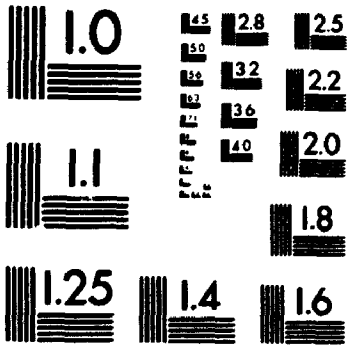

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THE EFFECTS OF GROUP PRESENTATIONS ON INTENTIONS TO ADOPT SMART CARD TECHNOLOGY: A DIFFUSION OF INNOVATIONS APPROACH

by

FILIPPO A. GAGLIARDI, B. COMM. (HONOURS)

A thesis submitted to
the Faculty of Graduate Studies and Research
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the requirements for the degree of

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THE EFFECTS OF GROUP PRESENTATIONS ON INTENTIONS TO ADOPT SMART CARD TECHNOLOGY: A DIFFUSION OF INNOVATIONS APPROACH

submitted by Filippo A. Gagliardi, B. Comm. (Honours) in partial fulfillment of the requirements for the degree of Master in Management Studies.

Deborah Compeau

Thesis Supervisor

Director, School of Business

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December 14, 1994

ABSTRACT

This study examines the effectiveness of using group presentations in affecting people's intentions to adopt smart card technology. The hypotheses are drawn from Everett M. Rogers' *Diffusion of Innovations* work which examines how innovations are introduced and diffused throughout society. It is shown that: 1) participants exhibit moderately positive attitudes towards the introduction of smart card technology; 2) group presentations have a significant but small effect on people's perceptions of Relative Advantage/Compatibility, Ease of Use, Trialability and Image; 3) perceived characteristics of innovations have significant effects and are good predictors of intentions to adopt smart card technology; 4) people have difficulty forming perceptions of less tangible perceived characteristics of innovation without exposure to the innovation; 5) regarding predicting intentions to adopt, similarities exist between Davis' Technology Assessment Model (1986) and the role played by the perceived characteristics of innovations for Ease of Use and Relative Advantage/Compatibility; and, 6) certain innovativeness predictor variables can also be used to predict general intentions to adopt an innovation.

ACKNOWLEDGMENTS

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CHAPTER 1

INTRODUCTION

The introduction of a new technology into the workplace is both a source of anxiety and excitement (Danziger and Kraemer, 1986). On one hand, new technology can breed disruptive feelings and contempt from skeptical users who view it as being full of promises but rarely achieving realization of those promises. The other view of technology is that it can be a facilitator that will help an overburdened work unit to cope with its workload through gains in user efficiency and effectiveness.

In both the private and public sector, much attention has been focused on the introduction of various types of information technology into the work environment. For the most part, this technology has served to allow institutions in the private and public sector to remain competitive through gains in productivity, cost savings accruing from automation and through increased knowledge provided to managers resulting from the use of computer analytical programs. When the introduction of information technology has been poorly handled, however, the resulting outcomes have been unachieved goals, lack of integration, and confusion between users, management and information systems specialists (Ward, Griffiths and Whitmore, 1990)

Notwithstanding the occasional failure, private and public sector firms continue to explore ways to exploit information technology to its fullest degree. One of the trends

that has emerged in this period of exploitation is a migration to the use of portable information technology. Having achieved great changes in the static environment of the office, private and public sector firms have been looking at ways to use information technology throughout the organization (Conroy, 1994).

One of the most portable information technologies to gain attention recently has been smart cards. A smart card is a plastic card which resembles a credit card and contains an embedded computer chip capable of storing, retrieving and processing information on the chip (Svigals, 1985). Smart card technology represents the ultimate form of a portable information technology. It has attracted the attention of both private and public sector organizations interested in capitalizing on the cost saving benefits that may accrue from the adoption of smart card technology.

The Canadian Federal Government has been particularly interested in harnessing the smart card's cost savings potential as the delivery of programs has been hurt in recent years by wide-scale cuts to departmental budgets. This reality is echoed in an excerpt from the Treasury Board of Canada Secretariat *Shaping the Future Public Service, Public Service Work Force 2000 Phase 2 Report* (1991):

> "This is an age of budget constraints. A high level of public debt has shrunk the share of discretionary spending in the federal budget and challenged Public Service employees to find more efficient ways of tackling existing program requirements as well as new programs."

One department, Canadian Heritage, has been testing the capabilities of smart cards since 1988. The Department of Canadian Heritage (hereafter referred to as "the Department") is a medium sized department with a complement of 6,762 employees and an annual budget of over $1.2 billion. The Department's mandate (source: Canadian Federal Government Handbook (1993)) is:

> "To support and encourage a strong sense of Canadian identity and heritage based on the fundamental characteristics of Canada - bilingualism and multiculturalism - and Canada's diverse cultures and heritage."

Canadian Heritage's interest in smart card technology was fueled by a number of factors including the desire to explore promising areas of emerging information technology, enhance the security of information stored on various information storage devices, and replace the growing number of disparate cards in use throughout Canadian Heritage with a single, multi-purpose identification/smart card.

In 1992, based on information gained from previous successful smart card trial projects, the Department established a smart card team to accelerate research into the use of smart cards. To date, progress in the development of applications has been substantial, with the planned release of three applications designed to exploit the smart card's ability to act as; 1) a secure key gateway to multiple applications, 2) an unforgeable token for use in electronic verification and approval applications, and 3) a secure storage facility for employee information. Given the availability of these applications, the smart card team was interested in assessing employees' attitudes towards use of smart cards to determine if the technology would be widely, easily and quickly adopted within the Department. As such they were interested in finding out:

1. how receptive employees are towards adoption of smart card technology; and,

2. the effectiveness of using smart card presentations to affect employees' perceptions of smart card technology.

The mechanism through which they have proposed to introduce the technology to the Department is the administration of wide-scale smart card group presentations (hereafter referred to as presentations). In the past, these presentations have been used

sporadically to provide general smart card information to special interest groups and although the general feedback from attendees has been positive, the effectiveness of these presentations has never been measured.

Diffusion of innovations theory (Rogers 1962) provides a useful framework to allow the formal measurement of attitude towards use and adoption of a new technology. The diffusion of innovations area of research examines how new ideas and practices spread by attempting to explain how innovations are introduced into and diffused throughout society and by looking at what factors determine how widely, rapidly, and easily innovations are adopted. This area of research is dominated by the work of Everett M. Rogers, whose book, *Diffusion of Innovations* (1983) is now in its third edition. Rogers (1962) was the first to compile the results of diffusion studies into a complete diffusion of innovations framework.

Contributions of this Research

To date, most studies dealing with diffusion of innovations have looked at adoption and intentions to adopt from an historical perspective, that is, studies have been conducted after the adoption of an innovation has been well established. The main thrust has usually been to look at how intentions to adopt an innovation (measure after adoption occurred), correlated with the actual adoption patterns and what measures could be used

to define this relationship. This research study addresses the early stages of the diffusion of innovations model by studying the effects of smart card presentations as a form of interpersonal communications on employees' development of intentions to adopt or reject an innovation. By concentrating on this sparsely-researched facet of diffusion of innovations, this study will provide insight into: how well this model can be applied in a pre-adoption setting, the link between diffusion of innovation theory and intentions to adopt an innovation, and the effectiveness of using group presentations to help people form favourable or unfavourable perceptions of an innovation.

Organization of The Thesis

Chapter 2 presents a review of the pertinent literature in this field of study. This chapter is followed by the presentations of the research model and hypotheses in Chapter 3. Chapter 4 describes the research methodology that was used, including a description of the research design, the procedures used, a discussion of population and sample size, a description of the measuring instrument used and some insight into the data analysis that was conducted. Chapter 5 presents the results of the data collection, preparation and analysis. Finally, Chapter 6 presents the implications of the results, the most pertinent limitations of this study, the summary of conclusions, and some suggestions for follow-up studies.

CHAPTER 2

LITERATURE REVIEW

This chapter, which is divided into three sections, discusses the bodies of knowledge which are relevant to this study. The first section of this chapter is concerned with providing an introduction to smart card technology, while the second area discusses various behaviour research models. The final section of this chapter is devoted to presenting the general literature surrounding diffusion of innovations theory.

Smart Cards

A smart card is a plastic card which resembles a credit card and contains an embedded computer chip capable of storing, retrieving, and processing information stored on the chip. The arrival of this technology to the electronic data processing (EDP) sector has provided users of EDP technology with a very portable and highly secure information medium. The technology, which was first introduced in France in March 1974, did not become commercially available in North America until the latter part of the 1980's. Today, smart card technology is firmly established in the marketplace. Duthie (1993) reports that there are an estimated 225 - 255 million cards in use world-wide, which is reasonably consistent with the estimate provided by Seidman (1994), editor and publisher of Smart Card Monthly, a leading periodical reporting on world-wide developments in smart card technology . Seidman reports that 295 million smart cards were used world-wide in 1993.

The first widespread use of smart cards was to replace coin-operated payphones in the French telephone system in 1984 (Bright, 1988). Their implementation was timely because the French national telephone system was antiquated, overloaded and greatly in need of an overhaul. The conversion to smart cards was greeted happily by payphone customers and the French Telephone system management, and resulted very quickly in widespread use throughout France. Gemplus Corporation (1993) reports that there were approximately 100,000 French smart card payphones in use by 1992 and that 85 million payphone smart cards were used in that same year. Aside from the convenience of using a card loaded with a prepaid amount of telephone credits, the elimination of coins provided the added benefit of removing the incentive for petty thieves to vandalize the telephones in efforts to get at the coins. Gemplus corporation (1993) reports that 44,000 French payphones were broken into in 1985. With the switch to smart card payphones the number of payphone break-ins dropped to only 900 by 1992.

The first generation smart cards were much less sophisticated than today's designs. Bright (1988) states that typically, the first generation smart cards were capable of storing only 512 characters of data (equivalent to a quarter page of text) on an electronically programmable read-only-memory chip (EPROM). The recent introduction of electronically erasable programmable read-only-memory chips (EEPROM) and storage capacities up to 8192 characters (about four pages of text) means that smart cards can

now be used and re-used as required. In addition, the increased storage capacity allows the storage of data fields for numerous applications, thus endowing the smart card with the ability to handle the data requirements for multiple diverse applications (Bright, 1988).

One of the smart card's truly revolutionary features is its security protection capability. Like the magnetic stripe card that is used in Automated Teller Machines (ATM's) the smart card uses the concept of a Personal Identification Number (PIN) for access control. It is at this point, however, that the similarity ends. According to Svigals (1985), in the magnetic stripe card ATM setup, the PIN is stored on the ATM system's database, not on the card. The smart card PIN, on the other hand, is actually stored in encrypted form within the memory storage area of the card. When a PIN is submitted to an ATM, the verification sequence is made on the central database. The magnetic stripe card is only used to identify the cardholder's name and account numbers. When a PIN is submitted to a smart card based system, the PIN verification sequence is activated within the smart card chip and processed by the smart card chip's microprocessor. This capability translates into true plastic card security because the smart card microprocessor is able to count the number of wrong PIN access attempts and shut itself down when that threshold has been reached, regardless of the device that is used. By contrast, magnetic stripe application access control can only be controlled at the device level. The number of

wrong attempts is registered by the device, not the card. An example of the impact of this difference follows:

Assume a smart card based system and the equivalent magnetic stripe based system are set to allow a maximum of three consecutive failed PIN access attempts except that the smart card system employs access control on the card whereas the magnetic stripe system employs access control via the access devices. Table 3.1 shows the effects of incorrect PIN entries to a smart card system and a typical magnetic stripe system. After two failed attempts, someone trying to secure fraudulent access to either system would retrieve the card and go to a new card reading device. As attempt 3 in table 2.1 shows, the smart card system would recognize the third failed attempt and lock up the smart card, whereas the magnetic stripe system would interpret this third attempt as a first attempt at a new terminal and would therefore allow our would-be thief to continue his/her attempts to gain fraudulent access to the system.

Another feature unique to smart cards is the availability of on-board data encryption. Most smart card chips come equipped with the Data Encryption Standard (DES) software, making it possible for a user to encrypt all data that is resident on the smart card.

ATTEMPT NUMBER	SMART CARD SYSTEM	MAGNETIC STRIPE SYSTEM
Attempt 1	Smart Card registers 1 failed entry	Mag stripe device registers 1 failed entry
Attempt 2	Smart Card registers 2 failed entries	Mag stripe device registers 2 failed entries
Attempt 3	Smart Card registers 3 failed entries and locks the card contents rendering it useless for the would-be thief. The fact that a new device was chosen is irrelevant from the smart card point of view.	Mag stripe device registers 1 failed entry (as can be seen, a would-be thief gets a new start because he/she went to a new device. Theoretically, this device-hopping could continue for a long time).

Table 2.1 Accessing Smart Card Systems vs. Magnetic Stripe Systems

Each year since their introduction, the number of smart cards in use around the world has grown. Svigals (1985) states that European countries currently account for the bulk of usage (about 150 million cards per year), whereas North American usage is minute in comparison (150,000 cards per year). Indications are, however, that the North American market is on the verge of significantly expanding its use of this technology (Miller, 1994). Credit card fraud has increased so much in recent years that banks are very close to making a decision to replace credit cards with smart cards. The Nilson Report (1992), a leading periodical reporting on worldwide developments in the advanced card technology field, reported that the value of losses from counterfeiting credit cards totaled about $225 million dollars worldwide in 1992. The smart card security aspects and authentication routines would be an effective first step in curbing this fraud (Svigals, 1985). When this conversion to smart card technology happens, it will result in a huge increase in smart card usage (according to the Nilson Report (1992) there are more credit cards in circulation in North America (1,423,000,000) than in the rest of the world combined (999,400,000)). The widespread implementation of smart card technology will have a profound impact on the way we conduct business and our lives in the future.

Models of Individual Behaviour

As discussed in the introduction, the management at Canadian Heritage is interested in determining employees' receptiveness to adopting smart card technology. One way to measure this receptiveness is by determining employee intentions to adopt

smart card technology. This section will discuss the pertinent aspects of behaviour theory as they apply to individuals and predicting intentions to adopt.

Despite the wealth of theories abounding in behaviour research, three models have enjoyed much popularity within the area of information technology, Fishbein and Ajzen's (1975) Theory of Reasoned action (TRA), Davis' (1986) Technology Acceptance Model (TAM), and Ajzen's (1991) Theory of Planned Behaviour (TPB).

The TRA model (see figure 2.1) states that behavioural intentions are formed as a function of Attitude and Subjective Norm, where Attitude is defined as a "person's general feeling of favourableness or unfavourableness towards some stimulus object" and Subjective Norm is defined as "the person's perception that most people who are important to him think he should or should not perform the behavior in question", (Fishbein and Ajzen, 1975).

In TAM (see figure 2.2), behavioural intentions are formed as a function of Attitude Toward Using some object and the Perceived Usefulness of the object. Attitude Toward Using expands on Fishbein and Ajzen's definition of Attitude and is defined as a person's general feeling of favourableness or unfavourableness towards the use of some

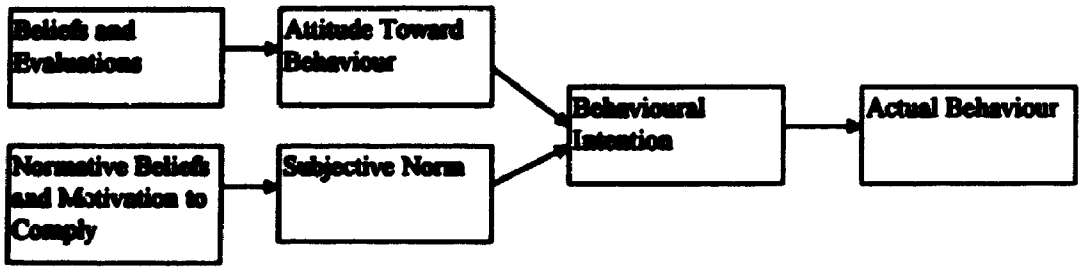

Figure 2.1 - Theory of Reasoned Action Model

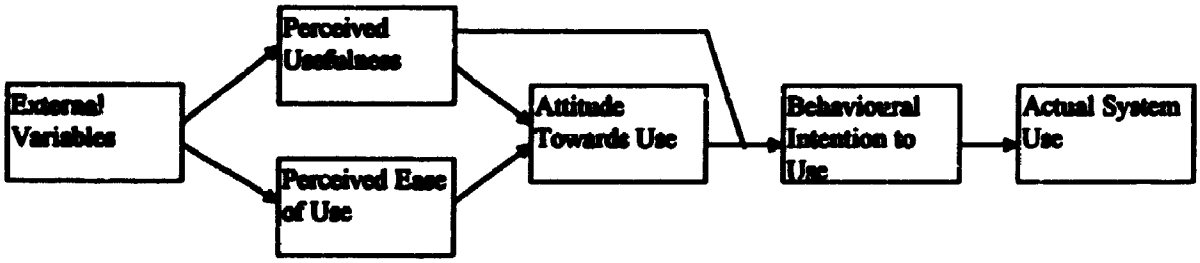

Figure 2.2 - Technology Acceptance Model

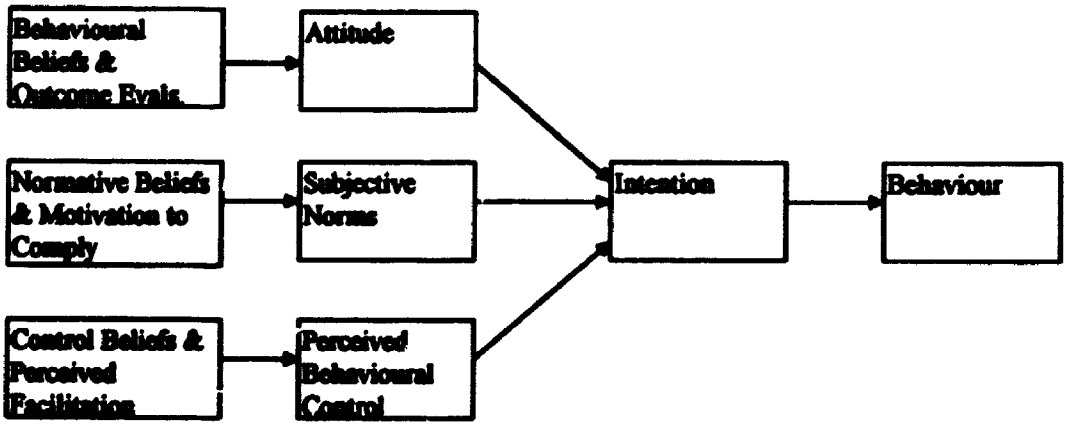

Figure 2.3 - Theory of Planned Behaviour Model

stimulus object. Perceived Usefulness is defined by Davis (1986) as "the degree to which a person believes that using a particular system would be free of effort". The Attitude Toward Using construct was derived from the Perceived Usefulness of an object and the Perceived Ease of Use of that object.

