EVALUATING RADIO FREQUENCY IDENTIFICATION TECHNOLOGY ADOPTION FROM A REAL OPTIONS PERSPECTIVE

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A THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF INFORMATION SYSTEMS
NATIONAL UNIVERSITY OF SINGAPORE

2009

Acknowledgement

I would like to express my sincere gratitude and thanks to all individuals who have, in different ways, made this thesis possible.

I would like to thank by supervisors Prof. Teo Hock Hai and Prof. Chan Hock Chuan for their advice and guidance throughout the various stages of my doctoral study. Not only have they have been available for discussion and consultation at various times of need, their own achievements and excellence has been a source of inspiration for me.

Many faculty members at the National University of Singapore and other universities have enriched my Ph.D experience in different ways. I would like to thank my thesis committee members – Dr. Atreyi Kankanhalli, Dr. Klarissa Chang and previously Dr. Bock Gee Woo, for their evaluations, constructive comments and feedback during various stages of the dissertation. In particular, Atreyi who has been in my thesis committee from the very beginning has been a mentor to me in many different ways. I would also like to thank Dr. Kim Hee Woong, Dr. Calvin Xu and Dr. Bernard Tan who have collaborated with me, taught me different things, and given feedback and comments; and, Dr. Carol Saunders and Dr. T. Ravichandran with whom I could discuss various research ideas during their visits to NUS.

Several graduate students in the department have made my stay at NUS enjoyable. These include my labmates – Yang Xue, Sumeet Gupta, Xu Lingling, and Yu Jie, and other peers such as Mamata Bhandar, Oh Lih Bin, Tan Chuan Hoo, Xu Heng, Calvin

Chan and David Phang. In particular, I am indebted to Lih Bin for the immense amount of help and cooperation that I received from him while conducting the survey. Mamata Bhandar has been a really good friend and source of support. Over the last four years we have shared the joys and perils of doing Ph.D over many a cup of tea. I would also like to acknowledge the help of several students and faculty members of the department in carrying out item sorting procedures.

Most importantly, I would like to thank my family members for their constant support and encouragement. Without them, this thesis would not have been possible. My parents have always been there for me; they have worked hard and made a lot of sacrifices to give me the best possible opportunities. My brother has been a cheerful critic of my ideas and work, lending a patient ear whenever necessary. Finally, I thank my husband Samarjit for his help and support, and his unfailing confidence in me. He has motivated and inspired me in more ways than I can count.

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Summary

Information systems play important roles in the functioning of modern day organizations. At the same time they often call for significant investments on behalf of the organization. This makes the decision to adopt IS innovations a challenging decision-making scenario for organizational decision-makers. This thesis aims to examine the decision-making process through which organizational decision-makers evaluate and decide on the adoption of RFID – a particular information technology innovation that is currently being considered for adoption by many organizations.

With this motivation in mind, RFID adoption is framed as an IT investment project that is amenable to applying real options reasoning by decision-makers. Based on survey of relevant literature in the areas of technology adoption, organizational strategy, human cognition and, application of real options analysis in previous research, the different real options that managers are likely to recognize from the adoption of RFID technology are identified. Three different studies identify the various environmental, organizational and individual factors that affect adoption decision-making by helping managers recognize the real options from RFID technology and propose research models delineating the relationship between these factors, the recognition of real options and their effect on the adoption decision.

The first study identifies the role of institutional and individual factors in decision-makers' recognition of the various real options from RFID adoption and how this recognition of real options affects their intention to adopt RFID. The empirical results provide strong support for the proposition that real options reasoning is significantly

associated with the intention to adopt RFID and, institutions play an important role in the recognition of these real options.

The second study analyzes how organizational strategy affects the relationship between the recognition of real options by decision-makers and their intention to adopt RFID. Empirical results show that different business strategic types have implications on the importance that decision-makers attribute to the different real options and how this affects their adoption decision-making.

A human cognitive perspective on innovation adoption recognizes the role of mindfulness in adoption decision-making. Accordingly, the third study identifies and empirically validates the individual, organizational and technological factors that determine decision-maker mindfulness in the context of RFID adoption.

A survey approach is used for all three studies. Large scale sample survey of top-level organizational decision-makers in the manufacturing and logistics sector is carried out to validate the proposed research models. Responses were subjected to empirical construct validation in addition to the validation of the actual structural model. The implications of the findings from these three studies are discussed and directions for future research stimulated by this thesis are presented. The three studies contribute towards theory building in the area of applying real options analysis to IT innovation adoption, and in enhancing our understanding of the strategic decision-making process through which IT innovations are adopted. They also help in identifying organizational and individual profiles that can result in more effective IT investment decision-making.

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Chapter 1

Introduction

Information technology (IT) and information systems (IS) innovations and their adoption and diffusion amongst organizations is a topic that has received sustained research interest over time, primarily because innovations in general, and IT / IS innovations in particular, are often associated with efficiency gains, business value, performance improvements and economic dominance in an environment that is dynamic, and globally interlinked resulting in competitive advantage being less sustainable (Brynjolfsson and Hitt 1996, Kohli and Devaraj 2003, Mukhopadhyay et al. 1995). It has been proposed that organizations must continually innovate to maintain and enhance their performance under such circumstances (Nohria and Ghoshal 1997).

Based on the assumption that IT / IS innovations are strongly associated with efficiency gains, prior innovation research has often focused on identifying factors that contribute towards the widespread adoption or diffusion of some innovations, while relatively less successful adoption or total rejection in the case of other innovations. This has resulted in a significant body of literature in organizational IT / IS innovation adoption where the innovation adoption and diffusion problem has been analyzed using different theoretical lenses or perspectives. Primary among these research efforts are the use of diffusion of innovations theory (Rogers 2003), theory

of reasoned action and planned behavior (Ajzen and Fishbein 1980), technology acceptance model (Davis 1989), an organizational learning perspective (Cohen and Levinthal 1990, Fichman and Kemerer 1999), institutional theory (DiMaggio and Powell 1983, Teo et al. 2003) and structuration theory (DeSanctis and Poole 1994, Giddens 1979, Orlikowski et al. 1995).

The findings from this vast pool of research can be broadly classified into three categories of factors – *technological characteristics* of the innovation such as relative advantage, compatibility, complexity, perceived benefits (Rogers 2003); *organizational factors* such as managerial innovativeness, considering IT as an strategic resource, overall IT experience, existing IS knowledge base, and the availability of financial resources, etc. (Chwelos et al. 2001; Fichman and Kemerer 1997; Lai and Guynes 1997); and, *environmental factors* such as competitive pressures, normative influences, institutional regulations (Chwelos et al. 2001; Teo et al. 2003) as primary determinants of adoption or the intention to adopt information technology innovations in organizations. While most of the above-mentioned factors are found to have high explanatory powers in describing the adoption of IT innovations, past research tells us little about how these factors contribute towards the actual decision-making process that result in the decision to adopt or not to adopt an innovation.

1.1 Motivation

The strategic potential of information systems in often well recognized (Sabherwal and King 1995), and, the adoption of information technology is believed to have competitive impacts on the organization and contribute positively towards

organizational performance (Brynjolfsson and Hitt 1996, Kohli and Devaraj 2003, Mukhopadhyay et al. 1995). However, attempts to delineate the business value that can be appropriated from organizational information technology have often resulted in uncertain and conflicting findings (Melville et al. 2004). At the same time, failing to keep abreast with technological advances by adopting innovations results in a risk of the organization becoming saddled with old and outdated information technologies that prevent them from grabbing innovative business opportunities. Researchers have also argued that new technologies will continue to give companies the chance to differentiate themselves from their competitors, and temporary competitive advantage to early adopters which can be converted to sustainable competitive advantage if the technology happens to provide follow-on possibilities (McFarlan and Nolan 2003).

Under such circumstances, organizational decision-makers responsible for deciding on an IT innovation that is new, uncertain in terms of its expected outcomes or the way it is going to evolve over time and its potential impacts on the organization, and, calls for large investments of organizational resources, are faced with an increasingly difficult decision making scenario. However, there is little research on understanding the process through which managers decide on potentially strategic information systems (Sabherwal and King 1995).

Conceptualizing IT / IS innovation adoption in organizations as a strategic decision-making problem for organizational decision-makers, this thesis attempts to provide a better understanding of the factors that influence the decision-making process resulting in the decision to adopt or not adopt in the context of Radio Frequency Identification (RFID) technology. We use real options reasoning (Bowman and

Moskowitz 2001, McGrath et al. 2004, Stark 2000) as the theoretical lens to explain the process through which managers decide upon RFID technology. Real options reasoning has been considered an appropriate lens to examine strategic investments decisions to acquire organizational resources that have the potential to provide future opportunities to the organization (Bowman and Hurry 1993, McGrath et al. 2004). For the real options reasoning to be applicable, the investment project being analyzed should satisfy the three criteria: (a) uncertainty of outcome, (b) irreversibility of costs, and (c) high managerial flexibility in terms of structuring the investment (Dixit and Pindyck 1994).

RFID technology is believed to have the potential to provide significant strategic opportunities to the adopting organization. By allowing physical entities to be tagged and wirelessly scanned within certain technical limitations, RFID technology promises to dramatically change the capabilities of organizations to acquire a vast array of data about the location and properties of any tagged entity and allows the entity to become a mobile, intelligent and communicating component of an organization's overall information infrastructure (Curtin et al. 2007, Stanford 2003). Therefore, RFID can be thought of as a new type of inter-organizational systems that crosses organizational boundaries and provides new opportunities to transform the supply chain for real time optimization (Curtin et al. 2007). At the same time, there are several uncertainties regarding the adoption, usage and impacts of the technology. In addition to certain technical problems, there are managerial, organizational and societal issues pertaining to the adoption and use of RFID technology that need to be addressed before its performance impacts can be assessed and recognized. Because of

these characteristics of RFID technology, we believe that real options reasoning can be applied to the decision-making process involved in considering investment in RFID technology. The following two sections provide overviews on RFID technology and on real options reasoning. These are followed by outlining the research questions that this thesis aims to answer, and an overview of the structure of the remaining thesis.

1.2 Radio Frequency Identification Technology

1.2.1 Technical Overview

Radio Frequency Identification, or RFID, is a wireless tracking technology that uses radio frequency communication to automatically identify, track and manage physical entities such as objects, people or animals. The two fundamental components of a RFID system are – an electronic tag and a tag reader (IDA 2004). The devices are paired and able to "recognize" each other through the transmission of radio waves. The tag can be attached to or embedded in some object such as shipping containers, pallets, items, livestock, baggage, machinery, healthcare instruments, library books, etc. All applications and variations of RFID systems share the same basic components which are also combined in a similar manner. Objects to be sensed are tagged with electronic radio frequency tags, and tag readers (or transceivers) are used to read the data contained in the tags. The type of tag used and the data stored in the tag varies from application to application.

The tags typically contain an electronic microchip that stores data and a coupling element such as a coiled antenna that can communicate with the reader via radio frequency waves (Agarwal 2001). The tags can be active, passive or semi-passive.

Active tags possess their own power supply (such as a battery), while passive tags draw power from the signal of the tag reader. Semi-passive tags use both the battery and the signal from the tag-readers to get powered. Consequently, passive tags are much cheaper and smaller than active or semi-passive tags which are typically used for higher valued objects that are scanned over long distances.

The tag readers typically consist of a radio-frequency module, a control unit and a coupling element to send interrogatory signals to the electronic tags via radio frequency waves. An important characteristic of the RFID system is the read range, which depends on both the power of the tag reader and the frequency used to communicate. More powerful readers and higher frequency tags have higher read ranges. The information stored in the tags can range from static identification numbers to user written data to tag sensory data. Upon receiving the data, tag readers can then communicate this data to various data-processing subsystems via interfaces.

1.2.2 Applications of RFID

While RFID technology has been around for more than sixty years, the June 2003 Wal-Mart mandate to its top 100 suppliers to start using RIFD tags at the pallet levels by January 2005 was a major instigating factor causing a sudden leap in the industry and public interest in RFID (Curtin et al. 2007). Many major retailers such as Target, Best Buy, Tesco, Metro AG, Carrefour, Albertson's and others soon followed suit by mandating supplier adoption of RFID technologies (Vollmer 2004). While the current popularity in RFID is primarily in the consumer goods and retail sector, there are possible applications of RFID technology across different industry sectors such as in transportation and logistics, pharmaceuticals, healthcare, aerospace, defense,

manufacturing and the retail consumer goods industry. Thus, different organizations can benefit from different applications of RFID. For example, airlines can use RFID applications for baggage tracking to reduce incidences of misplaced and lost passenger baggage, RFID applications can be used in the healthcare industry to provide more customized and efficient patient care. RFID applications can be used in the manufacturing industry to reduce lead times, WIP inventory, better shop-floor management, and more efficient usage of production capacity.

RFID has potential applications across the value chain of different organizations. It can be applied in B2B logistics, internal operations, B2C marketing and B2C after-sales service (Curtin et al. 2007). For example, organizations typically have to deal with both inbound and outbound logistic arrangements such as receiving goods from their suppliers and / or some other storage facility, and shipping goods to their customers. The goods received have to be matched against the advanced shipping notice (ASN), either by manual counting and matching or via bar-code scanning. Using RFID chips to tag pallets of goods can make to whole process of receiving goods faster and more efficient by eliminating the need for human intervention. Strategically placed tag readers can read the tag attached to a pallet and automatically match its content against the ASN. Similarly, for outbound pallets being sent to customers, RFID tags can be used to verify the contents of the pallet to ensure that they contain the correct shipment.

RFID tags can be used for controlling and ensuring that the required conditions for objects sensitive to temperature and atmospheric changes (such as fresh produce, drugs, etc.) are met during the process of transporting them from one place to the

other, and also help in cutting down loss and spoilage caused when the required conditions are not met. Car rental companies can tag their cars and use strategically positioned readers to better manage their fleet of cars by having real-time access to the exact location of the cars. In fact, transportation, logistics and shipping is considered one of the most interesting and potentially valuable application areas of RFID technology (Curtin et al. 2007).

RFID technology can also be applied within the boundaries of a single organization. Many organizations have pilot tested RFID by first deploying it only for internal operations (Curtin et al. 2007). Using RFID technology, the stock-verification process can be automated by passing the products through tag readers, thus eliminating manual effort and speeding up the process. RFID can help in removing the whole process of inventory reconciliation because the system can always give real time information of what is available, in how much quantity, and in which location. By capturing the movement of goods across the value chain in real time, demand forecasts are likely to become more accurate, thus making it possible to avoid out of stock or excess inventory situations. RFID technology can also be used for enabling stock rotation to avoid expiry or rejection due to insufficient remaining shelf-life. Inside organizations, RFID can be used for maintaining a regular internal asset inventory system. For instance, large hospitals have already started rolling out RFID technology to keep track of expensive medical equipment to be sure the item is in the right place at the right time (Bazzoli 2004). Many libraries across the world, the National Library Board of Singapore being one of the pioneers, have started using

RFID to tag individual books to prevent loss of books, speed the checkout process and provide overall better customer service.

Another attractive area for the application of RFID technology is that of B2C marketing and after sales service. By tagging individual items, the retailers will be able to identify the exact buying patterns and preferences of customers. This can help them in designing more customized marketing campaigns. Tag readers attached to the shelves of a retail store can record the movement of goods out of the shelf in real time, and can send out restocking requests whenever the quantity available falls below a certain level to prevent stock-outs and lost business (Curtin et al. 2007). After sales service can also be made more efficient and effective when maintenance crew are able to scan tags on products to read their date of purchase, warranty period, possible abusive use, and so on. While promising applications of RFID technology can be designed and implemented in the arena of B2C marketing and post-sales services, unresolved issues regarding concerns over threats to consumer privacy from inappropriate use of RFID remain largely unresolved, and these have been deterring organizations from deploying such applications. Thus, organizations should take steps towards assuring customer privacy both in fact and in perception.

1.2.3 Issues Pertaining to RFID Adoption

Although RFID promises significant strategic benefits and opportunities, financial, technical and operational challenges may make it infeasible for many organizations, especially those whose supply chains are not rationalized and standardized (Asif and Mandviwalla 2005). Even though prices have been decreasing, RFID tag prices are still quite high to be feasible for individual item level tagging, especially for low-

valued everyday consumer goods. According to the online RFID journal[1], currently, the cheapest tag can cost anywhere between 7 to 15 US cents, while a fully functional stand alone reader can cost anywhere between 500 to 750 US dollars. In addition to tags and readers, companies also need to purchase middleware to filter the RFID data.

Other than the cost of the RFID system, there are technical issues such as the distortion of signals in the presence of metallic objects, false reads, duplicate reads or the inability to read all tags (Angeles 2005). Further, the collection, storage and usage of the huge amount of data collected by the RFID system poses significant challenges to existing IT infrastructure of the organizations. In order to timely and appropriately process and benefit from the information captured by the RFID system, there are several integration related issues that the organizations should be prepared to face. The adoption of RFID may call for further investments towards integrating the RFID system with existing enterprise systems, and significant changes in existing business processes. Therefore adopting organizations need to assess their readiness for RFID technology. For example, organizations that have already streamlined their supply chains and implemented initiatives such as vendor-managed inventory will be better suited for the adoption of RFID (Asif and Mandviwalla 2005).

In addition to the technical and organizational challenges, there are social challenges that have to be taken into consideration when considering RFID adoption. There are significant concerns regarding privacy, data security and threats of legislative oversight. Concerns regarding privacy infringement and unethical use of the data captured using the RFID systems has been publicized by human rights activists and

[1] http://www.rfidjournal.com/faq

other civil bodies. Public opinions surveys have also found that more than 60 percent of surveyed consumers who had heard of RFID are highly or somewhat concerned about the privacy implications of RFID technology (Asif and Mandviwalla 2005).

1.3 Real Options Reasoning

A real option is an investment in physical and human assets that provides the opportunity to respond to future contingent events (Kogut and Kulatilaka 2001). It is a limited commitment investment in an asset that conveys the right, but not the obligation, to make further investments should the payoff look attractive (McGrath and MacMillan 2000). In strategic management literature where several concepts and frameworks are used for deciding upon future investment decisions, real options are an excellent analytical tool for evaluating future investment decisions because they allow firms to integrate project management, budgetary decisions and overall corporate strategy, while also maintaining the link to internal and external uncertainties (Brach 2003). A real options perspective offers a complementary approach to normative models of evaluating investments under uncertainty borrowed from the field of finance and behavioral theories of decision making (McGrath and Nerkar 2004).

Organizations are often faced with complex investment decisions where the traditional discounted cash flow techniques and net present value analysis result in an unfavorable picture of the overall project, although managers may intuitively recognize and appreciate the potential strategic opportunities that the project could create later. Under such circumstances, the real option reasoning provides an alternative way of evaluating the investment decision, by taking into account the

value of the future opportunities that are created by the project. The application of *real options reasoning* implies that decision-makers implicitly (or explicitly) recognize the value of the right to preserve decision rights in the future in their investment choices (McGrath and Nerkar 2004).

There has been significant recent research interest in understanding how real option reasoning complements traditional net present value based approaches to investment decision (e.g., Bettis and Hitt 1995, McGrath 1997, Trigeorgis 1996). Investments that give firms the right, but not the obligation, to make further investment if conditions turn out to be favorable typically contain real options (Kester 1984). Drawing from the notion of financial options on which the real options perspective is based, this initial investment can be likened to a financial call option, the initial investment being the call option's purchase price, whereas the cost of expanding in the future is the option's strike price. Since the firm has the right, but not the obligation, to expand in the future, it experiences asymmetric payoff. If conditions turn out to be highly favorable, the option is exercised, and the firm receives positive payoffs. If conditions turn out less favorable, the option is allowed to go unexercised, and the firm receives zero payoffs. This potential to enjoy some of the upside if things turn out favorable while restricting potential downside losses is what drives the value of options, and makes them attractive strategic investments.

Real options analysis is based on the recognition that there can be *uncertainty* regarding the future turn of events and the resulting returns from the investment decisions, investments made are often *irreversible*, and that there is *managerial flexibility* in investment decisions. Real options analysis values managerial insight

and flexibility. This flexibility entails the option to change the scale of an ongoing project by either downgrading or upgrading; the option to abandon a project altogether; the option to learn from an investment projects; the option to structure a project in incremental steps, with an option to grow at each step; and the option to wait for more information to resolve uncertainties before committing to a project.

1.3.1 Real Options in IS Research

Real options analysis has been used to analyze investments in real estate, natural resources, capital budgeting decisions, research and development of new products, drugs, mining, etc. Many IS projects also possess characteristics that make them suitable for the application of real options analysis. Accordingly, an emerging stream of research in IS has suggested the application of the real options analysis to investigate the adoption of information systems innovations (Kambil et al. 1993; Benaroch and Kauffman 1999; 2000; Taudes et al. 2000; Fichman 2004b).

Using a real options perspective, an information systems project can be viewed as a real option, which confers upon the organization, a right, but not the obligation to make further investments, should the initial results look attractive. Investment in technologies can create options for follow-on projects (growth options), option to wait and see, the option to abandon the project if the situation turns out to be unfavorable (deferral options) and the option to learn from an IT adoption (Brach 2003; Trigeorgis 2001). In prior research, Taudes et al. (2000) investigated the growth option conferred upon an organization by its initial investment in a SAP R/3 project, Benaroch and Kauffman (2000) investigated the deferral option in implementing a point-of-sale debit card network, while Fichman (2004b) modeled the

early adoption of information technology platform as a real growth option to identify a set of determinants of option value.

Intuitively organizational decision makers often recognize the long-term rent generating potential of certain IS investment decisions that confer strategic advantages or improve the overall IS knowledge base of the organization. Therefore, the real options thinking can be used to formally recognize and appreciate the different future options provided by the technology when evaluating the decision to adopt the technology. By valuing uncertainty and managerial flexibility, real options analysis is particularly applicable to new and evolving technologies, where uncertainty is high, but the nature of the technology – does not call for large one-time investments, gives organizations the freedom to space-out the overall adoption and deployment project, and also has the potential of conferring strategic benefits to the adopting organization depending on how the technology is used. Radio frequency identification (RFID) possesses many of the above characteristics, thus making it a suitable candidate for analysis from a real options perspective.

1.4 Research Questions

There exists an established body of scholarly work which identifies strategic investment decisions that are amenable to real options reasoning, and then analyzes the specific decision scenario to show that the findings are consistent with predictions from a real options perspective (e.g., Chi and McGuire 1996, Folta 1998, Kogut 1991, Kogut and Kulatilaka 1994, Reuer and Leiblein 2000). Along similar lines, this thesis identifies RFID adoption as a strategic decision-making context to which the real options reasoning is applicable, and then attempts to delineate the factors that

contribute towards determining the real option value from RFID adoption, and the relationship between organizational decision-maker's recognition of the real options available from RFID adoption and their intention to adopt RFID. More specifically, this research attempts to answer the following questions: (i) What are the different real options that organizational decision-makers are likely to recognize from the adoption of RFID technology? (ii) What are the different organizational, environmental, technological or individual decision-maker characteristics that determine the recognition of the different real options? (iii) What role does individual decision-maker characteristic play in RFID adoption decision?

The following three studies which are reported in the subsequent chapters are designed to address the above research questions:

Study 1: Real Options from RFID Adoption: The Role of Institutions and Managerial Mindfulness (Chapter 2).

Study 2: Role of Organizational Strategy in the Recognition of Real Options (Chapter 3).

Study 3: Mindfulness in RFID Adoption: The Determinants of Decision-maker Mindfulness (Chapter 4).

1.5 Expected Contributions

By framing RFID adoption in organizations as a strategic decision-making problem, this thesis aims to contribute towards the IS innovation literature as well as the strategic decision-making literature, and show the applicability of the real options

theoretical lens in evaluating IS innovation adoption decisions. While, previous research on IS innovation adoption have considered various organizational, technological and institutional factors that influence the adoption of technology, this thesis intends to provide an explanation of the decision-making process involved in the adoption decision and identify the factors that shape this decision-making process.

