gains on an initial investment project (Tiwana et al. 2006). They give management the opportunity to adapt traits (timing, scale, scope) of a technology investment to unforeseen conditions (Benaroch, 2001). They assess the value of actions such as: postponing, expanding, contracting, abandoning or staging an investment project based on the information occurred. Prior research has developed a categorisation of this type of options, as the following.

5.2.1 Stage- Scale or abandon option

The stage option refers to the opportunity to break up an investment into sequential steps (Brach, 2003). In the case of RFID, a firm can break up its investment into incremental stages based on an RFID trait which is the "tagging" of the products. The cost of tagging unlike previous technology systems is variable and dependent on the number of the products which get a tag. This characteristic gives flexibility to a firm to stage its investment and tag a small amount of products as a pilot investment and then implement or not a full-scale investment, based on the outcome of the pilot. At the same time, this characteristic generates two types of other options. It gives the company the "option to scale" up its investment by increasing the number of the products which are tagged if conditions prove successful or to "abandon" the investment if the environment and the pilot are fruitless. In addition, the type of the tagging (case/item level tagging) can generate the above types of options. For instance, a company can initially invest in the case level tagging and then tag each individual product item. This action can yield to a scale up, a stage option or even a growth option. Furthermore, another characteristic of this technology that justifies the flexibility of such an investment is the number and the location of the devices that read a tagged product. Increasing the number of the readers and changing their location in a store can lead to different business functions and goals, thus leading to many options, such as staged or scale up options.

5.2.2 Defer option

The deferral option refers to the opportunity to postpone an investment until favourable conditions occur (Benaroch, 2001). In the case of RFID, the cost of tagging and the readers can lead to this option. A company can defer an investment in the RFID technology and wait until the prices of the tags or the prices of the reading devices fall down. A firm can avoid the high cost if it defers a current investment in the RFID technology to another timing period. By deferring an RFID investment uncertainties regarding the market/users/consumers adoption of the RFID technology can be confronted. The investor can have the opportunity to wait and see the RFID adoption by other companies and take lessons for the use of RFID.

5.2.3 Switch option

When an IT asset is developed for one purpose and then is redeployed for another purpose, it results to the "option to switch" its use (Fichman, 2005). RFID infrastructure can lead to such an option as it can initially be utilised for one application, for example for backroom activities and then redeployed for other purposes such as customer support.

5.2.4 Compound option

A compound option is a collection of various options (Trigeorgis, 1996). RFID technology can offer "multiple interacting options". For instance, an initial investment in RFID technology can offer future applications leading to a growth option. At the same time, this investment can be broken up into several steps, offering the option to stage the employment of the RFID technology. If one stage proves to be successful then a company can go further to the following implementation stage. On the contrary, if one stage is fruitless then the firm can decide to dispose the RFID project without going further to the next step. This decision is an example of the option to abandon an investment project. Thus, a variety of different options can be given to an investor for the RFID investment offering the possibility of maximising the profit or minimising the cost.

Table 2 summarises the above types of options in the case of the RFID technology, the RFID characteristics that can lead to these options and the issues of flexibility and uncertainty which are the main reasons for using the RO approach.

Type of option	Definition	The case of RFID	RFID trait which creates the option	What is the uncertainty?	What is the flexibility?
Growth option	An initial investment opens the door for potential follow-on investments (Trigeorgis, 1996).	RFID as an infrastructure can create future growth opportunities	Application type	What applications should follow? What is the value of the future projects?	A variety of combinations of future applications and functions can follow an initial investment in an RFID infrastructure.
The option to stage	Break up the investment into incremental, conditional steps (Brach, 2003).	RFID investment can be broken up into several stages.	Application type, No of readers/tagged products/stores, location of the readers, level of tagging	There is uncertainty regarding the successfulness of one step in order to get into the following one.	Several decisions (ex. expand or contract an investment) can be made based on the outcome of each stage.
The option to change the scale	Expand or reduce the scale of operations (Trigeorgis, 1996)	RFID investment can be expanded ex. more products can be tagged, RFID can be implemented in more than one store	No of tagged products, No of readers, No of stores	Uncertainty about whether or not one scale up option would be beneficial. Uncertainty about the way an investment could be scaled up.	Several types of scale options
Option to defer	Postpone an investment (Benaroch, 2001) Wait until further information	RFID investment can be deferred. The investor can wait some	Cost-prices of tags/readers	When to invest? Cost of tags and readers Market adoption/maturity	Flexibility to adapt the "timing" trait of the RFID investment to unforeseen conditions (ex. tag