Ajzen's (1991) TPB states that behaviour is determined by behavioural intention and intention is predicted by the combination of three factors; 1) attitude toward the behaviour, 2) subjective norms, and 3) perceived behavioural control which is defined as " the individual's perceptions of the presence or absence of requisite resources and opportunities" (Mathieson, 1991). This model is shown in figure 2.3.

Davis, Bagozzi and Warshaw (1989) conducted a comparison of TRA and TAM's predictive ability on user acceptance of computer technology. Their results indicated that, while TRA predicted user intentions reasonably well, TAM's predictions were more accurate and applicable in the information technology field. Mathieson (1991) tested the predictive power of TAM against Ajzen's (1991) Theory of Planned Behaviour (TPB) and also found TAM to have a slight edge in predictive capability. In addition, both studies found that the Subjective Norm component of TRA did not contribute any explanatory power to the prediction of behavioural intentions. Even Fishbein and Ajzen (1975) acknowledge that Subjective Norm is a very elusive construct to deal with by stating that it is difficult to distinguish whether the effect of Subjective Norms on behavioural

intention is direct or indirect via their effect on Attitude. These findings form the basis for interpreting individual behaviour from attitude. Their implications for diffusion of innovations theory will be discussed in the next section.

Diffusion of Innovations

One of the most quoted and well known authors in the field of diffusion of innovations theory is Everett M. Rogers. Rogers (1962) was the first to develop a structured framework for looking at the diffusion of innovations. Over the years the framework has evolved slightly but still remains very similar to the original model. Much of the theory presented in this paper is based on Rogers' 1983 work.

Rogers (1983) defines the diffusion of innovations as "the process by which an innovation is communicated through certain channels over time among the members of a social system". This definition is consistent with Assael (1977) who states that diffusion is "the process by which the adoption of an innovation is spread by communication to members of a target market over a period of time". These definitions imply that diffusion of innovation research involves; 1) processes, 2) an innovation, 3) communication channels, 4) a dimension of time and 5) a target group, i.e. the social system.

One of the main goals of diffusion of innovations research is to observe the effects of different forms of communications on people's decision to adopt or reject an innovation. Rogers provides a framework for an Innovation-Decision Process that is used to address this area of analysis. The framework involves studying the actions of individuals as they gather information over time to reduce their uncertainty about using an innovation, leading them to make a decision to adopt or reject the use of the innovation. Each of the remaining components (the innovation, communication channels, time, and target group) are integral parts of the Innovation-Decision Process and therefore need to be explained before a discussion of the Innovation-Decision Process can take place.

Innovations

According to Rogers, an innovation is "a new idea, practice or object which is perceived as being new to a person or group of people". Gatignon and Robertson (1991) build upon the work of Rogers by including Robertson's (1971) concept of continuous or discontinuous innovation and Hirschman's (1981) proposal for two dimensions for innovations, symbolic and technological. The Gatignon and Robertson definition is:

> "An innovation is a new product or service that is perceived by consumers within a market segment to have effects upon established consumption patterns. A continuum of innovation exists from continuous (having minor effects on consumption patterns) to discontinuous (creating new consumption patterns)." (p.323)

In the first part of Gatignon and Robertson's definition, they establish the newness of the innovation and the effect that it will have in changing existing ways of doing work. In the second part of Gatignon and Robertson's definition, a concept of impact on usage patterns is implied. Smart card technology fits this definition for an innovation since it is new to North America and its implementation has significant implications on usage patterns (e.g. smart card payphone systems or smart card credit cards as used in Europe).

Communication Channels

Communication channels are the ways in which information is transmitted between people. In Rogers' Innovation-Decision Process, the purpose of the communication channel is to allow a sharing of knowledge between individuals who are informed about an innovation and those who are not. This transmission of information is necessary to allow an individual to assess the personal attractiveness of an innovation.

The most important forms of communication that are used in the Innovation-Decision Process are mass media channels of communications such as advertisements and interpersonal channels of communications such as peer to peer communications. Rogers maintains that mass media channels of communications are most important in promoting initial awareness of an innovation, while interpersonal channels of communications are most important in helping individuals form attitudes towards innovations.

Time

Time is an important component of diffusion and is central to determining at which phase of the Innovation-Decision Process an individual may be, determining the innovativeness of individuals, and in observing an innovation's rate of adoption. In the Innovation-Decision Process. individuals build knowledge about innovations through five stages, in a more or less linear fashion over time, leading to adoption/rejection and confirmation of the adoption/rejection decision. Rogers' concept of innovativeness also involves a time dimension as evidenced by its definition, "The degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system".

Social System

The final component of diffusion is the social system, which Rogers refers to as the unit(s) that are together for the purpose of accomplishing a common goal. In business, social systems can be delineated at the organization level and work group level. All employees within an organization or work group tend to work towards the common goal of the organization. Rogers maintains that innovations diffuse within the boundaries of the social system. Diffusion of Innovations within the social system is affected by; 1) structure of the social system, which acknowledges the effects of interpersonal (person-to-person) communications and peer pressure to conform on the diffusion of an innovation, 2) system norms which represent the established behaviour patterns of the social system, which in the context of an organization includes expectations of superiors and pressure to conform from peers, and 3) opinion leaders and change agents who act as catalysts in increasing the rate of adoption of an innovation. The role of the social system in the Innovation-Decision Process is critical. The social system represents a key source of communications and provides a framework from which an innovation can be introduced and understood.

The Innovation-Decision Process

As discussed earlier, an integral process of the diffusion of innovations is Rogers' Innovation-Decision Process. The process is described by a model of actions and decisions that individuals take as they gather information about an innovation that leads

them to adopt or reject an innovation. The basis for the model was first identified by Beal and Rogers (1962) and has been updated to its present form in each of Rogers' books. The Innovation-Decision Process is characterized by 5 distinct stages. These stages are:

1. **Knowledge** - when the individual first finds out about the innovation and begins to understand its use;

2. **Persuasion** - when the individual has been exposed to enough information that he/she forms an attitude (favourable or unfavourable) towards the innovation in question;

3. **Decision** - when the individual pursues activities that will influence his/her choice to adopt or reject the innovation;

4. **Implementation** - when the innovation is initially adopted by the individual; and,

5. **Confirmation** - when the individual seeks reinforcement for the implementation decision that was made.

The Innovation-Decision Process model is shown in figure 2.4.

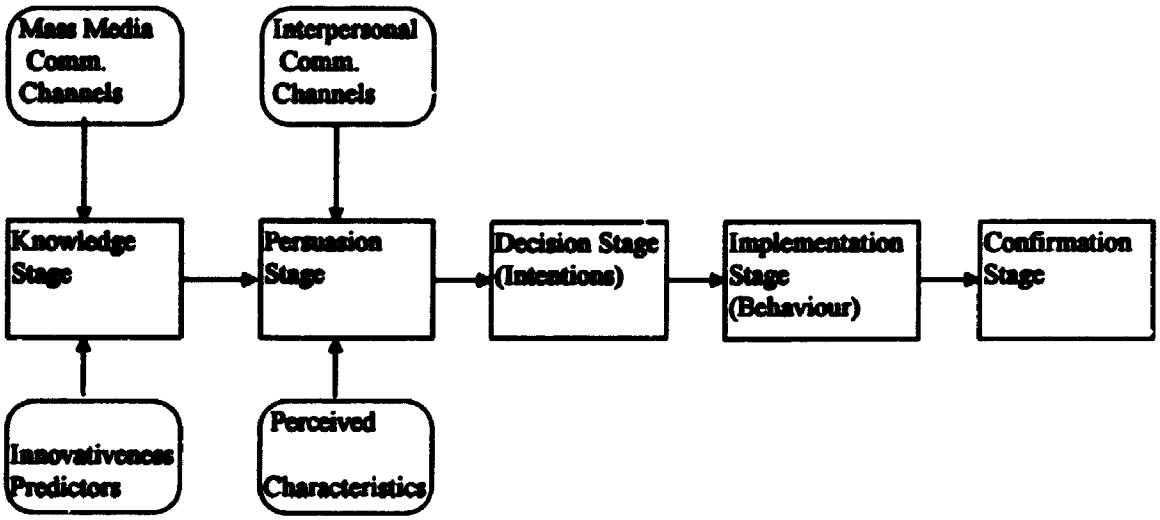

Figure 2.4 - Rogers' Innovation-Decision Process Model

Since this research explores the early stages of the Innovation-Decision Process, interest in this process lies mainly with the Knowledge and Persuasion stages.

According to Rogers, an individual who is motivated to learn more about the use of an innovation will generally do so because he/she feels that the innovation will have a significant impact (direct or indirect) on his/her way of life. It is through this acquisition of knowledge that the individual becomes acquainted with the innovation (Knowledge stage), gathers information to determine the expected impact on his/her way of life (Persuasion stage), obtains very specific information (often by means of short trials) that allows a decision to adopt or reject the innovation to be made (Decision stage), adopts the innovation and incorporates it into his/her environment (Implementation stage), and after extended use, re-evaluates his/her previous decision (Confirmation stage).

In the Knowledge and Persuasion stage, Rogers states that communications channels are the main source of information available to the individual to gain knowledge associated with an innovation. In the Knowledge stage, individuals know very little about a particular innovation and are motivated to gather more information about the innovation. The information gathered in this stage is of a general nature such as, what is the innovation, how does it work, what are some of the features that make it desirable, and what is it intended to replace. At this stage, the individual will generally not form strong attitudes towards use of the innovation because information describing the impacts on

his/her way of life are not provided. The typical communication channel referred to in this stage is a mass-media communication channel.

At the Persuasion stage, Rogers maintains that while the individual is still seeking to gather information about the innovation, the information gathering is more focused towards learning about an innovation's expected consequences to the individual. While Rogers acknowledges that such information can be obtained from a number of sources, he states that most often, the individual will get this information from interpersonal communication channels. This finding is supported by Brancheau and Wetherbe (1990) who found that potential adopters of innovations strongly favoured the use of interpersonal channels of communication. Group presentations can be thought of as a form of interpersonal communications because presenters can tailor presentations to the needs of attendees and because group presentations allow and encourage two-way communications between the presenter and his/her audience.

In gathering this information, the individual is most interested in evaluating the personal advantages and disadvantages of the various characteristics of an innovation so that he or she can form a favourable or unfavourable attitude towards adoption of the innovation. Rogers called these characteristics the perceived characteristics of innovations (PCI).

The Perceived Characteristics of Innovations

Rogers' perceived characteristics of innovations (PCI) are:

Relative Advantage: the degree to which an innovation is perceived as being better than its precursor;

Compatibility: the degree to which an innovation is perceived as being consistent with the existing values, needs and past experiences of potential adopters;

Complexity: the degree to which an innovation is perceived as being difficult to use:

Observability: the degree to which the results of an innovation are observable to others; and,

Trialability: the degree to which an innovation may be experimented with before adoption.

In working with Rogers' PCI's, Moore (1987) modified the interpretation of perceived characteristics of innovations to include the "use of" clause present in Davis'

(1986) Attitude Toward Using construct, effectively changing emphasis from perception towards an object (perception towards an innovation) to perception towards behaviour (perception towards use of an innovation). Fishbein and Ajzen (1975) in their definition of behavioural intention state that "when the probability dimension links the person to a behavior, the concept 'behavioral intention' should be used". Therefore, based on these arguments, Moore and Benbasat's characteristics of innovations act as predictors of behavioural intentions.

In a later study, Moore and Benbasat (1990) expanded Rogers' PCI list to include; 1) Image, which Rogers included as part of the Relative Advantage PCI, and a breakdown of Rogers' Observability PCI into 2) Result Demonstrability and 3) Visibility. In addition, Davis' (1986) Ease of Use characteristic replaced Rogers' Complexity characteristic, thus drawing attention to the positive aspect of use (an innovation's Ease of Use) versus focusing on the negative aspect of use (an innovation's complexity or difficulty of use), while Davis' Perceived Usefulness construct was incorporated in the Relative Advantage Construct. Moore and Benbasat's (1990) list of PCI's of innovation are:

> **Relative Advantage**: the degree to which using an innovation is perceived as being better than using its precursor;

Compatibility: the degree to which using an innovation is perceived as being consistent with the existing values, needs and past experiences of potential adopters;

Image: the degree to which using an innovation is perceived to enhance one's image or status in one's social system;

Result Demonstrability: the degree to which the results of using the innovation are observable and communicable to others;

Visibility: the degree to which the innovation is apparent to the sense of sight (e.g. something which is highly visible is conspicuous by its presence);

Ease of Use: the degree to which an innovation is perceived as being easy to use; and,

Trialability: the degree to which an innovation may be experimented with before adoption.

In addition to the above characteristics, Moore and Benbasat (1990) also studied the effects of a new construct they called Voluntariness of Use which they defined as "the degree to which use of the innovation is perceived as being voluntary" and rationalized its inclusion by arguing that the freedom with which an individual is allowed to decide whether or not to adopt an innovation affects his/her intentions towards that innovation. In an organizational context this freedom to decide is largely determined by the employee's perceptions that his/her superior expects or wants him/her to perform the behaviour in question. As such, this construct embodies a component of Fishbein and Ajzen's (1975) Subjective Norm component, namely "The subjective norm is the person's perception that most people who are important to him(her) think he(she) should or should not perform the behavior in question".

Interpersonal Communications and the Innovation-Decision Process

As was pointed out earlier, Rogers (1971, 1983) identifies interpersonal communications as the most effective form of communications during the Persuasion stage of the Innovation-Decision Process. In the Knowledge stage of the Innovation-Decision Process, individuals seek to reduce uncertainty about the general aspects of an innovation. In the Persuasion stage, individuals move beyond general uncertainty reduction to more specific uncertainty reduction concentrating on the consequences of adopting an innovation. Interpersonal communications are preferred at this stage because, unlike mass media channels of communications, interpersonal communications allow a two-way

exchange of ideas. It is this exchange of ideas that allows an individual to gain an appreciation of the consequences inherent to the adoption of the innovation.

Support for the use of interpersonal communications during the Persuasion stage is provided by Sill (1983) and Beal and Rogers (1960) who found that in order to maximize probability of adoption, communication channels had to be utilized in a sequential manner, going from mass media communications in the Knowledge stage to interpersonal communications in the Persuasion and Decision stages. The use of the wrong type of communications at a particular stage of the Innovation-Decision Process served to slow the rate of adoption of an innovation. Brancheau and Wetherbe (1990) also found that interpersonal communication was the most effective means of communications during the Persuasion Stage of the Innovation-Decision Process.

Characteristics of Individuals

While Rogers (1983) acknowledged that the PCI's could be used to predict the rate of adoption of an innovation, he also argued that certain characteristics of individuals also played a role in determining when an individual was apt to adopt an innovation. Rogers introduced the term innovativeness to address this timing/adoption issue and defined it as, "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system". In relation to innovativeness, Rogers found that adopter categories could be established to denote how

quickly an individual adopted an innovation. He classified these categories as: 1)innovators (idea producers); 2) early adopters (opinion leaders, adopt innovations early in lifecycle); 3) early majority (more conservative but open, turn to opinion leaders for evaluation); 4) late majority (cautious adopters of innovations, wait for innovation to become well established); and 5) laggards (resistant to change, adopt only as last measure and often after innovation is superseded by a new innovation already being used by innovators).

Rogers and Shoemaker (1971) performed a content analyses of over 3000 findings associated with relationships between independent variables and innovativeness. Their analysis resulted in the development of 31 empirically based generalizations regarding various variables and innovativeness. The generalizations were then categorized into one of three identifying areas: 1) socioeconomic characteristics which refers to identifying social characteristics of an individual such as age, education, literacy levels, social status and upward social mobility; 2) personality variables such as level of empathy, ability to deal with abstractions, levels of intelligence, and ability to cope with uncertainty; and 3) communication behaviour which refers to individual characteristics of communications such as level of social participation, level of interconnections within the social system and level of exposure to communications channels. The best established relationships with innovativeness were the relationships between socioeconomic characteristics and innovativeness and between communication behaviour and

innovativeness. Brancheau and Wetherbe (1990) confirmed Rogers' findings and positive relationships between innovativeness and level of education, mass media exposure, exposure to interpersonal communications, and level of opinion leadership.

When looking at the relationship between innovativeness predictor variables and behavioural intentions, Moore and Benbasat's (1990) work also provides some support. They found that a significant relationship existed between innovativeness and attitude, and innovativeness and subjective norm. As proposed by TRA, behavioural intention is a function of attitude and subjective norm. If these findings are accepted, then a relationship between behavioural intentions and innovativeness can be postulated. Since innovativeness is measured through the innovativeness predictor variables then a relationship should also exist between these predictor variables and behavioural intentions.

In this chapter it has been shown that smart card technology, from a North American perspective, is a new and exciting technology. The discussion of individual behaviour theory served to show what components are important in determining how to predict employee intentions to adopt. Finally, it was shown that diffusion of innovations

theory, when combined with aspects of individual behaviour theory, provides a framework to allow the measurement of employee intentions at the individual level, through use of Moore and Benbasat's modifications and expansions to Rogers' PCI's. These bodies of knowledge form the basis for the presentation of the research model, in the next chapter.