From a strategic decision-making perspective, this thesis aims to show that the IS adoption decision is similar to other strategic decisions that organizations make, such that the overall strategy followed by the organization and certain characteristics of the individual decision-maker within the organization play a significant role in the adoption decision-making problem.

Chapter 5 discusses the contributions from this research and their implications for future research and practice.

Chapter 2

Real Options from RFID Adoption: The Role of Institutions and Managerial Mindfulness

2.1 Introduction

Information technology (IT) innovations are generally believed to impart strategic and competitive benefits to the adopting organization (Brynjolfsson and Hitt 1996; Kohli and Devaraj 2003; Mukhopadhyay et al. 1995). However, it also involves significant resource commitments on behalf of the organization, and chances of failing to successfully implement the technology or to appropriate business value from it are often quite high (Melville et al. 2004). Thus, organizational decision-makers are faced with a complex decision-making scenario of deciding to adopt a technology that is relatively new and uncertain in terms of expected outcomes, but calls for large resource investments on the organization's behalf, or embrace the risk of becoming saddled with outdated technology, and losing the flexibility to deploy new IT capability when the market conditions call for.

To explain organizational engagement with IT innovations and their adoption, previous research has examined the role of different technological, organizational and environmental factors (classified under the TOE framework), and used different theoretical perspectives to hypothesize relationships between these factors and diffusion and adoption of IT in organizations. For example diffusion of innovations theory (Rogers 2003) has been used to predict the influence of different technological

factors on IT adoption, and the institutional theory (DiMaggio and Powell 1983) has been used to predict how different institutional factors affect adoption behavior (e.g., Teo et al. 2003). The role of organizational factors (viz. top management support) in influencing IT adoption has also been investigated.

In spite of the focus on technological, organizational and environmental factors, researchers have acknowledged that whether, when and how to innovate with IT is a complex and crucial question faced by managers in almost all organizations and also acknowledged the role of managerial sense-making in organization engagement with an IT innovation (Swanson and Ramiller 1997; 2004). However, most of this research stops short of outlining the underlying decision-making process which organizational decision-makers go through in order to arrive at a decision related to the adoption of a given IT innovation. Therefore, little is known of how managers' understanding of factors external to his organization, the technology and his own organizational context influences the decision process leading to IT adoption. This research uses real options perspective to understand the decision-making process that managers go through in the adoption of radio frequency identification (RFID) technology. We investigate the role played by the recognition of the real options in determining managers' intention to adopt RFID. Since real options are not generic, but depend on context specific factors, the role of institutions in making sense of these real options, and decision-makers' cognitive abilities in recognizing these real options is examined.

Real options theory is a useful framework for evaluating investment decisions under uncertainty (Dixit and Pindyck 1994; Trigeorgis 2001; Amram and Kulatilaka 1999). Compared to traditional techniques for evaluating investment decisions in

organizations (such as net present value and discounted cash flow analysis), the real options approach recognizes the value of managerial flexibility in structuring and timing investment decisions on the face of uncertain conditions, varying levels of risks at different stages of an investment project and irreversible investments. Therefore, this approach is deemed suitable for application to the investigation of IT innovation adoption decisions, more specifically when the technology is relatively new and uncertain in terms of its likely outcomes; and managers have the flexibility of timing the adoption decision depending on factors such as prevailing market conditions and availability of information (Benaroch and Kauffman 1999; 2000; Fichman 2004b).

RFID technology satisfies many of the conditions that are required for applying the real options thinking. Organizational decision makers may intuitively realize the strategic potential from investing in RFID even if initial returns look unfavorable. They are likely to appreciate the current uncertainty pertaining to the technology and the way it is going to evolve over time, thus making it prudent to wait for more information to arrive before investing in the technology. Further, they might also realize that while investing in RFID is somewhat irreversible, they have the flexibility of structuring the investment project in small incremental steps. The recognition of these real options is likely to influence organizational decision-makers intention to adopt by influencing the sense-making and justification process that managers go-through when evaluating RFID adoption.

2.2 Theoretical Background

2.2.1 Real Option Analysis

Real options analysis is a method to evaluate investment decisions under conditions of high uncertainty, irreversibility of costs and relatively high managerial flexibility in structuring the investment (Dixit and Pindyck 1994). A real option is a limited commitment investment in physical and human assets that provides the opportunity to respond to future contingent events should the payoff look attractive (Kogut and Kulatilaka 2001; McGrath and MacMillan 2000). Although the notion of real options has been derived from financial investment options, real options cannot be valued in the same way as financial options, they are typically less liquid and the real option value is contingent on different firm-specific factors, as the real value of an investment to one firm differs a lot from its value to another firm.

The different real options identified in prior research are *growth option*– the future growth opportunities that can be realized from an initial investment, *deferral option* – the option to wait and delay an investment till more information arrives, *learning option* – the option to learn and gather information and reduce uncertainty through an initial investment, the *option to stage* – the choice of breaking up an investment into incremental conditional steps where each step can be carried out only after the successful completion of the prior steps, *option to change scale* – the flexibility to respond to changing conditions by altering the capacity, *option to switch* – put the initial investment into an application different from what it was initially intended for, and *option to abandon* – the option to discontinue a project and redeploy resources

elsewhere (Brach 2003; Kogut and Kulatilaka 1994; Fichman et al. 2005; Tiwana et al. 2006; Tiwana et al. 2007).

Traditionally, real options analysis has been used to evaluate investments in real estate, natural resources, capital budgeting decisions, research and development projects, etc. Although less prevalent, the application of real options perspective is gaining popularity in IS literature because IT projects often possess characteristics that make them ideal cases for real options analysis. According to the options theory, real options are more valuable under conditions of greater uncertainty, because uncertainty raises the value of managerial flexibility provided by the real options. Investments in IT are often characterized by high uncertainty and this uncertainty can arise from various sources such as uncertainty regarding the future of the technology under consideration, uncertainty regarding technical details and uncertainty regarding the business and market conditions. Using a real options perspective therefore becomes particularly attractive for IT investment scenarios with a high level of uncertainty.

Real options theory is finding increasing use in IS research for evaluating IT investment scenarios such as IS project continuance and escalation, IT innovation adoption decisions, managing risks in IT investment projects (Kambil et al. 1993; Benaroch and Kauffman 1999; 2000; Taudes et al. 2000; Fichman 2004b; Tiwana et al. 2006). In addition to the widely recognized growth option, the different real options that are often associated with IT investments are the option to change scale of operations, the option to abandon, the option to defer an investment, the option to switch, the option to learn, and the option to stage the investment. For instance, while

Taudes et al. (2000) investigated growth option conferred upon an organization by its initial investment in a SAP R/3 project, Benaroch and Kauffman (2000) investigated the deferral option in implementing a point-of-sale debit card network. Fichman (2004b) modeled the early adoption of IT platform as a real growth option and identified the determinants of option value of the project based on IS innovation literature. Tiwana et al. (2006) showed that the recognition of the different real options from an IS project could predict managers' intention to escalate and continue with the project under conditions of high uncertainty.

In the case of IT adoption, managers may have to decide between keeping their options open by deferring the adoption or securing a stake in the technology by deciding to adopt. Therefore both growth options and deferral options will influence the decision to adopt RFID. From the real options perspective, investment in RFID can be viewed as a real option, which confers upon the organization, a right, but not the obligation to make further investments, should the initial results look attractive. To decide on making the initial investment, managers are likely to also consider the value of other options that might be embedded in the adoption decision, such as the option to learn from the initial project and the value of this learning for future use and exploitation of the technology or the option to stage the investment in small incremental steps i.e., the option to stage (Brach 2003; Trigeorgis 2001).

An investment has different value for different organizations depending on the contextual factors within which the investment is made. Thus, using real options analysis to evaluate IT investments is considered difficult because the real options that an organization can recognize from the adoption of an technology is not generic

for all organizations, but vary depending on characteristics that are unique to the adopting organization and also the decision-maker responsible for evaluating the IT. For example, RFID technology can have different implications for different organizations based on the prevailing business conditions that the organization operates in, and the effect of external factors such as competitors, trading partners, governmental regulations, etc. It has been shown that institutions play an important role in the adoption of IT innovations (e.g., King et al. 1994; Teo et al. 2003). Institutions can also play a somewhat indirect role by helping in making sense of the innovation and perceptions regarding its legitimacy, desirability etc (Swanson and Ramiller 1997). The role of institutions is particularly pronounced when an IT innovation is in its early stages of diffusion because of the associated uncertainty and lack of sufficient information or understanding regarding the technology. Under such circumstances, managers are likely to take cues from the external environment, such as actions of other organizations that have direct or indirect influence over the actions of their organization. Therefore, institutions are likely to affect the recognition of real options from RFID, especially when the value of the option comes from a promise of strategic and competitive benefits that can be obtained from the technology.

Previous research has indicated that managerial cognition plays an important role in strategic decision-making (e.g., Schwenk 1988). Therefore, in addition to the inherent characteristics of the technology, such as the uncertainty associated with its development and evolution, and the role of institutions, the cognitive characteristics of the manager who is responsible for RFID adoption within the organization is likely to affect the recognition of real options from the adoption of RFID. Managerial

mindfulness (which can be defined as the cognitive ability or capability of the manager) in innovating with IT refers to the act of making contextually nuanced decisions based on factors that are relevant to their organization (Swanson and Ramiller 2004). Mindful managers are likely to consider the implications of RFID on their organization based on their own organizational facts and specifics. Accordingly, they will be in a better position to appreciate and recognize the different real options that the adoption of RFID will provide to their organization. Therefore, we discuss the influence of managerial mindfulness in recognizing the real options from RFID adoption.

2.2.2 An Overview on RFID

RFID is a wireless tracking technology that uses radio frequency communication to automatically identify, track and manage objects, people or animals. Objects to be sensed are tagged with electronic radio frequency tags, and tag readers are used to read the data contained in the tags. The type of tag used and the data stored in the tag varies from application to application. The information stored in the tags can range from static identification numbers to user written data to tag sensory data.

The June 2003 Wal-Mart mandate to its suppliers to start using RIFD tags by January 2005 was a major instigating factor causing a sudden leap in the industry and public interest in RFID technology (Curtin et al. 2007). Many companies are now engaged in implementing pilot projects on RFID to understand the potential and business case for this emerging technology. RFID dramatically increases the potential for organizations to collect data about any tagable entity, and has implications for supply chain management, human resources management, and customer relationship

management across different industry sectors such as in transportation and logistics, healthcare, aerospace, manufacturing and retail consumer goods industry. In spite of its manifold applications, and promising future applications, issues such as high cost of tags, technical uncertainties over possible configuration for tags and tag-readers, differences in available frequency bandwidths, social concerns regarding loss of privacy and security, etc. are some of the factors that result in uncertainty over the future destiny of the technology and its outcomes. While this uncertainty is currently deterring the widespread diffusion and adoption of RFID, the potential of the technology make adoption RFID an attractive proposition for organizations, thus making RFID an appealing case for applying real options analysis.

2.2.3 Role of Institutions

Modern day organizations operate in complex dynamic environments and have business relationships with multiple external parties. Under such circumstances, their decisions and actions are often determined by a consideration towards factors external to their own organization such as market dynamics, regulatory institutions, actions of dominant industry players, and trade and industry associations (DiMaggio and Powell 1983). This holds true in the context of IT adoption, especially if the technology spans across organizational boundaries (Teo et al. 2003). Even technologies which are contained within the boundaries of the adopting organization may be affected by the actions of other organizations. Accordingly, institutional influences and regulations (King et al. 1994) will play a role in determining the strategic and competitive benefits that can be obtained from the adoption of RFID technology, because RFID can not only be applied to functions and processes within the

organization, it can also be used to facilitate inter-organizational IS linkages. In addition, RFID is still evolving in terms of various technology related issues, cost of tags, and issues related to integration with other information systems. Under such circumstances, the actions of other potential adopters, trading partners or those of regulatory bodies are likely to play an important role in determining how managers perceive the value of the technology based on its current and future prospects.

2.2.4 Mindfulness

Mindfulness has been described as a cognitive ability or cognitive style (Sternberg 2000) that characterizes active information processing and is reflected by openness to novelty, alertness to distinction, sensitivity to different contexts, awareness of multiple perspectives, and orientation in the present (Langer 1989; 1997). Mindful individuals may not necessarily be the most knowledgeable person, however, they can contextualize their knowledge and understanding regarding things based on what a situation demands. Originally defined as an individual level characteristic, mindfulness was subsequently extended to the organization level (Weick 1995; Weick and Sutcliffe 2001) where it has been conceptualized as a desirable property or state that organizations should strive to achieve, since it is likely to make them more adept in managing the unexpected.

The notion of mindfulness has been used to study organizational engagement with innovations (e.g., Fichman 2004a; Fiol and O'Connor 2003; Swanson and Ramiller 2004), because innovations incorporate concepts of newness or novelty, and IT innovations that are adopted in organizations are often characterized by new and complex technical knowledge and process changes, resulting in unexpected or

uncertain outcomes. When engaging with an IT innovation, mindfulness pertains to attending to the innovation with a contextually differentiated reasoning based on the organization's own facts and specifics (Swanson and Ramiller 2004). Therefore, mindfulness in the context of IT innovation adoption refers to not only being knowledgeable about the technology and its implications, but also being able to contextualize this understanding regarding the technology based on the specific circumstances prevailing in the organization and their implications on the adoption. Mindfulness is likely to have implication in RFID adoption, because the decision of evaluating and adopting RFID underlines an organization's attempt to make sense of something that is uncertain and can result in unexpected outcomes.

In organizational adoption of innovations, mindfulness has been considered as both an organization-level property (Swanson and Ramiller 2004), and an individual decision-maker characteristic (Fiol and O'Connor 2003). Since managers are responsible for fostering mindfulness in their organization, it has been suggested that organizational mindfulness is a consequence of the mindfulness of its managers and decision-makers (Swanson and Ramiller 2004). Therefore, this study also investigates the role of managerial mindfulness in the adoption of RFID.

2.3 Research Model and Hypotheses

The increasing popularity of RFID as the next generation auto-identification technology with the potential to collect vast amounts of data to endow efficiencies across the value chain of different industries along with the associated uncertainties regarding the development of the technology makes the adoption of RFID technology a suitable context for applying the real options theory.

Previous applications of the real options methodology in IS research is primarily based on quantitative analysis of IT investment options using financial option pricing models such as the Cox-Rubenstein model or the Black-Scholes model, and estimating the model parameters (Benaroch and Kauffman 1999; 2000; Taudes et al. 2000). However, uncertain opportunities are often difficult to quantify since the actual value of an investment is idiosyncratic, and depends on organization-specific factors such as the configuration of competencies and resources already belonging to the firm and the market in which the firm operates. Quantification of real options under such circumstances can call for too many assumptions and simplifications to be of informational purposes as there is limited information regarding the model parameters (McGrath and MacMillan 2000; Fichman 2004b). However, this can be overcome by managers applying real options thinking to recognize the different options that the adoption of the technology provides and their value, even if they are not able to quantify the value. In fact, past research has already shown that managers intuitively rely on real options thinking to justify their decisions regarding different IT projects such as a willingness to escalate and continue with the project even when the net present value of the project is not favorable (Tiwana et al. 2006). It has also been shown that IT managers took actions and/or gave rationales consistent with options thinking even when real options were not a formal part of the project assessment (Fichman et al. 2005)

In the case of RFID adoption, employing the real options framework as an intuitive and analytical tool can help managers in reconciling conflicting assumptions and expectations within the organization in order to arrive at better adoption decision-

making. This study identifies the real options that managers are likely to recognize from RFID technology and how recognition of these real options influence their intention to adopt the technology. The role of institutions and managerial mindfulness in recognizing these real options is discussed.

2.3.1 Options Realized from RFID

Different IT adoption scenarios can create different real options, for instance a decision to outsource IT operations confers the option to change scale, and the option to switch, while adoption of a technology such as RFID can confer growth options or deferral options, since it might be more valuable to delay the adoption based on prevailing conditions. When adopting a technology that allows the implementation to be carried out in small incremental steps, the organization can realize the option to stage. Learning options are conferred upon the organization, when there is a significant value in learning or gaining knowledge from the adoption of an IT innovation. Even for the same technology, different phases in adoption and implementation may have different implications for the options that are likely to be appreciated to evaluate the technology. For example, the option to abandon, the option to change scale and the option to switch use are inherently options pertaining to salvaging a situation that has not worked out as planned and will have more value after the adoption decision has been made, the organization is going through the implementation phase, and there are periodic evaluations of the status of the implementation project. Also, prior survey results have shown that managers are less appreciative of options that only serve to curtail losses such as the abandonment option (Busby and Pitts 1997; Tiwana et al. 2006). Therefore, although seven

different types of real options that have been identified in literature, it is unlikely that for every IT project all the options will get recognized and play a role in managerial decision-making.

Using the above reasoning, when considering RFID adoption as an initial investment project, managers are likely to appreciate the options that have inherently positive connotations. Therefore, growth option, which enhances the value of the adoption project by opening up possibilities of future add-on projects, learning option, which derives value from the opportunities of learning and gaining knowledge from the adoption of RFID, and the option to stage – which gets value from the realization that investment in the technology can be carried out in incremental steps, rather than having to outlay a large amount of resources in order to carry out the adoption project are identified as the three real options that are likely to be appreciated in considering RFID adoption. These options will positively affect managers' intention to adopt by increasing the potential value of the initial investment. When evaluating RFID adoption, managers are still in the process of deciding on the timing of the adoption project, therefore, they are likely to appreciate the value of deferral option, as prevailing conditions may suggest that there is more value in deferring or delaying the investment in RFID. Recognition of the deferral option will have a negative impact of the intention to adopt RFID.

Growth Options

Software growth options embedded in an information system is defined as the possibility to introduce new IS functions when it is economically feasible to do so

after the base system has been installed (Taudes 1998). Information systems that are easily adaptable to changing business scenarios with the built-in possibility of implementing add-on functions to the base system is considered to be of higher value to the organization because of the growth options that can be realized from them. Often investments in IT platforms such as an ERP application or in IT infrastructure are viewed as positioning investment because they open up opportunities for further investment (growth options) in other information systems (Taudes et al. 2000).

In a similar vein, adoption of RFID technology can be considered as the source of future growth options for the organization because by adopting RFID, the organization comes to possess the option of integrating the RFID system with its existing supply chain management system or inventory systems. Innovative marketing initiatives can be designed and executed by building on and adding features to the basic RFID system. RFID confers upon the adopting organization options for implementing a wide array of novel IS functions when they are called for. Other than the immediate benefits derived from the system in terms of operational efficiencies, growth options derived from the adoption of RFID technology contributes to the overall value of the technology. Thus, recognition of the growth options from RFID technology will positively influence a manager's intention to adopt the technology.

H1: Recognition of growth options derived from RFID will positively influence the intention to adopt RFID.

Learning Options

When faced with the option to invest in a new technology with uncertain benefits and effects on its overall value, there is a strong incentive for an organization to adopt some form of active information gathering (McCardle 1985). For instance preliminary market survey to judge the economical and technical feasibility of a product before it has been launched or undertaking the development of a small prototype in the case on many IT projects can be viewed as an investment to garner more information and reduce uncertainty before undertaking the actual project.

In a similar way, initial adoption of the technology may be viewed as a positioning investment to gain first hand information, and learn about the technology. Organizations learn from the adoption of most IT innovations, however, the value of the learning is likely to be much more in the case of technologies which are shrouded in significant amount of uncertainty regarding outcomes (Brach 2003). The knowledge gained enhances managers' flexibility on the deployment and execution of the project and increases the likelihood of success. Initial investment in an IT can thus provide an organization with valuable learning option which helps in successfully applying the technology on a larger scale within the organization in future.

Many organizations have already started pilot tests using RFID to gain insight regarding the technology before putting it to use in business functions that are of inter-organizational nature. From a real options perspective, the adoption of RFID can be viewed as an investment to acquire the learning option, which derives value from the fact that it can help the organization in better decision-making, and also improve

the probability of success when the organization decides to use the technology for more advanced applications. Thus recognizing the learning options embedded in the adoption of RFID technology will positively influence the intention to adopt the technology.

H2: Recognition of learning options derived from RFID will positively influence the intention to adopt RFID.

Staging Options

Information technology projects are often executed as a series of small projects which are of a more manageable magnitude. For instance, ERP implementation projects in organizations are usually carried out in incremental phases, with each successive phase starting after the completion of the previous phase. The option to stage is embedded in an IT adoption project when managers have the flexibility of deciding when and how to execute each incremental step. Staging IT projects derives value from the fact that organizations can manage their risk by cutting down the downward potential while retaining the investment option for favorable scenarios. This is possible because they have the option of timing the subsequent projects or even forgoing them depending on the situation.

RFID technology has a wide range of applications in the organization. It can be used to facilitate B2B activities, intra-organizational operations, and also several B2C activities. Organizations have the flexibility of deploying different applications as small individual projects rather than undertaking the deployment of all possible applications at one shot. Some of these small projects may have dependencies

requiring the successful completion of the previous project. For example, to be able to use the data captured by the RFID system for inventory management, the organization should have first installed the infrastructure for RFID technology, i.e., the tags to identify different objects and the tag readers. Similarly, in order to be able to use RFID to B2C marketing, the pre-requisite is to first tag the items that are being sold. Thus, given the nature of the technology, the adoption of RFID give organizations the flexibility to sequence the overall implementation project, which in turn makes the initial adoption of RFID technology more attractive to the organization. Thus, recognition of the option to stage will positively influence the intention to adopt RFID technology.

H3: Recognition of the staging option derived from RFID will positively influence the intention to adopt RFID.

Deferral Options

When faced with the decision of adopting an information technology, one alternative that is available to organizations is that of delaying the adoption in order to wait and see the developments pertaining to the technology and how these affects the technology. The option to defer or delay derives value from the fact that uncertainty gets reduced by the availability of more information as time progresses (Brach 2003). In the context of IT adoption project, the recognition of the deferral option indicates that managers may be wary about the adoption based on facts and specifics pertaining to their own context or external environmental conditions, and consequently decide to forestall the IT project (Swanson and Ramiller 2004). For instance, using real options

analysis previous research showed that based on situational information there was more value in deferring the deployment of point of sale debit services by a shared electronic banking network firm (Benaroch and Kauffman 2000).

RFID technology is currently evolving, standards are being finalized, and implementation and integration related issues are yet to be resolved. For example, currently RFID tags are incompatible with several metals, fluid; and frequency related issues often prevent their use in materials like aircraft parts. Given these characteristics, organizational decision makers might realize that there is value in deferring RFID adoption in their organization. Since the recognition of the deferral options implies that organizations are likely to wait for more information to be available and uncertainties to be reduced, it will negatively influence the intention to adopt RFID technology.

H4: Recognition of the deferral option derived from RFID will negatively influence the intention to adopt RFID.

2.3.2 Factors Determining the Recognition of Options

When a manager is considering the adoption of RFID technology, there are several factors that this person is going to take into account in the decision-making process. As discussed above, institutions are likely to play a significant role in shaping the perceptions of the decision-maker and the value that he intuitively recognizes from the adoption of RFID. In order to understand the role of institutions in the recognition of real options, we distinguish between institutional influences and institutional regulations. This distinction between influences and regulations is derived from the

three elements or pillars of institutional structure – regulative, normative and cognitive elements which differ in terms of the mechanism through which the institutional forces act, indicators of their effects and their basis for legitimacy (Scott 1995). The regulative pillar underlines coercive forces or pressures, are usually legally sanctioned and are indicated by rules, laws and sanctions. The normative and cognitive pillars on the other hand result in normative and mimetic institutional pressures, and are usually morally governed and culturally supported. Normative and cognitive institutional effects are indicated by certifications, accreditations, prevalence and isomorphism (DiMaggio and Powell 1983; Scott 1995).