	reduces market uncertainty (Brach,2003)	years for the investment to see for example the prices of the RFID tags to fall down.		User acceptance Consumers acceptance Regulatory framework	prices) (based on Benaroch, 2001)
The option to abandon	Dispose of an unprofitable project (Brach, 2003)	Abandon an RFID application which seems to be unprofitable for the company.	Application type, No of readers/tagged/ products/stores, location of the readers, level of tagging	Uncertainty regarding whether or not to abandon the project.	Flexibility to keep or abandon an RFID project.
The option to switch	An IT asset developed for one purpose can be redeployed to serve another purpose (Fichman,2005)	RFID infrastructure initially used for one RFID application can be reused for another.	Application type	What alternative purpose/project can an RFID infrastructure support?	Alternative RFID applications and a variety of different purposes.
Compound option/ Multiple interacting options	A collection of various options (Trigeorgis, 1996)	An RFID infrastructure investment can be staged and offer growth opportunities.	Application type, No of readers/tagged products/stores, location of the readers, level of tagging	Which combinations of options to implement for the RFID investment?	A variety of different combinations of options for the RFID investment can be valued.

Table 2. Types of options in the case of the RFID technology

6 CASE STUDY- REAL OPTIONS APPROACH FOR THE INVESTMENT EVALUATION OF THE RFID-ENABLED IN-STORE PROMOTION MANAGEMENT

6.1 Case study Background

This section has the aim to apply the above mentioned Real Options thinking to a real RFID case. An RFID service which is tested within a current European project is going to be used as an example. The project has the goal to support intelligent business networking and consumer services in the retailing sector based on the use of RFID technology. The examined service has the aim to utilize RFID technology for the management of in-store promotions.

The company where the service is applied to is a European retailer with 200 stores-supermarkets from which the 150 stores run promotions. The retailer cooperates with 80 suppliers for the execution of all the product promotions. One of the purposes of the project is to evaluate the utilization of the RFID technology regarding its impact on the business processes for promotions held in the stores. To do so, the current business processes of the retailer are examined and an RFID system is built to underpin these processes with the aim to enhance the promotion management of the retailing stores. As a following step, the impact of this RFID-enabled service is justified through the Real Option Analysis.

6.2 Description of the RFID service

RFID technology is deployed to monitor the availability of the products on promotion and the promotion performance in a store. Every time a supplier sends to a retailer's store a case with the products for promotion, an RFID-enabled system identifies and checks the tagged case and all the products automatically, as they pass through the portal RFID readers which are located at the entrance of the backroom. In this way, manual scans and verifications with the purchase orders and shipment notifications are avoided. At the same time, through the RFID readers which are placed at the promotion stand, the availability of the products on the stand is checked in-order to avoid out-of stock occurrences. In addition, every time a product on the stand is sold, the system automatically updates the remaining stock. In that way, the retailer or the supplier can check automatically without human intervention the stock (availability) and the sales (performance) of the promotions in-store.

6.3 Applying Real Options thinking to the RFID enabled in-store promotions management

One of the goals of the specific project is to assess the value of such an investment in the RFID-enabled service. This investment through the Real Options thinking is considered as a set of several types of multi-interacting options as it is analyzed below and it is depicted in the following figure. The aim of this section is to identify the real options that are embedded in such an investment and justify their occurrence through the description of the flexibility and the uncertainty that the specific project includes. In addition, this section aims at identifying the importance of these options referring to the business gains that they can lead to.

6.4 The option to stage and scale up or abandon the investment in RFID enabled promotion management

The investment in the RFID-enabled promotion management instead of a full scale implementation can be broken up and considered as a sequence of conditional stages leading to a "Stage Option" (Figure 2). The retailer can decide to proceed to the implementation of one stage only if the previous stages prove successful. Thus, potential losses can be avoided than if the project is implemented as a full-scale investment.