CHAPTER 3

RESEARCH MODEL

The research model for this study examines the Knowledge and Persuasion phases of Rogers' Innovation-Decision Process. For this study, it is proposed that smart card presentations can be used as a form of interpersonal communications and that their use will have a significant effect on employees' intentions to adopt smart card technology through their impact on the knowledge and persuasion phases. To test this hypothesis, an experiment was designed which employed two levels of treatment, a base level (distribution of a one-page smart card document) and an advanced level (the smart card document plus the smart card presentation). The research model can be illustrated as shown in figure 3.1 and is explained in the following paragraph.

Individuals' PCI's of smart card technology (shown as the eight constructs in the middle of the model) are affected by the exposure to smart card technology that they receive (the treatment, either a one-page smart card summary document or a one-page smart card document and a smart card group presentation). In this part of the model, the treatment is the independent variable and the PCI's act as eight dependent variables. The second half of the model theorizes that individuals' PCI's can then be used to predict their intentions to adopt smart card technology (the behavioural intentions construct). For the

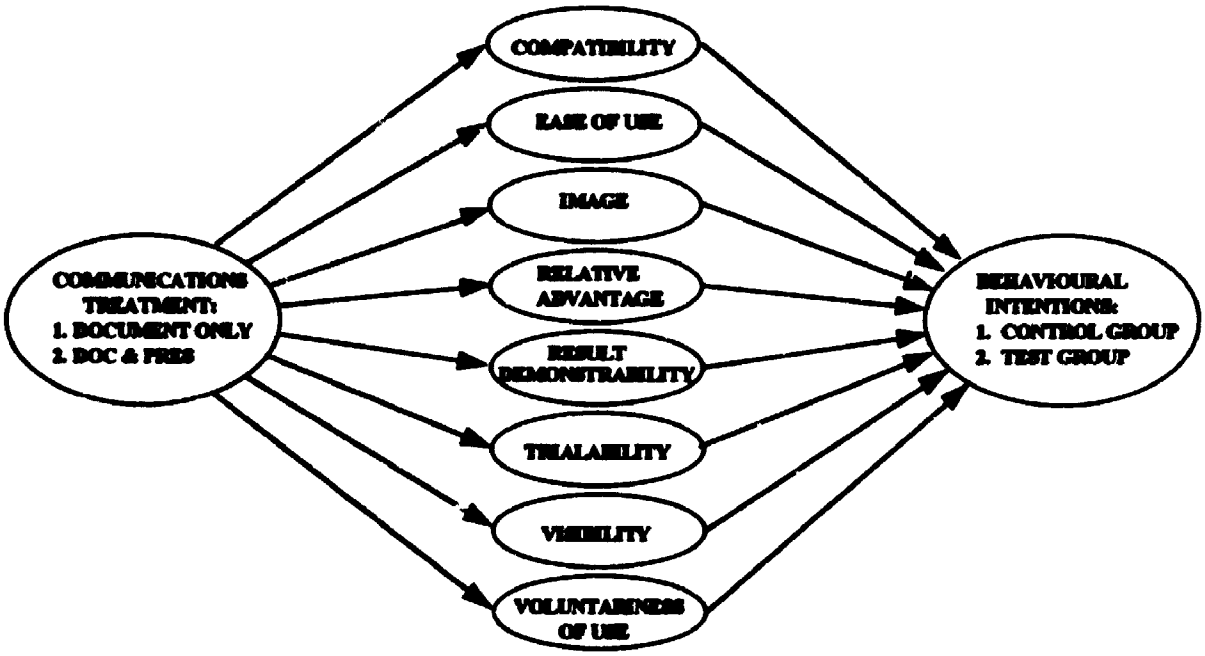

Figure 3.1 Research Model

second half of the model, the PCI's become the independent variables while behavioural intentions to adopt becomes the dependent variable. These relationships are explained more fully in the sections that follow.

Hypotheses

The main hypotheses for this study are grouped into two distinct categories, one group testing the effects of smart card presentations on participants' PCI's of smart card technology and the other group testing the relationship between participants' perceived characteristics of innovations and behavioural intentions to adopt smart card technology.

In addition to the research model, the Literature Review provides support for a possible relationship between socioeconomic and communications behaviour innovativeness predictor variables and behavioural intentions. Five supplemental hypotheses are identified to test these relationships.

Hypotheses Relating to Group Presentation Effects

In this study, it is proposed that smart card presentations which were given to randomly selected employees of the Department of Canadian Heritage can be used as a form of interpersonal communications. These presentations are designed to be as informative as possible and involve discussions of the general characteristics of smart cards as well as full demonstrations of working smart card applications. During

presentations, two-way discussion is encouraged and every effort is made to adequately address employees' questions about smart cards.

The impact of interpersonal communications in the Persuasion stage of the Innovation-Decision Process is to provide an individual with specific information that brings about a heightened awareness (beyond that experienced in the Knowledge stage) of the impact of use of an innovation.

It has been shown that the main output of the Persuasion stage is the formation of behavioural intentions as predicted by the PCI's. Therefore, exposure to interpersonal communications serves to improve employees' familiarity with the pros and cons of use of an innovation, which therefore affects the PCI's. Certain aspects of the smart card presentation provide specific support for expecting this change to occur as a result of attending a smart card presentation. They are described in the following discussion of the hypotheses of this study.

With regards to Relative Advantage, the smart card presentation illustrates the increased Relative Advantage of using smart card technology, by demonstrating applications where use of the smart card allows an individual to perform a desired task that would not be available without smart cards. An example is the use of smart card technology to allow electronic review, authorization and approval of leave requests (sick,

annual or other types of leave). The manager uses his/her smart card and the corresponding PIN as the key to unlock access to the leave request files and to release his/her electronic signature codes to prove verification and approval of the request. Previously this type of transaction could not be executed without compromising the security of the entire computer system. The first hypothesis is therefore:

H_1: There is a significant difference in the perceptions of the Relative Advantage of using smart card technology between people who attend smart card presentations and those who do not attend such presentations.

In the Knowledge stage, the absence of two-way communication may mean that issues regarding the compatibility of the new technology with existing values, needs and experiences of individuals are not addressed. The two-way communications aspect of smart card presentations allows the smart card presenter to receive, interpret and provide feedback concerning the Compatibility of smart card technology. For example, during a presentation, employees could typically ask questions regarding how well the smart card integrates with their work, that is, how compatible is it with their existing values. In such situations, the presenter is able to adequately address these concerns and provide a suitable answer to the question, thus providing more evaluative information to the employee. Thus, the second hypothesis of the study is:

H_2: There is a significant difference in the perceptions of the Compatibility of using smart card technology between people who attend smart card presentations and those who do not attend such presentations.

The smart card presentations show how common information can be stored onto a smart card to simplify the user interface to applications which currently rely on such information. By storing an individual's name, personal record identifier (PRI - the government equivalent of a Social Insurance Number), and language preference onto the smart card, applications using the smart card can immediately identify the individual, use the PRI to access the appropriate records of a database, and present information screens in the preferred language of the individual. All these actions can be activated without the need to key in the information. The Ease of Use of the smart card is very visible in the smart card presentations, thus leading to the third hypothesis:

H_3: There is a significant difference in the perceptions of the Ease of Use of smart card technology between people who attend smart card presentations and those who do not attend such presentations.

In the context of a pre-adoption setting, characteristics of Trialability, Result Demonstrability, Visibility and Image are more difficult to perceive than the characteristics

of Relative Advantage, Compatibility and Ease of Use. As such, general purpose knowledge acquired through reading a smart card summary document (as is the case for the control group of individuals) should not provide much to establish employees' perceptions of these characteristics. It is expected that people who attend smart card presentations will acquire more evaluative information regarding these characteristics as a result of observations made during the smart card presentations, coupled with the two-way communication that is a feature of these presentations. Therefore, perceptions of the Trialability, Result Demonstrability, Visibility and Image of smart card technology will be shaped by these presentations, making the next four hypotheses:

H_4: There is a significant difference in the perceptions of the Trialability of smart card technology between people who attend smart card presentations and those who do not attend such presentations.

H_5: There is a significant difference in the perceptions of the Result Demonstrability of using smart card technology between people who attend smart card presentations and those who do not attend such presentations.

H_6: There is a significant difference in the perceptions of the Visibility of smart card technology between people who attend smart card presentations and those who do not attend such presentations.

H_7: There is a significant difference in the perceptions of the Image of using smart card technology between people who attend smart card presentations and those who do not attend such presentations.

Finally, participants should find it easier to form perceptions of the Voluntariness of Use of smart card technology as a result of attending the smart card presentations, because they will be afforded the opportunity to ask questions aimed at helping them to decide whether or not adoption of smart card technology will be forced on them. This two-way communication cannot be duplicated by mass-media channels of communications, therefore the eighth hypothesis is:

H_8: There is a significant difference in the perceptions of Voluntariness of Use of smart card technology between people who attend smart card presentations and those who do not attend such presentations.

Hypotheses Relating to the Impact of Perceived Characteristics of Innovations on Behavioural Intention

The discussion of the perceived characteristics of innovations in the Literature Review Chapter established that Moore's (1987) perceived characteristics of innovation could be used as predictors of behavioural intention. Support for this relationship was provided by Davis' TAM model (1986) and Fishbein and Ajzen's definition of intentions. It was also shown that Moore and Benbasat (1991) found that relationships existed between all the PCI's and intentions to adopt an innovation. Of special note in the work by Moore and Benbasat was the strong positive relationships that were found for the Relative Advantage, Compatibility, Ease of Use and Result Demonstrability characteristics. H_9 through H_{15} were formulated to test these relationships against intentions to adopt smart card technology, hence:

H_9: There is a significant positive relationship between the perceived Relative Advantage of using smart card technology and intentions to adopt smart card technology.

H_{10}: There is a significant positive relationship between the perceived Compatibility of using smart card technology and intentions to adopt smart card technology.

H_{11}: There is a significant positive relationship between the perceived Ease of Use of smart card technology and intentions to adopt smart card technology.

H_{12}: There is a significant positive relationship between the perceived Trialability of smart card technology and intentions to adopt smart card technology.

H_{13}: There is a significant positive relationship between the perceived Result Demonstrability of using smart card technology and intentions to adopt smart card technology.

H_{14}: There is a significant positive relationship between the perceived Visibility of smart card technology and intentions to adopt smart card technology.

H_{15}: There is a significant positive relationship between the perceived Image of using smart card technology and intentions to adopt smart card technology.

Moore and Benbasat also found that a negative relationship existed between perceived Voluntariness of Use and intentions to adopt an innovation. Within the context of the social system, Moore and Benbasat's findings are in-line with Rogers' (1983) explanations of the dynamics of the social system. The effects of social structure pressure from a superior and expectation of peers and superior as described in system norm serve to pressure an individual to make a decision to conform or risk being outcast and penalized by peers and superior. Therefore H_{16} is:

H_{16}: There is a significant negative relationship between perceived Voluntariness of Use and intentions to adopt smart card technology.

Supplemental Hypotheses Relating to Selected Innovativeness Predictor Variables and Behavioural Intentions

In developing the innovativeness construct, Rogers (1983) identified 31 socioeconomic characteristic, personality and communication behaviour variables as being related to innovativeness in a specific manner. Since a link was established between innovativeness and behavioural intentions (Moore and Benbasat, 1990), this study looked instead at identifying relationships between some of the 31 innovativeness predictors and behavioural intentions. The basis for formation of the supplemental hypotheses was Rogers' findings regarding these variables and innovativeness.

For this study, the innovativeness predictors that were studied were concentrated in the socioeconomic characteristic factor and the communication behaviour factor, which Rogers (1983) stated were better defined and easier to measure than the personality variables factor. These variables were Age, Level of Education, Social Status (measured by position in the organization), Awareness of innovations, and Exposure to Mass Media Communication Channels.

Rogers stated that a person's age was not related to innovativeness, however based on an analysis of studies examining the relationships between age and innovativeness, he also acknowledged that the evidence concerning this relationship was inconclusive. Rogers' (1983) findings showed that 48% of the studies supported no relationship between age and innovativeness, 19% supported a negative relationship between age and innovativeness, and 33% supported a positive relationship between the two constructs. Brancheau and Wetherbe (1991) on the other hand, tested the relationship of age versus innovativeness and found that for their study, age was negatively related to innovativeness. This finding was also was supported by Assael (1981). Given Rogers' inconclusive findings about the relationship of age to innovativeness combined with the results obtained by Brancheau and Wetherbe and the results obtained by Assael it seems unclear whether a relationship can be expected to exist between age and innovativeness. Since Rogers compiled his data from the work of

numerous other studies, his observations are more statistically supportable. This allows H_{17} to be formulated as follows:

H_{17}: There is no significant relationship between Age and intentions to adopt smart card technology.

The relationship between level of education and innovativeness was established by both Rogers and Brancheau and Wetherbe. Rogers' analysis of 275 studies testing level of education versus innovativeness revealed that 203 studies supported a positive relationship or 74%. Therefore based on our previous discussions we should expect this relationship to be supported for behavioural intentions as well. Therefore:

H_{18}: There is a significant positive relationship between level of education and intentions to adopt smart card technology.

For the relationship between social status and innovativeness Rogers found that 68% of the studies he analyzed supported a positive relationship. Therefore H_{19} is:

H_{19}: There is a significant positive relationship between social status and intentions to adopt smart card technology.

In examining awareness of innovations and innovativeness Rogers found that 76% of the studies supported a positive relationship between awareness of innovations and innovativeness. As formulated for H_{17-19}, H_{20} is expected to show that the same relationships will be evidenced for behavioural intentions:

H_{20}: There is a significant positive relationship between awareness of innovations and intentions to adopt smart card technology.

Both Rogers (1983) and Brancheau and Wetherbe (1991) found an existing relationship between mass media exposure and innovativeness. Rogers' analysis of 116 studies examining the relationship between mass communications exposure and innovativeness revealed that 80 studies supported a positive relationship or 69%. Therefore H_{21} is:

H_{21}: There is a significant positive relationship between exposure to mass media communication channels and intentions to adopt smart card technology.

CHAPTER 4

RESEARCH METHODOLOGY

Overview

The research design used in this study was an experiment in which control groups, who received only a one-page smart card document, and test groups, who received the one-page smart card document and group presentations, were compared. Participants' perceptions of PCI's and intentions to adopt were then recorded via use of a survey instrument. Their responses were then analyzed using Partial Least Squares (PLS) analysis. This type of research design is called a Randomized Post-Test Only Control Group research design The design choice was appropriate for the following reasons:

1) By allowing the control of the environment and variables to be included and manipulated in the study, an experiment comes closer than any other data collection method to establishing causal relationships;

2) Based on informal discussions with some Department of Canadian Heritage managers, it was felt that Canadian Heritage employees would resent completing a survey twice (as would be the case if a pre-test post-test design were chosen). Furthermore, Emory and Cooper (1991) state that

pre-tests are not necessary when the test-groups and control-groups can be randomized; and,

3) This research design addresses internal and external validity threats more adequately than many other possible research designs.

Sample Size

In order to test the research model, PLS requires that the minimum sample size be approximately 10 times the number of independent variables in the most complex regression, which in this study is the regression of intentions to adopt on the eight PCI's of an innovation (Fornell, 1984). Using this formula the minimum sample size for control group and test group combined, would be 80 participants. To allow these requirements to be met, three medium-sized organizations (about 100 employees per organization) within the department of Canadian Heritage were selected. For each organization, 25-30 people were randomly assigned to a test group which received the smart card presentation and an equivalent number of people were randomly assigned to a control group which did not receive the smart card presentation. The final results yielded 80 test group participants and 75 control group participants (uncontrollable circumstances resulted in time conflicts for 5 of the control group participants).

Each group received a one-page smart card summary document. This summary document, presented in Appendix A, was used to provide employees with general knowledge about smart card technology, appropriate to Rogers' Knowledge stage of the Innovation-Decision process.

In addition to the summary document, the test group participants also received a presentation from a member of the Advanced Card Systems group at Canadian Heritage who knew about the study, but only in a general sense, as he was not made aware of the hypotheses that were to be tested. The presenter was asked to conduct his usual presentation which; 1) describes smart cards and smart card technology, 2) demonstrates the advantages of using the technology, and 3) presents some of the applications that are ready for implementation. The test group participants were encouraged to ask questions throughout the presentation and every effort was made to present the material in a relaxed and uninhibiting environment.

Control group participants received the survey while the test group participants attended the smart card presentation. The control group participants were given sufficient time to complete the survey and return it to the administrator (average completion time was 15 minutes). Test group participants received their surveys after the smart card presentation had been completed. Surveys were collected as participants left the test site or presentation room.

Instrumentation

The survey (Appendix B) that was used in this study includes items designed to measure the general knowledge of smart cards, smart card attitudes, PCI's for smart cards, behavioural intentions, participant age, level of education, and social status, participant level of awareness of innovations and exposure to communications channels, and lastly, a section to obtain direct feedback on the usefulness of the treatment received.

Items pertaining to the PCI's were taken from a survey developed by Moore and Benbasat (1991). In developing their survey, Moore and Benbasat included only items that were phrased in such a way as to make the items generalizable to most technological innovations. For this study, "smart card" was used to identify the technological innovation used for the Moore and Benbasat instrument.

Items taken from the Moore and Benbasat survey have been thoroughly tested and have passed all measures of validity and reliability, returning Cronbach alpha reliability scores ranging from 0.71 to 0.92. Since Nunnally (1991) argued that for basic research, increasing reliabilities beyond 0.80 was often wasteful, Moore and Benbasat set a lower limit of 0.70 for acceptable reliability. Their results show that they achieved this goal.

As the Moore and Benbasat survey did not include items to measure behavioural intentions, eight statements designed to measure behavioural intentions were developed

for this study. These items asked the respondents about their intentions to use smart cards directly, as well as their intentions to promote smart card technology.

Seven-point Likert scales with "strongly disagree" to "strongly agree" endpoints were used for items dealing with the PCI's, items pertaining to intentions to adopt smart cards and items aimed at determining the value of the smart card presentations. The use of the seven-point Likert scales meant that interval data was captured for the variables of this study.

Respondents were directly asked their age, level of education and position in the organization (a measure of social status). Awareness of innovations was determined using five point scales with "I don't know what it is" to "I know what it is" endpoints applied to a listing of different technological innovations (such as CD-ROM, Optical Cards, , etc.). The list of technological innovations was culled from areas of interest covered by the Consumer Reports yearly guide (1994). Exposure to mass media communications channels (such as television, newspapers, radio, etc.) as identified by Brancheau and Wetherbe (1990) were determined using five point scales with "Seldom" to "Very Often " frequency of use phrases.