In RFID adoption, the regulative institutional pillar will result in institutional regulations – such as rules, sanctions and directives on the adopting organization from various institutional bodies such as regulatory government agencies, dominant trading partners (suppliers and customers) and industry and trade associations, etc. Regulations can be in the form of mandates from a dominant supplier or customer to adopt the technology (such as the Walmart mandate to its suppliers to adopt RFID), rules governing the RFID adoption, and standards set up by the government. Institutional influences will arise from the normative and cognitive pillars of the institution. Institutional influences will be in the form of normative and mimetic pressures on the organizations based on the actions of other members of the institution, such as trend setting organizations, competitors, and trade and industry association. Institutional influences exert persuasive control over the practices, rules and beliefs of those under the institution's sway (Kimberly 1979).

Institutional regulations that legitimize RFID adoption and make it mandatory for the organization will result in the decision-maker realizing that the option to wait and watch does not exist, as there is a direct pressure on the organization to adopt. Therefore institutional regulations are likely to have a negative effect on the recognition of the deferral option. On the other hand, it is unlikely that the mere presence of regulations mandating RFID adoption results in the recognition of growth options. In order to be able to recognize the growth options from the investment, managers should be able to make sense of the technology by observing the effect or implication of the technology on other similar organizations that have already adopted. Also, actions from industry and trade associations that promote RFID adoption will influence the views and beliefs of the decision-maker that adopting RFID is an appropriate action as there will be scope of future opportunities to be realized from the technology. Therefore, institutional influences will be positively associated with the recognition of growth options from RFID adoption.

H1a: Institutional influence will be positively associated with the recognition of growth option from RFID.

H4a: Institutional regulations will be negatively associated with the recognition of deferral option from RFID.

Organizational mindfulness is characterized by contextually differentiated reasoning (Swanson and Ramiller 2004). When faced with the decision to adopt an innovation, greater mindfulness aids in an expanded environmental scanning for information and more context relevant interpretations of the available information, which in turn leads

to more discriminating decisions. Organizational mindfulness is a function of the mindfulness of individual decision-makers within the organization. An awareness of multiple perspectives, active information processing and alertness regarding latest happenings in the technology, accompanied with a contextually differentiated reasoning based on the organization's own facts and specifics can make organizational decision-makers more conducive towards recognizing the various real options that the technology can generate. Thus, mindfulness among organizational decision-makers is likely to increase the likelihood of recognizing the real options from RFID technology.

Mindfulness among organizational decision-makers can act in different ways. For technological innovations that give rise to bandwagon behavior i.e., when organizations end up adopting the innovation based on the perception that the technology is a tried recipe for success (Spender 1989; Weick 1995), greater mindfulness among the decision-makers will prevent them from succumbing to such bandwagon behavior by recognizing that there is more value in deferring the adoption decision. On the other hand, for innovations that have an unfavorable popular image resulting in its rejection by most organizations, mindfulness can result in the decision-maker realizing the future business opportunities generated by the adoption of the technology, in spite of the popular perception of belief regarding the innovation, resulting in a decision to adopt it. In other words, mindfulness is positively associated with the recognition on the growth option.

Since decision-maker mindfulness results in expanded information processing and a more discriminating evaluation of the technology based on organization-specific facts,

in addition to the recognition of growth and deferral options, it is likely that the mindful manager will also recognize the value of the option to stage the RFID adoption within their organization and the option to learn from investing in RFID. Therefore, mindfulness will be positively associated with the recognition of the staging option and the recognition of the learning option.

H1b: Managerial mindfulness will be positively associated with the recognition of growth option from RFID.

H2a: Managerial mindfulness will be positively associated with the recognition of staging option from RFID.

H3a: Managerial mindfulness will be positively associated with the recognition of learning option from RFID.

H4b: Managerial mindfulness will be positively associated with the recognition of deferral option from RFID.

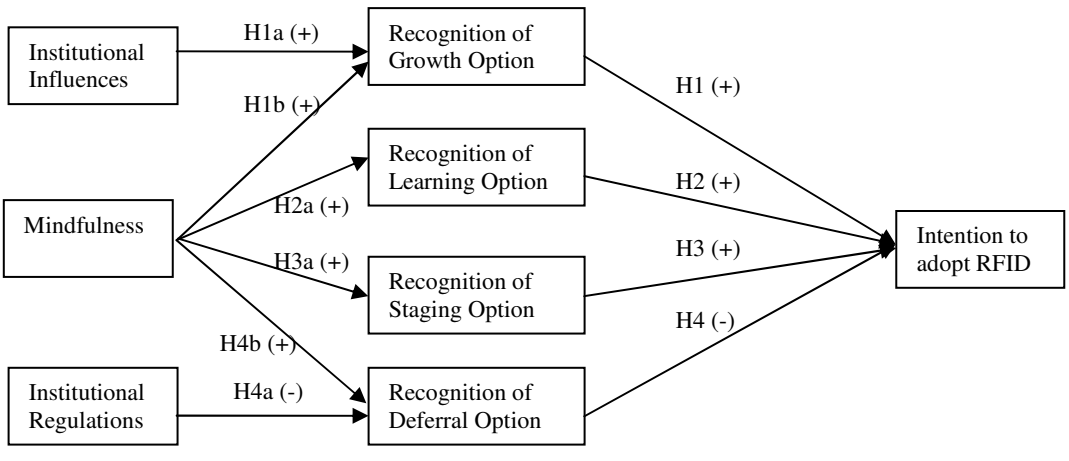

Figure 2.1 Research Model

2.4 Research Methodology

A questionnaire survey research methodology was chosen for this research because of the generalizability of results (Dooley 2001). The survey was carried out over a six month period in late 2007. The sample of our research comes from Singapore based firms in the manufacturing and logistics industry. Manufacturing and logistics are two industry sectors where RFID has a very high potential for providing operational and strategic efficiencies upon adoption. The unit of analysis is at the individual decision maker/ manager level within the organization.

2.4.1 Operationalization of Constructs

Wherever possible, we used instruments from previous studies to measure the constructs as this enhances validity (Stone 1978). Where no suitable instruments were available to adopt or adapt, we developed new questions based on a review of the related literature. IS faculty members from a large Singapore based university were asked to assess the initial face and content validity of the measurement items and their feedback was used to refine the items. Following this, two rounds of questionnaire sorting exercise (labeled and unlabeled) was carried out based on Moore and Benbasat (1991). Four graduate students participated in each sorting exercise. For the unlabeled sorting exercise, the labels that the sorters came up with closely corresponded with the actual construct names and on the average more than 80 percent of the items were correctly sorted into their intended constructs. After refining the measurement items based on the results of the unlabeled sorting exercise, the labeled sorting exercise – in which the sorters were provided with the name and definition of each construct – resulted in an average of 94% of the items getting

correctly sorted into their intended constructs, thus indicating a high level of face and content validity.

Measures were taken to control for common method bias given that a single respondent was used to measure all the constructs of interest in the research model. We followed the recommendations of Podsakoff et al. (2003) to design the instrument items and the overall questionnaire so as to minimize common method bias. Care was taken to word the items in such a way that they did not introduce social desirability bias. Further, respondents were assured of response anonymity in order to minimize the occurrence of social desirability bias. Similarly, constructs were positioned in the questionnaire in a way that is likely to reduce the possibility of respondents forming implicit theories about the research model or trying to maintain consistency in their responses. For example, the items measuring the construct "Intention to Adopt" preceded the items measuring the different options (Growth, Deferral, Learning and Staging), because a respondent who has already indicated a high recognition for growth option is also likely to assign high ratings to intention to adopt, just to appear consistent with his previous reply even if in reality he does not intend to adopt RFID.

All constructs were measured on a seven-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree" (and "Very Low" to "Very High" for institutional influences). Table 2.1 gives a brief description of the constructs, and the items measuring them.

Table 2.1 Operationalization of Constructs		
Construct	**Definition**	**Measurement Items**
Recognition of Growth Options (GroOpt)	Recognition of the value of future IT-related business and strategic opportunities from current adoption of RFID	RFID Adoption – *is a necessary foundation for future IT capabilities* (Tiwana et al. 2006) *gives us the possibility of implementing add-on applications later* (self developed) *opens up the possibility of designing new IS products and services around the RFID technology* (self developed)
Recognition of Learning Options (LrnOpt)	Recognition of the opportunities to learn and get a better understanding of RFID from its current adoption	RFID adoption – *allows us to gain important knowledge related to the technology* (self developed) *enables us to accumulate valuable know-how for future use* (self developed) *keeps us abreast with the latest developments in RFID* (self developed)
Recognition of Staging Options (StgOpt)	Recognition of the option or to carry out RFID implementation in incremental steps	RFID adoption – *can be incrementally funded through investment in stages* (Tiwana et al. 2006) *can be carried out in a series of incremental steps* (self developed) *can be done through a step-wise execution of the adoption project* (self developed)
Recognition of Deferral Options (DefOpt)	Recognition of the value in delaying current adoption of RFID based on prevailing conditions	In our firm – *RFID adoption can be deferred to some future period* (self developed) *there is more sense in not adopting RFID at the present* (self developed) *it is preferable to wait and see before deciding to adopt RFID* (self developed)
Institutional Influences (InstInf)	Normative and mimetic pressures on the organization based on the actions of the other members of the institution	*Extent of adoption of RFID by our competitors* (Teo et al. 2003) *Extent of adoption of RFID by our trading partners* (Teo et al. 2003) *Extent of promotion of RFID by industry, trade or professional bodies* (Teo et al. 2003) *Extent to which IDA and other professional bodies facilitate RFID knowledge and information sharing* (Teo et al. 2003)
Institutional Regulations (InstReg)	Rules, sanctions and directives from other members of the institution guiding the actions of the	*Our trading partners (suppliers / customers) mandate RFID adoption* (Teo et al. 2003) *Government regulations make RFID adoption necessary* (Teo et al. 2003) *Suppliers of RFID offer subsidies/discounts to*

	organization.	*facilitate RFID adoption* (Teo et al. 2003) *Standardization or RFID bandwidth in Singapore make RFID adoption easy* (Teo et al. 2003)
Mindfulness in RFID Adoption (Mindful)	Attending to RFID with reasoning grounded in one's own organizational facts and specifics	When considering RFID adoption – *I take into account our firm's preparedness for the changes involved* (self developed) *my decision is based on reasoning grounded on our firm's own facts and specifics* (self developed) *I usually get new information from multiple sources for decision making* (self developed) *I am aware that there are multiple implications of RFID for our firm* (self developed)
Intention to Adopt (AdpIntent)	The behavioral intention to adopt RFID	*I am seriously contemplating RFID adoption in a year's time* (Teo et al. 2003) *It is critical for my firm to adopt RFID in a year's time* (Teo et al. 2003) *I am likely to adopt RFID in my firm in a year's time* (Teo et al. 2003)

2.4.2 Survey Administration

Survey forms were mailed to top executives (CEO, CIO, Managing Director, etc.) of a list of firms obtained from the Singapore 1000 database. The survey questionnaire was accompanied with a cover letter with a brief description of the research project, and the recipient was requested to fill up the survey, or pass it on to a decision-maker within the organization who played a more important role in RFID adoption. The questionnaire contained a brief description of the RFID technology and some indicatory uses of the RFID technology. A total of 724 surveys were sent out, and we received 159 responses, thus giving a response rate of 21.96%. A copy of the completed research report and findings was promised as an incentive to the respondents. The completed survey forms were returned to the authors in envelopes with pre-paid postage. Out of the 159 responses received, 144 were found to be usable. Of these 144 responses, 34 responses came from managers whose

organizations had already adopted and were using RFID and the remaining 110 were from non-adopters and are analyzed in this study.

Table 2.2 Survey Response Rate				
Number of Surveys Sent	**Number of Responses**	**Number of Usable Responses**	**Number of Adopters**	**Number of Non-adopters**
724	159	144	110	34
Response Rate : 21.96%				

Out of the 110 responses, 62 respondents were from the manufacturing sector, while 36 were from the logistics, the remaining 12 respondents had not specified their industries. The respondents were primarily from top-level senior executives within the organization, 86% of them having more than 10 years of overall experience and held job titles such as CIO, COO, Vice-President, Executive Director, General Manager and Senior Manager. In terms of educational qualifications, 34% of the respondents held post-graduate or above degrees, while 52% were graduates, the remaining had high school education or diplomas.

Table 2.3 Survey Respondents' Demographics			
Demographic Variables	**Category**	**Frequency (n = 110)**	**Percent**
Industry	Manufacturing Logistics Not Specified	62 36 12	56.4% 32.7% 10.9%
Number of Employees	< 100 100 – 499 500 – 999 > 1000	23 28 18 41	20.9% 25.4% 16.4% 37.2%
Level of Experience of Respondent	Above 10 years 5 – 10 years Less than 5 years	95 10 5	86.4% 9.1% 4.5%
Educational Qualifications of Respondent	Post-graduate and above Graduates Diploma and Others	38 57 15	34.5% 51.8% 13.6%

2.5 Data Analysis and Results

Partial least squares (PLS) was used to perform the data analysis using the software SmartPLS Version 2.02. PLS possesses the ability to model latent constructs under conditions of non-normality, and in small to medium-sized samples (Chin 1998b). It allows researchers to specify the relationships among the conceptual factors of interest and the measures underlying each construct, resulting in a simultaneous analysis of the measurement model (i.e., how well the measures relate to each construct) and the structural model (i.e., whether the hypothesized relationships at the theoretical level are empirically true). Further PLS allows testing a two-stage model, i.e., a model which has two levels of dependent variables. Because of the above mentioned reasons, we used PLS to perform the data analysis, first examining the measurement model, and then the structural model.

2.5.1 Measurement Model

Internal consistency, convergent validity, and discriminant validity are assessed to validate the instrument (Gefen and Straub 2005). Internal consistency was examined using composite reliability. In PLS, composite reliability relies on actual loadings to compute the factor scores and is a better indicator of internal consistency than Cronbach's alpha (Ranganathan et al. 2004). Table 2.4 shows that the composite reliability for all constructs were above the suggested threshold of 0.7 (Chin 1998a; Chin 1998b; Straub 1989), thus supporting the reliability of the measures.

Convergent validity indicates the extent to which the items of a scale that are theoretically related are also related in reality. Convergent validity measures the

[2] Ringle, C. M., Wende, S. and Will, A. (2005): SmartPLS 2.0, www.smartpls.de.

correlation among item measures of a given construct using different methods of measurement. Table 2.4 presents information about the factor loadings of the measures of our research model. All items have significant path loadings at the 0.001 level. The average variance extracted (AVE) values are 0.604 or higher, above the recommended value of 0.50 (Fornell and Larcker 1981). Therefore, the convergent validity of the measurement scales are acceptable.

Table 2.4 Psychometric Properties of Measurement Model

Construct	**Item**	**Factor Loadings**	**Composite Reliability**	**AVE**
Growth Option	GroOpt1 GroOpt2 GroOpt3	0.939 0.941 0.929	0.955	0.877
Learning Option	LrnOpt1 LrnOpt2 LrnOpt3	0.963 0.965 0.927	0.967	0.906
Staging Option	StgOpt1 StgOpt2 StgOpt3	0.938 0.929 0.949	0.957	0.882
Deferral Option	DefOpt1 DefOpt2 DefOpt3	0.868 0.890 0.869	0.908	0.767
Inst. Influences	InstInf1 InstInf2 InstInf3 InstInf4	0.914 0.891 0.945 0.899	0.952	0.833
Inst. Regulations	InstReg1 InstReg2 InstReg3 InstReg4	0.732 0.843 0.840 0.833	0.886	0.662
Mindfulness	Minful1 Mindful2 Mindful3 Mindful4	0.820 0.891 0.847 0.769	0.898	0.604
Intention to Adopt	AdpIntent1 AdpIntent2 AdpIntent3	0.946 0.917 0.906	0.945	0.852

For discriminant validity, the AVEs for each construct should be greater than the square of the correlations among the constructs, indicating that more variance is shared between the construct and its measurement items than with another construct represented by a different set of measurement items. In Tables 2.5 the diagonal elements, which are the square roots of the AVE, are all higher than the correlations between the constructs.

Table 2.5 Correlations between Constructs

	Defer Option	Growth Option	Inst. Infl.	Inst. Reg.	Intent to Adopt	Learn Option	Mind fulness	Stage Option
Deferral Option	**0.875**							
Growth Option	-0.382	**0.936**						
Inst. Influence	-0.188	0.344	**0.912**					
Inst. Regulation	-0.255	0.226	0.593	**0.813**				
Intention to Adopt	-0.544	0.527	0.317	0.308	**0.923**			
Learning Option	-0.306	0.686	0.331	0.397	0.418	**0.951**		
Mindful ness	0.106	0.161	0.089	0.041	0.117	0.197	**0.777**	
Staging Option	-0.264	0.555	0.291	0.281	0.358	0.481	0.207	**0.939**

Note: Diagonal elements are the square roots of the average variance extracted (AVE)

Another way of assessing discriminant validity is through factor loadings and cross loadings (Table 2.6). Scanning down the columns indicate that the item loadings in their corresponding columns are all higher than the loadings of items used to measure the other constructs. Scanning across rows indicate that item loadings are higher for their corresponding constructs than for other constructs. Thus the measurement items

of this model satisfy the two criteria for discriminant validity suggested by Chin (1998b). Overall the data provides empirical support for reliability, convergent and discriminant validity of the scales of our measurement model.

Table 2.6 Factor Loadings and Cross-loadings

	Defer Option	Growth Option	Inst. Infl.	Inst. Reg.	Intent to Adopt	Learn Option	Mind fulness	Stage Option
AdoptIntent1	-0.544	0.446	0.245	0.286	**0.946**	0.367	0.113	0.279
AdoptIntent2	-0.451	0.573	0.268	0.249	**0.917**	0.467	0.137	0.395
AdoptIntent3	-0.514	0.434	0.370	0.319	**0.906**	0.318	0.070	0.313
DeferOpt1	**0.868**	-0.320	-0.143	-0.159	-0.517	-0.216	0.135	-0.170
DeferOpt2	**0.890**	-0.289	-0.182	-0.312	-0.452	-0.292	0.083	-0.265
DeferOpt3	**0.869**	-0.404	-0.169	-0.138	-0.457	-0.302	0.055	-0.264
GrowthOpt1	-0.354	**0.939**	0.355	0.239	0.512	0.626	0.123	0.502
GrowthOpt2	-0.370	**0.941**	0.313	0.180	0.499	0.636	0.152	0.514
GrowthOpt3	-0.349	**0.929**	0.295	0.214	0.466	0.668	0.178	0.546
InstInf1	-0.087	0.262	**0.914**	0.529	0.188	0.245	0.008	0.186
InstInf2	-0.062	0.187	**0.891**	0.583	0.235	0.252	-0.010	0.138
InstInf3	-0.187	0.337	**0.945**	0.563	0.328	0.344	0.068	0.285
InstInf4	-0.268	0.390	**0.899**	0.514	0.352	0.331	0.186	0.365
InstReg1	-0.113	0.116	0.435	**0.732**	0.259	0.242	0.018	0.239
InstReg2	-0.199	0.141	0.487	**0.843**	0.244	0.341	-0.061	0.257
InstReg3	-0.154	0.288	0.579	**0.840**	0.248	0.379	0.129	0.134
InstReg4	-0.248	0.189	0.455	**0.833**	0.260	0.319	0.058	0.265
LearnOpt1	-0.284	0.659	0.339	0.428	0.460	**0.963**	0.191	0.421
LearnOpt2	-0.300	0.696	0.327	0.358	0.384	**0.965**	0.168	0.477
LearnOpt3	-0.293	0.603	0.273	0.335	0.334	**0.927**	0.207	0.486
Mindful1	0.180	0.119	0.054	0.018	0.029	0.118	**0.820**	0.073
Mindful2	0.020	0.143	-0.009	0.003	0.135	0.222	**0.891**	0.162
Mindful3	0.087	0.132	0.122	0.088	0.104	0.201	**0.847**	0.221
Mindful4	0.091	0.138	0.124	0.015	0.103	0.095	**0.769**	0.207
StageOpt1	-0.266	0.491	0.302	0.342	0.389	0.451	0.202	**0.936**
StageOpt2	-0.223	0.533	0.211	0.172	0.291	0.431	0.167	**0.930**
StageOpt3	-0.250	0.546	0.295	0.253	0.315	0.472	0.211	**0.951**

2.5.2 Structural Model

Figure 2.2 shows the results of path analysis. Overall, the model explains 42% of the variance in the intention to adopt RFID technology. Tests of significance were performed using the bootstrap resampling procedure. As hypothesized, recognition of growth option (0.302) has a significant positive relationship with the intention to adopt, while the recognition of the deferral option (-0.395) has a significant negative relationship with the intention to adopt. However, the recognition of learning and staging option do not have any significant effect on the intention to adopt RFID. Therefore, hypotheses 1 and 4 are supported by the data, while hypotheses 2 and 3 are not supported. For the determinants of the options, institutional influences are found to be significantly associated with the recognition of growth option, while institutional regulations have a significant negative relationship with the recognition of deferral option. Mindfulness has a significant positive relationship with the recognition of staging option and somewhat significant relationship with the recognition of learning options (at 10% level of significance), but no relationship with the recognitions of growth and deferral options. Therefore, hypotheses 1a, 2a, 3a and 4a are supported by the data, while 1b and 4b are not supported. These findings are discussed in the next section.

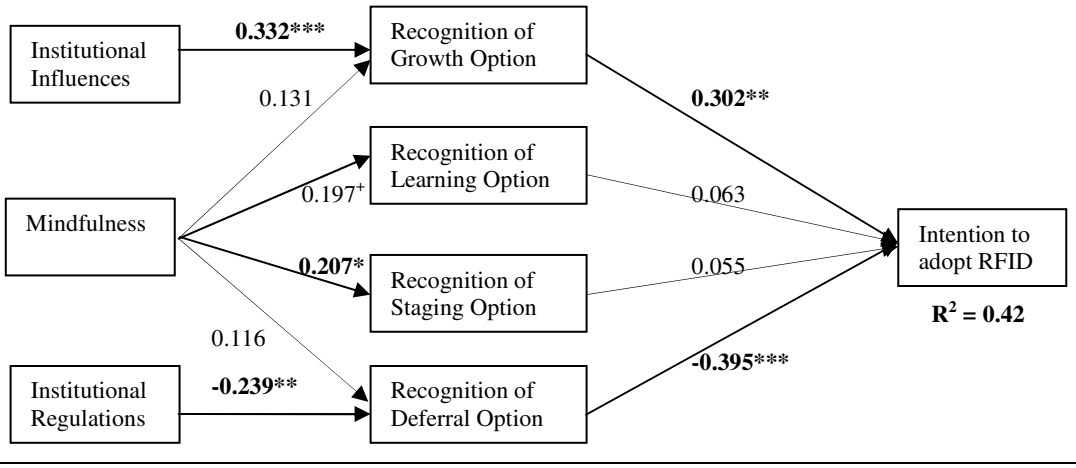

Figure 2.2 Results of Hypotheses Testing

+p<0.1; *p<0.05; ** p<0.01; *** p <0.001

2.6 Discussion and Implications

The primary finding of this study is that the recognition of real options from the adoption of RFID influences managers' intention to adopt the technology. As hypothesized, the recognition of growth options increases manager's willingness to adopt RFID, while the recognition of deferral option decreases the willingness to adopt RFID. However, the recognition of staging and learning options are found to be insignificant in determining the intention to adopt RFID. The significant roles of growth and deferral options in the intention to adopt RFID suggest that managers recognize and implicitly value the real options in the technology.