In particular, the stages of the investment are the following (Figure 2). The retailer as a first step can utilize the RFID technology for the inventory in order to check the availability of the products which are delivered by the supplier at the backroom store, by placing a reading device at the backroom entrance. If this stage works favorably the retailer can invest further in another reader on the promotion stand to check the sales and the stock of the products on the stand. If this step proves successful, an additional investment in another reader placed on the shelf can add some value on this investment. The retailer or the supplier can check on the availability or the sales performance of the products on the shelf and compare them with these on the stand.

The location of the readers and the type of applications which are traits of the RFID technology can lead to this stage option. Investing further in additional reading devices can result to the support of additional business processes from the inventory monitoring to that of the promotion stand and the shelf. Each of this stage has its own benefit and cost and creates the option to proceed to a following stage of investment. There is uncertainty in each stage regarding its successfulness and the benefits that may occur. These benefits are contingent on several risk issues such as the level of the users' involvement to utilize the RFID technology for the promotions management, resistance to change the current process, and technical issues. This risk issues can be overcome, through a staged investment as it creates the flexibility for the manager to decide whether or not to go to the next step investing in additional RFID equipment based on the outcome of the previous steps.

As a result of the staging process, other types of options emerge. If RFID technology works favorably at the first stage for the checking of the inventory availability then the manager can have the option to "Scale" the investment and proceed to the next step. The RFID resources (ex. reading devices) can be expanded to support additional functions. Under the same perspective, if the first stage of the inventory audit is not successful the manager can decide to abandon the project for promotions and not go further. Disposing of the project can curtail any future losses and avoid any additional expenses. This is a result of the "abandon option".

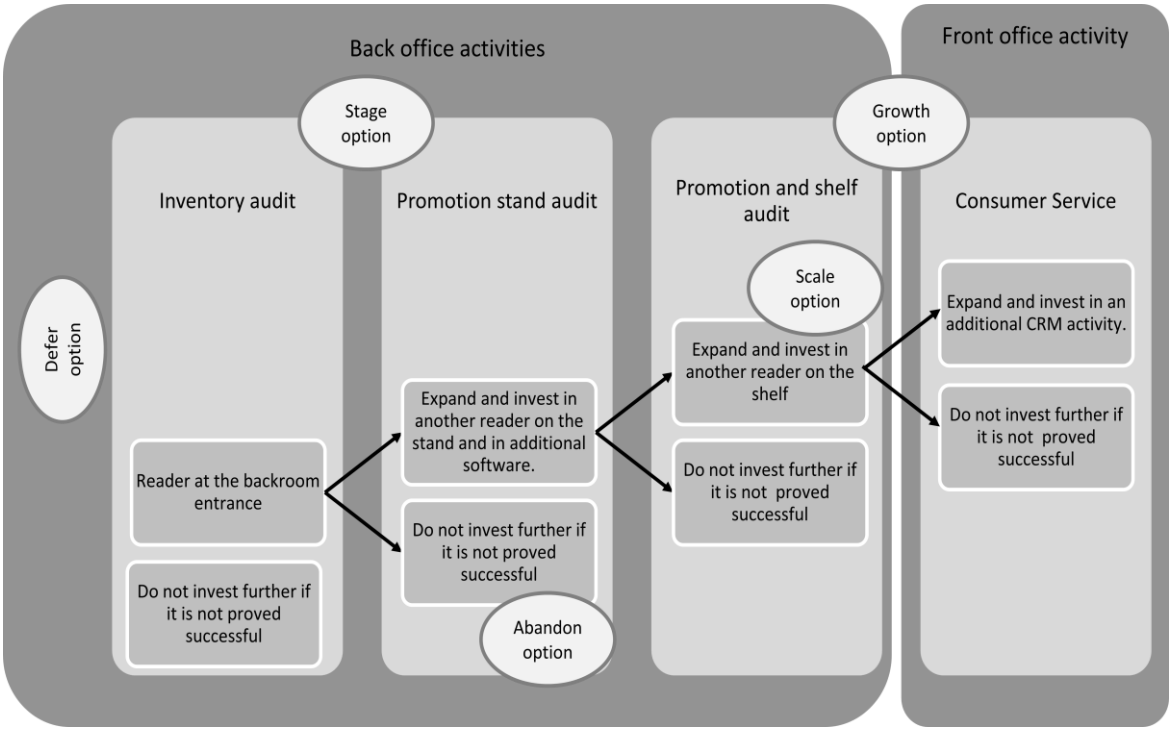

Figure 2. Real Options approach for the investment evaluation of the RFID enabled in-store promotion management