Data Analysis

In looking at the research model, the multiple independent variable dependent variable relationships present a problem for using traditional statistical analysis techniques to evaluate the whole model, because use of traditional techniques would require evaluating the theoretical and measurement models separately. This limitation means that some interaction effects of the model could be lost. Under such circumstances, it is preferable to employ techniques which allow the theoretical and measurement model to be tested simultaneously. Second-generation multivariate analysis techniques have this capability.

Of the techniques that were available for use, Partial Least Squares Analysis (PLS) seemed most appropriate for the purposes of this study. Fornell (1984) explains that PLS is a method used to estimate predictive-causal relationships. Furthermore, of the available second generation techniques, Fornell goes on to say that "PLS , covariance structure analysis (LISREL) and (to a more limited extent) confirmatory Multi-dimensional Scaling provide a means for assessing causal relationships". According to Fornell "PLS is a flexible method...which provides a powerful means for theory-data interaction".

LISREL (covariance structure analysis) is an application that has enjoyed much popularity in the research field. Both LISREL and PLS are concerned with structural equation modeling (Fornell and Bookstein, 1982). However, PLS was more appropriate

for this study because of the restrictions involved in the use of LISREL. In order to satisfy LISREL's maximum likelihood orientation, substantially larger sample sizes are required than for PLS and its fixed point estimation orientation (Fornell and Bookstein, 1982). Secondly, Fornell (1984) also points out that LISREL requires a strong theoretical knowledge base in the area of research whereas PLS is less restrictive.

PLS analysis is conducted in two stages. The first stage involves the development of the measurement model. Grant (1989) explained that the measurement model is made up of the relationships between constructs and items used to measure them. Thus reliability, and the convergent and discriminant validity of the measures in the model are of primary concern. The second stage involves the assessment of the structural model, which Grant (1989) states includes unobservable constructs and theoretical relationships.

PLS output consists of principal components factor loadings which measure the appropriateness of item measures to the constructs that they are intended to measure, path coefficients which represent the standardized regression coefficients of the variables and measure the direct effects of antecedent constructs of the model, and R^2 statistics to indicate the portion of variance explained in each construct.

CHAPTER 5

RESULTS

Data Preparation

Following the methodology described in Chapter 4, 75 control group surveys and 80 test group surveys were collected for a total sample of 155 surveys. After the responses were gathered and keyed into an electronic database, the raw data was examined and worked to eliminate unusable or unreliable sets of responses. Following Emory and Cooper (1991) guidelines the first step in the database clean-up was to eliminate sets of responses where more than 10% of the replies were missing. This resulted in the elimination of three control group surveys and five test group surveys thus leaving 72 in the control group and 75 in the test group for a total of 147 sets of responses for the analysis of the research model.

A few additional surveys where missing responses were concentrated within particular sections of the survey, posed some additional problems. For example, in one survey, a respondent missed eight questions overall, which is less than the 10% cutoff. However, all eight missed questions were in the awareness of innovations section, which only has 16 questions. In instances such as this the unusable section was eliminated. This action resulted in a drop from 147 responses to 143 responses for the section dealing with awareness of innovations and exposure to communications channels, and the section pertaining to age, job category and education (see table 5.1 for details).

Having purged unusable and incomplete surveys, the next step in preparing the database was to fill-in any remaining missing values from the remaining sets of responses using the procedure described in the following paragraph.

When a missing value was encountered, an entry would be generated by taking the average of the other responses within the section in question. For example if a missing value was encountered for an PCI Image item (see appendix A for survey details) the fill-in value would be calculated by taking the average of the responses to the other three PCI Image items for that set of responses (Rea and Parker, 1992).

The final step in preparing the database for analysis was to return all reverse-coded item responses back to the same orientation as other responses. Table 5.1 summarizes, the breakdown of valid sets of responses by section.

Analysis of Results

As described earlier, the survey was designed to measure participants' knowledge of smart cards, evaluate their perceptions towards the PCI's of smart cards, assess the impact of presentations on the PCI's (covering hypotheses H_1-H_8), evaluate their intentions to use smart cards (hypotheses H_9-H_{16}), gain an appreciation of participants' awareness of innovations and exposure to communications channels (hypotheses H_{20}-H_{21})

NAME OF SECTION	# OF CONTROL GROUP SETS OF RESPONSES	# OF TEST GROUP SETS OF RESPONSES	TOTAL # OF VALID SETS OF RESPONSES
Knowledge	72	75	147
PCI's and Intentions	72	75	147
Awareness of Innovations & Exposure to Communications Channels	69	74	143
Age, Job Category and Education	69	74	143

Table 5.1 - Breakdown of Final Valid Sets of responses

and finally, look at the demographic characteristics regarding age, education and social status (as measured by occupation within the department - hypotheses H_{17}, H_{18}, and H_{19} respectively). Due to the multiple areas covered by the survey, the results of the analysis will be presented in four sections. The first section will discuss results pertaining to the assessment of participants' knowledge of smart card technology, while the second section presents the results examining the employee receptiveness towards smart card technology. The third section discusses the results for the research model, that is, the effect of presentations on participants' PCI's and the effectiveness of using participants' PCI's to predict their intentions to adopt smart card technology. The final section of this chapter discusses the results vis-à-vis the tested innovativeness predictors and intentions to adopt smart card technology.

Analysis of Knowledge Section

The survey's knowledge section consisted of five multiple choice questions designed to verify that all participants (both Control and Test group) had acquired an adequate level of knowledge regarding the definition and uses of smart cards. The distribution of the one-page smart card document (see appendix A) was designed to provide participants with the information necessary to fulfill the requirements of Rogers' Knowledge stage of the Innovation-Decision Process. The analysis of this section of the survey was conducted to establish that a baseline knowledge was instilled in both test group and control group participants.

The results for this section of the survey were tabulated by determining the number of correct replies for each participant, performing a T-test that compared the scores of test group participants to control group participants, and evaluating and interpreting the results obtained.

The results of the analysis showed that the mean number of correct answers for the control group (smart card document only) was 3.4 out of 5 or approximately 68%. The mean number of correct answers for the test group (smart card document and presentation) was 3.8 out of 5 or approximately 76%. The results of the T-test returned a T-value of -2.48 indicating that at alpha = .025 there was a statistically significant difference in the mean number of correct answers. However, on a practical level the difference between 3.4 out of 5 and 3.8 out of 5 is not substantially significant (one extra correct answer for every 12 test group answers as compared to control group answers). In addition, the marginally higher test group scores probably take into account some knowledge reinforcement that was obtained by attending the smart card presentation. Since the overall knowledge scores for both groups were relatively high, it was concluded that both groups met the requirements of Rogers' Innovation-Decision Process Knowledge Phase.

Employee Receptiveness Towards Smart Card Technology

One of the areas of interest for management at Canadian Heritage was the general attitudes of employees towards smart card technology. Employee attitudes towards the innovation were measured by their perceptions of the PCI's of smart card technology, represented by the overall PCI means and standard deviations (shown in table 5.2). These means were derived from participants' responses to items on the survey (which ranged in value from 1 to 7). Interpreting the table, a mean of 4 indicates a neutral perception of the PCI in question. Means below 4 indicate a negative perception of the PCI in question, while means above 4 indicate a positive perception of the PCI in question. The results from table 5.2 indicate that participants attributed the strongest positive perceptions to Ease of Use (5.35), Visibility (5.06), Result Demonstrability (4.92) and Trialability (4.88) and modest positive perceptions for Compatibility (4.37) and Relative Advantage (4.16). On the other hand, participants exhibited negative perceptions towards Image (3.37) and Voluntariness of Use (3.71). The negative value for Image implies that participants do not look to smart card technology as a status symbol. The negative Voluntariness of Use value means that participants' do not feel that adoption of smart card technology will be voluntary.

Table 5.2 also shows that participants' intentions to adopt smart card technology were also positive (4.85). These results indicate that overall, participants were receptive to the notion of adopting smart card technology, however a score of 4.85 out of 7 for

VARIABLE	MEAN (all respondents)	STANDARD DEVIATION
Compatibility	4.37	1.19
Ease of Use	5.35 (most favourable)	1.06
Image	3.37 (least favourable)	1.37
Relative Advantage	4.16	1.08
Result Demonstrability	4.92	1.07
Trialability	4.88	0.96
Visibility	5.06	1.15
Voluntariness of Use	3.71	1.10
Intentions to adopt	4.85	1.14

Table 5.2 - Overall PCI and intentions Means and Standard Deviations

intentions to adopt, indicates that the participants were not particularly inspired by the technology.

Analysis of the Research Model (testing of Hypotheses H_1-H_8 and H_9-H_{16})

The research model predicts that smart card group presentations will have an effect on participants' perceptions of the PCI's of smart card technology and that the perceptions of the PCI's can be used as predictors of intentions to adopt smart card technology. The first step in analyzing the research model was to assess the measurement properties (reliability and validity) of the PLS model by first assessing the individual item loadings and cross-loadings to ensure that they were adequate and that no item loaded higher on another factor than on the one it was intended to measure. This was followed by an analysis of the reliability of the construct scales and the convergent and discriminant validity of the research model. The factor loadings that PLS produces can be found in the PLS Latent Variable Loading Structure Matrix (table 5.3). Although the results of the first PLS run were quite encouraging and most items loaded strongly on their intended factors, some items returned weaker loading values. According to Comrey (1973) loadings in excess of 0.55 can be considered good while 0.67 or higher is considered very good to excellent. It was therefore decided that 0.67 would be employed as a cutoff for automatic inclusion to the model. Based on this decision, survey items which returned

Survey Item	Treat-ment	Comp.	Ease of Use	Image	Rel. Adv.	Res. Dem.	Trial-ability	Vis	Vol. of Use	Inten to adopt
Trtmnt	1.00	-.13	.04	-.04	-.14	.01	.09	.03	-.02	0
CO-1	-.11	.82	.23	.40	.63	.26	.14	.31	-.16	.40
CO-2	-.08	.90	.45	.34	.71	.52	.32	.39	-.27	.46
CO-3	-.14	.90	.47	.29	.75	.46	.36	.40	-.27	.49
CO-4	-.13	.86	.32	.39	.73	.38	.21	.42	-.26	.42
EU-1	-.03	.13	.22	.21	.25	.27	.38	.29	-.11	.16
EU-2	-.02	.40	.84	.11	.38	.64	.37	.54	-.36	.55
EU-3	.11	.18	.68	-.18	.02	.35	.05	.23	-.24	.23
EU-4	.03	.30	.78	.02	.24	.50	.21	.32	-.27	.40
EU-5	.10	.35	.82	0	.19	.53	.24	.38	-.24	.50
EU-6	-.01	.33	.67	-.03	.33	.30	.25	.22	-.13	.36
IM-1	-.04	.33	.10	.83	.37	.23	.25	.44	-.05	.18
IM-2	-.03	.19	-.13	.76	.18	.03	-.03	.16	-.12	.07
IM-3	-.02	.39	-.01	.87	.33	.18	.15	.29	-.12	.20
IM-4	.03	.10	-.19	.58	.05	.05	-.10	.08	-.06	-.02
RA-1	.01	.45	.31	.18	.64	.36	.40	.29	-.22	.46
RA-2	-.08	.59	.15	.35	.78	.15	.34	.10	-.10	.30
RA-3	-.13	.60	.19	.29	.81	.32	.35	.21	-.16	.33
RA-4	-.12	.58	.19	.35	.76	.33	.15	.18	-.10	.28
RA-5	-.06	.66	.39	.32	.76	.43	.41	.41	-.16	.40
RA-6	-.11	.77	.37	.25	.79	.42	.33	.29	-.19	.41
RA-7	-.20	.58	.21	.31	.74	.29	.21	.25	.06	.22
RA-8	-.20	.70	.22	.42	.83	.38	.26	.30	-.09	.27
RD-1	-.03	.31	.48	.21	.32	.82	.23	.46	-.21	.41
RD-2	-.09	.38	.56	.15	.34	.84	.27	.48	-.28	.44
RD-3	.11	.42	.52	.13	.46	.73	.39	.32	-.21	.43
RD-4	.04	.35	.40	.16	.25	.67	.31	.43	-.25	.31
TR-1	.04	.30	.28	.13	.44	.19	.76	.21	-.16	.37
TR-2	.13	.12	.12	.18	.14	.32	.29	.11	-.27	.12
TR-3	-.05	.17	.28	.11	.24	.27	.63	.29	-.16	.18
TR-4	.13	.07	.18	.09	.16	.29	.73	.15	-.08	.17
TR-5	.07	.16	.17	.14	.11	.23	.51	.15	0	.14

Table 5.3 - PLS Latent Variable Loading Structure Matrix (pg. 1 of 2)

Survey Item	Treat-ment	Comp [illegible]	Ease of Use	Image	Rel. Adv.	Res. Dem	Trial-ability	Visi-bility	Vol. of Use	Inten to adopt
VS-1	.03	.23	.46	.20	.24	.47	.23	**.81**	-.22	.34
VS-2	.03	.42	.41	.34	.24	.41	.27	**.81**	-.20	.29
VS-3	.01	.38	.15	.47	.32	.32	.16	**.58**	-.19	.18
VS-4	-.01	.13	.03	.23	.15	.19	.08	**.28**	-.09	.01
VU-1	.18	-.20	-.08	-.07	-.05	-.08	.13	-.04	**.54**	-.10
VU-2	-.16	-.26	-.29	-.14	-.27	-.34	-.43	-.29	**.71**	-.28
VU-3	.14	-.16	-.23	.05	-.06	-.17	-.02	-.14	**.63**	-.14
VU-4	.01	-.11	-.22	-.07	.02	-.12	.03	-.14	**.74**	-.21
INT-1	.03	.49	.43	.17	.45	.39	.34	.32	-.27	**.80**
INT-2	-.05	.36	.49	.11	.23	.45	.15	.33	-.16	**.77**
INT-3	.08	.28	.35	.20	.24	.35	.30	.22	-.20	**.78**
INT-4	-.05	.41	.45	.20	.42	.41	.33	.27	-.26	**.79**
INT-5	-.02	.40	.41	.18	.43	.43	.32	.28	-.25	**.84**
INT-6	-.02	.35	.54	.12	.25	.42	.29	.36	-.32	**.81**
INT-7	.01	.49	.48	.19	.44	.43	.34	.29	-.23	**.85**
INT-8	.02	.51	.54	.23	.49	.53	.33	.39	-.31	**.91**

Table 5.3 (cont'd) - PLS Latent Variable Loading Structure Matrix (pg. 2 of 2)

loadings lower than 0.67 were reviewed to determine suitability for continued inclusion in the model.

Interestingly, the results obtained in this first PLS run closely parallel some of the observations made by Moore and Benbasat (1991) who found weaker loadings (below .67) for items within Ease of Use, Image, Relative Advantage, and Visibility. Two deviations from the Moore and Benbasat results are the low loadings for two of the Trialability items and one of the Voluntariness of Use items. Each of the items as identified in table 5.3 were reviewed to determine if a rationale could be given for the low factor loadings when compared to other items within their group (see table 5.4 for a summary of the problem items and their loadings). In some cases, an item's cross-loadings were higher than the loadings on its intended construct. Such was the case for the EU-1 and TR-2 items, thereby indicating that these items were better at measuring other constructs than the ones they were intended to measure. A review of the applicability of each of the identified factor items revealed that some of the items were difficult to interpret for smart card technology which might have resulted in confusion on the part of the respondent, thus leading to low factor scores. These items include:

- **EU-1, Ease of Use PCI** - I believe that it would be easy to get a smart card to do what I want it to do. This item was difficult to apply to smart cards because smart card applications are closed applications, there is no flexibility for a user to modify them.
- **RA-1, Relative Advantage PCI** - Using a smart card would make it easier to do my job. This item was difficult to apply to smart cards because smart card applications are aimed at simplifying bureaucratic overhead, not at actual job tasks.
- **TR-2, Trialability PCI** - I know where I could go to satisfactorily try out various uses of a smart card. In the context of smart card technology, this item is difficult for a person to interpret if there are no trial site installations in place.
- **TR-5, Trialability PCI** - If smart cards are implemented, I would be permitted to use a smart card on a trial basis long enough to see what it could do. This item is difficult to interpret in a pre-adoption setting because the employee is being asked to forward a perception based on pure speculation.
- **VS-3, Visibility PCI** - If smart cards are implemented, it would be easy for me to observe others using a smart card in my department. Once again, a pre-adoption setting means that perceptions of this item are based on pure speculation. Also complicating perceptions of this item however, is the fact that smart card portability means that smart cards are usually stored out of sight.

Survey Item	Wording of Item	Reason for Removing Item from Survey	Factor Loading
Q-10, EU-1	I believe that it would be easy to get a smart card to do what I want it to do	Smart card applications are closed applications, there is no flexibility for a user to modify it	0.22
Q-41. IM-4	Having a smart card would be a status symbol in my organization	Implies using a smart card for elitist purposes, neg. connotation when compared to others	0.58
Q-6. RA-1	Using a smart card would make it easier to do my job	Smart card applications are aimed at simplifying bureaucratic overhead, not at actual job tasks	0.64
Q-21. TR-2	I know where I could go to satisfactorily try out various uses of a smart card	Difficult to interpret in pre-adoption setting, also smart cards do not have many types of uses	0.29
Q-40. TR-5	If smart cards are implemented, I would be permitted to use a smart card on trial basis long enough to see what it could do	Difficult to interpret in pre-adoption setting	0.51
Q-30 VS-3	If smart cards are implemented, it would be easy for me to observe others using a smart card in my department	Difficult to interpret in pre-adoption setting. Aiso, smart card portability means that it's usually out of sight until use.	0.58
Q-34 VS-4	If smart cards are implemented, I would see what others do using their smart card	Smart cards are passive, people don't "do" active things with them	0.28
Q-7 VU-1	My use of a smart card would be voluntary (as opposed to required by my supervisor)	Awkward and confusing wording.	0.54

Table 5.4 - Items Eliminated from Sets of Responses

- **VS-4, Visibility PCI - If smart cards are implemented, I would see what others do using their smart card. Since smart cards are passive devices and people don't "do" active things with them, this item is also difficult to apply.**

As a result of these findings the above items were deleted from the research model.