The insignificant effects of staging and learning options could be because of the difference in importance that managers assign to the different options. Tiwana et al. (2006) suggested that managers assign more importance to strategic options (such as the growth option) than to operational options (such as staging, switch use, change

scale, etc.). Growth option is considered a strategic option because it provides the opportunity for appropriating business value through the creation of additional assets from the adoption of the initial base system. For instance, initial investment into RFID will provide the organization with the possibility of implementing business processes and functions that build on the base RFID system. Similar to growth option, the deferral option can also be considered a strategic option because decision-makers may realize strategic value in deferring or delaying the adoption decision based on the organization's own business and IT strategies, the technological conditions and the prevailing environmental conditions. On the other hand, both staging and learning options are likely to be viewed as operating options because they will also have an effect on the operational success of the RFID adoption project by giving managers the flexibility of scheduling the adoption project, or making use of the knowledge gained from the initial investment into RFID.

Over time, organizational engagement of IT innovations has evolved such that current day organizations are more concerned with the expectation of strategic or competitive benefits that an IT innovation provides rather than the operational efficiencies that can be realized from the adoption of the innovation. This can explain why strategic options are significant in adoption decision-making while the operational options are not. Managers are more likely to make their decision to adopt RFID based on the strategic value or competitiveness that RFID affords. Therefore, the options that have strategic implications pertaining to the adoption of RFID are likely to be assigned higher importance. The operational options (learning and staging) on the other hand do not seem to influence the adoption decision because the value of these options are

likely to be perceived as less strategic, and more for internal efficiency generating, and for the success of the adoption/ implementation project. We believe that managers will attribute more importance to these options once the decision to adopt RFID has been made, and they are more concerned with successfully executing the adoption project and implementing RFID.

The findings regarding the determinants of option value underline the above reasoning on the relative importance of the different options in adoption decision making. As predicted, institutional influences were significant in the recognition of the growth options, however managerial mindfulness was insignificant. This finding suggests that in the presence of strong institutional forces, managers anchor their perceptions and beliefs regarding the value of growth option from the adoption of RFID based on the actions of the institutions (trading partners, competitors, regulatory bodies, etc.) within which they operate, rather than their own mindfulness. This can happen due to the strategic nature of the growth option, where managers are likely to feel that they will gain legitimacy and hence strategic advantages within their institutional environment from RFID adoption (DiMaggio and Powell 1983), even if their own contextually grounded reasoning may suggest otherwise. Similarly, institutional regulations have a significant negative association with the recognition of deferral option, because in the presence of rules, laws and sanctions that mandate or necessitate the RFID adoption, the option to delay RFID adoption will not be available to managers. Mindfulness was found to be insignificant in deferral option, because managers' own beliefs and perceptions regarding the value of deferring RFID adoption is overruled in the presence of institutional regulations.

Combining the findings regarding the relationship between the recognition of the strategic options (growth and deferral) and the decision to adopt, and the significant relationship between the two institutional effects (influences and regulations) and the recognition of options indicate that in the initial stages of adoption, organizational decision-makers are more inclined towards complying with the requirements of the external institutional environment in order to realize strategic benefits, especially in the presence of strong institutional influences and regulations. Therefore, compliance is viewed by them as a value-generating option form the adoption of RFID. Accordingly, it is possible to visualize compliance as a real option from the adoption of IT innovations in the presence of strong institutional pressures.

Mindfulness was found to be significantly associated with the recognition of staging option and somewhat associated with learning option. This suggests that managers who are prone to be more contextually grounded and differentiated decision-making, are likely to recognize the value from staging and learning options. These managers are able to see beyond the adoption and also understand the day-to-day implications of the RFID adoption project. However, since the option to stage and/or the option to learn are unlikely to result in strategic gains, they are not significant in the formation of the intention to adopt the technology.

Our findings regarding the effect of mindfulness on the recognition of different options can be explained using prior research on mindfulness in the organizational context. It has been suggested that mindfulness and its anti-thesis mindlessness are often complementary to each other (Levinthal and Rerup 2006) and organizations are likely to choose between mindfulness and mindlessness based on different

innovations and during particular periods of their engagement with an IT innovation (Swanson and Ramiller 2004). Mindlessness is more likely in initial engagement with the technology, while mindfulness will be more observable during prolonged engagement with the technology. In our study all respondents are in the pre-adoption phase, and since strategic options are very important in the pre-adoption phase, these options are considered important by managers regardless of their mindfulness levels. In other words, the ramifications of mindfulness are ignored by managers in recognizing the options and that influence their RFID adoption decision. In contrast, operational options, that are likely to be valuable in the post-adoption phase, which is far in the future for organizations at the pre-adoption phase, are considered more important by managers with higher levels of mindfulness.

2.7 Limitations

The survey research methodology used to test the research model in this study allows for generalizability of results, however, the cross-sectional data collected through the survey only allows us to predict associations among the different constructs rather than the direction of causal relationship. Therefore, future research can aim in collecting longitudinal data in order to examine how the recognition of the different options change over time and the varying effects of mindfulness / mindlessness over the course of an organization's engagement with RFID. For instance, the findings for this study showed that for prospective adopters, growth and deferral options play an important role in the decision to adopt; however, learning option and the option to stage are not significant in the option to adopt. Longitudinal data or field studies may

help in finding out if the importance of these options increases once the decision to adopt RFID has been made.

Secondly, all constructs were measured using a single respondent. This increases the threat of introducing common method bias. While special care was taken during the operationalization and design of the questionnaire to minimize common method bias, we realize that some of the variance between the constructs could be attributed to common method. While previous research has suggested certain statistical techniques for assessing the common method bias, there are also potential problems associated with the use of these statistical techniques (Podsakoff et al. 2003). Further, it has been found that common method biases in IS research is not as serious as in other disciplines, and structural relationships not only remain significant when adjusted for common method variance, they are also statistically not differentiable from unadjusted relationships (Malhotra et al. 2006). However, future studies could be designed in a way that further reduces the threat from common method bias. For example, some of the constructs such as institutional influences and institutional regulations can be measured from different sources.

Based on a sample size of 110 respondents, the research model was empirically tested and several significant results were obtained. A larger sample size would have allowed for more statistical power in predicting the relationships.

2.8 Conclusion

This study develops and tests a theoretical model that predicts how the recognition of the different real options from RFID affects the managerial intention to adopt RFID.

This study corroborates the findings of previous research in innovation diffusion by showing that institutions play a significant role in predicting adoption behavior or the intention to adopt. By employing the real options perspective, we show that the recognition of different real options can mediate the effect of strong institutional forces on adoption decision-making. This study also investigates the role of managerial mindfulness in the recognition of the different real options from RFID technology. The findings of this research shed some light to the debate over whether mindfulness and mindlessness can co-exist in organizational engagement with innovations by showing that recognition of some options may be affected by managerial mindfulness, while other are not. Future research can be directed towards designing empirical studies to gain a better understanding on the role of real options and the complementary influences of mindfulness and mindlessness in organizational adoption of IT innovations.

Chapter 3

Role of Organizational Strategy in the Recognition of Real Options

3.1 Introduction

Information systems research has applied several aspects of business strategy in the study of information systems (IS) and information technology (IT) in organizational settings. Business strategy and IS strategy can be viewed as sharing a two way relationship. While business strategy determines a firm's IS strategy, information technology is a critical organizational resource that must support a firm's competitive strategy (Powell 1992). The impact of information technology (IT) on business performance has been increasing noticeably over time. Although there can exist distinct variations among firms in the degree to which their information technology and systems is aligned with their business strategies (Johnston and Carrico 1988), strategic IS management literature suggests that an alignment between the IS and business strategy of an organization can lead to better business performance (Sabherwal and Chan 2001).

An important question that previous research has attempted to answer in the context of IS strategy is that of how an organization develops and implements an IS strategy (Sabherwal and Chan 2001). Difficulties in developing IS strategies have been highlighted (Lederer and Mendelow 1987; Henderson and Sifonis 1988), and taxonomies have been developed to define and classify strategic IS planning (Earl

1989), and strategic IS decision making (Sabherwal and King 1995). It has been suggested that deriving the IS strategy of a firm from its business strategy can lead to alignment of the business and IS strategies (King 1978; Das et al. 1991; Zviran 1990) and therefore better performance. Research has also established a link between an organization's competitive strategy and its IT maturity or IT management sophistication (Gupta et al. 1997).

An integral aspect of developing and implementing IS strategy is deciding on the appropriate IT to adopt and ways of deriving competitive value from the technology. Accordingly, organizational decision makers are often faced with the important task of evaluating and deciding upon different IT investment projects, and the adoption of new and innovative information technologies. Different competitive business strategies can cause different forms of IT adoption (Ives and Learmouth 1984; Johnston and Vitale 1988; Porter and Millar 1985). Given the previously established relationship between business and IS strategies, this study contends that business strategy that the organization follows will be an important factor determining the way in which organizational decision-makers evaluate different IT investment decisions within the organization.

The strategic choice perspective of organizations proposes that organizational behavior depend on the choices that organizational decision makers make, and these choices are determined by the strategy that the organization follows (Miles et al. 1978). Based on similar reasoning, the attention-based view of the firm suggests that what decision-makers do is a function of where they allocate their attention; and the firm's structure influences where its decision makers choose to focus their attention

(Ocasio 1997). Therefore organizational decision makers responsible for forming and implementing the IS strategy of the organization and subsequently making IT adoption decisions will be guided by the overall business strategy of the organization. The attention based view and the strategic choice perspective suggests that given a particular IT that is being considered for adoption, decision makers from different organizations will focus their attention on different aspects of the technology and accordingly recognize different opportunities or options from the technology. Therefore, organizational decision-making will be shaped by what is considered important by the organization based on the strategy that it follows.

The adoption of IS innovation has been studied from different theoretical perspectives. Previous research has examined the role of institutions (e.g., Teo et al. 2003), the role of the technology characteristics outlined by the diffusion of innovations theory (Rogers 2003), and organizational factors in the adoption of IT/IS innovations. More recently, real options analysis – an approach that analyzes managerial decision-making under conditions of uncertainty and flexibility – has been used to evaluate different IT investment projects (for e.g., Benaroch and Kauffman 1999; 2000). While real options analysis calls for a quantitative analysis of the value of real options created by an IT investment project, it is often difficult to assign numerical value to the parameters that are required for valuing the real options. As an alternative to this quantitative analysis, real options reasoning, a conceptual approach of taking into account the value of preserving the right to make future choices under uncertain conditions, while assessing potential investment projects has been gaining popularity in strategic management literature (McGrath and Nerkar 2004). Real options

reasoning (ROR) has previously been used in the context of IT/IS projects (e.g., Tiwana et al. 2006) and to evaluate IT adoption decisions (Fichman 2004b).

Using real options reasoning, the adoption of an IT can be viewed as an investment that confers upon the adopting organization different real options or opportunities which can have strategic and competitive value for the organization. However, since real options are not context-neutral, as investment in an IT has different implications for different organizations and therefore option value will vary from firm to firm depending on inherent characteristics of each adopting organization (Brach 2003; McGrath and MacMillan 2000). Since real options can be translated into future opportunities for the organization, decision-makers' recognition of real options from the adoption of an IT is likely to be a significant factor influencing their decision to adopt the IT (Fichman 2004b).

Based on the strategic choice perspective and attention-based view of a firm, the business strategy that the organization follows will guide organizational decision-makers in evaluating a particular IT investment decision, by making them focus their attention on different aspects of the IT investment project under consideration. Accordingly, using ROR, organizational decision-makers will recognize different real options from the adoption of a given IT. In this study we use both strategic choice perspective and attention based view to guide real options reasoning and propose that a firm's business strategy will play an important role in its decision-makers' recognition of real options from the adoption of RFID technology.

We identify the different real options that are likely to be present in RFID adoption. Miles and Snow's (1978) classification of the organizational strategies is used to distinguish between different organizations based on the strategies they follow. Attention-based view guides us in identifying the real options that are likely to be considered important by decision-makers from the different organizational strategy types.

3.2 Theoretical Background

3.2.1 Real Options from RFID Adoption

Real options analysis is a method to evaluate investment decisions under conditions of high uncertainty, irreversibility of costs and relatively high managerial flexibility in structuring the investment (Dixit and Pindyck 1994). A real option is a limited commitment investment in physical and human assets that provides the opportunity to respond to future contingent events should the payoff look attractive (Kogut and Kulatilaka 2001; McGrath and MacMillan 2000). Although the notion of real options has been derived from financial investment options, they are typically less liquid and their value is contingent on different firm-specific factors. Therefore, real options cannot be valued in the same way as financial options.

The different kind of real options are *growth option* – the future growth opportunities that can be realized from an initial investment, *deferral option* – the option to wait and delay an investment till more information arrives, *learning option* – the option to learn and gather information and reduce uncertainty through an initial investment, the *option to stage* – the choice of breaking up an investment into incremental conditional steps where each step can be carried out only after the successful completion of the

prior steps, *option to change scale* – the flexibility to respond to changing conditions by altering the capacity, *option to switch* – put the initial investment into an application different from what it was initially intended for, and *option to abandon* – the option to discontinue a project and redeploy resources elsewhere (Brach 2003; Kogut and Kulatilaka 1994).

Real options analysis is more commonly used to evaluate investments in real estate, natural resources, capital budgeting decisions, research and development projects, etc. In recent times, employing the real options perspective to evaluate IT investment decisions is gaining popularity in IS literature, because IT projects often possess characteristics that make them suitable cases for applying the real options reasoning. Real options are more valuable under conditions of greater uncertainty, because uncertainty raises the value of managerial flexibility provided by the real options. Using a real options perspective therefore becomes particularly attractive for IT investment scenarios with a high level of uncertainty, such as the adoption of information systems innovations. In IS research, real options reasoning has been used for evaluating IT investment scenarios such as IS project continuance and escalation, IT innovation adoption decisions, timing of IT investment projects, managing risks in IT investment projects (Kambil et al. 1993; Benaroch and Kauffman 1999; 2000; Taudes et al. 2000; Fichman 2004b; Tiwana et al. 2006).

Investments in IT are often characterized by high uncertainty and this uncertainty can arise from various sources such as uncertainty regarding the future of the technology under consideration, uncertainty regarding technical details and uncertainty regarding the business and market conditions. Organizational adoption of IT has previously

been modeled as an initial investment that generates growth option. For example, Taudes et al. (2000) investigated growth option conferred upon an organization by its initial investment in a SAP R/3 project. Fichman (2004b) modeled the early adoption of IT platform as a real growth option where the option value was determined by various organizational, technological and institutional factors.

RFID technology satisfies many of the conditions that are necessary for applying a real options thinking. Organizational decision makers may intuitively realize the strategic potential from investing in RFID even if initial returns look unfavorable (growth option). The adoption of RFID can be thought of as an investment to gain growth option because of the future opportunities that its adoption can generate. The growth option becomes especially valuable when the technology holds a promise to bestow the adopter with competitive and strategic advantage, however there is also a significant uncertainty regarding technical and institutional issues and how the technology will unfold over time. On the other hand decision-makers are likely to appreciate the current uncertainty pertaining to the technology and the way it is going to evolve over time, thus making it prudent to wait for more information to arrive before investing in the technology (deferral option). The recognition of these real options is likely to influence organizational decision-makers intention to adopt RFID technology.

Therefore, for new technologies such as RFID which are yet to gain widespread acceptability among potential adopters, the recognition of the growth option is likely to have important implications for the adoption of the technology. On the other hand, some organizations may also decide to defer adoption if they believe that there is

more value in delaying the adoption decision. The option to wait to invest or the deferral option derives its value from reducing uncertainty by delaying an investment decision until more information is available (Brach 2003). The deferral option is applicable when applying the real options analysis to IT adoptions, especially when an organization is considering investing in an IT innovation which is encompassed by a certain degree of uncertainty regarding its future. In IS literature researchers have appreciated the option to defer by suggesting that an organization does not always have to be positively inclined towards innovation adoptions, but more discerning organizational decision-makers may actually be wary about certain circumstances and forestall a new initiative as facts and conditions relevant to their own organizational context dictate (Swanson and Ramiller 2004). In IS literature, Benaroch and Kauffman (2000) investigated the value of deferral option in implementing a point-of-sale debit card network and found that an immediate entry into the POS debit market was not worthwhile; rather waiting for some more time before entry was a more rational way forward.

Based on real options reasoning, investment in RFID can be viewed as a real option, which confers upon the organization, a right, but not the obligation to make further investments, should the initial results look attractive. Therefore, when considering the adoption of RFID, organizational decision-makers may have to decide between keeping their options open by deferring the adoption, or securing a stake in the technology by deciding to adopt. Accordingly, both growth and deferral options will influence the decision to adopt RFID. While the recognition of growth options will make organizational decision-makers more inclined to adopt RFID, and will therefore

have a positive relationship with the intention to adopt RFID, the recognition of deferral options indicate that decision-makers see more value in delaying adoption decision and therefore, will be negatively associated with the intention to adopt RFID.

Real options reasoning is considered an attractive alternative to using traditional methods of project valuation such direct cash flow (DCF) or net present value (NPV) because it allows for a more conceptual approach to investment analysis and helps in recognizing the value of future opportunities and managerial flexibility. Therefore, firms can use the real options reasoning to guide their strategic decision-making (Busby and Pitts 1997). However, real options reasoning has also been criticized for making decision-makers prone to making overly risky investment decisions by positioning their firms to experience strong future gains, while managers may be unable to even capture the gains made possible by taking on more and riskier projects (Barnett 2008). Such criticisms against real options reasoning have been further strengthened by previous research where different researchers analyzing the same decision making contexts reached different conclusions as to whether real options reasoning was beneficial or harmful. Therefore, it appears that there is a need to refine the real options reasoning by taking into account the managerial decision-making process.

While real options reasoning highlights the value of flexibility under conditions of uncertainty, it does not explain how a firm's decision-maker makes use of this discretion. Managers should be able to make sense of their immediate and surrounding environment to capture the upside potential, as well as to prevent the downside losses. We use the strategic choice perspective in order to explain the

managerial sense-making and the decision process that results in the recognition of real option from RFID adoption. The strategic choice perspective suggests that the choices that organizational decision-makers make are determined by the strategy that the organization follows. Derived from the notion of bounded rationality (Simon 1947), the attention based view suggests that what decision-makers do is a function of where they choose to allocate their limited attention, and this in turn depends on the environment in which decision-makers operate such as the different attention structures and how the organization distributes and controls the allocation of issues and answers (Ocasio 1997). Accordingly, the business strategy that the organization follows will provide the underlying decision-making context for organizational decision-makers and will therefore shape decision-makers' recognition of the real options that can be recognized from the adoption of RFID.

3.2.2 Business Strategy

Literature on strategic management and organizational behavior has proposed several frameworks or typologies for classifying various aspects of an organization (e.g., Anderson and Paine 1975; Chandler 1962; Miles and Snow 1978; Porter 1980). Accordingly, there have been different classifications and typologies for organizational strategy. For example, Porter (1980) proposed three generic strategies that an organization can adopt – differentiation, cost leadership and focus. Miles and Snow (1978) viewed the organization as an integrated system in dynamic interaction with its environment, and suggested that more than one strategy type can be successful in a given environment. They suggested that it is important for a firm to be organized appropriately and to plan and implement relevant strategies for a particular

strategic type. The typology proposed by Miles and Snow (1978) is the only one that viewed the organization and its strategic orientation as a complete system (Snow and Hrebiniak 1980).

The typology suggested by Miles and Snow (1978) is particularly applicable for this study because it does not classify any particular strategy type as preferable or more desirable, suggests that different organizations can be equally successful following the different strategy types, and, analyzes the way in which firms following different strategies interact with their environment. Miles and Snow (1978) further argued that any strategy can be successful in any given environment if the organization acts consistently in all areas of its operation. Therefore, all the three organizational types – Defender, Prospector and Analyzer can be equally successful in carrying out their respective strategies.

Each strategic organization type has its own unique strategy and has a particular configuration of technology, structure and process that is consistent with its business strategy (Miles and Snow 1978). The fourth type of organization is classified as a Reactor, and is deemed as a strategic failure in the sense that there are inconsistencies among its strategy, technology, structure and process. Therefore, in accordance with previous research (such as Sabherwal and Chan 2001), we will only focus on the three strategic types that are discussed below for the purpose of further analysis. Based on the strategy that the organization follows, decision-makers will attend to different aspects of the environment, and accordingly notice and interprete different environmental signals, choosing to attend to certain stimuli, while ignoring others.

Defenders

Defenders strive to maintain an environment for which a stable form of organization is appropriate. They are concerned with achieving and maintaining production and cost control efficiency with little or no scanning of the environment for new areas of opportunity. While defenders strive to make continuous improvement in the single core technology to maintain efficiency, they also try to keep technological problems familiar and predictable for long periods of time. The key characteristic of the Defender's strategy is stability rather than looking out for novel opportunities in their environment. Therefore, in a Defender organization, decision-makers are likely to choose to focus their attention on the internal operational aspects of their organization in order to maintain or improve their efficiency levels rather than focus their attention on the external environment in search for new opportunities.

Miles and Snow (1978) suggested that the Defender strategy is a viable one when pursued vigorously, however, there is a potential risk of being unable to respond to major changes in the environment, since they are likely to be incapable of locating new areas of opportunity.

Prospectors

Prospectors are opposites of Defenders in terms of the way they react to their environment. Prospectors are more dynamic and their primary capability is that of finding and exploiting new product and market opportunities. In order to locate new areas of opportunity, the Prospector develops and maintains the capacity to survey a wide range of environmental conditions, and therefore, the Prospector invests in

environmental scanning activities to identify potential opportunities. In order to serve the changing environment, a Prospector has to maintain a good deal of flexibility in its technology and administrative systems. Prospectors rely on change as a major tool to gain an edge over competitors, so decision-makers within Prospector organizations typically perceive more environmental uncertainty than decision-makers within Defenders or the other organizational types (Miles et al. 1978).

While Prospectors are well adapted to respond to changing environments, they face the risk of low profitability and over-extension of resources. Also, since they have to maintain multiple technologies in order to maintain a technological flexibility that permits a rapid response to a changing environment, Prospectors might not be able to develop as much efficiency as Defenders in their production and distribution systems (Miles et al. 1978). Given the strategic orientation of Prospectors, decision-makers in this organizational type will be more adept in noticing and attending to external stimuli. On the other hand, it might also make decision-makers more prone to taking up risky investment decisions.

Analyzers

An Analyzer is an organization that attempts to minimize risk while maximizing the opportunity for profit. Thus an Analyzer is a unique combination of the Prospector and Defender types and represents a viable alternative to these other strategies. An experienced Analyzer combines the strengths of both the Prospector and Defender into a single system and has an adaptive approach of “balance”. The Analyzer tries to locate and exploit new opportunities while maintaining a stable core of traditional

products and customers. Thus while a Defender adheres to a single technology and resists change, and a Prospector actively scans the environment for new technologies and often has its resource spread over multiple technologies, an Analyzer moves towards new technologies, products and markets only after their viability has been demonstrated. An Analyzer must learn to achieve equilibrium between conflicting demands for technological flexibility and for technological stability.

Therefore, decision-makers within Analyzer organizations will be tuned towards attending to external stimuli as well as have an internal efficiency-maximizing outlook. While they are likely to notice opportunities in the external environment, they will also be less prone to making risky investment decisions.

3.3 Research Model

3.3.1 Business Strategy and it role in Recognizing Real Options

Different business strategies will result in different IS investment strategies in organizations. For example, prior research has shown that different kinds of information systems are associated with the different strategy types (Camillus and Lederer 1985), and that the three strategic types differ in terms of the information management sophistication that they possess (Gupta et al. 1997). Karimi et al. (1996a, 1996b) found that different business strategies result in different levels of IT investment. Sabherwal and Chan (2001) showed that an alignment between the business strategy and the IS strategy resulted in better firm performance. This relationship between the business strategy of a firm and its IS strategy suggests that organizational decision-makers are likely to attend to IT / IS investment decisions in ways that is in agreement with the overall strategy of the organization.