6.4.1 The option to defer the investment in RFID-enabled promotion management

This investment can embed another kind of operational option, the option to defer the project for promotions (Figure 2). The retailer or the supplier can wait for some years to gather more information on the RFID technology and postpone the specific investment. Through this option uncertainty and risk issues can be overcome. In particular, the investor due to the uncertainty of the prices of the readers and the tags can wait some years expecting that the prices will decrease. In that way, potential high amount of investment cost due to the current prices can be avoided.

In addition, because of the fact that the RFID-enabled promotion management scenario requires the collaboration among retailers and suppliers, investors can wait and postpone their investment until the market becomes more mature and ready to accommodate such an implementation. The value of the option of waiting to invest derives from reducing the uncertainty that the project has got by getting more information from the market. In the specific example, the investor knows little about the users' reaction in the store towards the change of the current inventory and promotion management activities as a result of the RFID technology. In addition, the investor is not informed about the consumer acceptance of the new service that can run for promotion offerings. As an option, the investor can postpone the investment and wait to get more information for the above as other competitors may invest in this technology even in other retailing applications. However, there is the risk of loosing the opportunity to act as a "first mover"

and adopt the innovative technology. Ultimately, the investor can choose to wait if the value of deferring the investment is higher than the opportunity cost of losing current revenues of the RFID project.

6.4.2 The option to grow an investment in RFID-enabled promotion management

Except for the above "operational options", this investment in the RFID technology can lead to a "growth option" (Figure 2). The RFID infrastructure utilized for the above mentioned backroom activities can work as a basis for future applications such as promotion offerings to the consumers, displayed on a screen every time a product is picked up from the stand. An additional investment in CRM software can offer personalized promotion offerings, based on the consumer's purchase history. In contrast to the backroom activities which deal with the review of the products stock and promotions performance, this activity is a front-office activity as it embraces the interaction of the system with the consumer. As this add-on project creates a new asset (for customer relationship management) rather than modifying the value of an existing asset, it represents a growth option rather than a scale-up option (based on Fichman, 2005). This growth option can be based on the synergies among the related RFID projects. The initial RFID investment for the backroom activities share common resources with the follow-on investment, such as the cost of the readers and the tags. Thus, considering this aspect, the implementation cost can be diminished and more benefits can be gained (Santhanam and Kyparisis, 1996).

The uncertainty regarding this option is mainly related to the variability of the benefits expected through such a service and the consumers' acceptance of their interaction with the technology. This option offers flexibility for a manager to implement the future business RFID enabled projects in different ways and functions. A manager for instance can run a service only for giving information to a consumer about products characteristics on a screen or alternatively for offering promotional recommendations to the consumer. Flexibility also occurs based on the variety of the choices regarding the type of the reader. For instance a consumer can use a handheld device or a fixed-mount one which can be placed on the promotion stand. The embedded option and the flexibility that the manager has to grow its investment add value to the initial investment in RFID and should be considered for the evaluation of the investment.

7 DISCUSSION AND CONCLUSIONS

In contrast to previous research, this study suggests another perspective for the RFID investment evaluation that of the Real Options approach.

From a theoretical perspective, this study seeks to fill the identified gap in the literature concerning the identification of the different types of options that an RFID investment can lead to. In contrast to the previous studies on the RFID investment evaluation, this paper aims at identifying the different kinds of options that an RFID investment can entail. As it is supported by research on evaluation of other kind of information technologies (Benaroch, 2001, 2002; Benaroch and Kauffman, 1999, 2000; Kumar, 2002; Wu et al. 2008), these types of options entail value for an investment. Thus, if not considered, the evaluation may lead to ambiguous results. However, the literature on RFID investment evaluation disregards this perspective. This study suggests that RFID technology can be evaluated through the Real Options thinking as it can lead to several types of options such as growth or operational options. This study shows how and why this approach is applicable to the case of the RFID technology, underling the necessity of this approach for the RFID investment evaluation. In addition, this paper shows how the several RFID traits can lead to different kind of options.