A review of the fourth item in the Image PCI (IM-4, Having a smart card would be a status symbol in my organization) revealed that its wording was much more direct and carried a more negative connotation (i.e. use of the smart card for elitist purposes) than the other three Image PCI items (e.g. IM-1, Using a smart card would improve my image within the organization). While IM-4 makes a clear statement regarding using the smart card in an elitist manner, IM-1's meaning is much more subtle and open to positive interpretation (e.g. one might interpret IM-1 to mean that using a smart card would improve people's perception of that individual). Because of the strong and direct wording as compared to the other Image PCI items, it was felt that IM-4 did not reflect participants' true perceptions of the Image PCI, therefore this question was also dropped from the research model.

The final item to be dropped from the sets of responses was item one of the Voluntariness of Use PCI (VU-1, My use of a smart card would be voluntary, as opposed

to required by my supervisor) which was considered to be awkward and confusing in its wording and meaning.

The two final items with loadings below 0.67 were TR-3, (Trialability PCI - A smart card would be available to me to adequately test run various applications, loading 0.63) and VU-3, (Voluntariness of Use PCI - Although it might be helpful, using a smart card would not be compulsory in my job, loading 0.63). Since both items appeared to be valid in the context of smart cards, it was decided that these two items should be retained in the model. A final observation with regards to the original model was the very-high cross-loadings between Compatibility and Relative Advantage, which indicated that perhaps the items for these two constructs were measuring the same characteristics (later in this chapter, the relationship between these two constructs is discussed in detail).

Having eliminated the above items from the research model, the revised PLS model was tested. Table 5.5 presents the item loadings for the revised model. There are a number of interesting observations that can be made with regards to the revised model factor loading. First, the table shows that unlike the original model, all items load highest on their own constructs and the number of items with loadings below 0.67 has dropped from ten to three. Two of these three items are the TR-3 item and the VU-3 item that displayed lower loadings in the original model, but were kept because of their appropriateness as questions for smart card technology. The third item, TR-4, which

Survey Item	Treat-ment	Comp.	Ease of Use	Image	Rel. Advan.	Result Dem.	Trial-ability	Visi-bility	Vol. of Use	Intent to adopt
Trtmnt	1.00	-.13	.05	-.04	-.16	.01	.05	.03	-.07	.00
CO-1	-.11	.82	.22	.40	.62	.26	.11	.26	-.15	.40
CO-2	-.08	.90	.44	.33	.71	.52	.27	.32	-.27	.46
CO-3	-.14	.90	.47	.28	.76	.46	.36	.36	-.27	.49
CO-4	-.13	.86	.31	.39	.73	.38	.21	.38	-.24	.42
EU-2	-.02	.40	.83	.10	.35	.64	.34	.56	-.38	.55
EU-3	.11	.18	.70	-.18	-.01	.35	.04	.27	-.24	.23
EU-4	.03	.30	.79	.02	.24	.50	.18	.32	-.27	.40
EU-5	.10	.35	.83	-.01	.16	.53	.21	.41	-.24	.50
EU-6	-.01	.33	.67	-.04	.31	.30	.29	.24	-.14	.36
IM-1	-.04	.33	.07	.82	.37	.23	.22	.36	-.06	.18
IM-2	-.03	.19	-.14	.78	.19	.03	-.07	.09	-.11	.07
IM-3	-.02	.39	-.02	.88	.34	.18	.09	.21	-.12	.20
RA-2	-.08	.59	.12	.34	.77	.15	.36	.06	-.11	.30
RA-3	-.13	.60	.16	.28	.82	.32	.36	.16	-.18	.33
RA-4	-.12	.58	.17	.34	.77	.33	.17	.12	-.09	.28
RA-5	-.06	.66	.37	.31	.77	.43	.40	.36	-.17	.40
RA-6	-.11	.77	.37	.24	.81	.42	.33	.24	-.18	.41
RA-7	-.20	.58	.20	.31	.77	.29	.21	.21	.06	.22
RA-8	-.20	.70	.21	.41	.86	.38	.23	.24	-.08	27
RD-1	-.03	.31	.46	.21	.30	.82	.17	.42	-.24	.41
RD-2	-.09	.38	.55	.15	.32	.84	.19	.48	-.27	.44
RD-3	.11	.42	.51	.13	.43	.73	.30	.32	-.23	.43
RD-4	.04	.35	.39	.16	.26	.67	.30	.39	-.26	.31
TR-1	.04	.30	.25	.12	.41	.19	.88	.19	-.22	.37
TR-3	-.05	.17	.25	.10	.23	.27	.64	.33	-.20	.18
TR-4	.13	.07	.16	.08	.12	.29	.65	.14	-.14	.17
VS-1	.03	.23	.45	.19	.20	.47	.23	.87	-.25	.34
VS-2	.03	.42	.39	.33	.24	.41	.24	.82	-.21	.29
VU-2	-.16	-.26	-.27	-.13	-.22	-.34	-.41	-.26	.80	-.28
VU-3	.14	-.16	-.23	.05	-.03	-.17	.01	-.17	.54	-.14
VU-4	.01	-.11	-.23	-.08	.02	-.12	.04	-.12	.71	-.21

Table 5.5 - Revised PLS Latent Variable Loading Structure Matrix (pg. 1 of 2)

	Treat-ment	Comp.	Ease of Use	Image	Rel. Advan	Result Dem.	Trial-ability	Visi-bility	Vol. of Use	Intent to adopt
INT-1	.03	.49	.43	.16	.39	.39	.33	.33	-.29	.80
INT-2	-.05	.36	.48	.10	.21	.45	.15	.33	-.15	.77
INT-3	.08	.28	.34	.19	.21	.35	.29	.21	-.22	.78
INT-4	-.05	.41	.44	.19	.38	.41	.31	.25	-.26	.79
INT-5	-.02	.40	.40	.17	.38	.43	.32	.28	-.26	.84
INT-6	-.02	.35	.54	.11	.22	.42	.29	.36	-.34	.81
INT-7	.01	.49	.48	.18	.40	.43	.35	.31	-.25	.86
INT-8	.02	.51	.53	.22	.45	.53	.31	.40	-.32	.91

Table 5.5 (cont'd) - Revised PLS Latent Variable Loading Structure Matrix (pg. 2 of 2)

exhibits a factor loading of 0.65 in the revised model, originally exhibited a factor loading of 0.73 in the original model. Since this question was already deemed satisfactory in the original model, it was retained for this revised model.

The second aspect of determining the validity of the research model was to assess the reliability, convergent validity and discriminant validity of the model's constructs (see table 5.6). The reliability measure used in this analysis is Cronbach's coefficient alpha, which Lord and Novick (1986) explain is a measure for determining the proportion of a factor that is free from error. Various researchers argue different cut-off values for a scale to be considered reliable. Nunnally (1991) argues that a Cronbach Alpha between 0.50 and 0.60 is acceptable for early stages of research with a 0.70 reliability as a standard for more established research. Hughes, Price and Marrs also support a 0.50 cutoff for reliability. On the other hand Moore and Benbasat (1991) in the creation of their factors aimed for an Cronbach alpha of at least 0.70. Since pre-adoption setting research is non-existent (at least to this author's awareness) and reliability standards for such circumstances were not available, it was decided to follow Nunnally and Hughes, Price and Marrs 0.50 cutoff values. Using the 0.50 cutoff, all scales, including the behavioural intentions scale, qualified as being sufficiently reliable. In fact, only three of the eight scales possess reliabilities below the 0.70 cutoff used by Moore and Benbasat, (Trialability (0.60), Visibility (0.59) and Voluntariness of Use (0.53)). In their study, even Moore and Benbasat (1991) confess that initial reliability scores for Trialability and Visibility were lower than desired, as items had to be dropped from both scales to improve reliability.

	Reli-ability	Treat-ment	Comp	Ease of Use	Image	Rel. Advan.	Result Dem.	Trial-ability	Visi-bility	Vol. of Use	Intent to adopt
Treat-ment	n.a	n.a									
Comp.	0.89	-0.13	0.87								
Ease of Use	0.82	0.05	0.42	0.76							
Image	0.79	-0.04	0.40	0.00	0.83						
Rel. Advan	0.90	-0.16	0.81	0.30	0.40	0.79					
Result Dem.	0.77	0.01	0.47	0.63	0.21	0.43	0.77				
Trial-ability	0.60	0.05	0.28	0.30	0.14	0.38	0.31	0.73			
Visi-bility	0.59	0.03	0.38	0.50	0.30	0.26	0.52	0.28	0.84		
Vol. of Use	0.53	-0.07	-0.27	-0.34	-0.11	-0.15	-0.32	-0.26	-0.27	0.69	
Intent to adopt	0.93	0.00	0.51	0.56	0.20	0.41	0.52	0.36	0.38	0.32	0.82

notes: 1. The reliability measure used is Cronbach's coefficient alpha.

2. Diagonal elements are the correlation between the construct and its underlying variables. Off diagonal elements are the correlations between the constructs.

Table 5.6 - Revised Model Reliability, Convergent and Discriminant Validity

An explanation for the lower reliabilities of the Trialability, Visibility and Voluntariness of Use factor scales lies with some of the problems that were noted with the factor analysis. As indicated above, the factor loadings for three out of five Trialability indicators, two out of four Visibility indicators and two out of four Voluntariness of Use indicators returned relatively low factor loadings. As a result, two Trialability indicators, two Visibility indicators and one Voluntariness of Use indicator were dropped. Alpha reliability coefficients are sensitive to the number of indicators used in a scale, therefore higher numbers of indicators result in higher reliability coefficients with the same average levels of correlation. Since only three indicators were used for Trialability, two for Visibility and three for Voluntariness of Use, the preceding discussion provides a partial explanation for the low reliabilities for the scales of these three constructs.

A second factor that could contribute to the lower reliabilities concerns the possibility that respondents had trouble formulating perceptions of Trialability, Visibility, and Voluntariness of Use due to timing of the study. This possibility was alluded to in Chapter 4 where it was acknowledged that perceptions of Trialability and Visibility might be difficult for respondents to formulate because, in a pre-adoption setting such as was the case with this study, participants could not draw upon established perceptions of PCI's as a result of prolonged exposure to smart cards. Items regarding the PCI's of smart cards were asked based on the participants' very brief exposure to the innovation (either the one-page summary document and/or the smart card presentation). Since perceptions of

Trialability, Visibility and Voluntariness of Use intuitively rely on people's mid to long-term exposure to an innovation in a work environment, it would be understandable that respondents might have problems accurately answering questions dealing with these constructs. Better reliabilities may have been obtained if the study had been conducted at a time closer to adoption (i.e. a near-adoption setting). The impact of the timing of this study is discussed in further detail in the Chapter 6 section - implications regarding the administration of the survey used in this study.

Notwithstanding the above, however, the Trialability, Visibility and Voluntariness of Use scales were left in the research model because the reliability scores for the scales of these constructs were still high enough (by Nunnally and by Hughes, Prices and Marrs guidelines of $\alpha >= 0.50$) to allow the results for these constructs to be interpreted.

Having established the reliability of the constructs, attention was focused on the convergent and discriminant validity of the model. In assessing the convergent and discriminant validity of a research model, the researcher wants to show that when looking at a construct, the correlation between it and any other construct (off diagonal elements in table 5.6) is lower than correlation between itself and its measures (diagonal elements in table 5.6). A violation of this guideline indicates a lack of discriminant validity. In reviewing table 5.6, a lack of discriminant validity is exhibited between Compatibility and Relative Advantage as the correlation between the two constructs (0.81) is higher than the

square root of the average variance extracted between the Relative Advantage construct and its underlying indicator variables (0. ').

This lack of discriminant validity indicates that, for this study, Compatibility and Relative Advantage appear to measure the same characteristics. In addition, the high correlation between Compatibility and Relative Advantage presents multicollinearity problems in attempting to determine the specific effects of Compatibility and Relative Advantage on the dependent variable, intentions to adopt smart card technology. This finding is consistent with Moore and Benbasat (1991) who found a 0.99 correlation between Compatibility and Relative Advantage in their study.

In situations such as this, one would normally consider collapsing the two constructs into one. Moore and Benbasat did not do this however, since during sorting tests of the survey, Compatibility and Relative Advantage were consistently separated by the testers. While the Moore and Benbasat explanation may show that people are able to conceptualize differences between Compatibility and Relative Advantage, it fails to explain why the two constructs are so highly correlated and therefore does not provide justification for continuing to treat Compatibility and Relative Advantage as two distinct constructs. An explanation for the high correlations between Compatibility and Relative Advantage is that, although people are able to conceptualize differences between the two constructs, they find it difficult to evaluate their perceptions to these two constructs

independent of each other. Therefore, if an individual does not view the innovation as being compatible with his or her values, needs and past experiences, it becomes difficult to recognize any Relative Advantage accruing to the innovation. This implies that Relative Advantage will be cast concurrently with the person's view towards the Compatibility of the innovation. For example, consider a person who has strong feelings regarding the protection of private information. If the use of smart cards necessitated that sensitive personal information be entered to the card, this person's perception of the Compatibility of smart card technology would be adversely affected because he/she would perceive the card as invading his/her right to privacy of personal information. In light of such a circumstance, this person's perception of the Compatibility of smart card technology could cloud their perceptions towards any Relative Advantage of the innovation (such as reduced data entry because the card can access and use personal information directly), since acknowledging the existence of a Relative Advantage might signal acceptance of the innovation. Thus while Compatibility and Relative Advantage may be conceptually distinct, empirically they are not. Based on this discussion, the high correlation, and the lack of discriminant validity between Relative Advantage and Compatibility, the model was revised once more and Compatibility and Relative Advantage were combined into one construct.

Using this new model, a PLS run was executed and a new table of reliabilities and convergent and discriminant validity was constructed. Table 5.7 presents the PLS latent

variable loading structure matrix indicating the factor loadings of the variables on the new model. As would be expected, since the only change that has been made to the model was to combine Relative Advantage with Compatibility, factor loadings for all other constructs remain unchanged (except where there are cross-loadings with the Relative Advantage/Compatibility construct). The resultant factor loadings for the new combined Relative Advantage/Compatibility construct indicate excellent construct validity, as all items loaded at or above 0.71.

The reliability, convergent and discriminant validity table for the new model is reproduced in table 5.8. Since the only change to the model was to combine the Relative Advantage and Compatibility items, the reliabilities for all other constructs is unchanged from the values presented and supported in table 5.6. With regards to the reliability of the Relative Advantage/Compatibility construct, the Cronbach alpha of 0.94 indicates that it is very reliable. As the table further shows, the convergent and discriminant validity of the model is confirmed as all entries for the correlation between the construct and its underlying variables (i.e. the diagonals) are higher than the correlations with any other variable (i.e. correlations along the row or column).

Survey Item	Treat-ment	R.Adv/ Compat	Ease of Use	Image	Result Demo.	Trial-ability	Visi-bility	Vol. of Use	Intentions to adopt
Treatment	**1.00**	-0.15	0.05	-0.04	0.01	0.05	0.03	-0.07	0.00
RA/CO1	-0.11	**0.75**	0.22	0.40	0.26	0.11	0.26	-0.15	0.40
RA/CO2	-0.08	**0.84**	0.44	0.33	0.52	0.27	0.32	-0.27	0.46
RA/CO3	-0.14	**0.86**	0.47	0.28	0.46	0.36	0.36	-0.27	0.49
RA/CO4	-0.13	**0.83**	0.31	0.39	0.38	0.21	0.38	-0.24	0.42
RA/CO5	-0.08	**0.72**	0.12	0.34	0.15	0.36	0.06	-0.11	0.30
RA/CO6	-0.13	**0.76**	0.16	0.28	0.32	0.36	0.16	-0.18	0.33
RA/CO7	-0.12	**0.72**	0.17	0.34	0.33	0.17	0.12	-0.09	0.28
RA/CO8	-0.06	**0.76**	0.37	0.31	0.43	0.40	0.36	-0.17	0.40
RA/CO9	-0.11	**0.83**	0.37	0.24	0.42	0.33	0.24	-0.18	0.41
RA/CO10	-0.20	**0.71**	0.20	0.31	0.29	0.21	0.21	0.06	0.22
RA/CO11	-0.20	**0.82**	0.21	0.41	0.38	0.23	0.24	-0.08	0.27
EU2	-0.02	0.40	**0.83**	0.10	0.64	0.34	0.56	-0.38	0.55
EU3	0.11	0.08	**0.70**	-0.18	0.35	0.04	0.27	-0.24	0.23
EU4	0.03	0.28	**0.79**	0.02	0.50	0.18	0.32	-0.27	0.40
EU5	0.10	0.26	**0.83**	-0.01	0.53	0.21	0.41	-0.24	0.50
EU6	-0.01	0.34	**0.67**	-0.04	0.30	0.29	0.24	-0.14	0.36
IM1	-0.04	0.37	0.07	**0.82**	0.23	0.22	0.36	-0.06	0.18
IM2	-0.03	0.20	-0.14	**0.78**	0.03	-0.07	0.09	-0.11	0.07
IM3	-0.02	0.38	-0.02	**0.88**	0.18	0.09	0.21	-0.12	0.20
RD1	-0.03	0.31	0.46	0.21	**0.82**	0.17	0.42	-0.24	0.41
RD2	-0.09	0.36	0.55	0.15	**0.84**	0.19	0.48	-0.28	0.44
RD3	0.11	0.44	0.51	0.13	**0.73**	0.30	0.32	-0.23	0.43
RD4	0.04	0.31	0.39	0.16	**0.67**	0.30	0.39	-0.26	0.31

Table 5.7 - PLS Latent Variable Loading Structure Matrix, New Model (pg. 1 of 2)