Drawing from the attention based view which suggests that firms' decisions and actions can be explained by explaining how firms regulate the attention of their decision-makers, we propose that organizations' decision to adopt an IT / IS innovation will also be influenced by where and how their decision-makers focus their attention. The attention based view further explains that where decision-makers focus their attention is governed by the organizational structures that are in place. Since organizational strategy is an important factor determining organizational structure, strategy will also influence the way decision-makers' focus their attention. Therefore, depending on the strategic orientation of the firm, its decision-makers will attend to different aspects of the external or internal environment and sense different opportunities for value creation. The real options reasoning suggests that the bundle of options that are associated with an investment project remain latent and only come into being when decision-makers recognize them (Bowman and Hurry 1993). We propose that the business strategy that an organization follows will influence the real options that the organizational decision-makers recognize from the adoption of RFID technology and subsequently their intention to adopt RFID.

Among the three strategic types, Prospectors pursue aggressive competitive strategies and pioneer products and services in their markets. Because of their aggressiveness in pioneering products and services, they operate in an environment characterized by rapid and unpredictable changes. Therefore, decision-makers in organizations that follow the strategy of a Prospector are required to scan their firm's environment in order to understand the changes and innovation in the industry (Daft and Weick 1984). The strategic structure of Prospectors will encourage an external orientation in their

decision-makers' scanning activities for identifying opportunities to differentiate themselves from their competitors in terms of products, markets and services.

The more externally oriented a firm's attention structures are, the more likely decision-makers will be to notice options in new markets and technologies (Barnett 2008). Further, because of this external orientation, decision-makers in Prospector firms are also more likely to notice opportunities to acquire such option-generating technologies such as RFID. Accordingly, the recognition of growth option from the adoption of RFID will be a significant factor influencing Prospectors' intention to adopt RFID.

On the other hand, an external focus prevents organizational decision-makers from seeking and noticing opportunities in their existing market and technological conditions (Barnett 2008). Therefore, in order to support their competitive strategies, decision-makers are unlikely to recognize the value in deferring the RFID adoption decision. Accordingly, the recognition of deferral options will not be significant in the determination of the intention to adopt RFID for Prospectors.

H1a: For Prospectors, the recognition of growth options will be a significant determinant of decision-maker's intention to adopt RFID

H1b: For Prospectors, the recognition of deferral options will not be a significant determinant of decision-maker's intention to adopt RFID

Defenders are typically less dynamic organizations that operate in a more stable and predictable environment. They try to maintain equilibrium in their immediate

environment and rarely seek new opportunities. Their primary concern is to continuously improve their existing technology to maintain efficiency. The strategic orientation of the Defender organization and the corresponding structures are likely to influence decision-makers to be internally focused in their opportunity seeking behavior. Such an internal orientation will make managers less likely to notice options in new markets and technologies, but more prone towards identifying ways of utilizing their existing organizational resources such as existing technological base for opportunities to improve operational efficiency and maintain their market shares (Barnett 2008).

Defenders engage in less environmental scanning and try to overlook new market developments in IT (Teng et al. 1995). Therefore, when confronted with a novel technology such as RFID, Defenders are unlikely to recognize the value of gaining the options that are associated with the adoption of RFID. The opportunities for competitive and strategic benefits that the technology can provide will be less valuable for decision-makers in Defender organizations and hence the recognition of growth option will not be an important factor in the adoption of the technology.

Defenders on the other hand are likely to focus on the uncertainty regarding the unpredictable evolution of the technology and hence the risk associated with its adoption. Accordingly, the Defender is likely to place more value on the option to defer adoption of RFID, because by deferring the adoption, they can maintain the stability of the existing IS setup within their organization and avoid making a risky investment decision.

Given the tendency towards maintaining status quo and the resulting internally oriented attention structures of Defenders, the recognition of the Deferral option will be an important factor in their intention to adopt RFID. However, such attention structures will prevent the recognition of growth options from influencing the adoption decision, as adoption of RFID will call for significant amount of change and departure from the existing condition of equilibrium. Therefore we hypothesize,

H2a: For Defenders, the recognition of growth options will not be a significant determinant of decision-maker's intention to adopt RFID

H2b: For Defenders, the recognition of deferral options will be a significant determinant of decision-maker's intention to adopt RFID

The acquisition of a resource in an organization comes associated with a bundle of options, however, which options are recognized and which are not depends on where and how the people in charge of making decisions decide to focus their limited attention. For Analyzers, which are combinations of the Prospector and the Defender strategic types, the way in which decision-makers sense their external and internal environment is governed by some characteristics of Prospectors and some characteristics of Defenders. While characteristics similar to Defenders make Analyzers prone to seeking technological stability in their environment, characteristics similar to Prospectors, encourage them to focus on locating new market opportunities. Therefore, decision-makers within Analyzer firms will simultaneously have both an internal as well as external orientation in the recognition of options from an investment project.

Analyzers look out for chances to capture new market opportunities, especially those that have been tested and proved before. Accordingly, IT innovations that help in exploiting the new market opportunities will be considered valuable by decision-makers in Analyzer organizations and therefore they will place a significant importance on the value of the growth options that can be realized from the adoption of RFID technology. On the other hand their cautiousness towards change and inclination towards maintaining stability in their organization will also result in valuing the option to defer RFID adoption. In an attempt to maintain balance between the active environment scanning and scouting for new technologies, and retaining stability, for Analyzers, both the recognition of growth options and the recognition of deferral option will play a significant role in their decision to adopt RFID technology.

H3a: For Analyzers, the recognition of growth options will be a significant determinant of decision-maker's intention to adopt RFID

H3b: For Analyzers, the recognition of deferral options will be a significant determinant of decision-maker's intention to adopt RFID

The recognition of growth options and the recognition of the option to defer are both important factors that will affect organizational decision-makers intention to adopt RFID. However, depending on the business strategy that organizations pursue, the extent to which these two options will affect the adoption decision making will differ. Therefore, as shown in Figure 3.1, business strategy will moderate the relationship between the recognition of real options and organizational decision-makers intention to adopt RFID.

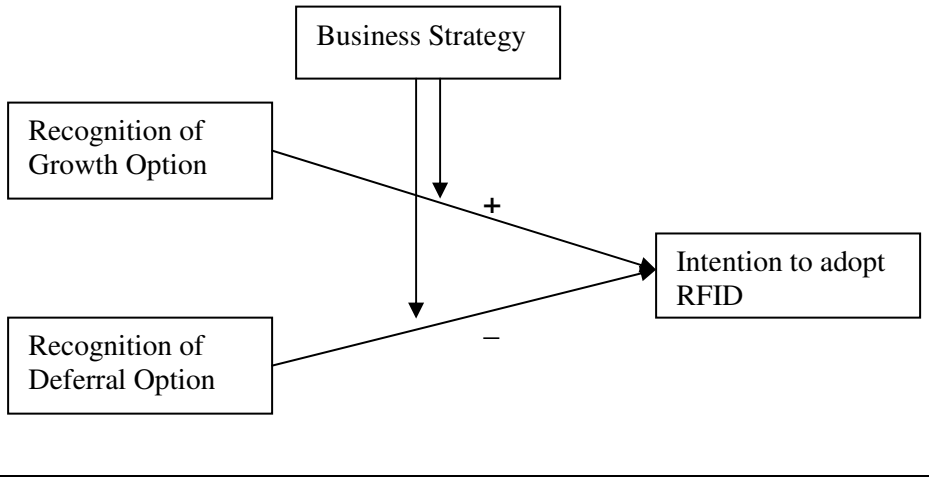

Figure 3.1 Research Model

3.4 Operationalization of Constructs

In order to enhance the validity of the study, instruments from previous studies were used to operationalize the constructs (Stone 1978). For certain constructs where existing measures were not available or did not capture the complete notion of the intended construct, new measurement items were developed based on the review of related literature. IS faculty members from a large Singapore based university were asked to assess the initial face and content validity of the measurement items and their feedback was used to refine the items. Following this, two rounds of questionnaire sorting exercise (labeled and unlabeled) was carried out based on Moore and Benbasat (1991). Four graduate students participated in each sorting exercise. For the unlabeled sorting exercise, the labels that the sorters came up with closely corresponded with the actual construct names and on the average more than 80 percent of the items were correctly sorted into their intended constructs. After refining the measurement items based on the results of the unlabeled sorting exercise,

the labeled sorting exercise – in which the sorters were provided with the name and definition of each construct – resulted in an average of 94% of the items getting correctly sorted into their intended constructs, thus indicating a high level of face and content validity.

3.4.1 Business Strategy

This study distinguishes between three business strategy types based on Miles and Snow's (1978) typology of Defenders, Analyzers and Prospectors. This typology parsimoniously captures strategic differences between industry-independent characteristics (Hambrick 1983). In order to empirically measure the three business strategy types, we measured the different business strategy attributes and map them to the three organizational strategy types as suggested by Sabherwal and Chan (2001). Six different attributes of business strategy (Venkatraman 1989) that view realized strategy in terms of management action is measured. Based on previous literature, theoretically ideal values of these six attributes were identified by Chan and Sabherwal (2001), and these were used to develop the strategy profiles for Defenders, Analyzers and Prospectors.

Venkatraman (1989) operationalized business strategy in terms of six different attributes – Defensiveness, Riskiness (its reverse Risk Aversion is used in this study), Agressiveness, Proactiveness, Analysis and Futurity. This operationalization, called the STROBE (strategic orientation of business enterprises) operationalization has been widely used in past research (e.g., Chan et al. 1997; Croteau and Bergeron 2001, Gilbert 1995, Sabherwal and Chan 2001). Using a three-point scale (high, medium and low), Sabherwal and Chan (2001) mapped the above mentioned strategy

attributes to the three strategy types identified by Miles and Snow (1978). We briefly discuss the associated reasoning behind the mapping.

The two attributes – *defensiveness*, which reflects defensive behavior and an emphasis on cost reduction and efficiency, and *proactiveness*, which reflects proactive behavior in terms of participation in emerging technologies, search for new market opportunities and experimentation with new technological and environmental trends, represent Defenders and Prospectors respectively (Venkatraman 1989). Therefore, Defenders will rank high on defensiveness and low on proactiveness, while Prospectors will rank high on proactiveness and low on defensiveness. Analyzers, on the other hand will rank medium for both defensiveness and proactiveness.

Riskiness (and its reverse – *Risk Aversion*) is defined to reflect the variations in resource allocation decisions and the choice of products and markets. It is a key aspect of business strategy. Defenders choose to operate in a stable domain, while Prospectors frequently take risk with new products and markets in order to exploit opportunities. Analyzers, are however more conservative in terms of risk taking, while they look for new opportunities to grow, they only add products and services that has been successfully tested and adopted by other organizations (Prospectors). Accordingly, Sabherwal and Chan (2001) ranked Defenders, Analyzers and Prospectors high, high and low in risk aversion.

Analysis, which represents the overall problem solving behavior of an organization, is an important characteristic of organizational decision-making and refers to the

tendency to search deeper for the roots of the problem and generate the best possible solution. Segev (1989) and Miles et al. (1978) identified Analyzers to rank high in terms of both internal and external analysis and perform comprehensive as well as intensive planning. Defenders in contrast rank high in terms of internal analysis but low in terms of external analysis, and perform intensive but not comprehensive planning, and, Prospectors rank high in external analysis but low in internal analysis, and excel in comprehensive planning but not intensive planning. Therefore Analyzers are ranked high in analysis, while Defenders and Prospectors are ranked medium (Sabherwal and Chan 2001).

Aggressiveness refers to the organization's attempt to improve market conditions at a rate relatively faster than its competitors. These can be based on product innovations, market development or high investments to improve market share and competitive position. Based on this definition, Prospectors rank high in terms of Aggressiveness since they actively scan their environment to look for new product and market opportunities. Analyzers on the other hand are more conservative, and although they look for opportunities to increase their market shares, they are not as keen in seeking out innovations to improve their market conditions and therefore they are classified as medium in aggressiveness. While Defenders are strive to maintain stability and equilibrium in their immediate environment, their success in the industry hinges on their ability to aggressively maintain their dominance in their chosen market segment (Miles and Snow 1978). Accordingly, Prospectors, Analyzers and Defenders are ranked as high, medium and medium respectively in terms of aggressiveness (Segev 1989; Doty et al. 1993; Sabherwal and Chan 2001).

Futurity reflects the temporal considerations in key strategic decisions and the relative emphasis on effectiveness (long-term) considerations versus efficiency (shorter-term) considerations. Based on Doty et al. (1993) and Sabherwal and Chan (2001), Prospectors, Analyzers and Defenders are ranked as medium, medium and high in terms of Futurity. Table 3.1 represents the mapping between the six strategic dimensions and the three organizational strategy types.

Table 3.1 Business Strategy Profiles of Defenders, Prospectors and Analyzers

Business Strategy Attributes	**Defenders**	**Prospectors**	**Analyzers**
Defensiveness	High	Low	Medium
Proactiveness	Low	High	Medium
Risk Aversion	High	Low	High
Analysis	Medium	Medium	High
Aggressiveness	Medium	High	Medium
Futurity	High	Medium	Medium

3.4.2 Real Options

Growth option is defined as the recognition of the value of future IT related business and strategic opportunities from the current investments in RFID. Deferral option is defined as the recognition of the value in the option to defer current adoption of RFID based on prevailing conditions. Research has primarily tried to quantitatively assess the value of growth options or deferral options using different mathematical modeling techniques (e.g., Benaroch and Kauffman 1999). However, in this study we measure the two options by using questionnaire based items in order to gauge the extent to which the decision-makers recognize the option from the adoption of RFID in their

organizations. Similar ways of measuring the different real options have been used previously (e.g., Tiwana et al. 2006).

3.4.3 Adoption Decision-making

We use intention to adopt RFID as a proxy for the decision to actually adopt RFID. Previous research has suggested that the behavioral intent is the immediate antecedent to actual behavior and provides a good measure of the actual behavior being performed (Ajzen 2002, Ajzen and Fishbein 1980).

3.5 Methodology

3.5.1 Data Collection

Survey forms were mailed to top executives (CEO, CIO, Managing Director, etc.) of a list of firms obtained from the Singapore 1000 database. The survey questionnaire was accompanied with a cover letter with a brief description of the research project, and the recipient was requested to fill up the survey, or pass it on to a decision-maker within the organization who had a more important decision-making role to play in RFID adoption. The questionnaire contained a brief description of RFID technology and some indicatory uses of the technology. A total of 724 surveys were sent out, and we received 159 responses, thus giving a response rate of 21.96%. A copy of the completed research report and findings was promised as an incentive to the respondents. The completed survey forms were returned to the authors in envelopes with pre-paid postage. Out of the 159 responses received, 142 were found to be usable. Of these 142 responses, 34 responses came from managers whose organizations had already adopted and were using RFID and the remaining 108 were from non-adopters. Since in this study we are interested in understanding the

influence of recognizing the value of real options in deciding on RFID adoption, we only analyzed the non-adopters.

Out of the 108 responses, 61 respondents were from the manufacturing sector, while 35 were from the logistics, the remaining 12 respondents had not specified their industries. The respondents were primarily from top-level senior executives within the organization, nearly 86% of them having more than 10 years of overall experience and held job titles such as CIO, COO, Vice-President, Executive Director, General Manager and Senior Manager. In terms of educational qualifications, 34% of the respondents held post-graduate or above degrees, while 52% were graduates, the remaining had high school education or diplomas (Please refer to Table 2.4 for the demographic distribution of the respondents).

3.5.2 Measures

All items in the survey questionnaire were measured on a 7-point likert scale ranging from 1 = strongly disagree to 7 = strongly agree. Table 3.2 provides the measurement items used to measure each of the constructs.

Table 3.2 Operationalization of Constructs	
Construct	**Measurement Items**
Recognition of Growth Options (GroOpt)	RFID Adoption - *is a necessary foundation for future IT capabilities* (Tiwana et al. 2006) - *gives us the possibility of implementing add-on applications later* (self developed) - *opens up the possibility of designing new IS products and services around the RFID technology* (self developed)
Recognition of Deferral Options (DefOpt)	In our firm - *RFID adoption can be deferred to some future period* (self developed) - *there is more sense in not adopting RFID at the present* (self developed) - *it is preferable to wait and see before deciding to adopt RFID* (self developed)
Intention to Adopt (AdpIntent)	- *I am seriously contemplating RFID adoption in a year's time* (Teo et al. 2003) - *It is critical for my firm to adopt RFID in a year's time* (Teo et al. 2003) - *I am likely to adopt RFID in my firm in a year's time* (Teo et al. 2003)
Defensiveness	- *We develop strong relationship with our suppliers* (Sabherwal & Chan 2001) - *We develop strong relationships with our customers* (Sabherwal & Chan 2001) - *We optimize coordination across our departments and product lines* (Sabherwal & Chan 2001) - *There is a constant drive to improve operating efficiency* (Sabherwal & Chan 2001)
Proactiveness	- *We generally increase capacity (i.e., prepare to handle a greater volume of business) before our competitors do so* - *We are usually the first ones to introduce various products and or services in the market* - *We adopt innovations early*
Risk Aversion	- *Our business decisions generally follow tried and true paths* (Sabherwal & Chan 2001) - *We adopt a rather conservative view when making major decisions* (Sabherwal & Chan 2001) - *In general, our mode of operation is less risky than that of our competitors* (Sabherwal & Chan 2001)

Analysis	- *We tend to be number-oriented and analytical in our operations* (Sabherwal & Chan 2001) - *We require detailed, factual information to support our day-to-day decision-making* (Sabherwal & Chan 2001) - *We develop comprehensive analyses of each business opportunity or challenge we face* (Sabherwal & Chan 2001)
Aggressiveness	- *We sacrifice current profitability to gain market share* (Sabherwal & Chan 2001) - *Gaining market share is more important than cash flow* (Sabherwal & Chan 2001) - *We frequently use price cutting to increase market share* (Sabherwal & Chan 2001)
Futurity	- *The performance measures reviewed by our senior management team emphasize our long term business effectiveness* (Sabherwal & Chan 2001) - *Our criteria for budget allocations generally reflect long-term considerations* (Sabherwal & Chan 2001)

3.5.3 Data Analysis

In order to validate the hypotheses, the respondent organizations were first classified into Defenders, Prospectors and Analyzers and the research model was tested for each strategic group.

Classification into Defenders, Prospectors and Analyzers

Following the method used by Sabherwal and Chan (2001), the respondents were classified into the three business strategy types based on the proximity of each organization's business strategy attributes to the ideal profiles of Defenders, Prospectors and Analyzers. The ideal profiles of the three strategy types were based on the mapping of the six strategy attributes to the three overall strategy types (as in Table 1). Following Govindarajan (1988) and Sabherwal and Chan (2001), high, low

and medium values for the ideal business strategy values were operationalized as +1, -1 and zero respectively.

In order to categorize the organizations, the Euclidian distance between each firm's business strategy and the ideal business strategies of the three organizational types – Defenders, Analyzers and Prospectors was computed. For instance, for a particular organization, its distance for the ideal profile of Defenders was computed as:

$$\text{Distance (Defenders)} = \sqrt{\sum} \{(X_j - l_{jDEF})^2\} \ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 1}$$

where X_j is the normalized score of the jth business strategy attribute, and l_{jDEF} is the ideal normalized score of the j^{th} business strategy attribute for Defenders. The summation is across the various values of j, where j ranges from 1 to 6 for the six business strategy attributes. The distances from the ideal business strategy profiles for Prospectors and Analyzers were similarly computed. Therefore we obtained three different distance measures. The three distances were compared, and the organization was classified as following the particular strategy to which it had the lowest distance. For instance, if we consider an organization that had standardized scores of 0.84, 1.18, 0.57, 0.11, 0.58 and -1.40 respectively on defensiveness, analysis, risk aversion, proactiveness, futurity and aggressiveness, then the distance scores for the organization, Distance(Defenders), Distance(Prospectors) and Distance(Analyzers) will be 2.70, 3.76 and 1.80 respectively. For this organization, the distance to the ideal profile of the Analyzers is the lowest, and therefore the organization will be considered as an Analyzer.

Hypotheses Testing

After classifying the respondent organizations into the three strategy types, the research model was tested for each strategy group. All the research hypotheses focused only on three variables – the recognition of growth option, the recognition of deferral option and the intention to adopt RFID.

3.6 Results

Using equation 1 to classify the 108 firms in the dataset, 45, 39 and 24 firms were found to be closest to the ideal profiles of Analyzers, Prospectors and Defenders. The distribution of the three strategy profiles in our study is consistent with the findings of previous studies where Analyzers are typically more frequent than the other two strategic types (Chan and Sabherwal 2001, Conant et al. 1997, McDaniel and Kolari 1987, Odom and Boxx 1988, Smith et al. 1989, Zajac and Shortell 1989).

Partial Least Squares (PLS) was used to test the research hypotheses using the SmartPLS version 2.01 software. PLS has enjoyed increasing popularity because of its ability to model latent constructs under conditions of non-normality and in small to medium-sized samples (Chin 1998b). PLS allows researchers to simultaneously analyze the measurement model (i.e., how well the measures relate to each construct) and the structural model (i.e., whether the hypothesized relationships at the theoretical level are empirically true). We assessed the measurement model using the overall sample (all 108 firms). For testing the research hypotheses, the structural model was assessed separately for each of the three strategy types.

3.6.1 Measurement Model

The quality of the measurement model was assessed by measuring internal consistency, convergent validity, and discriminant validity (Gefen and Straub 2005). Internal consistency was examined using composite reliability. In PLS, composite reliability relies on actual loadings to compute the factor scores and is a better indicator of internal consistency than Cronbach's alpha (Ranganathan et al. 2004). As shown in Table 3.3, the composite reliability for the constructs in the model were all above the suggested threshold of 0.7 (Chin 1998a; Chin 1998b; Straub 1989), thus supporting the reliability of the measures.

Convergent validity indicates the extent to which the items of a scale that are theoretically related are also related in reality. Table 3.3 presents information about the factor loadings of the measures of our research model. All items have significant path loadings at the 0.001 level. The average variance extracted (AVE) values are all higher than the recommended value of 0.50 (Fornell and Larcker 1981). Therefore, the convergent validity of the measurement scales are acceptable.

Table 3.3 Psychometric Properties of Measurement Model

Construct	**Item**	**Factor Loadings**	**Composite Reliability**	**AVE**
Growth Option	GroOpt1 GroOpt2 GroOpt3	0.939 0.941 0.929	0.955	0.877
Deferral Option	DefOpt1 DefOpt2 DefOpt3	0.872 0.880 0.885	0.908	0.767
Intention to Adopt	AdpIntent1 AdpIntent2 AdpIntent3	0.946 0.917 0.906	0.945	0.852

In order to assess discriminant validity, the AVEs for each construct should be greater than the square of the correlations among the constructs, indicating that more variance is shared between the construct and its measurement items, than with another construct represented by a different set of items. In Tables 3.4 the diagonal elements, which are the square roots of the AVE, are all higher than the correlations between the constructs.

Table 3.4 Correlations between Constructs

	Growth Option	Deferral Option	Intention to Adopt
Growth Option	**0.936**		
Deferral Option	-0.385	**0.876**	
Intention to Adopt	0.526	-0.545	**0.923**

Discriminant validity can also be assessed using the factor loadings and cross loadings (Table 3.5). Scanning down the columns indicate that the item loadings in their corresponding columns are all higher than the loadings of items used to measure the other constructs. Scanning across rows indicate that item loadings are higher for their corresponding constructs than for other constructs. Thus the measurement items of this model satisfy the two criteria for discriminant validity suggested by Chin (1998b). Overall the data provides empirical support for reliability, convergent and discriminant validity of the scales of our measurement model.