This study aims at fulfilling another opportunity for research as it is expressed by the literature (Curtin and Kauffman, 2007). This deals with the need of considering investments in infrastructure technologies, such as RFID, as options for follow-on investments. Although the importance of this issue has been acknowledged by the literature (Trigeorgis, 1996; Panayi and Trigeorgis, 1998), it has been neglected by the literature on RFID investment evaluation as RFID applications are assessed as independent projects.

Drawing from the literature for the IS evaluation (Iniestra and Gutierrez, 2008; Lee and Kim, 2000; Santhanam and Kyparisis, 1996; Verma and Sinha, 2002; Liesio et al. 2008), the study exploits the synergies that RFID projects can have as trigger points for the investment of interrelated projects leading to growth options. It is concluded that an investment in the RFID technology can be considered as a bundle of sequential investments which have common characteristics such as their business aim or their resources.

The implications of this research for managers are important. Traditional project appraisal within the context of capital budgeting, in contrast to the Real Option analysis, ignores the value of managerial flexibility to react to future uncertainties (Brach, 2003:4). Traditional project appraisal assumes that the project implementation will take place regardless of the occurring conditions in the market. In the case of the RFID investment, the manager has the flexibility to adjust to the environment by deferring or abandoning the investment if fruitless conditions for the RFID technology emerge (ex. prices of the tags increase). Not taking into consideration this opportunity can underestimate the value of the investment. This study aims at underlining this flexibility that the managers can exploit for enhancing the value of an RFID investment.

In addition, this study encourages managers during the evaluation of RFID technology to consider an investment in this technology as an initial investment in an infrastructure that can offer future growth opportunities, such as additional RFID applications. Based on Panayi and Trigeorgis (1998) research on IT infrastructure evaluation, when a firm invests in an information system, it would not gain so much from the direct inflows but rather from follow-on projects. In the case of RFID, which can be seen as an IT infrastructure, this flexibility gives value to the investment, which can be estimated through the Real Options approach. Otherwise, if this flexibility is ignored by the managers, the investment appraisal can be inadequate and lead to ambiguous results. Managers can deploy this idea for justifying more adequately the encouragement of RFID investment projects.

However, although Real Options thinking gives the chance to a manager to consider RFID investments as opportunities for further investments, it has its own disadvantages. One of the main shortcomings that have to be discussed is the fact that Real Options may require systems to operate in parallel which might add to the overheads or opportunity costs of the investing company. One example is the growth option that RFID technology can create. In this case, an RFID system works as the basic investment based on which a second additional system can be produced. This second system working as a growth option may increase the overall cost of the RFID technology. Nevertheless, this issue can be eased if the forthcoming benefits from this additional system outweigh the yielding cost.

8 LIMITATIONS AND FURTHER RESEARCH

This study has several limitations. However, these limitations can offer opportunities for further research. Firstly, although this study is based on a case study and on the literature for the investigation of the types of options for the case of RFID, it lacks to offer an adequate validation. A focus group or a Delphi approach with IT and business experts can confront this limitation.

Secondly, although this research employs the Real Options approach for identifying the embedded options of the RFID investment, it does not include an empirical quantified evaluation example. However, the scope of the research is exploratory as it investigates the applicability of this approach to the case of RFID. The aim of the study was to identify the kind of options that an RFID investment can lead to. Further research can use data from an organization in order to estimate the impact of RFID investments on the business value through the proposed approach. The results can be compared to the ones come from a traditional approach, such as the NPV.

Alternatively, further research can study the impact of these types of Real Options on the RFID adoption. Future studies can test how the different types of Real Options influences the likelihood of the RFID adoption.

In addition, the study is not comprised of a comparison among the different kind of the identified options for the RFID technology, regarding the level of their importance for the case of the RFID investment. Further research can focus on this aim and justify the importance of these types of options.

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