Survey Item	Treat-ment	R.Adv./ Compat	Ease of Use	Image	Result Demo.	Trial-ability	Visi-bility	Vol. of Use	Intentions to adopt
TR1	0.04	0.38	0.25	0.12	0.19	**0.88**	0.19	-0.22	0.37
TR3	-0.05	0.21	0.25	0.10	0.27	**0.64**	0.33	-0.20	0.18
TR4	0.13	0.10	0.16	0.08	0.29	**0.65**	0.14	-0.14	0.17
VS1	0.03	0.23	0.45	0.19	0.47	0.23	**0.87**	-0.25	0.34
VS2	0.03	0.34	0.39	0.33	0.41	0.24	**0.82**	-0.21	0.29
VU2	-0.16	-0.25	-0.27	-0.13	-0.34	-0.41	-0.26	**0.80**	-0.28
VU3	0.14	-0.09	-0.23	0.05	-0.17	0.01	-0.17	**0.54**	-0.14
VU4	0.01	-0.04	-0.23	-0.08	-0.12	0.04	-0.12	**0.71**	-0.21
INT1	0.03	0.46	0.43	0.16	0.39	0.33	0.33	-0.29	**0.80**
INT2	-0.05	0.29	0.48	0.10	0.45	0.15	0.33	-0.15	**0.77**
INT3	0.08	0.25	0.34	0.19	0.35	0.29	0.21	-0.22	**0.78**
INT4	-0.05	0.41	0.44	0.19	0.41	0.31	0.25	-0.26	**0.79**
INT5	-0.02	0.41	0.40	0.17	0.43	0.32	0.28	-0.26	**0.84**
INT6	-0.02	0.29	0.54	0.11	0.42	0.29	0.36	-0.34	**0.81**
INT7	0.01	0.46	0.48	0.18	0.43	0.35	0.31	-0.25	**0.86**
INT8	0.02	0.50	0.53	0.22	0.53	0.31	0.40	-0.32	**0.91**

Table 5.7 - PLS Latent Variable Loading Structure Matrix, New Model (pg. 2 of 2)

	Reli-ability	Treat-ment	R.Adv/ Comp.	Ease of Use	Image	Result Demo.	Trial-ability	Visi-bility	Vol. of Use	Intent to adopt
Treat-ment	n.a	n.a								
R.Adv/ Comp	0.94	-0.15	0.78							
Ease of Use	0.82	0.05	0.37	0.76						
Image	0.79	-0.04	0.41	0.00	0.83					
Result Demo.	0.77	0.01	0.47	0.63	0.21	0.77				
Trial-ability	0.60	0.05	0.35	0.30	0.14	0.31	0.73			
Visi-bility	0.59	0.03	0.33	0.50	0.30	0.52	0.28	0.84		
Vol of Use.	0.53	-0.07	-0.21	-0.34	-0.11	-0.32	-0.26	-0.27	0.69	
Intent to adopt	0.93	0.00	0.48	0.56	0.20	0.52	0.36	0.38	0.32	0.82

notes:
1. The reliability measure used is Cronbach's coefficient alpha.
2. Diagonal elements are the correlations between the construct and its underlying variables. Off diagonal elements are the correlations between the constructs.

Table 5.8 - New Model Reliability, Convergent and Discriminant Validity

Having established the validity and reliability of the new model, the next step was to analyze the structural model and test the hypotheses. The new research model and the PLS generated path coefficients and the R^2 statistics are presented in figure 5.1. Since PLS modeling places minimal assumptions on the data within a research model, standard statistical tests of significance cannot be directly applied to the output. To overcome this limitation, Tukey's jackknife (1982) approach is often used. According to Fornell, "Jackknifing involves the computation of sample statistics based on using the complete sample of observations and on several subsamples that overlap in the observations they contain". Jackknife output includes jackknife estimates of the research model parameters, standard errors of those estimates and most importantly (for our purposes) t-values for the testing of significance of all parameter estimates. For the jackknife run, n = 29 jackknife subgroups were created by omitting 5 cases from each sub-group (147/5 = 29.4 rounded down).

Since the Compatibility and Relative Advantage constructs were combined, the hypotheses dealing with these constructs (H_1, H_2, H_9, H_{10}) could no longer be evaluated separately. To maintain consistency and avoid renumbering the other hypotheses H_1, H_2 and H_9, H_{10} will be combined and referred to as $H_{1,2}$ and $H_{9,10}$.

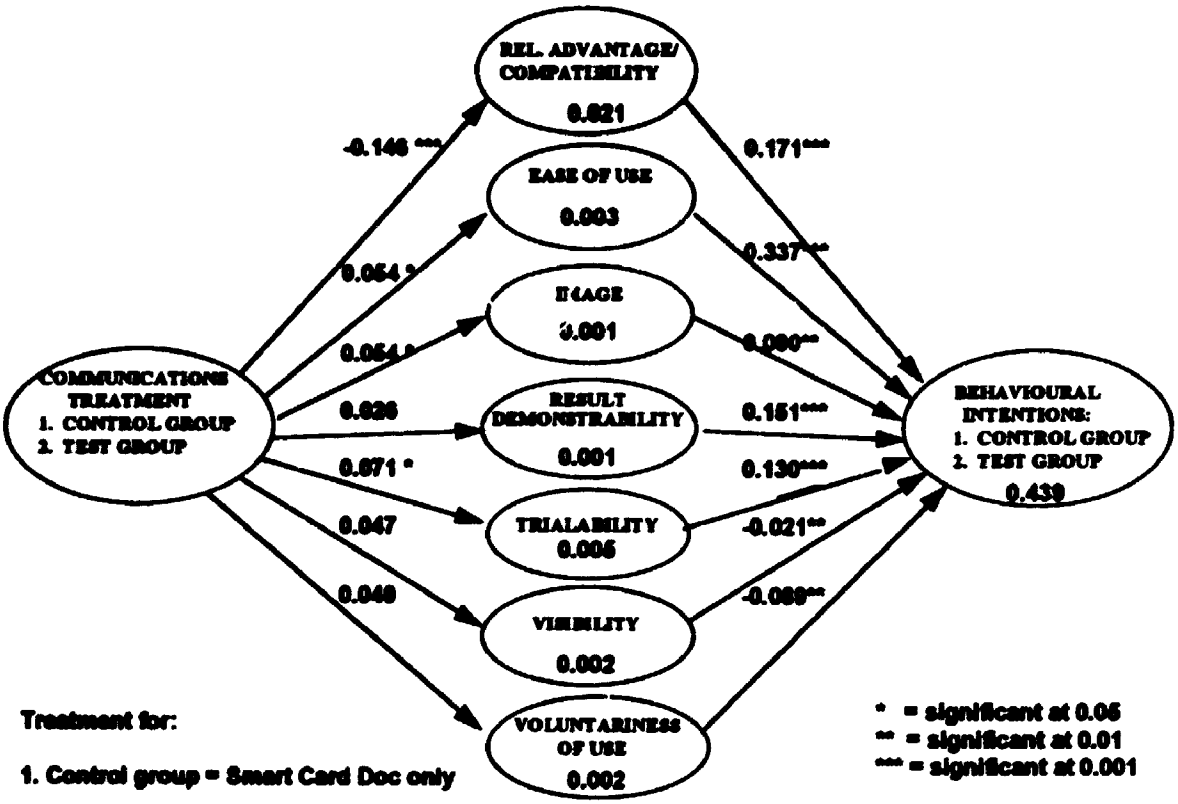

Figure 5.1 PLS Results

$H_{1,2}$-H_8 are concerned with the effects of smart card presentations on people's perceptions of the PCI's of smart cards while $H_{9,10}$-H_{16} are concerned with the relationship between people's perceptions of the PCI's of smart card technology and their intentions to adopt smart card technology. In Chapter 4, $H_{1,2}$-H_8 hypothesized significant differences in each of the PCI's of smart card technology between people who attended a smart card presentation and those who did not attend such presentations whereas $H_{9,10}$-H_{16} hypothesized significant relationships between perceptions of the PCI's of smart card technology and their intentions to adopt smart card technology. As explained earlier, jackknife t-values were used to evaluate the statistical significance of the relationships identified in the PLS research model output. The statistical significance of the PLS generated path coefficients determine whether or not a hypothesis is supported. Table 5.9 presents the jackknife results as applied to $H_{1,2}$-H_{16} and shows that statistical support (α = .05 or better) is provided for $H_{1,2}$-H_4, H_7. Thus the presentations had a significant effect on Relative Advantage/Compatibility, Ease of Use, Trialability and Image. By contrast, since H_5, H_6, and H_8 were not supported, presentations do not have a significant effect on Result Demonstrability, Visibility or Voluntariness of Use.

In order to determine the significance of these results, the PLS research model output presented in figure 5.1 is useful. Since treatment level is the independent variable in relation to the first half of the model ($H_{1,2}$-H_8) and there are only two states for

H_0	Description	Path Coeffic.	α
$H_{1,2}$	Significant difference in Relative Advantage/Compatibility	-0.146	.001
H_3	Significant difference in Ease of Use	0.054	.02
H_4	Significant difference in Trialability	0.071	.02
H_5	Significant difference in Result Demonstrability	0.026	.30
H_6	Significant difference in Visibility	0.047	.10
H_7	Significant difference in Image	0.054	.02
H_8	Significant difference in Voluntariness of Use	0.049	.30
$H_{9,10}$	Positive Relationship: Relative Advantage/Compatibility & Intentions to adopt	0.171	.001
H_{11}	Positive Relationship: Ease of Use & Intentions to adopt	0.337	.001
H_{12}	Positive Relationship: Trialability & Intentions to adopt	0.130	.001
H_{13}	Positive Relationship: Result Dem. & Intentions to adopt	0.151	.001
H_{14}	Positive Relationship: Visibility & Intentions to adopt	-0.021	.01
H_{15}	Positive Relationship: Image & Intentions to adopt	0.090	.01
H_{16}	Negative Relationship: Voluntariness of Use & Intentions to adopt	-0.089	.01

Table 5.9 - Summary of Results for Research Model Hypotheses

treatment (document + presentation or document only, no presentation) then it was logical to treat presentation as a dummy variable. This means that the output path coefficients from treatment to the PCI's, indicate the strength of the incremental effect of the presentation versus no presentation. Relative Advantage/Compatibility exhibited moderate and unexpected negative presentations effects as denoted by the -0.146 path coefficient for Relative Advantage/Compatibility (the implications of this negative effect are discussed in Chapter 6). Presentations were found to only exhibit a minimal effect on the other PCI's as evidenced by the fact that all path coefficients were between 0.026 to 0.071. The subtlety of the effects are visible in table 5.10 where the means and standard deviations for each variable with presentation or without presentation are presented. As table 5.10 illustrates, the Relative Advantage/Compatibility means for "without presentation" and "with presentation" are 0.31 apart, indicating a moderate difference between the two means. By comparison, the means "without presentation" and "with presentation" for all other constructs are all less than or equal to 0.18 apart, indicating subtle presentation effects.

Another area of discussion for the $H_{1,2}$-H_8 results, concerns the directional effect smart card presentations have on participants' perception of the PCI's of smart card

VARIABLE	WITHOUT PRESENTATION		WITH PRESENTATION	
	MEAN	STD. DEV.	MEAN	STD. DEV.
Relative Adv./ Compatibility	4.40	0.94	4.07	1.15
Ease of Use	5.28	1.05	5.41	1.06
Image	3.42	1.32	3.32	1.43
Result Demonstrability	4.91	0.91	4.93	1.20
Trialability	4.83	0.95	4.92	0.98
Visibility	5.02	1.16	5.10	1.13
Voluntariness of Use	3.70	1.19	3.73	1.00
Intentions to adopt	4.85	1.07	4.85	1.22

Table 5.10 - Means and Standard Deviations for Test Group and Control Group

technology. Since the smart card presentations were intended to help develop participants' perceptions of the PCI's of smart card technology, no directional effects expectations were incorporated into the hypotheses. However, feedback from Canadian Heritage's Advanced Card Systems section, showed that they theorized that the smart card presentations would have a positive effect on Relative Advantage, Compatibility, Ease of Use, and Image. The group's feedback indicated that they had no idea what effect the smart card presentations would have on Result Demonstrability, Trialability, Visibility and Voluntariness of Use.

As seen in figure 5.1 the observed results (i.e. the path coefficients to each PCI) show some interesting results. Recalling that the smart card presentations had a significant effect only on Relative Advantage/Compatibility (negative effect), Ease of Use (positive effect), Trialability (positive effect) and Image (positive effect). The effects observed for Ease of Use, Trialability and Image are fairly easy to explain. The positive effect observed for the Ease of Use PCI probably resulted from the ability of the presenter to visually demonstrate throughout the presentation, that little effort was required to use a smart card. Likewise, the positive effect for Image may have been affected by the demonstrated appeal of using the smart card, which in turn affected people's perceptions of the image of using a smart card. The smart card presentations may have had positive effect for Trialability because during the presentation, participants may have been able to acquire significant evaluative information regarding the Trialability of smart card

technology. On the other hand however, it should be remembered that the Trialability scale exhibited somewhat lower reliability (0.60) than was ideally desired, thereby serving as a reminder that the results for Trialability should be interpreted with some caution. By the same token it should also be noted that the same argument can be applied to the results for Visibility and Voluntariness of Use, where it was found that presentations had no effect on these two constructs. However, notwithstanding the aforementioned discussion, it has already been noted that support exists for the retention and use of these scales, therefore implying that the results for Trialability, Voluntariness of Use and Visibility are fairly stable and valid.

The effect that the smart card presentations had on Relative Advantage/ Compatibility however, was the opposite of what Canadian Heritage's Advanced Card Systems section thought would be observed. Instead of having a positive effect on Relative Advantage/Compatibility, the smart card presentations had a negative effect. This effect was surprising since indications were that smart card technology facilitated higher levels of productivity and accuracy while not requiring significant adjustments in the work styles of people.

To obtain some indication as to why this negative effect on Relative Advantage/Compatibility might have occurred, the presenter was interviewed for his impressions regarding this observation. The presenter commented that participants who

attended the presentations appeared to be "all geared up" before the presentation, but somewhat less enthusiastic and more pensive after the presentation. This comment seemed to indicate that the reality of the presentations did not live up to the expectations that the participants brought with them to the presentations. Why would audience enthusiasm drop? A possible reason for this drop may be that the one-page document fueled the imagination of the participants so that they came to the presentations expecting to see revolutionary Relative Advantage benefits as a result of the use of smart card technology but were disappointed when the presentations failed to meet these lofty expectations. This explanation for the presentation's negative effect on Relative Advantage/Compatibility therefore implies that people's perceptions of the PCI's of an innovation at the Knowledge stage of the Innovation-Decision Process are affected, in part, by their expectations regarding the innovation in question. As more information is gathered, however, expectations are replaced by information based on increased exposure to the innovation.

With regards to $H_{9,10}$-H_{16}, only H_{14}, a positive relationship between Visibility and intentions to adopt, was not supported by the results. All PCI's except Visibility exhibited the predicted effect on intentions to adopt. In addition, the high R^2 of 0.439 for intentions to adopt indicates that participants' perception of smart card PCI's accounted for approximately 44% of the variance of the intentions to adopt construct, thus confirming

that perceptions of PCI's are good predictors of people's intentions to adopt an innovation.

In examining the results for each PCI vs. intentions to adopt, the path coefficients generated by the PLS output relay much information about the nature and importance of relationship with intentions to adopt. For PCI's that exhibit positive path coefficient values, an increase in the PCI of the innovation will result in an increase in the intentions to adopt. By the same token, if a PCI exhibits a negative path coefficient value, then an increase in the PCI of the innovation will result in a decrease in the intentions to adopt. When comparing PCI's relationships with intentions to adopt, the magnitude of the path coefficient for a PCI indicates the strength of the relationship with intentions to adopt vis-à-vis the other PCI's.

As hypothesized, Relative Advantage/Compatibility, Ease of Use, Image, Result Demonstrability, and Trialability were shown to exhibit a positive influence on intentions to adopt. Therefore, an increase in any of these PCI's would result in an increase in intentions to adopt. Likewise, it was seen that, as hypothesized, Voluntariness of Use exhibited a negative influence on intentions to adopt. Therefore, an increase in the perceptions of the Voluntariness of Use would result in a decrease in intentions to adopt. The results for the Visibility PCI indicated that the effect it had on intentions to adopt was the opposite of what had been hypothesized.

In examining the importance of the relationships between the PCI's and intentions to adopt, examination of the path coefficients showed that there were three distinct groupings of relationships with intentions to adopt. Most significant among the PCI's and their relationship with intentions to adopt was the PCI for Ease of Use, whose path coefficient of 0.337 was roughly twice as large as the next largest path, Relative Advantage/ Compatibility which possessed a path coefficient of 0.171. This means that a unit increase in Ease of Use will generate approximately twice the rise in intentions to adopt as compared to the second most important PCI, Relative Advantage/Compatibility. At the second level of importance were the PCI's of Relative Advantage/Compatibility (0.171), Result Demonstrability (0.151) and Trialability (0.130). The third and least significant level of relationships with intentions to Adopt included the PCI's of Image (0.090), Visibility (-0.020) and Voluntariness of Use (-0.089). These results suggest people's motivation to adopt this innovation is most affected by their perceptions regarding the innovation's Ease of Use, followed by the innovation's Relative Advantage/ Compatibility, Result Demonstrability, and Trialability. With regards to Image, Visibility and Voluntariness of Use, the size of their path coefficients suggest that, from a practical viewpoint, their effects are not significant.

Analysis of the Linkages Between Characteristics of Individuals and Intentions

Five supplemental hypotheses were presented to test the relationships between intentions to adopt smart card technology and participants' age, level of education, social status, awareness of innovations and exposure to mass media communication channels. The goal of this part of the research was to determine how certain characteristics of individuals were related to participants' intentions to adopt smart card technology.

The analysis conducted for this section of the study involved comparing the mean intention scores based on the response classes for each of the characteristics of individuals. Analysis of Variance (ANOVA) was used as it allowed for comparisons between an independent variable(s) with multiple classes and a continuous dependent variable. When looking at the five characteristics of individuals examined in this study, it must be remembered that, by Rogers' definition, they fall into two distinct groupings; 1) the socioeconomic characteristics of Age, Education and Social Status, and 2) the communication behaviour variables of Awareness of Innovations and Exposure to Communications Channels. Since ANOVA results are sensitive to the way independent variables are grouped together, it was decided that two ANOVA runs would be generated, one for each group of distinct characteristics of individuals. Since this is not interested in exploring what, if any, interaction effects exist between Awareness of Innovations and Exposure to Communications Channels or between Age, Social Status and Education, the ANOVA was concentrated only on main effects. Tables 5.11 and 5.12 present the

ANOVA results for each class of variable, while table 5.13 presents a summary of support for the hypotheses.