Table 3.5 Factor Loadings and Cross-loadings			
	Growth Option	**Deferral Option**	**Intention to Adopt**
GrowthOpt1	**0.939**	-0.358	0.512
GrowthOpt2	**0.941**	-0.371	0.499
GrowthOpt3	**0.929**	-0.352	0.466
DeferOpt1	-0.319	**0.872**	-0.517
DeferOpt2	-0.289	**0.879**	-0.452
DeferOpt3	-0.404	**0.875**	-0.457
AdoptIntent1	0.446	-0.545	**0.946**
AdoptIntent2	0.573	-0.453	**0.916**
AdoptIntent3	0.434	-0.514	**0.906**

3.6.2 Structural Model

In order to test the research hypotheses, the structural model was tested for three different datasets – Prospectors, Analyzers and Defenders. Figures 3.2, 3.3, and 3.4 represent the results of the hypotheses testing for the three strategy types.

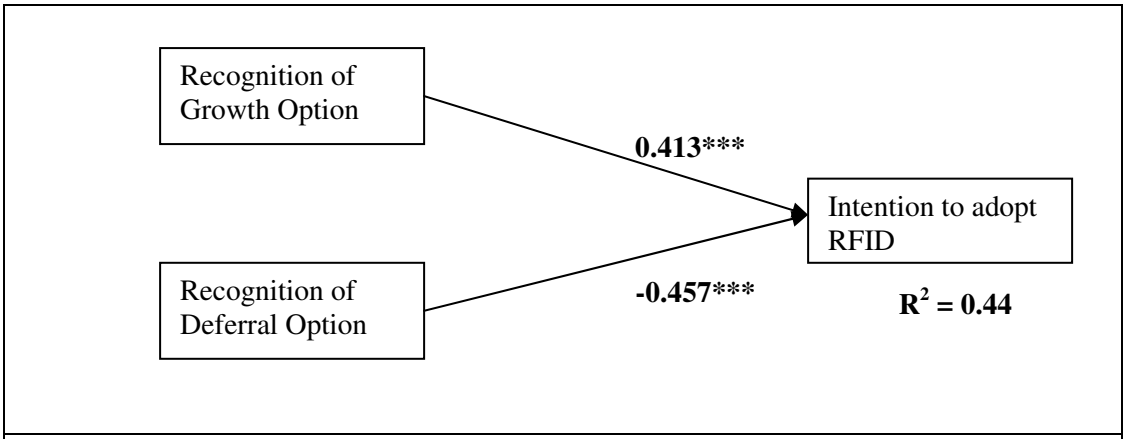

Figure 3.2 Hypotheses Testing - Prospectors

*p<0.05; ** p<0.01; *** p <0.001

The results of the data analysis for Prospectors indicate that recognition of growth option is significantly associated with the intention to adopt RFID, therefore supporting H1a. However, the recognition of deferral options is also significantly

associated with the intention to adopt RFID, thereby indicating that H1b is not supported by the data. Overall the model explains 44% of the variance in the data.

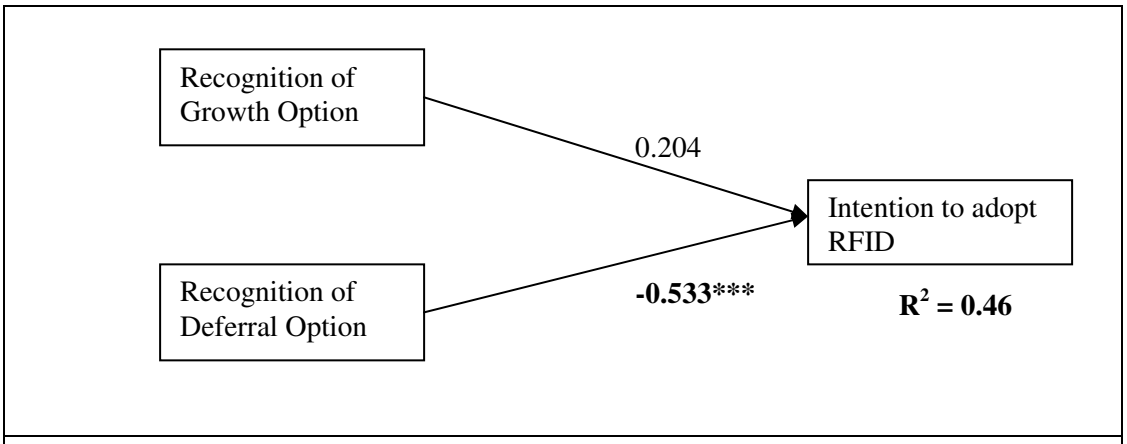

Figure 3.3 Hypotheses Testing - Defenders

*p<0.05; ** p<0.01; *** p <0.001

Figure 3.3 indicates that for Defenders, both hypotheses – 2a and 2b are supported. Figure 3.4 shows that as predicted, both recognition of growth options and the recognition of deferral options are significant in determining the intention to adopt RFID in the case of Analyzers. Therefore, both hypotheses 3a and 3b are supported. For Defenders and Analyzers, the research model explains 46% and 40% of the variance in the data.

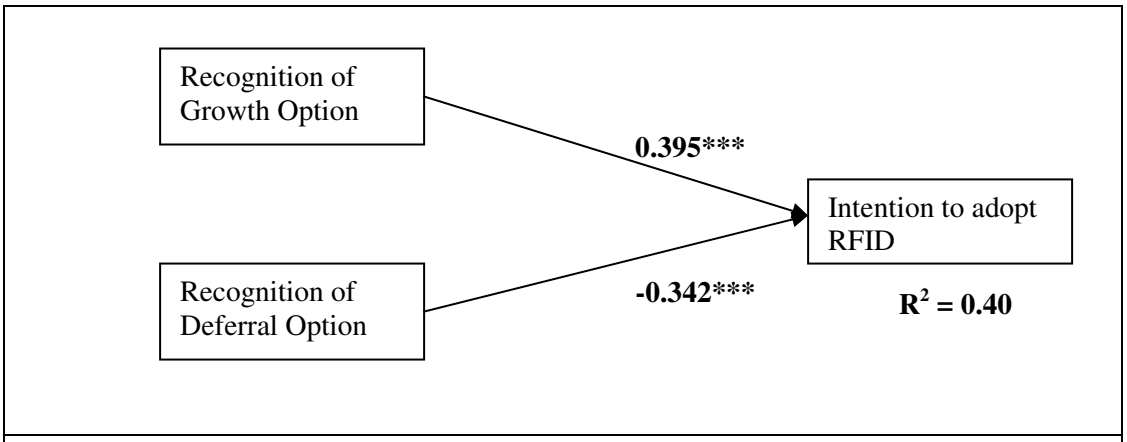

Figure 3.4 Hypotheses Testing - Analyzers

*p<0.05; ** p<0.01; *** p <0.001

3.7 Discussion and Implications

Previous research has proposed that business strategy can be visualized as a series of options and executing a strategy involves making a sequence of major decisions (Luehrman 1998). By framing the adoption of RFID technology as an option generating investment scenario, this study establishes the role of business strategy in the context of IT adoption decision-making. The key finding of this study is that organizational business strategy is an important factor that affects adoption decision-making by influencing the options that decision-makers recognize from RFID adoption and how this recognition affects the intention to adopt RFID.

The hypothesized relationships between the recognition of the two options – growth and deferral and the intention to adopt RFID is supported for both Defenders and Analyzers, but only partially supported for Prospectors. For decision-makers within the Defender strategic type, the recognition of growth options is not a significant determinant of intention to adopt RFID, however the recognition of the option to defer RFID adoption plays an important role in the adoption of RFID. According to

Miles and Snow's classification of strategy types, organizations following the Defender strategy value stability over exploiting new market opportunities, and work towards using their existing resource and technology bases to improve operational efficiency. These characteristics of the Defenders' strategy guide decision-makers within these organizations to focus their attention on aspects of the RFID adoption decision-making scenario which assists in maintaining status quo rather than taking advantage of the new opportunities. Accordingly, the recognition of deferral options is significant in adoption decision-making and therefore the intention to adopt RFID technology. In order to benefit from the opportunities provided by the adoption of RFID, the organization has to face the associated changes that are required and sacrifice an existing stable situation. Therefore, decision-makers will choose to ignore the value of growth options from RFID adoption. So the recognition of growth options is not significant in adoption decision-making for Defenders.

For Prospectors, the hypothesized relationship between the recognition of growth options and the intention to adopt RFID is supported. However, contrary to expectation, the recognition of deferral option is also found to be significantly associated with the intention to adopt RFID. The possible explanation to this finding could be that in spite of the more aggressive and risk taking characteristics of Prospectors, current market conditions pertaining to RFID technology are such that decision-makers also recognize the value in deferring RFID adoption to a future period of time. Therefore, even though Prospectors recognize the value of the growth option (as signified by the statistically significant and high valued path coefficient), they also feel that it is more judicious to defer the adoption decision. Miles and

Snow's classification of the characteristics of each organizational strategy type suggests that decision-makers in Prospector organizations will have an external orientation when faced with the task of evaluating and deciding upon RFID adoption. Therefore they will be more responsive to stimuli from the external environment. When the environment signals an unfavorable adoption context, this will get reflected in the decision made by decision-makers in Prospectors. Currently there are a lot of unresolved technological and environmental issues pertaining to RFID adoption. A scanning of the external environment to inform decision-making is likely to reveal these uncertainties and unresolved issues related to RFID, and therefore decision-makers may realize more value in waiting before committing to the technology. Therefore, the recognition of deferral option also plays a significant role in the intention to adopt RFID.

Although the survey data indicates that the recognition of the option to defer is significantly related to the intention to adopt for decision-makers from both Defenders and Prospectors, the attention based view suggests that the mechanisms through which the decision-makers from the two organizational types come to recognize this option is likely to be different. The attention based view of the firm proposes that organizations influence individual decision processes by allocating and distributing stimuli that channels the attention of administrators in terms of what aspects of a given situation are to be attended, and what aspects are to be ignored (Ocasio 1997, Simon 1947). For Defenders, recognition of the option to defer reflects that they only attend to stimuli from within the organization and have an internal orientation in deciding on RFID adoption because of the relatively conservative

strategic characteristics of their organization that encourages stability rather than actively seeking for new opportunities. Therefore, for Defenders, deferring RFID adoption decision means that they can go on maintaining and improving their technology base. Prospectors on the other hand have an external orientation in their decision making and therefore they are likely to attend to stimuli form the external environment. Their recognition of the option to defer is based on a better understanding of the impediments (institutional or technological factors) towards successfully adopting and using RFID technology.

Analyzers' strategy is a combination of the strategic characteristics of Defenders as well as Prospectors and as hypothesized the recognition of growth options as well as the recognition of deferral options is significantly associated with decision-makers' intention to adopt RFID in Analyzer organization. An external focus helps Analyzers identify market opportunities that can propel future growth for their organization, while an internal focus is likely to make them more cautious in grabbing new opportunities or deciding to adopt new technologies. Accordingly, for decision-makers in Analyzer organizations, the recognition of growth option and the recognition of deferral option both influence their decision to adopt RFID technology.

The finding that organizational strategy moderates the relationship between the recognition of real options from RFID technology and organizational decision-makers' intention to invest in RFID also provides some empirical validation to the proposition that IT / IS strategy of the organization is determined by its business strategy. Innovation diffusion research often classifies early adopters of an innovation as 'innovators', while late adopters are classified as 'laggards', where the term

laggards typically has a slightly negative connotation, as adoption is usually considered a more desirable behavior (pro-innovation bias). This study helps in countering the pro-innovation bias that is often associated with technological innovations by showing that organizations may make an informed choice of adopting or not adopting an innovation based on the business strategy that their organization follows. As organizations can thrive by successfully following any of the three strategic types, this research shows that all organizations do not need to be aggressive in adopting IT innovations as early as possible, but base their decision through contextually grounded evaluation of their own scenario.

3.8 Limitations

Despite the above contributions, the findings of this research should be interpreted in light of its limitations. First, it has been suggested that the pure strategies of Prospectors, Analyzers and Defenders are archetypes, and in practice, organizations are likely to flexibly combine these strategies (Sabherwal and Chan 2001). However, as in previous research, we did not test hybrid strategies in order to avoid complications in analysis and discussion. Second, by restricting the study to only two industry sectors – the manufacturing and logistics industry, we were able to compare each firm's strategy with respect to its competitors. While this enhanced the internal validity of the study, further research is needed to ascertain the applicability of the results to other industries.

Finally, strategy was measured using a single respondent. While the respondent in each organization is someone in a senior management position who has a good overview of the overall organizational strategy, it is the perception of one single

person in the organization. In order to strengthen the external validity of the measure, future research can consider using multiple respondents to measure business strategy.

3.9 Conclusion

The previous study showed that the recognition of real options influences managerial intention to adopt RFID. This study further shows that the relationship between the recognition of real options and the intention to adopt RFID is moderated by the business strategy that an organization follows. Previous research has contended that an alignment between the business strategy of the organization and its IS strategy results in better overall performance (Chan and Sabherwal 2001), however, the role of business strategy in IT adoption has received little attention in IS innovation diffusion research. This study addresses this gap in the literature by empirically assessing the impact of business strategy on the decision-making process that results in the decision to adopt or not adopt an innovation. While this research focuses on how the business strategy affects the recognition of the two strategic options (growth and deferral), future research can focus towards identifying the other real options (staging, abandon, switch, etc.) that are likely to be influenced by the business strategy that the organization follows and the impact that the portfolio of options that organizations belonging to different strategic types have on the successful adoption, implementation and assimilation of IT/ IS innovations on their organizations.

Chapter 4

Mindfulness in RFID Adoption: The Determinants of Decision-maker Mindfulness

4.1 Introduction

Information technology (IT) innovations and their adoption has received sustained research interest over time due to the multitude of factors that can affect the adoption decision, resulting in a complex decision making process. Different technology, organizational and environmental factors (commonly classified under the TOE framework) has been investigated to understand the phenomenon of IT innovation adoption. However, little is understood about the actual cognitive processes that are involved in the decision making, although it is acknowledged that whether, when and how to innovate with IT is a complex and crucial question faced by decision makers in almost all organizations (Swanson and Ramiller 2004).

In an attempt to understand how organizations decide on technological innovations researchers have started using several psychological constructs and cognitive theories in innovation and strategic decision-making research to explain the cognitive processes involved in innovation adoption decisions in organizations. One such construct is *mindfulness*. The notion of mindfulness has been introduced to investigate differences in innovative behavior among organizations (Fichman 2004a; Fiol and O'Connor 2003; Swanson and Ramiller 2004). In organizational decision-

making, mindfulness is a characteristic that is believed to aid in making contextually differentiated interpretations of situations and information scenarios.

For organizations, adoption of IT innovations constitutes a complex information processing and decision making scenario that involves making sense of an information technology that the organization is unfamiliar with and is typically characterized by uncertainty and ambiguity over the outcomes of the innovation process. Although IT innovations are usually believed to be able to confer strategic and competitive benefits to the adopting organization, they often constitute complex technologies, and call for significant investment of organizational resources. Thus, managers are faced with the task of analyzing the ramifications of the innovation on their organization. Under such circumstances, deciding on whether a particular innovation is a good thing for the organization, whether the timing of the innovation is appropriate, and how the adoption is best carried out, requires organizational decision makers to attend to the innovation with reasoning grounded in their own facts and specifics (Fichman 2004a).

In the context of organizational adoption of IT innovations, mindfulness corresponds to an engagement with a given innovation based on facts and details which are unique to the organization itself (Swanson and Ramiller 2004; Weick and Sutcliffe 2001). It has been suggested that mindfulness can reduce the possibility of failure when innovating with IT because mindfulness will result in a decision which is based on richer and more contextually relevant interpretation of a given situation (Fichman 2004a; Swanson and Ramiller 2004). Therefore, decision-maker mindfulness is a desirable property in the process of adoption of IT innovations in organizations.

Given the possible favorable outcomes of mindfulness this research is directed towards understanding the factors that affect decision-maker's mindfulness when deciding on IT innovations. Drawing from two streams of research which characterize mindfulness as (a) an individual level property (e.g., Langer 1989) and, (b) an organization level characteristic (e.g., Swanson and Ramiller 2004), in this study we conceptualize decision-maker mindfulness in the context of IT innovation adoption as an individual level property, which is influenced by both – a person's individual traits or characteristics, and the context under which he operates and makes decisions (e.g., organizational factors, technology factors). The determinants of mindfulness – individual factors, as well as factors external to the individual's persona that determine decision-maker mindfulness in IT innovation related decisions are identified and empirically validated. Therefore, this research not only underlines the role of mindfulness in adoption of IT innovations, it also provides means for identifying more efficient organizational decision-makers, and lays down guidelines for improving decision making mindfulness in organizations.

4.2 Theoretical Foundations of Mindfulness

The concept of mindfulness was introduced by Langer (1989). Mindfulness is defined as a state of alertness and lively awareness that characterizes active information processing, creation and refinement of different categories and awareness of multiple perspectives. Mindfulness can be conceptualized as a cognitive ability or cognitive style (Sternberg 2000) that is reflected by (a) openness to novelty; (b) alertness to distinction; (c) sensitivity to different contexts; (d) awareness of multiple perspectives; and (e) orientation in the present (Langer 1997). Mindlessness, on the other hand,

reflects the lack of these attributes. Thus, mindfulness captures a quality of consciousness that is characterized by clarity and vividness of current experience and functioning. In contrast, mindlessness is characterized by less conscious states, where people tend to function habitually and automatically (Brown and Ryan 2003).

Originally defined as an individual level characteristic, the notion of mindfulness was subsequently extended to the organization level (Weick 1995). At the organization level, mindfulness was defined as an organizational property or capability that allowed organizations to operate under conditions that are characterized by high risk of functional and technological complexity and with little scope to learn from trial and error. It was found that high reliability organizations (such as air traffic control systems, nuclear power generating plants, emergency departments in hospitals, etc.) successfully operate under such conditions and avoid failures and accidents by being (a) preoccupied with failure, (b) reluctant to simplify interpretations, (c) sensitive to operations, (d) committed to resilience, and (e) deferent to expertise. Accordingly, these five characteristics have been identified as the indicators of mindfulness of an organization in managing their day to day operations (Weick 1995; Weick and Sutcliffe 2001).

Although normal business operations are carried out by organizations under significantly less stringent conditions, inculcating the above characteristics in their organizational operations can reduce chances of failure by avoiding errors in the first place (Weick and Sutcliffe 2001). Thus, mindfulness can be thought of as a desirable property or state that all organizations, irrespective of their line of operation should

strive to achieve, since it will make them more adept in managing unexpected circumstances.

Weick's (1995) conceptualization of mindfulness as a desirable organizational property was primarily in the context of managing day to day operations of organizations. Subsequently, researchers have extended the notion of mindfulness to study organizational engagement with innovations, because by its very definition, innovations incorporate concepts of newness or novelty, and IT innovations that are adopted in organizations are often characterized by new and complex technical knowledge and process changes, resulting in unexpected or uncertain outcomes. Organizational adoption of IT innovations thus underlines an organization's attempt to make sense of an uncertain situation that can result in unexpected outcomes, therefore, calling for mindfulness to be exercised when innovating with IT. Accordingly, mindfulness in organizational adoption of innovations has been receiving growing interest in recent years (e.g., Fichman 2004; Fiol and O'Connor 2003; Swanson and Ramiller 2004).

There are different interpretations of the role of mindfulness in the organizational adoption of innovations. Certain innovations are observed to give rise to a bandwagon behavior among organizations, where organizations end up adopting the innovation based on the perception that it is a well tried recipe for success (Spender 1989; Weick 1995) because others have adopted it as well. By conceptualizing mindfulness as an individual level property, it has been proposed that mindfulness among organizational decision makers can prevent them from succumbing to such bandwagon behavior in the adoption of the innovation (Fiol and O'Connor 2003). The basic premise of this

view is that greater mindfulness aids in an expanded environmental scanning for information and more context relevant interpretations of the available information, which in turn leads to more discriminating decisions, in the face of bandwagons. By applying the same argument, such mindfulness can also result in a decision to adopt an innovation where the bandwagon or popular behavior is that of rejecting the innovation. Often innovations that are not considered fashionable by the majority opinion are rejected even though they may be beneficial for a particular organization. Thus, in contrast to traditional IS innovation research which is primarily concerned with explaining how to enhance or speed up adoption of innovations among a population of possible adopters (Fichman 2004), mindfulness can be used to explain both the adoption and rejection behaviors among organization. Hence, mindfulness also provides innovation diffusion research means of overcoming the pro-innovation bias that it is sometimes believed to suffer from (Fichman 2004a; Kimberly 1981).

In IS innovation research, mindfulness has primarily been defined as an organizational property, and *an organization is said to be mindful in innovating with IT when it attends to an innovation with reasoning grounded in its own organizational facts and specifics*. Based on this definition, mindfulness can be characterized by contextually differentiated reasoning by the organization (Swanson and Ramiller 2004). Further, both mindfulness and mindlessness (an organizational characteristic that reflects a lack of mindfulness) have been simultaneously juxtaposed over the whole innovation process, starting from pre-adoption engagement, to adoption and subsequent implementation of the innovation; and organization, environmental and technology specific characteristics of the IT innovation that can

result in mindful or mindless behaviors have been examined. Swanson and Ramiller (2004) provided a somewhat positive connotation to the notion of mindlessness by arguing that organizations might make the strategic choice of being mindless in innovating with IT, when it is more beneficial to be mindless, given that mindfulness is a rather demanding and costly sensemaking endeavor. Although mindfulness is conceptualized as an organization level property that is not necessarily reducible to the mindfulness of individual managers, they conceded that managers are responsible for fostering mindfulness in their organization.

4.3 Determinants of Decision-makers Mindfulness in IT Innovation Adoption

The concept of mindfulness has been analyzed in depth, however, there is little existing research towards identifying factors that determine mindfulness, especially mindfulness in the context of organizational decision-making. On one hand mindfulness has been defined as a characteristic of the individual (Langer 1989), and on the other hand it has been suggested that mindfulness is a property of the organization (Swanson and Ramiller 2004; Weick 1995). This study synthesizes these two seemingly divergent characterizations of mindfulness to identify the antecedents of organizational decision-maker's mindfulness in innovating with IT.

Based on research in cognitive psychology, we identify individual factors that affect mindfulness among organizational decision-makers. While individual decision-makers contribute towards fostering mindfulness in the organization, it has also been suggested that mindfulness at the organization level is not necessarily reducible to mindfulness of any individual within the organization (Swanson and Ramiller 2004).

Therefore, certain organizational characteristics will also be important in determining decision-maker mindfulness. In addition to individual and organizational factors, the decision scenario in which mindfulness is being examined will play an important role in determining managerial mindfulness. For instance, mindfulness in carrying out day-to-day organizational operations is different from mindfulness in making out-of-the-regular decisions, such as adoption of IT innovations. The decision-context in this study is that of organizational engagement with IT innovations, and more specifically the adoption of RFID technology. Hence, the influence of innovation characteristics in determining decision-maker mindfulness is also considered.

4.3.1 Individual Factors

In psychology, mindfulness has been considered as a factor that enhances individual well-being and other well-being related outcomes (Kabat-Zinn 1990). Therefore, prior research has been primarily concerned with identifying interventions that can increase mindfulness among individuals. However, researchers have also started recognizing mindfulness as a naturally occurring characteristic that can differentiate individuals (Brown and Ryan 2003).

Recent research developments offer a more expanded view of mindfulness, by proposing that individuals differ in their propensity or willingness to be aware and to sustain attention to what is occurring in the present. This mindful capacity varies within persons, and can be enhanced or diminished by several factors (Brown and Ryan 2003). Other attempts to conceptualize the construct of mindfulness, has suggested that mindfulness could be viewed as cognitive ability, or a personality trait, or as a cognitive style (Sternberg 2000). Viewing mindfulness as a cognitive ability

suggests that people are likely to differ in their ability to think mindfully in the same way as they differ in terms of memory or intelligence. When viewed as a personality trait, the characteristic of mindfulness becomes akin a relatively stable individual disposition like the various personality traits such as conscientiousness, or extraversion of neuroticism. When visualized as a cognitive style, mindfulness represents a preferred way of thinking (Sternberg 2000). The above characterizations of mindfulness indicate that there are likely to be relatively stable individual differences in mindfulness. At the same time, it seems that individuals can be trained to think in a more mindful manner. Both of these observations have potent implications for organizations.