For the first ANOVA run, the socioeconomic characteristics of Age, Education and Social Status were compared with behavioural intentions. The results as shown in table 5.10 indicate that at $\alpha = 0.05$ or better, both employees' Social Status (represented by respondents' job, $\alpha = 0.017$) and Education level ($\alpha = 0.033$) are related to respondents' intentions to adopt smart card technology, thereby supporting H_{18} and H_{19} and in agreement with Rogers' findings vis-à-vis Education level and innovativeness and Social Status and innovativeness. By contrast, it was found that the relationship between Age and intentions to adopt smart card technology was not significant at $\alpha = 0.05$ level, therefore also providing support for H_{17} (no relationship between Age and intentions to adopt smart card technology) which is also in agreement with Rogers' findings regarding Age and innovativeness.

The second ANOVA run tested the relationships between the communications behaviour variables of Awareness of Innovations and Exposure to Communications Channels with respondents' intentions to adopt smart card technology. The results of the ANOVA run (see table 5.11) indicate that at $\alpha = 0.05$ or better, both Awareness of Innovations ($\alpha = 0.017$) and Exposure to Communications Channels ($\alpha = 0.008$) are

Source of Variation	Sum of Squares	DF	Mean Square	F-statistic	Sig. of F.
Main Effects	34.320	12	2.860	2.418	.007
Age	8.727	3	2.909	2.459	.066
Social Status	14.789	4	3.697	3.126	.017
Education Level	14.840	5	2.968	2.509	.033
Explained	34.320	12	2.860	2.418	.007
Residual	153.762	130	1.183		
Total	188.082	142	1.325		

Table 5.11 ANOVA Results, Tested Socioeconomic Characteristics

Source of Variation	Sum of Squares	DF	Mean Square	F-statistic	Sig. of F.
Main Effects	27.811	7	3.973	3.347	.003
Awareness of Innov.	14.927	4	3.732	3.143	.017
Exp. to Comm. Ch.	14.538	3	4.846	4.082	.008
Explained	27.811	7	3.973	3.347	.003
Residual	160.271	135	1.187		
Total	188.082	142	1.325		

Table 5.12 ANOVA Results, Tested Communication Behaviour Variables

$H_{\#}$	DESCRIPTION	F-VALUE	α
H_{17}	No relationship: Age vs. B. Intentions	2.459	.066
H_{18}	Relationship: Social Status vs. B. Intentions	3.126	.017
H_{19}	Relationship: Education Level vs. B. Intentions	2.509	.033
H_{20}	Relationship: Awareness of Innovations vs. B. Intentions	3.143	.017
H_{21}	Relationship: Exp. to Comm. Channels vs. B. Intentions	4.082	.008

Table 5.13 Summary of Results for Supplemental Hypotheses

related to respondents' intentions to adopt smart card technology, therefore supporting H_{20} and H_{21} and once again in agreement with Rogers' findings vis-à-vis these variables and innovativeness.

As shown in this chapter, most of the hypotheses that were formulated in this research study were supported. The next chapter will present a discussion regarding the implications of these results as well as a discussion of the limitations and conclusions.

CHAPTER 6

DISCUSSION

This chapter will discuss: 1) the implications of the results for the research and work environment, 2) the limitations of this thesis, 3) suggestions for areas of further study, and, 4) the conclusions drawn from this study.

Implications of Knowledge Results

As was shown in the previous chapter, both the control and treatment groups achieved satisfactory scores on the knowledge section of the survey, supporting the conclusion that the one-page smart card document was sufficient to impart general knowledge to participants. Since the one-page smart card document was mass-distributed to all participants, the results verify Rogers' contention that mass-media communications channels work well in the Knowledge phase of the Innovation-Decision Process. It was interesting to note that the knowledge test scores for participants that attended smart card presentations were marginally, but significantly higher than the knowledge test scores for participants who only received the one-page smart card document. This finding implies that the smart card presentations may have provided some form of knowledge reinforcement to the participants. This implication is important for business because it identifies a tangible benefit accruing to group presentations.

Given that the knowledge results confirmed that both groups had acquired the necessary base level of knowledge, it may have been fruitful to expand this section of the survey to include some questions that would test people's evaluative knowledge of smart cards. Since evaluative knowledge would be gathered through the presentations, one would expect employees attending the presentations to score considerably better that employees who received the smart card document only. Such an exercise would serve to further distinguish the benefits of conducting group presentations

Implications for Effects of Smart Card Presentations on Participants' PCI's of Smart Card Technology

The results of the hypothesis tests in Chapter 5 showed that, when compared to the perceptions of participants who only received a one-page smart card summary document, smart card presentations have a statistically significant, although small effect on participants' perceptions of Relative Advantage/Compatibility (note, however, that the observed direction of effect was opposite to what was expected), Ease of Use, Trialability and Image but do not have a statistically significant effect on participants' perceptions of Visibility, Result Demonstrability or Voluntariness of Use.

The fact that the presentations had only minor effects on people's perceptions of smart cards has some significant implications for this study. It was interesting to note that, from a departmental point of view, the Advanced Card Systems Group at Canadian

Heritage was surprised to hear of these results. Up until the conduct of this study, it had always been assumed that smart card presentations were very useful tools in educating people on the merits of using smart cards and in gaining information on the use of smart cards themselves. It should be noted, however, that in the past, presentations were used as a sole form of introduction to smart cards, that is people attending presentations would not receive any form of documentation prior to the presentation. Therefore, in the Canadian Heritage setting, the usefulness of the presentations was exaggerated by the fact that people attending the presentations typically did not know how to define a smart card and therefore extracted both basic and evaluative knowledge from the presentations. While it is acknowledged that under such circumstances presentations could have a great impact on people attending them, the fact that this study showed that the distribution of a simple document achieved almost equivalent results suggests that different types of communications should be developed by Canadian Heritage and tailored so as to deliver the "best bang for the buck" to the intended audience.

Notwithstanding the above, the expectations of this study were that presentations would have significant effects on perceptions of smart card PCI's, over and above those observed for people who received only smart card documents. Referring back to DOI theory, Rogers stated that interpersonal communications was the form of communications responsible for allowing the acquisition of evaluative knowledge necessary to make a decision to adopt or reject an innovation. If group presentations were accepted as a form

of interpersonal communications (as proposed by this study), then sizable differences should have been noticed between people who received the document only and those who received the document and presentation. Since the results indicated otherwise, it is possible that an internal or external factor may have served to minimize the difference in impact between the two treatments. If this is the case then a number of explanations are possible for the minor differences that were observed.

First, it is possible that the smart card document provided some evaluative knowledge in addition to basic knowledge, thereby reducing the difference in evaluative knowledge between the test group and control group participants. In reviewing the smart card document, one notices that several superlatives were used, such as "revolutionize the public telephone system" and "sophisticated encryption/decryption techniques". It is possible that these superlatives may have presented evaluation-type knowledge to its readers rather than just a basic level of non-evaluative information, thereby reducing the impact of the presentations. However, it should also be noted that the evaluative information contained within the smart card document is minuscule in comparison to the evaluative information that is presented during a smart card group presentation, as participants to group presentations are able to view and ask questions about actual smart card applications that have been developed for use. As such, it seems unlikely that the smart card document would have significantly reduced the effectiveness of the smart card presentations.

If it is accepted that the smart card document did not serve to mitigate the effects of the presentations, then the suitability of the presentations as a form of interpersonal communications can be questioned. Interpersonal communications is usually characterized by a one-to-one or one-to-few relationship, that is the size of the groups involved in interpersonal communications are small. In such situations people tend to be more open and participative. The average presentation size of 30-40 people may have proved too large and as such, prevented participants from asking the necessary questions to develop a comprehensive evaluative framework on the merits of using smart cards. Since the results of this study indicated that presentations had minor effects on perceptions of PCI's, the logic of this argument therefore implies that smart card presentations can only be viewed as weak forms of interpersonal communications. How would these results be interpreted for use in the workplace? One answer is that although exposure to smart card presentations would only result in marginal changes in developing people's perceptions of the PCI's of an innovation, the per person cost for imparting this form of communications would be low as well, because one presentation could be used to reach many people. Therefore, in a program of innovation diffusion where major change in perception towards the innovation was identified, presentations alone would be ineffective in achieving the desired effect and more expensive means of communications investment would have to be used. On the other hand, if only minimal change in perception towards the innovation was required, or if budgets were tight, the use of presentations could be viewed as be a cost-

effective way to achieve at least some change in people's perceptions of the PCI's of an innovation.

Bearing in mind the above arguments, it seems most likely that as concluded, the presentations are weak forms of interpersonal communications. However, to investigate the meaning of these results further, it is suggested that Canadian Heritage would be prudent to go back and interview some of the people in the targeted organizations to determine their impressions of the smart card document, the incremental benefits of attending the group presentations, what they liked or disliked about the presentations, how the presentations could have been improved, and whether some other form of communications would have been more effective.

An interesting finding regarding the effects of group presentations on participants' perceptions of PCI's of smart cards was the significant negative presentation effects that were documented for Relative Advantage/Compatibility. Although $H_{1,2}$ postulated no direction for the presentation effects on Relative Advantage/Compatibility, the Advanced Card Systems Group had indicated that the results would probably support positive presentation effects for Relative Advantage/Compatibility. The results that were obtained were therefore surprising and merit discussion.

Rogers' definition of Relative Advantage centered around the degree to which an innovation was better (that is more useful, attractive, etc.) than its precursor. Smart cards were thought to possess Relative Advantage because they provided higher security of information, simplified access to computer systems, and provided a mechanism to allow for the elimination of paper-based request procedures by providing a means for entering an electronic signature. Similarly, Rogers' definition of Compatibility concerned the determination of an innovation's consistency with peoples values, needs, and past experiences. The smart card was thought to possess significant a significant Compatibility quotient because its use blended well with its intended applications, that is, the smart card represented a portable information repository, a natural extension of the current push to increase information portability. Why then would negative effects have been observed?

In Chapter 5 it was noted that the presentation's apparent negative effect on Relative Advantage/Compatibility may have been due to the possibility that the presentations were unable to meet the expectations formed by the participants reading of the one-page smart card document. Again, as discussed earlier, a review of the smart card document showed that it was written in a fairly convincing manner. The above explanation is all the more plausible when one notes that the participants, for the most part were naive with regards to the capabilities of technology. If this argument holds true, then unmet expectations rather than presentations, were responsible for the negative effect on Relative Advantage/Compatibility. For similar future research, this implies that

participants' expectations should be a factor that is accounted and controlled for in the research design.

It is also possible, however, that the presentation's negative effect on Relative Advantage/Compatibility may also have been a result of low credibility given to the presenter. Since the presenter was not part of the reference group of participants, the participants may have been less receptive to accepting the presenter's message. Such a reaction would dampen their perceptions of Relative Advantage/Compatibility thereby implying that credibility is an important attribute for the presenter to possess. By training members from the groups of participants, to give the presentations, credibility and acceptance afforded to the presenter (which in this case would be the trained group member) would be higher than for the smart card presenter, who would be looked upon as an outsider. This higher level of credibility and acceptance could result in higher perceptions of Relative Advantage/Compatibility.

A final explanation for the negative effects of presentation on Relative Advantage/Compatibility concerns the dynamics of introducing information technology in the current employment environment. The increasing pressures of government-wide fiscal restraint has, from time to time cast a dark shadow on information technology, associating its introduction with corresponding job cuts. If this were the case, participants, might see the technology as a threat to their employment therefore naturally tainting their

perceptions of smart card benefits. However, the results for intention scores indicated that the participant's were moderately receptive to smart card technology, therefore providing support that no connection was made between the introduction of smart cards and job losses.

Implications for the Relationships between PCI's of Smart Card Technology and Intentions to Adopt Smart Card Technology

In Chapter 5 it was seen that Ease of Use and Relative Advantage/Compatibility were the two most important PCI's in the relationship with intentions to adopt. In addition it was seen that both of these PCI's exhibited positive relationships with intentions, that is higher perceptions of Relative Advantage/Compatibility and/or Ease of Use resulted in higher intention scores. This finding is significant since these two PCI's correspond to the two basic constructs that Davis (1986) uses in his TAM model (see Literature Review). Davis' TAM states that behavioural intentions are a function of the Perceived Usefulness of the object, which is incorporated into the Relative Advantage construct, and the Perceived Ease of Use of the object. TAM has weathered comparisons with other behavioural intention models very well where it has been shown that TAM has significant ability to predict behavioural intentions. Considering the similarities between Ease of Use and Relative Advantage/Compatibility and TAM, it is suggested that TAM could be used as a quick means of evaluating people's intentions to adopt future innovations. If an innovation's adoptability through TAM looks promising, or if more

insight into other characteristics of an innovation is desired, then an examination using the Moore and Benbasat PCI's could be performed to gain a more complete picture of the predicted level of acceptance for that innovation.

In Chapter 5, it was seen that Image and Voluntariness of Use exhibited weak influence on intentions to adopt. In considering why such results were observed, it is useful to look at Voluntariness of Use and Image separately, to see how each of these PCI's might have been evaluated by the participants.

It is possible that the results obtained for Voluntariness of Use reflect confusion regarding interpretation of the construct. Moore and Benbasat (1991) argued that as the expectation to adopt an innovation grew, so did intentions to adopt, since an employee would feel that it was in his/her best interest to get more interested in the innovation. However, contrary to Moore and Benbasat, it could be argued that as Voluntariness of Use decreases (that is adoption is seen as being less voluntary) intentions will decrease as well, as people revolt to the loss of their freedom of choice. If this latter interpretation is correct, then interpretations of the results obtained would be the opposite of what was identified, and Moore and Benbasat's use of Voluntariness of Use would have been mis-specified. On the other hand, if Voluntariness of Use is interpreted as identified by Moore and Benbasat then mandatory adoption within an organization would result in higher intentions to adopt. The results obtained in Chapter 5 seem to support this interpretation

for Voluntariness of Use. If this is the case however, it raises into question the significance of other constructs such as Relative Advantage/Compatibility because if mandatory adoption results in higher intentions, who cares about perceptions of Relative Advantage/ Compatibility. This argument therefore brings into question the validity of Moore and Benbasat's contention that Voluntariness of Use directly affects intentions. As an alternative, a more plausible definition might be that PCI's relations to intentions are affected by perceptions of Voluntariness of Use, therefore Voluntariness of Use has a moderating effect on the impact of the relationships between the PCI's and intentions.

It is possible that the weak link between Image and intentions is due to the nature of innovation that smart card technology represents. When discussing the Image PCI, Rogers and others have usually associated its importance to its status conferring attributes, that is the Image PCI is most important when the innovation in question can confer an element of status to its user. Usually, status is also associated with limited availability/accessibility and visibility. Limited availability/accessibility is important because possession of such items differentiates the holder from his/her peers. Visibility however is also important, because status will not be conferred upon the owner of a status item unless his/her peers are aware of the fact that he/she possesses the item. Based on this argument, participants may have rationalized that Image was not important because use of smart card technology would be commonplace within the department, since smart card technology would be targeted for use in everyday processing. Contrary to this

explanation however, it has been suggested that Canadian Heritage's culture is one of "reverse snobbery", that is employees of the department characteristically have looked with disdain to anything that is considered to be a status-conferring object. If this were the case then the Image relationship would most likely have been a fairly strong negative relationship, since "reverse snobbery" defines an attitude extreme, and people with extreme views tend to be strongly opinionated. The results however, showed weak effects for Image therefore not supporting the "reverse snobbery" proposition. In addition, this author's experience with Canadian Heritage's employees suggests that, Canadian Heritage employees are as image conscious as employees of any other department, and many ist the time that employees have been seen hoarding technology simply for the sake of having it.

The fact that Visibility was found to have no real effect on intentions to adopt (path coefficient of 0.020) can be tied once again to problems observed with conducting this study in an early pre-adoption setting, that is, exposure to the innovation is required before individuals can form perceptions of Visibility. If the timing of the study had been delayed more to a near-adoption setting perhaps stronger effects might have been observed.

Implications for the Relationships Between Characteristics of Individuals and Intentions to Adopt Smart Card Technology

The supplemental hypotheses for the relationship between characteristics of individuals and intentions to adopt were formulated to test the likelihood that certain characteristics of individuals are related to behavioural intentions. The three socioeconomic characteristics variables and two communications behaviour variables that were chosen were meant to show that on a basic level, certain groups or types of participants tend to embrace new technology more enthusiastically than others. When Rogers talked about innovativeness, he was referring to how quickly or at what stage a person was apt to adopt an innovation. In the context of this study, an argument was made that someone who was apt to adopt an innovation quickly, would probably be more enthusiastic about the desirability of the innovation, and as such would display higher levels of intentions to adopt the innovation. While intuitively, this argument makes sense it had not been directly or formally tested.

As was seen in Chapter 5, Rogers' conclusions regarding innovativeness and the variables in question were shown to be supported for intentions to adopt smart card technology as well. The results showed that Level of Education, Social Status, Awareness of Innovations, and Exposure to Communications Channels are positively related to intentions to adopt, while Age is not related to intentions to adopt. Rogers' research showed that people with higher levels of education and social status were more open to

taking risks. From the point of view of this study, adopting an innovation in its early stages is risky since failure can have an impact on other people's perceptions of the individual. As well, a failed adoption of an innovation can also cause a loss of face in the eyes of one's superior officers. However, as noted by Rogers, the greatest benefit and advantages of adoption go to early adopters of innovations. These observations can be used to explain why, in this study, Level of Education and Social Status were related to intentions to Adopt. Participants at higher levels in these groups, tended to possess higher responsibility/management levels in the department. As such, successful adoption of smart cards for their areas of responsibility would have a broader impact than for an individual who was responsible only for his or her own work.