Based on the different conceptualizations of mindfulness in prior research, there appears to be some sort of relationship between individual mindfulness and human cognitions. An individual's cognitions, motivations and behaviors in different situations are often determined by his or her personality (Ryckman 2004). Therefore, we draw from personality psychology to determine the antecedents or individual variables that can predict decision-makers' mindfulness in adoption of IT innovations.

The five human personality related traits or factors, commonly known as the Big-Five or the five factor model (McCrae and Costa 2003) are considered as one of the most stable and enduring characteristics that define human personality. The five factors of personality that have been measured and consistently received significant research support in a wide variety of research are *neuroticism*, *extraversion*, *openness to experience*, *agreeableness* and *conscientiousness*. Individuals have been found to possess varying levels of these factors. Each of these five factors is a broad dimension

of personality that can be considered as a super-trait made up of several subordinate traits. For instance, the neuroticism trait is thought to be made up of the sub-traits of anxiety, hostility, depression, self-consciousness and vulnerability. For the purpose of this research we focus only on the five super-traits, rather than on the more detailed sub-traits that constitute them.

The five personality factors tap into different aspects of human personality that are briefly described as follows: *Openness to experience* indicates an appreciation for variety of experience, curiosity, imagination, art and unusual ideas. *Conscientiousness* reflects a tendency to show self-discipline, planned behavior, aim for achievement and act dutifully. *Extraversion* reflects energy, surgency, a tendency to seek stimulation and the company of others. *Agreeableness* reflects a tendency to be compassionate and cooperative, while *neuroticism* reflects a tendency to experience unpleasant emotions such as anger, anxiety and depression easily. Among these five factors, different factors become particularly important under different research contexts. For instance, conscientiousness typically characterizes the need for achievement and is therefore likely to be relevant in studies that attempt to understand factors that cause individual differences on performances. Agreeableness and extraversion are likely to be considered important in studies that focus on social interaction skills in human beings. Similarly, neuroticism is typically associated with emotional and mental well-being. Since openness to experience is associated with various cognitive skills in individuals and conscientiousness refers to persistence and planned behavior, when innovating with IT, we consider these two personality traits to play a significant role in determining decision-maker mindfulness.

Among the five factors, *openness to experience* is often associated with various cognitive skills and abilities in human beings (McCrae 1996). Openness to experience has been found to be associated with creativity and divergent thinking (McCrae 1987). It can be thought of as a motivational tendency to think about ideas, scrutinize information, and puzzle-solving. Openness to experience is a personality trait that distinguishes imaginative, inventive, reflective people from those who are conventional. People having low scores of openness are found to prefer familiarity over novelty and are usually resistant to change, while high scores involves receptivity to and interest in new experiences (McCrae and Costa 2003). Such receptive attention can support the assimilation of new ideas and feelings (Brown and Ryan 2003). Since one of the characteristics of mindfulness is openness to novelty (Langer 1989), an open and receptive awareness is a quintessential aspect of mindfulness (Martin 1997). Therefore, the personality trait of openness to experience is likely to be most strongly associated with mindfulness. Previous research has also suggested that there should be a thorough investigation of the relationship between mindfulness and openness to experience (Brown and Ryan 2003; Sternberg 2000).

For organizational decision makers, mindfulness in innovation adoption calls for expanded information processing and sense-making abilities. People who are imaginative and reflective are more likely to be able to make better sense of the available information. Natural tendencies towards scrutinizing information and problem solving can to a certain extent make one reluctant to simplify, which is one of the attributes of mindfulness (Weick and Sutcliffe 2001). Mindfulness also calls for an awareness of multiple perspectives (Langer 1989). In the context of

organizational innovation adoption, this translates into consideration towards the different ramifications of the innovation on the organization's operational and strategic advantages. Divergent thinking which is characterized by the ability to consider a variety of approaches to a problem simultaneously and elaborate on the details of an idea and carry it out (Guilford 1967), will make a person aware of the multiple perspectives and therefore have a positive influence on mindfulness in innovation adoption decision making. Divergent thinking in positively related to openness to experience (McCrae 1987). Openness to experience includes openness to different ideas and values. Thus individuals scoring high on openness will be receptive of different ideas, and be able to simultaneously process and make sense of multiple viewpoints, rather than being restricted by a single perspective. Therefore, possessing the personality trait of openness to experience is likely to make organizational decision-makers more mindful in deciding to adopt RFID.

Hypothesis 1: *Openness to experience will be positively associated with mindfulness in RFID adoption decision-making among organizational decision-makers.*

Conscientiousness is the personality trait that is characterized by purposeful planning and persistence in individuals. It contains elements of thoroughness, carefulness, organization, self-discipline and deliberation (McCrae and Costa 2003). Although, conceptually openness to experience is believed to have a closer association with individual mindfulness (Brown and Ryan 2003; Sternberg 2000), prior research has also suggested that there might be some relationship with conscientiousness as well (Sternberg 2000). Further, significant amount of prior research has found that conscientiousness is one of the best predictors of performance in the workplace across

different categories of jobs (Salgado 1997). Therefore it is likely that conscientiousness will be associated with mindfulness, particularly, when analyzing mindfulness of organizational decision-makers, as opposed to just general mindfulness in individuals.

A reluctance to simplify, commitment to resilience, and a preoccupation with failure are the hallmarks of mindfulness in an organizational context (Fiol and O'Connor 2003; Weick and Sutcliffe 2001). Strategic decision-making in organizations (as is the case of IS innovation adoption) usually involves high levels of complexity. Under such circumstances most individuals are prone to rely on cognitive simplifying process to manage the complexity (Fiske and Taylor 1991). A reluctance to simplify indicates that organizational decision makers are willing to do the hard work which is required to fully understand a complex decision-making scenario. Personality traits of thoroughness, deliberation and persistence are likely to make an individual willing to do the hard work of fully understanding and contextually interpreting a complex innovation related decision making scenario.

Commitment to resilience is about recovering from failure or a setback. It is the overall capacity to investigate, learn, detect, contain and bounce back from inevitable errors (Weick and Sutcliffe 2001). Conscientious individuals often have a high need for achievement. This, along with a deliberate, thorough and persistent nature is likely to make individual decision-makers more committed to resilience in the organizational context. The need for achievement is also likely to make individuals pre-occupied with failure and device ways of getting over it. Further, organizational mindfulness calls for a deeper consideration of their own organizational particulars

(Swanson and Ramiller 2004), and such a consideration can come about by individual characteristics of thoroughness, persistence and deliberation. Thus, conscientiousness among individuals will make them more mindful in an organizational decision-making context.

Hypothesis 2: *Conscientiousness will be positively associated with mindfulness in RFID adoption decision-making among organizational decision-makers.*

4.3.2 Organizational Factors

Differences in organization culture give rise to variations in the cognitive styles of organizational managers and decision makers (Schein 1985). Thus, based on the conceptualization of mindfulness as an individual cognitive style (Sternberg 2000), we investigate the role of organizational culture in promoting mindfulness among its decision-makers. Organizational culture is a broad term that essentially refers to a shared understanding of the reality by the members of the organization. Among other things, organizational culture dictates the rules and norms within which an organization operates, governs the way in which members obtain information from the environment, and the way that this information is dealt with. Organizational culture also helps in differentiating between acceptable and unacceptable behaviors within the organization, and it governs the ways in which an organization deals with failure and mishaps, and how rewards systems are defined within the organization (Schein 1985).

Although culture is a broad term that encompasses many things, in this study we am interested in considering the aspects of organizational culture that can have an impact

on the decision-making styles of managers and other organizational decision-makers. Based on an analysis of the characteristics of high reliability organizations, the notion of *informed culture* has been put forward and described as a culture that fosters mindfulness among organizations (Weick and Sutcliffe 2001).

The concept of informed culture is derived from safety culture, which represents an organization's proficiency of, and commitment to their safety programs. Organizations that have a positive safety culture are characterized by shared perceptions of the importance of safety, and communications founded on mutual trust and confidence in the efficacy of built-in preventive measures (Reason 1997). Informed culture builds on and broadens the concept of safety culture, and is about strengthening the organization's defenses to prevent unfavorable incidents that can affect the organization as a whole. Therefore, informed culture necessitates sustaining an intelligent wariness within the organization.

An *informed culture* can be defined as an organizational culture that encourages reporting of errors and near misses, a culture that is just in terms of apportioning error when things go wrong, a culture that is flexible enough to be able to adapt to sudden and radical increases in pressure, pacing and intensity of organizational operations, and a culture that enables members of the organization to use lessons learnt from past experiences to fine tune present operations and, assumptions and acts based on the past learning. Thus, in essence, the informed culture makes the organization more tolerant, and indicates to its members that it is acceptable to report errors or incidents which could have lead to errors because it is unlikely that they will be blamed, punished or negatively evaluated for reporting such incidents. An informed culture

creates an environment of trust and trustworthiness within the organization. It makes the organization better suited for adapting to changing demands by making timely and candid information available and encouraging learning from past experience and best practices. Accordingly, it has been proposed that these four components of the informed culture - reporting culture, just culture, flexible culture and learning culture can make an organization more mindful in managing unexpected occurrences, and preventing failures (Weick and Sutcliffe 2001).

When innovating with IT, decision makers in an organization are faced with a situation that can lead to unexpected outcomes. They are faced with information pertaining to a technology which is new to their organizational context and can bring about radical changes in the functioning of the organization, but at the same time, the cost of failure in the innovation initiative is high. Under such circumstances, an organizational culture that does not shy away from reporting about and analyzing unfavorable information will make decision makers more open towards considering both the favorable and unfavorable aspects of an IT innovation in the justification process involved in adopting an innovation.

Mindfulness calls for a contextually differentiated and thorough interpretation and analysis of the implications of the innovation based on an organization's own facts and specifics (Swanson and Ramiller 2004). This might result in decisions that go against a majority opinion, both within the organization (when other members of the organization harbor a different opinion regarding the organization), and outside the organization (when other organizations in the external environment have varying perceptions regarding the innovation). Further, since the outcomes of the innovation

process can only be felt over a period of time and are not immediately visible, this makes it even more difficult for decision makers to justify their decisions when it goes against the bandwagon's decision. If an organizational culture is just in terms of apportioning blame and punishment when things go wrong, decision-makers within the organization will be more comfortable in making decisions that go against the general opinion when the situation calls for such a decision.

One of the characteristics of mindfulness is deference to expertise, which means that decisions should be made by people who are most qualified to make them, irrespective of what the organizational structure or hierarchy demands. An organization that can adapt to changing demands by shifting authority structures is said to possess a flexible culture (Reason 1997), that encourages deference to expertise when circumstances demand for it.

Organizational learning is found to be a facilitator of the innovation process (Fichman and Kemerer 1997). Learning helps in overcoming the knowledge barriers that impedes the success of the organization with the innovation. Learning is especially valuable for technologies that are shrouded in significant amounts of uncertainty regarding outcomes (Brach 2003). A culture that encourages learning will assist decision makers in making a more informed decision by reducing the uncertainties associated with the technology. Thus, by encouraging reporting, justice, flexibility and learning, the informed culture of an organization will play a significant role in facilitating mindfulness in organizational decision makers when innovating with IT, such as the adoption of RFID technology.

Hypothesis 3: *Informed culture in the organization will be positively associated with mindfulness in RFID adoption decision-making among organizational decision-makers.*

4.3.3 Innovation Characteristics

Other than the individual and organization characteristics discussed above, the decision-making context in which mindfulness is being studied will play an important role in determining the mindfulness of organizational decision-makers. When the context is that of deciding on IT innovation, the characteristics of the innovation that is being considered for adoption are likely to influence mindfulness in adoption decision-making. Prior innovation research has used radicalness as a primary attribute to distinguish between innovations (Wilson et al. 1999), and shown that innovation adoption is influenced by the degree to which innovations can be considered as either radical or incremental (Damanpour 1988, Dewar and Dutton 1986, Ettlie et al. 1984, Tornatzky and Fleischer 1990). Further, Swanson and Ramiller's (2004) discourse on organizational mindfulness in IT innovation adoption suggests that radicalness of the innovation encourages the organization to behave mindlessly. Therefore, we propose that radicalness of the innovation will have an impact on the individual mindfulness of organizational decision-makers in RFID adoption.

Factors such as organizational structure and size and the existence of more specialized knowledge regarding the innovation are found to be significant in the adoption of radical innovations in organizations (Ettlie et al. 1984). This implies that the effect of radicalness of the innovation on its adoption is affected by certain organizational characteristics. As discussed above, informed culture within the

organization helps in determining decision-maker mindfulness by encouraging – reporting of facts even when things are not completely favorable, justice in apportioning blames and punishment when things go wrong, enabling authority to be granted to people with the appropriate expertise regarding the innovation, and facilitating learning from mistakes. These factors are likely to important considerations when the innovation calls for a substantial departure from current practices within the organization. Therefore, when an innovation is considered radical, informed culture will play a bigger role in determining decision-maker mindfulness. Accordingly, radicalness will positively moderate the relationship between informed culture and mindfulness in RFID adoption decision-making.

Hypothesis 4a: *The relationship between informed culture and mindfulness of organizational decision-makers will be positively moderated by innovation radicalness.*

The greater the difference between the innovation and the current technological setup within the firm, the more likely that firms will be tempted to dismiss their present circumstances as irrelevant or out-dated when considering the adoption of the innovation (Swanson and Ramiller 2004). Therefore, the general tendency within the organization will be to gloss over the firm's own facts and specifics, rather than scrutinizing them vis-à-vis the requirements of the innovation. Under such circumstances, a decision-maker who is characteristically more disposed towards being thorough and meticulous in considering all aspects of a particular decision-making scenario is also likely to demonstrate more mindfulness in decision-making.

Therefore, conscientiousness will have a stronger effect on decision-maker when deciding upon the adoption of a highly radical innovation.

Hypothesis 4b: *The relationship between conscientiousness and mindfulness of organizational decision-makers will be positively moderated by innovation radicalness.*

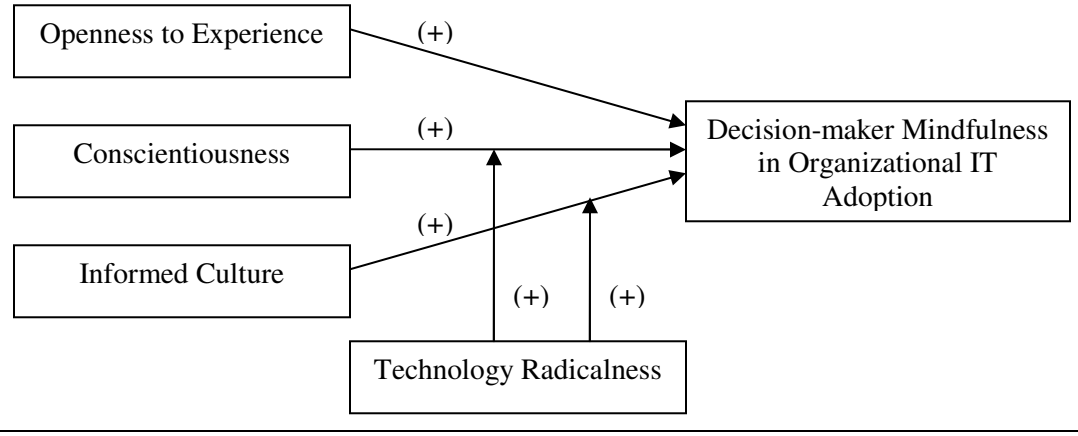

Figure 4.1 Determinants of Mindfulness in Decision-makers

4.4 Operationalization of Constructs

Where ever possible, validated instruments from previous studies were used to operationalize the constructs (Stone 1978). Based on the review of related literature, new measurement items were developed for constructs where existing measures were not available or did not capture the complete notion of the intended construct. IS faculty members from a large Singapore based university were asked to assess the initial face and content validity of the measurement items and their feedback was used to refine the items. Following this, two rounds of questionnaire sorting exercise (labeled and unlabeled) was carried out based on Moore and Benbasat (1991). Four

graduate students participated in each sorting exercise. For the unlabeled sorting exercise, the labels that the sorters came up with closely corresponded with the actual construct names and on the average more than 80 percent of the items were correctly sorted into their intended constructs. After refining the measurement items based on the results of the unlabeled sorting exercise, the labeled sorting exercise – in which the sorters were provided with the name and definition of each construct – resulted in an average of 94% of the items getting correctly sorted into their intended constructs, thus indicating a high level of face and content validity.

4.4.1 Personality Factors

The two personality factors – openness to experience and conscientiousness were measured as broad domains of human personality using 10-item indicators from the international personality inventory pools (Goldberg et al. 2006, IPIP 2008).

4.4.2 Informed Culture

Informed culture comprises four components of organizational culture – just culture, reporting culture, flexible culture and learning culture. Based on a definition of these four constituents of informed culture (Weick and Sutcliffe 2001), a formative scale was developed to capture each of these aspects of informed culture.

4.4.3 Decision-maker Mindfulness in RFID Adoption

Mindfulness is defined as attending to the innovation with reasoning grounded in one's own organizational facts and specifics (Swanson and Ramiller 2004). A four item measurement scale was developed to capture decision-maker mindfulness in adoption decision-making.

4.4.4 Radicalness

Radicalness is defined as the extent to which the innovation is a significant departure from existing technology used in the organization and incorporates new knowledge and technical expertise. Radicalness was measured using a three item measurement scale based on Dewar and Dutton (1986).

4.5 Methodology

4.5.1 Data Collection

The research model for this study was validated using survey research methodology. Survey forms were mailed to top executives (CEO, CIO, Managing Director, etc.) of a list of firms obtained from the Singapore 1000 database. The survey questionnaire was accompanied with a cover letter with a brief description of the research project, and the recipient was requested to fill up the survey, or pass it on to a decision-maker within the organization who played a more prominent role in deciding on RFID adoption. The questionnaire contained a brief description of the RFID technology and some indicatory uses of the RFID technology in an organization. A total of 724 surveys sent out, and we received 159 responses, thus giving a response rate of 21.96%. A copy of the completed research report and findings was promised as an incentive to the respondents. The completed survey forms were returned to the authors in envelopes with pre-paid postage. Out of the 159 responses received, 134 were completed responses and were therefore used in this study.

Among the 134 usable responses, respondents were primarily top-level senior executives within the organization, nearly 84% of them having more than 10 years of overall experience and held job titles such as CIO, COO, Vice-President, Executive

Director, General Manager and Senior Manager. In terms of educational qualifications, 35% of the respondents held post-graduate or above degrees, while 52% were graduates, the remaining had high school education or diplomas.

4.5.2 Measures

All items in the survey questionnaire were measured on a 7-point likert scale ranging from 1 = strongly disagree to 7 = strongly agree. Table 1 lists the measurement items used to measure each of the constructs. Three of the constructs of this study – Openness to Experience, Conscientiousness and Informed Culture were measured using formative indicators, while Mindfulness and Radicalness were measured using reflective scales.

Table 4.1 Operationalization of Constructs

Construct (Abbreviation)	**Measurement Items**
Openness to Experience (PerOpen)	- I believe in the importance of art - I have a vivid imagination - I tend to vote for liberal political candidates - I carry the conversation to a higher level - I enjoy hearing new ideas - I am not interested in abstract ideas (-) - I do not like art (-) - I avoid philosophical discussions (-) - I do not enjoy going to art museums (-) - I tend to vote for conservative political candidates (-) (Goldberg et al. 2006, IPIP 2008)
Conscientiousness (PerCons)	- I am always prepared - I pay attention to details - I get chores done right away - I carry out my plans - I make plans and stick to them - I waste my time (-) - I find it difficult to get down to work (-) - I do just enough work to get by (-)

	- I don't see things through (-) - I shirk my duties (-)
Informed Culture (InformCul)	In our firm, - the internal climate encourages people to report errors and near-miss situation - people are not blamed or punished for reporting errors or incidents that could have resulted in unfavorable outcomes - blame and punishment are justly apportioned when errors or unfavorable incidents occur - it is easy to adapt from a conventional hierarchical structure to a structure where control is held by the task experts depending on circumstances - it is possible to shift authority to professional experts when a situation calls for it - the internal environment encourages learning from available situational information - the internal atmosphere supports reforms and changes based on learning from previous incidents (All items self developed)
Radicalness (Radical)	Compared to existing auto-identification technologies such as bar-code - RFID has significant new knowledge contained in the technology or process - RFID represents an improvement over the existing technology - RFID represents a major technological advance (Dewar and Dutton 1986)
Decision-maker Mindfulness in RFID Adoption (Mindful)	When considering RFID adoption - I take into account our firm's preparedness for the changes involved - my decision is based on reasoning grounded on our firm's own facts and specifics - I usually get new information from multiple sources for decision making - I am aware that there are multiple implications of RFID for our firm (All items self developed)

4.6 Data Analysis and Results

The research hypotheses were tested using multiple regression analysis (MRA) and moderated multiple regression (MMR) analysis in SPSS 16.0. Multiple regression is the appropriate method of analysis when the research problem involves a single

dependent variable and two or more independent variables (Hair et al. 1998). MMR is an extension of MRA used to test the effects of multiplicative terms or interactions of factors (Sharma et al. 1981). This allows for testing both the direct and moderating hypotheses in the research model. Single scores were created for each variable and the assumptions of the multiple regression analysis assessed.

4.6.1 Measurement Model

The quality of the reflective indices can be assessed through measures of internal consistency, convergent validity and discriminant validity (Gefen and Straub 2005). However, similar measures cannot be used to assess the quality of measurement items when constructs are measured using formative indicators (Diamantopoulos and Winklhofer 2001). Therefore, there is no straight forward method for assessing the validity of formative measurement items. For formative constructs, as long as the indicators selected conceptually represent the domain of interest, they may be considered adequate from the standpoint of empirical prediction (Coltman et al. 2008). For measuring informed culture, we drew on its definition (Weick and Sutcliffe 2001) in order to come up with seven indicators that represented the total domain of interest for the construct. The content and face validity of the construct and its measures were assessed through multiple rounds of sorting exercise and mentioned in Section 4.4. The items were averaged to create a single score summated scale for informed culture.

Further, for the personality measurement scales, previous research has suggested that authors should limit their use of different validity measures to assess the validity of the scales as various measures of validity are often found not to reflect a true picture of the validity of the scales and lack in utility (Piedmont et al. 2000, Johnson 2005).

Therefore, in order to improve the quality of personality assessment, we adopted the widely used IPIP scales (Goldberg et al. 2006) for assessing Openness to Experience and Conscientiousness. Single measures for the personality factors were obtained by following the scoring criteria suggested in the IPIP website (IPIP 2008).

For the two constructs that were measured using the reflective indices, internal consistency was examined using composite reliability and Cronbach's alpha. As shown in Table 4.2, the composite reliability of both constructs are above the suggested threshold of 0.7 (Chin 1998a; Chin 1998b; Straub 1989), thus supporting the reliability of the measures.

Convergent validity indicates the extent to which the items of a scale that are theoretically related are also related in reality. Convergent validity measures the correlation among item measures of a given construct using different methods of measurement. Table 4.2 presents information about the factor loadings of the measures of our research model. All items have significant path loadings at the 0.001 level. The average variance extracted (AVE) values are higher than the recommended value of 0.50 (Fornell and Larcker 1981). Therefore, the convergent validity of the reflective scales are acceptable.

Table 4.2 Psychometric Properties of Measurement Model for the Reflective Constructs					
Construct	**Item**	**Factor Loadings**	**Composite Reliability**	**Cronbach's Alpha**	**AVE**
Radicalness	Radical1 Radical2 Radical3	0.899 0.949 0.943	0.951	0.923	0.867
Decision-maker Mindfulness in RFID Adoption	Mindful1 Mindful2 Mindful3 Mindful4	0.789 0.778 0.798 0.780	0.866	0.798	0.619

Reflective measures are said to have sufficient discriminant validity when the AVEs for each construct is greater than the square of the correlations among the constructs, indicating that more variance is shared between the construct and its measurement items that with another construct represented by a different set of measurement items. In Table 4.3, for each of the two constructs measured using reflective items, the square root of the AVE (shown as diagonal elements), are higher than the correlations between the constructs.

Table 4.3 Correlations between Constructs					
	Openness to Experience	Conscientiousness	Informed Culture	Radicalness	Mindfulness
Openness to Experience	**--**				
Conscientiousness	0.504	**--**			
Informed Culture	0.448	0.450	**--**		
Radicalness	0.264	0.311	0.284	**0.931**	
Mindfulness	0.460	0.435	0.476	0.379	**0.787**

Note: Diagonal elements (in bold) are the square roots of the average variance extracted (AVE)

Another method of assessing discriminant validity is through factor loadings and cross loadings. Table 4.4 shows the factor loadings and cross loadings of the reflective measurement items. Scanning down the columns indicate that the item loadings in their corresponding columns are all higher than the loadings of items used to measure the other constructs. Scanning across rows indicate that item loadings are higher for their corresponding constructs than for other constructs.

Table 4.4 Factor Loadings and Cross-loadings

	Conscientiousness	**Informed Culture**	**Mindfulness**	**Openness to Experience**	**Radicalness**
Radical1	0.2789	0.1684	0.3061	0.2374	**0.8997**
Radical2	0.2944	0.2998	0.3449	0.2411	**0.9499**
Radical3	0.2947	0.3097	0.3968	0.2578	**0.9434**
Mindful1	0.2980	0.3470	**0.7896**	0.3259	0.3089
Mindful2	0.1718	0.2680	**0.7783**	0.2198	0.2565
Mindful3	0.4625	0.4413	**0.7988**	0.3916	0.2780
Mindful4	0.3629	0.3963	**0.7804**	0.4493	0.3351

Thus, all items measuring the reflective constructs satisfy the criteria for discriminant validity as suggested by Chin (1998b). The factor analysis also indicated that these items could be averaged to create summated scales for each construct. Table 4.5 provides the descriptive statistics for the summated variables.

Table 4.5 Descriptive Statistics for Summated Variables

Construct	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Skewness**	**Kurtosis**
Openness to Experience	2.80	6.60	4.75	0.780	-0.041	-0.205
Conscientiousness	2.80	7.00	5.39	0.787	-0.435	0.287
Informed Culture	3.00	7.00	5.04	0.919	-0.188	-0.516
Radicalness	1.67	7.00	5.11	1.099	-0.745	0.864
Mindfulness	3.00	7.00	5.27	0.831	-0.261	-0.397

4.6.2 Structural Model

In order to assess the research model using multiple regression analysis, the data was analyzed to ascertain that the normality and linearity conditions were satisfied. Normality was visually assessed through the histograms of frequencies of the variables, and also by examining the skewness and kurtosis statistic. All skewness and/or kurtosis values were found to be within the acceptable range of -2 to 2 (Table 5). Scatterplots between the predicted variable and each predictor indicated that the linearity assumptions were not violated in the dataset. Two separate regression models were tested in order to assess the main effects as well as the moderated effects. Table 4.6 reports the results of the regression analysis. The multicollinearity diagnostics (variance inflation factor, condition indices and eigenvalues) were assessed for both models and it was found that the models did not suffer from multicollinearity. In order to ascertain that the assumption regarding homoscedasticity is satisfied, for each regression model the residuals were plotted against the predicted value, and the plots indicated that the variances in the data were homogeneous.

Model 1 tested only the main effects of the two personality factors and informed culture on decision-maker mindfulness in RFID adoption. Overall the regression model was significant and had a high predictability, explaining over 40% of the variation in decision-maker mindfulness. Conscientiousness and informed culture are significantly associated with decision-maker mindfulness ($p<.01$), while openness to experience is somewhat associated ($p<.05$). Therefore hypotheses 1, 2 and 3 were supported in Model 1.

Table 4.6 Regression Results: Dependent Variable (Mindfulness)			
Variables	**Standardized Coefficients (B)**	**T**	**Sig.**
Model 1 **(R^2 = 0.419; Adjusted R^2 = 0.406; F = 31.246; Sig = 0 .000)**			
Openness to Experience	**.174**	**2.340**	**.021**
Conscientiousness	**.236**	**3.069**	**.003**
Informed Culture	**.410**	**5.411**	**.000**
Model 2 **(R^2 = 0.424; Adjusted R^2 = 0.410; F = 31.871; Sig = 0 .000)**			
Informed Culture	**.404**	**5.338**	**.000**
Radical x Conscientious	**.246**	**3.254**	**.001**
Openness	**.181**	**2.470**	**.015**
Conscientiousness	.134	1.403	.163
Radicalness	-.126	-.867	.388
Radical x Informed Culture	-.316	-1.586	.115

In order to test the moderating effect of radicalness, the two interaction terms were calculated by multiplying radicalness with informed culture, and radicalness with conscientiousness. Model 2 tested the effect of the individual predictor variables as well as the moderator terms on decision-maker mindfulness. Individual terms and moderator terms were introduced into the regression model and stepwise regression analysis was used. Stepwise regression in particularly useful when testing interaction effects, as both individual terms and interaction terms can be simultaneously introduced into the regression analysis and their relative importance in explaining the variation in the predicted variable can be assessed.

Using stepwise regression it was found that while model 2 explained nearly the same amount of variation in decision-maker mindfulness, radicalness had a significant moderating effect on the relationship between conscientiouness and decision-maker

mindfulness. However, the hypothesized moderating effect of radicalness on informed culture was not significant in the model, and informed culture only had a significant main effect. Therefore, in model 2, hypotheses 1, 3 and 4a were supported, while 4b was not supported by the dataset.

4.7 Discussion

The notion of mindfulness has been receiving heightened interest in the context of different aspects of organizational functioning and decision-making such as media selection and use for organizational communications (Timmerman 2002), organizational learning and attention (Levinthal and Rerup 2006, Weick and Sutcliffe 2006), entrepreneurship behavior (Rerup 2005) and organizational innovation diffusion (Fichman 2004; Fiol and O'Connor 2003; Swanson and Ramiller 2004). While mindfulness is generally considered to be a favorable property or characteristic to possess both at the individual level as well as the organization level, there is little research to identify the factors that determine or contribute towards mindfulness. Recognizing the role of individual decision-makers in overall organizational mindfulness (Swanson and Ramiller 2004), this study identifies the factors that determine decision-maker mindfulness in the context of innovation adoption in organizations, and more specifically the adoption of RFID technology.

Drawing from research in psychology, two human personality traits – openness to experience and conscientiousness were identified as individual characteristics that determine managerial mindfulness in RFID adoption decision making. Both factors were found to be significant predictors of mindfulness in organizational decision-makers. Because this study is interested in determining mindfulness in the context of

organizational decision-making, informed culture in the organization was predicted to be important in shaping individual decision-maker's mindfulness. The results indicate that an informed culture indeed has a significant positive association with decision-maker mindfulness in RFID adoption. These findings emphasize that when assessing decision-maker mindfulness in the context of organizational decision-makers, both individual and organizational characteristics are important determining factors.

Given that the decision-making context is that of adopting an IT innovation in the organization, a typical innovation characteristic – radicalness was hypothesized to have a moderating effect on the role of the personality factor – conscientiousness and the organizational factor as determinants of decision-maker mindfulness. It was found that while technology radicalness moderated the relationship between conscientiousness and mindfulness, it had no effect on the relationship between informed culture and mindfulness.

The significant interaction term between radicalness and conscientiousness indicates that when faced with a highly radical innovation, the personality trait of conscientiousness will have a stronger effect on mindfulness in innovation adoption decision-making. Because of their thorough, deliberate and persistent nature, conscientious individuals will be less prone to simplify a complex situation. Since a highly radical innovation is likely to present a complex decision-making scenario marked with uncertainty and lack of understanding regarding the technology and the contextual factors associated with its adoption, conscientiousness will make organizational decision-makers willing to thoroughly analyze and deliberate on the

situation before deciding. Thus, innovation radicalness will cause conscientiousness to have a stronger effect on decision-maker mindfulness in RFID adoption.

Contrary to our expectation, radicalness does not moderate the relationship between informed culture and decision-maker mindfulness. A possible explanation is that in an organization that encourages an informed culture, decision-makers are able to learn from unfavorable outcomes, report unfavorable outcomes or failures from risky endeavors. Given such a circumstance, it is likely that radicalness of the innovation will not be an important consideration in their adoption decision-making. Consequently, perceived radicalness (and therefore, the riskiness of the innovation adoption) does not have an effect on the role of informed culture in determining decision-maker mindfulness. Therefore, radicalness does not moderate the relationship between informed culture and decision-maker mindfulness.

Previous research has contended that an innovation is radical to the extent that it is perceived as such by the management within a firm (Green et al. 1995), and therefore it is appropriate to measure radicalness of an innovation at the firm level or also by asking a single manager within the firm (e.g., Green et al. 1995, Nord and Tucker 1987). However, innovation radicalness has also been measured in absolute terms by asking a panel of experts (e.g., Ettlie et al. 1984). While both approaches of measuring innovation radicalness have their own merits, we believe radicalness measured in absolute terms is likely to have a significant moderating effect on the role of informed culture as well as conscientiousness in determining decision-maker mindfulness. Therefore, future studies can be designed to measure radicalness in absolute terms as perceived by the society or industry (Anderson and Tushman 1990,

Tushman and Anderson 1986) and then investigate its role in determining decision-maker mindfulness in innovation adoption. However, such studies will have to simultaneously consider more than one technological innovation having varying degrees of radicalness in order to be able to truly gauge the role of radicalness in determining mindfulness in innovation adoption decision-making.

4.8 Implications

By identifying the determinants of individual mindfulness in the context of IT adoption decision making, this research furthers existing research on mindfulness in organization innovation adoption. Drawing from psychology and organization research we identified individual and organizational factors that are likely to affect decision makers' mindfulness. Research in human psychology has suggested that the property of mindfulness shows both trait-like and state-like characteristics (Brown and Ryan 2003). Based on the 'trait-like' view of mindfulness, we identify the two human personality factors that are the most likely to be related to mindfulness. A 'state-like' view suggests that other than individual characteristics, there could be factors external to the individual that result in differences in mindfulness. Based on this view, it is proposed that organizational culture plays a significant role in determining individual decision-maker's mindfulness. More specifically, an informed culture (Reason 1997; Weick and Sutcliffe 2001) is believed to be conducive towards mindfulness.

The proposed model has implications for both researchers and practitioners. While this study empirically validated the role of openness to experience, conscientiousness and informed culture in determining decision-maker mindfulness, and the moderating

effect of innovation radicalness on the relationship between conscientiousness and mindfulness, there was no empirical support for the moderating effect of radicalness on the relationship between informed culture and decision-maker mindfulness in IT innovation adoption. Future empirical studies can be designed to capture radicalness at a different level in order to ascertain its role in determining mindfulness.

Researchers can also aim to identify other technology or innovation characteristics that are likely to affect managerial mindfulness and refine the model based on their findings. The proposed model in this study is not only applicable in the context of organizational innovation adoption, but can also be applied to assess decision-maker mindfulness in other areas of strategic decision-making within the organization. For example, it has been suggested that mindfulness can help in recognizing and exploiting opportunities from entrepreneurial endeavors (Rerup 2005). Therefore, a theoretical model that identifies the antecedents or determinants of mindfulness in strategic decision-making can significantly contribute to the overall strategic management literature.

For practitioners, this study lays down initial guidelines regarding the characteristics that should be considered important in managers responsible for strategic decision-making within organizations. While this research discusses mindfulness primarily in the context of IT innovation related decision making, we believe that mindfulness will play an important role in different kinds of strategic decision making, and therefore the findings from this research are relevant in various strategic decision making scenarios. Previous studies have often considered conscientiousness as an indicator of workplace performance (Salgado 1997). This study adds to the extant

literature on the role of human personality in organizational behavior by showing that the personality trait of openness to experience is positively associated with decision-maker mindfulness. Therefore, in addition to conscientiouness, practitioners should also consider openness to experience when assessing individuals, especially those that will be in charge of performing non-routine tasks such as strategic decision-making. Further, it has been shown that individuals can be trained to be more mindful (Kabat-Zinn 1990). This has important implication for practitioners, as it essentially says that managers can be trained to be more mindful. Thus, researchers along with practitioners can direct research efforts in tailoring executive training programs with the aim of training managers in strategic mindfulness.

4.9 Limitations

In this study all the constructs were measured using a single respondent. This introduces the threat of common method bias. Although special care was taken during the operationalization and design of the questionnaire to minimize common method bias, we realize that some of the variance could be attributed to common method bias. While it has been found that in IS research structural relationships remain significant even when adjusted for common method variance, future studies could aim towards measuring some of the constructs from different sources. For instance, informed culture and radicalness can be measured from different sources.

Another limitation of this study is that out of the five big personality factors, this study focuses on only openness to experience and conscientiousness. While theoretically these two personality factors are likely to be the most closely associated with decision-maker mindfulness, future research can also be directed assessing the

implications of the other three factors of the big five personality model on decision-maker mindfulness.

4.9 Conclusion

This study makes a significant contribution by elaborating on the determinants of mindfulness in IT innovation decision making. There is a growing appreciation of the need for using cognitive theories to understand strategic behaviors, including various IS/ IT related behaviors. With this intention in mind, this study uses a cognitive lens to get a better understanding of the role of human cognition, more specifically decision-maker mindfulness in information technology innovation adoption decision making. Drawing from research in psychology, organization research, and innovation research, determinants of decision-maker mindfulness in the context of RFID adoption and identified and their roles are empirically validated using survey research methodology.

Chapter 5

Conclusion

This chapter summarizes the findings from the three studies detailed in chapters 2, 3 and 4 and the overall contributions from this thesis. Potential limitations of this research are also discussed. Lastly, we provide suggestions for future research.

5.1 A Summary of Findings

Using real options analysis as the theoretical lens, this thesis investigates the strategic decision-making process through which organizations decide on adopting IT innovations. More specifically, the decision to adopt RFID technology in organizations is assessed through empirical research.

Chapters 2 and 3 show that the recognition of different real options (growth and deferral) is significantly associated with organizational decision-makers intention to adopt RFID. Previous research has suggested that even when it is difficult to quantify the option value of the different real options that can be realized from an investment, organizational decision-makers intuitively recognize the value of the options created by an investment project. This thesis gives further empirical validation to such propositions by showing that organizational decision-makers are indeed amenable to real options reasoning when considering the adoption of RFID technology as an IT innovation in their organizations.

This thesis also highlights the role of individual decision-maker characteristics, the influences of the external institutional environment in which the organization operates

and, the strategic orientation of the organization in informing the real options reasoning that decision-makers rely on to decide on an IT innovation in their organization. While previous research has often found a direct relationship between some of these factors and the adoption of IT innovations in organizations, this research emphasizes on the mediating role of the recognition of different real options in the relationship between these factors and decision-makers behavioral intent to adopt RFID technology.

Recognizing the role of human cognition in organizational decision-making, it has been suggested that IT innovation research should make more use of cognitive theories and cognitive constructs to provide a better understanding of the process of innovation adoption in organizations (Fichman 2004a). In this direction, this thesis examines the role of decision-maker mindfulness in the context of RFID adoption. It is found that decision-maker mindfulness helps in recognizing some of the real options from the adoption of RFID. Further, in chapter 4 we draw from previous research in psychology and human cognition to identify both individual and organization-level factors that determine decision-maker mindfulness in RFID adoption decision-making. Based on the findings from the three empirical studies, the contributions of this thesis are outlined in the following section.

5.2 Contributions

This thesis frames IS innovation adoption as a strategic decision-making problem for organizational decision-makers and uses real options analysis to show that decision-makers are more likely to consider adopting an IT innovation when they recognize the option value that can be realized from the technology. Therefore, this thesis shows

that, similar to investment decisions in areas such as real estate, research and development, capital projects and mining, real options reasoning is also applicable to investment in organizational information systems.

IS / IT innovation adoption research have primarily investigated the role of different technological, organizational and environmental factors in the diffusion and adoption of information technology innovations. However, there is little research that investigates the role of managers in the organizational decision-making process that leads to the adoption decision. By framing IT / IS adoption as a strategic decision-making process, this thesis shows that managers' understanding of the strategic opportunities that the technology affords plays an important role in determining their intention to adopt the technology. Further, this thesis adds on to the existing body of research in IS innovation adoption by showing that in addition to the direct effect of the various technological, organizational and environmental factors on the adoption of innovations, these factors also help in shaping the cognition of organizational decision-makers and therefore influence the option or opportunities they recognize from the technology.

Previous applications of real options analysis have often relied on mathematical modeling techniques such as the Black-Scholes model or the Cox-Rubenstein models to determine the value of real options. However, the many assumptions that are required for estimating the model parameters limit the usefulness of such models (McGrath and Macmillan 2000). Based on the understanding that managers intuitively recognize the different real options that are embedded in an investment project even if they may not be able to model and quantify them (Brach 2003,

McGrath and Macmillan 2000), this thesis provides an alternative mechanism for assessing the real options that are embedded in an IT adoption investment project, and the relationship between the value of these real options and the intention to adopt the innovation.

This thesis operationalizes and develops measurement scales for the different theoretical constructs used in the studies. Several measurement items for the four different types of real options, and for the construct of decision-maker mindfulness are developed and validated along the guidelines of Moore and Benbasat (1991). While Tiwana et al. (2006) used single-item measures to assess some of the real options, by using multiple items that tap into to the full domain of the theoretical construct, this thesis provides comprehensive measures for the different real options. Also, to the best of our knowledge, this thesis is the first to provide conceptually and empirically validated scales for assessing organizational decision-maker mindfulness.

The three studies have important implications for both theory and practice. While institutional theory has received significant interest in IS innovation research (e.g., Chwelos et al. 2003, Teo et al. 2003), this thesis enhances our understanding regarding the effects of institution by showing that in the presence of strong institutional pressures, organizational decision-makers may view compliance with the requirements of the institution as an effective mechanism for reaping significant strategic opportunities. It also extends strategic management literature by showing that organizational strategy is likely to play an important role in determining the adoption of different innovations by shaping decision-makers perceptions regarding the different real options that their organization can realize from the adoption of the

innovation. This thesis also establishes decision-maker mindfulness as an important factor influencing the recognition of real options from the adoption of IT innovations and provides a better understanding of what constitutes and contributes towards decision-maker mindfulness.

The findings of this thesis have important implications for adopting organizations, regulatory and statutory bodies, policy-makers and the suppliers and vendors of technological innovations. For organizational decision-makers, adopting a real options perspective will help in recognizing the future opportunities that an innovation provides and therefore justifying investments in IT innovations when the initial returns look unattractive. At the same time, it will help in countering the pro-innovation bias that is often present in the context or technological innovations by recognizing value in the option to defer adoption decision.

By showing that organizational decision-makers view compliance with the mandates of the institution as a strategic opportunity generating move, this research has implications for policy-makers. Regulatory and statutory bodies can design institutional influences that are favorable towards the focal innovation, and try to remove institutional deterrents in order to promote adoption.

Organizational strategy plays an important role in determining the options that the organization is likely to realize from the innovation. This can provide insights to vendors and suppliers of the innovation in creating more targeted marketing campaigns for organizations based on their strategy type. For instance, suppliers and solution providers for RFID technology are likely to be more successful in selling the

technology to firms that meet the profile of a Prospector in the early stages of adoption than attempting to sell it to a Defender.

By identifying the determinants of decision-maker mindfulness in IT innovation adoption decision and more generally in strategic decision-making, this thesis informs organizations regarding the individual and organizational characteristics that can result in contextualized and nuanced decisions based on the organizations own facts and specifics. Accordingly, organizations can work towards promoting these characteristics within their organizations.

5.3 Potential Limitations

The limitations of the three studies are discussed on the basis of the four potential threats to validity listed by Cook and Campbell (1979). The use of cross-sectional data gives rise to the *threat to internal validity* because it does not establish the causality between the independent variables as empirically measured and dependent variable as empirically measured. It confirms the association among variables rather than the direction of effects. While this is not a severe concern in this thesis as there is little temporal difference between beliefs and intentions, future research can test the theoretical models in this thesis by using a longitudinal design to assess the relationship between the recognition of real options and actual adoption behavior, and, by collecting complementary qualitative data (such as through interviews with decision-makers) to investigate the direction of causality.

Threats to construct validity mean that there is a possibility of rival explanations to the phenomenon under investigation. For all three studies theoretical foundations

were extensively reviewed to provide definitions and generate measures for the constructs of interest, and measures were rigorously developed and validated based on the suggestions of Churchill (1979) and Moore and Benbasat (1991) in order to minimize the threat to construct validity. Nonetheless, certain constructs such as institutional influences, institutional regulations, and business strategy could have benefited from more objective assessment. Further, for all three studies, the proposed research models explain around 40% to 45% of the variance in the dependent variables, suggesting that there are other important variables with significant explanatory power that could have been taken into consideration.

Measures were taken to ensure that we would have sufficient sample size even before the data was collected in order to minimize the *threat to statistical conclusion validity* which casts doubts on whether it is reasonable to accept the predicted relationships at a specified alpha level. A sample size of 110, 108 and 134 in Chapters 2, 3 and 4 respectively can be considered adequate based on the number of constructs in the model (at most 8 constructs in Chapter 2), and the number of measures in our largest construct is 4. One possible consequence of inadequate power is Type II error – a failure to identify a relationship that exists. Since most of our constructs were significant, we conclude that sample size was not a limiting factor in testing the hypothesized relationships. In addition, we used PLS which is suitable for analyzing small and medium sized samples for testing the research models in Chapters 2 and 3 which had a smaller size to circumvent the threat to statistical conclusion validity.

The use of survey research methodology helped in minimizing *threats to external validity*, which is concerned with whether causal relationships can be generalized to

and across populations of persons, settings, treatments, and times. Further, measures were taken to ensure that respondents were experienced and authoritative decision-makers within their organizations and in charge of RFID adoption decision-making, thus helping in establishing the validity of their responses. However, it is important to note that this study was conducted in organizations operating in Singapore. Although most of the organizations in our sample are typical companies in their industries, due caution must be exercised when generalizing the results of these studies to organizations operating in differing institutional and cultural contexts.

5.4 Future Research Directions

Future research can be directed towards replicating the theoretical models in other settings. For example, the models in Chapters 2 and 3 can be applied not only for studying other innovations, but also to other areas of strategic decision-making and investment scenarios. Similarly, the theoretical model in Chapter 4 could be empirically assessed in the context of other organizational decision-making and not just innovation adoption. In addition, the studies could be replicated in different country and cultural settings.

As discussed in the previous section, the use of cross-sectional data to test causal relationships may pose a limitation, especially when all data comes from a single source, i.e., a single respondent is used to measure all constructs. Therefore, future research can measure the constructs using different sources to validate the theoretical model and use longitudinal design to assess the link between intention to adopt and the actual adoption of the technology. Such studies will enhance our understanding of the direction of causality.

Longitudinal studies can also be used to analyze how decision makers' recognition of the various real options changes across different phases of adoption and implementation of an innovation. For example, while some options such as growth and deferral, are considered more important by decision-makers in the pre-adoption phase when they are still deciding on the innovation, other options such as the option to change scale, the option to abandon, the option to switch use are likely to be considered significant in the post-adoption implementation phase of the technology.

Future research can also be designed so as to supplement the quantitative data with more qualitative data, such as interviews with organizational decision-makers and in-depth case studies. This would not only enrich the finding and implications of this thesis, but also give us a better understanding of the managerial decision-making process and help in identifying other important variables that should be included in the research models to improve their explanatory powers.

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