With regards to Awareness of Innovations and Exposure to Communications Channels, people who score high in these categories have more information at their disposal, they tend to be very well informed and tend to seek out ways to improve aspects of their lives (both at home and at the office). As such, participants who score high in these categories would be more open to embracing smart card technology and may have been able to extract more evaluative information from the smart card one-page document or the smart card presentations.

Implications of Results for the Administration of the Survey used in the Study

The administration of the Moore and Benbasat based survey in the pre-adoption setting of this study revealed some significant areas of this survey that need improvement. The first area of findings concerned some problems that were noted with the ability to generalize this survey for measuring PCI's of smart card technology. Although the results obtained through use of this survey were very useful, it was seen that some of the items were not applicable to smart card technology. Much of the reason for this non-applicability probably stems from the rigidity of use of smart card technology. Unlike a microcomputer or a general purpose software application like word processing and spreadsheets, smart card technology is relatively inflexible in its capabilities and use by end-users. Moore and Benbasat maintain that their survey was designed to be applicable to information technology in general, but when looking at their survey, one sees that it is better suited to general information technology products that allow higher degrees of user input to determine how the technology is used. While the survey would work very nicely with the evaluation of a new spreadsheet software package, it would require substantial modification to work well with the evaluation of a new-technology CD-ROM drive where items like " I believe that it is easy to get a CD-ROM drive to do what I want it to do" and "I have seen what others do using their CD-ROM drives" are difficult to interpret and answer. For others interested in using this instrument, it is suggested that Moore and Benbasat's survey remains an excellent starting point for evaluating PCI's of an

information technology as long as the researcher carefully examines and modifies instances where the item does not fit the information technology innovation.

The context of a pre-adoption setting also had an apparent impact on the results obtained from the survey. It was suggested in Chapter 5, that due to a lack of direct exposure to smart card technology, participants may have had difficulty in formulating perceptions of Trialability, Visibility and Voluntariness of Use. Evidence of this difficulty was seen in the lower reliabilities and factor loadings of the Trialability, Visibility and Voluntariness of Use constructs. Since research concerning pre-adoption attitudes and intentions towards adoption of innovations is important for determining courses of action regarding the introduction of an innovation, solutions need to be found for improving the ability to measure constructs such as Trialability, Visibility and Voluntariness of Use in a pre-adoption setting.

Upon reflection, the experience of this study reveals two areas where changes could have had an effect on the measurement of the aforementioned constructs. The first area concerns the timing of the study. It is possible that the study was conducted too far in advance of the introduction of smart card technology. If the study had been delayed until near-adoption, that is after Department-wide promotion of the technology, the establishment of some trial sites and the proven viability of various test sites within the Department, employees would be able to acquire a modest level of exposure to the

technology. This exposure would therefore allow for significant development of attitudes towards smart card technology. However, by the time this stage of involvement in smart card technology is reached, the Department typically will have invested rather heavily in the technology, and a decision to abandon implementation of the technology would result in the loss of that significant investment. By contrast, the timing of this study was such that the Department's investment in smart card technology was still at a modest level and a decision to abandon the technology would therefore not result in much loss.

Another option that could have improved the measurement of the Trialability, Visibility and Voluntariness of Use constructs would have been to revise the survey items dealing with these constructs so that, in the setting of this study, participants would be able to answer the items more confidently. For example, the Trialability item "I know where I could go to satisfactorily try out various uses of a smart card" could have been replaced with "I would be able to try out the various uses of a smart card before making a decision regarding its use".

A final area of insight regarding the problems encountered with the use of the Moore and Benbasat survey concerns the apparent non-discrimination between the Relative Advantage and Compatibility constructs. As was seen in Chapter 5, the results obtained from the survey indicated that these two constructs were measuring the same characteristics. This conclusion was supported by the factor analysis which showed that

items in the two constructs loaded heavily on both constructs. A second indicator of the similarity of the two constructs was the extreme correlation (.81) between the two constructs. In their study, Moore and Benbasat (1991) obtained even higher factor cross-loadings and higher correlations (.99) for these two constructs than were evidenced within this study. Given that Moore and Benbasat chose not to combine Relative Advantage and Compatibility into one construct, it is somewhat surprising that they did not revise the survey in an attempt to lower the correlation between these two constructs.

Reflecting on the explanation given in Chapter 5 for why participants might assess Relative Advantage and Compatibility simultaneously as one construct, it is suggested that an effective approach to enable participants to discriminate between the two constructs would involve sensitizing the participant to treat Relative Advantage objectively in isolation from their perceptions of Compatibility. For example, the Relative Advantage item "Using a smart card would increase my productivity" could be changed to "Whether or not a smart card fits well with the way I work, I can see how it would increase my productivity". By sensitizing the participant to isolate Compatibility items from Relative Advantage items, the participant may return more focused Relative Advantage responses, which would improve the likelihood that the two constructs would measure different characteristics.

The above discussion regarding Relative Advantage and Compatibility implies that when applied to information technology, Moore and Benbasat's survey could benefit from revisions aimed at better exposing the differences between Relative Advantage and Compatibility. From a practical viewpoint, the findings vis-à-vis Relative Advantage and Compatibility underscore how difficult it can be to assess attitudes towards a new technology.

Limitations

It is believed that the results obtained from this study are valid and have been derived with due respect to established and accepted research methodologies and practices. However, as in the case of any research study, certain unavoidable circumstances limit the generalizability and applicability of the results. The following discussion presents the limitations for this study.

The research question posed for this study implied a causal relationship between smart card presentations and intentions to adopt smart card technology. While it is important to determine how smart card presentations affect intentions to adopt smart card technology, an even more fundamental issue concerns how these intentions to adopt smart card technology translate into actual adoption patterns (since this is the tangible end product of behavioural intention). Therefore, since this is not a longitudinal study, actual adoption patterns cannot be determined for smart card technology. However, according

to Fishbein and Ajzen (1975) and supported by Davis (1986), Moore (1987) and Mathieson (1991) intentions can be used to predict actual behaviour, provided the behaviour is within the accepted social norms of the groups in question. Therefore, this study design allowed for the extrapolation of an acceptable predictor of actual behaviour (adoption of smart card technology). It is the intention, however, to follow-up this study at some future point in time to assess the actual adoption of smart card technology that takes place within the Department of Canadian Heritage and compare those figures with the intention to adopt figures obtained in this study.

The experimental design chosen adequately handles all basic internal validity threats except experiment mortality. However, this threat was controlled for by conducting the experiment over a very short time frame, thereby reducing the chance of differential losses from treatment and control groups. With regards to limitations of external validity, the absence of the pretest removed the threat associated with Reactivity of Testing. However, there was a possible threat from Interaction of Selection and possible biasing effects. It is believed, however, that Interaction of Selection was adequately handled because the organizations and individuals that were selected represented a wide range of individuals with skills, backgrounds and cultural awareness similar to those within the Department as a whole. Possible biasing effects for self-selection were eliminated as selection of participants was controlled by the author. Response bias that might result from participants' fear of being evaluated was controlled

for by making participants understand that no one was being evaluated, that all information gathered was held in strict confidentiality, and that data would be analyzed and reported based on group response, not individual response.

Since the study was conducted within a relatively small area of one Canadian Federal Government Department, the ability to generalize the results obtained to the rest of the Department or to other Federal Government Department's represents another limitation that needs to be addressed. One of the issues that may have had a bearing on the generalizability of the results concerns the reality, that in the past two or three years, federal government downsizing and fiscal cuts have been concentrated within the administrative support operations of government resulting in significant in this population's work environment. People in such organizations have experienced increased levels of stress and workload, accompanied by a degradation in general quality of life. As such, there has been a general acknowledgment that government actions have demoralized this group considerably. Since this study was concentrated within the administrative support groups, it could be questioned as to what affect these factors would have on the results. In the development of the study, administrative support employees were chosen because they tended to be generalists, their functions could be found in every other government department as well as private industry enterprises, and because the makeup of these organizations always comprised a heterogeneous mix of classification levels, educational backgrounds, and social status. As such, it was felt that this group offered the

best chance at generalizability of results to other government departments. The effect of poor morale and high stress on the derivation of the results can be taken into account by noting that, if anything, these external factors would cause the results that were obtained to be on the conservative side, since the so called "least enthusiastic" groups were being tested. Therefore by following the results of this study, Canadian Heritage would have an indication of what the worst case results for receptiveness to smart cards and effectiveness of presentations would be. In implementations to more accommodating areas of the department, higher acceptance of smart cards could be evidenced.

A final area of limitations is concerned with the results of the data analysis that was conducted. As was discussed in the results section, conducting this study in a pre-adoption setting made it difficult for participants to form stable perceptions towards the PCI characteristics of Trialability, Visibility and Voluntariness of Use. This situation was possibly responsible for the lower factor loadings on some of the items for these constructs as well as the lower reliability coefficients observed for the corresponding scales. Remedies that were taken to improve construct validity and scale reliability were, however, in-line with accepted research procedures and, as discussed, the resulting validity and reliability for the Trialability, Visibility and Voluntariness of Use constructs were still shown to be acceptable, although not ideal.

Despite the limitations inherent in this study, it is felt that pre-adoption studies are very worthwhile exercises, given the importance that businesses place on acquiring information as early as possible before substantial decisions are made.

Areas of Further Study

Some of the questions that have been raised as a result of this study deserve further consideration and research. These areas include:

1. Revisiting the Department of Canadian Heritage to determine how well behavioural intentions translate into adoption and to measure and compare people's PCI's towards smart card technology in a post-adoption setting.

2. Studying the relationship between Compatibility and Relative Advantage and the strong intercorrelations that they often exhibit. As was discussed in this report, Compatibility and Relative Advantage were found to measure the same characteristics. This finding was also observed in another study by Moore and Benbasat. Research into this relationship could help in understanding the cause of this phenomenon.

3. Improving the ability to tap into people's perceptions of Trialability, Visibility and Voluntariness of Use in a pre-adoption setting. As discussed,

it was felt that the context of a pre-adoption setting caused difficulties in formations of the above mentioned PCI's. Research to establish the differences in conducting diffusion of innovations research in a pre-adoption versus post-adoption setting could help improve the measurement of these PCI's.

4. Performing a more detailed study of the relationship between innovativeness and behavioural intentions. This study has just scratched the surface of a possible relationship between innovativeness and behavioural intentions. More research into this relationship will help define the validity of the results that were obtained with this study.

Conclusions

The study has shown that smart card group presentations can be viewed as inexpensive forms of interpersonal communications (for use in situations where budgets are tight or desired change in perceptions is minimal). Furthermore, it was shown that employees of the Department are receptive to the adoption of smart card technology as evidenced by the 4.85 intentions to adopt score (recall that a 4 denoted neutral receptivity on a scale from 1 to 7). Although this intentions score is not high, it does indicate a positive view of the technology. One way that Canadian Heritage can capitalize on this information would be by moving quickly in marketing the benefits of smart card

technology to a broader group of employees through more presentations and the establishment of some test sites and trial sites. Another option that may cut costs of acceptance of smart card technology is for the Advanced Card Systems group to get involved in training members of target Canadian Heritage organizations to become familiar with smart card technology. These trained people could then make smart card presentations to their peers, which as explained earlier, could bring about higher acceptance levels.

The results showed that participants treated Relative Advantage and Compatibility as the same construct. As such, these results are supportive of the findings of Moore and Benbasat (1991). It was postulated that this outcome may have occurred because the survey did not sensitize the participants to be objective regarding Relative Advantage vis-à-vis Compatibility. In the future, efforts to separate these two constructs should be focused on this aspect of objectivity.

In this study, it was shown that perceived PCI's act as good predictors of intentions to adopt smart card technology. Whereas many diffusion of innovations studies link PCI's to attitudes, which are intermediary components of intentions, this study showed that, PCI's act as predictors of people's intentions to adopt an innovation. One of the interesting findings in this part of the study was the fact that these results provided

support for the use of TAM as a quick method to predict intentions, and in doing so, served to link diffusion of innovations theory to TAM.

This study helped uncover some challenges that face diffusion of innovations researchers who conduct studies in a pre-adoption setting. As it was noted in this study, the Moore and Benbasat instrument was found to need considerable modification for use in a pre-adoption setting. It was postulated that because participants could not draw upon experience regarding use of the innovation, the reliabilities and construct validities that were observed for the Trialability, Visibility and Voluntariness of Use constructs were not as good as those of the other constructs. Nevertheless, these limitations did not preclude the ability of this study to generate insightful and useful results.

Finally, this study has shown that diffusion of innovations research can be conducted effectively in a pre-adoption setting. As was discussed, research attempting to employ the diffusion of innovations Innovation-Decision Process in a pre-adoption setting is almost non-existent, which is unfortunate because it is precisely in a pre-adoption setting that business managers are most interested in predicting people's intentions to adopt an innovation. As such, the information that was obtained in the conduct of this study should prove very useful to the Department of Canadian Heritage in assisting them in making a decision regarding expansion or removal of the smart card project. In conclusion, conduct of similar studies in pre-adoption settings can help give

businesses the information to make an informed decision to proceed or stop the implementation of innovation diffusion projects before large amounts of capital and time are invested.

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APPENDIX A

SMART CARD SUMMARY DOCUMENT

SMART CARDS AT THE DEPARTMENT OF CANADIAN HERITAGE

A smart card is a credit card sized plastic card that contains an embedded computer chip which possesses computer logic and is capable of storing and retrieving information loaded onto the chip. The smart card's microprocessor is able to employ sophisticated encryption/decryption techniques to prevent unauthorized users from viewing data stores on the card. Also, the smart card's microprocessor is capable of performing computer logic functions.

Smart card technology has been in use around the world for several years in a variety of applications. France, where the smart card was invented, has made heavy use of the technology in a wide variety of service, industrial, and leisure industry sectors. In France, smart cards were first used to revolutionize the public pay telephone system, as their ability to store and manage pre-paid funds replaced the cash payment method previously used.

SMART CARD CAPABILITIES

1) Eliminating Paperwork Burden

While the arrival of the microcomputer has transformed office procedures substantially, it has not been able to reduce reliance on pre-printed forms, letters and memoranda used to provide an audit trails or to authenticate a request for action. The smart card's data storage ability and protection of that data allow the smart card to maintain this audit trail proof or authentication.

An application that could eliminate paperwork is the use of smart cards to replace all paper procedures required for acquiring materiel from stockrooms. Another application could be to eliminate paperwork associated with employee leave requests and use the smart card for electronic signature.

2) Provide Secure Portability of Information

Many of the systems that are being developed for smart card use rely heavily on the smart card's ability to protect its data contents. Security of data is provided in a number of ways:

a) The smart card's design prevents unauthorized users from using special electronic equipment to probe or tamper with the contents of the smart card. Any such attempt typically results in a smart card shutdown which locks the card and renders it useless.

b) Data that is stored on smart cards is encrypted using sophisticated encryption/decryption algorithms which ensures that data cannot be read unless proper access has been established.

c) Access to the smart card is established by the entry of the valid Personal Identification Number (PIN) by the owner of the smart card. Access to the smart card is not possible without PIN entry.

d) The smart card allows the smart card programmer to set up tamper-proof employee profiles, so that even the smart card's authorized user may be prevented from accessing or altering certain data areas of the card.

APPENDIX B

SURVEY

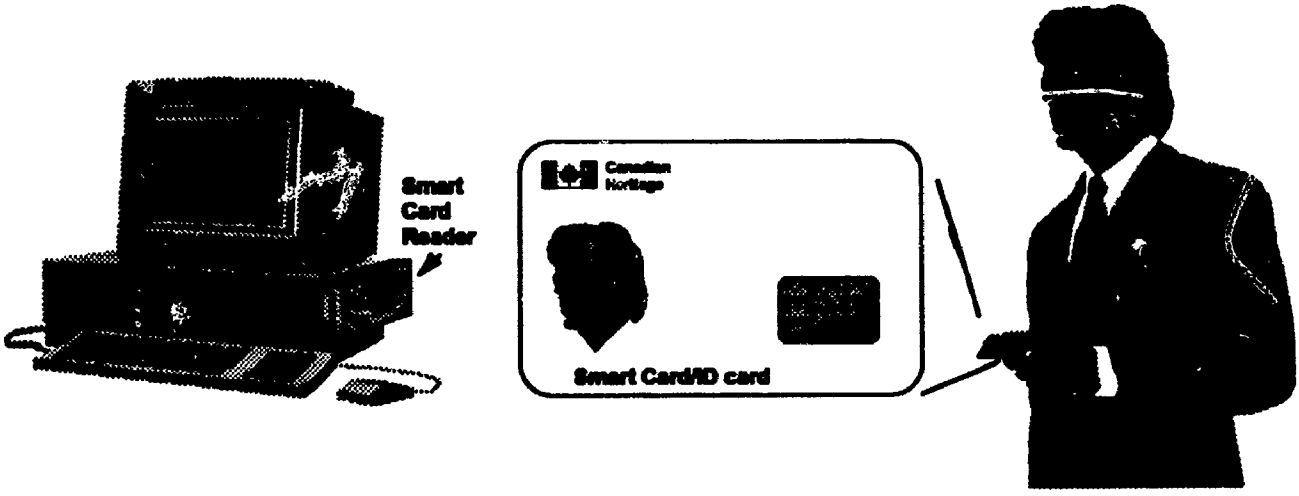
Notes to Reader:

In Section B (39 questions) the breakdown of items by content is:

VARIABLE BEING MEASURED	ITEM NUMBERS
RELATIVE ADVANTAGE	6, 8, 12, 19, 29, 36, 38, 42
VOLUNTARINESS OF USE	7, 11, 13, 18
TRIALABILITY	9, 21, 25, 31, 40
EASE OF USE	10, 22, 26, 32, 35, 44
VISIBILITY	14, 25, 30, 34
RESULT DEMONSTRABILITY	15, 16, 23, 33
IMAGE	17, 20, 39, 41
COMPATIBILITY	27, 28, 37, 43

DEPARTMENT OF CANADIAN HERITAGE

SMART CARD SURVEY



ADVANCED CARD TECHNOLOGY PROGRAM

Thank you very much for participating in this project. The Department of Canadian Heritage has made the commitment to explore the possibilities of using smart cards as a way to improve the quality and control over the information that is available to you, the employee in the day to day systems that form part of your daily work. This survey is your opportunity to provide feedback regarding your views towards use of smart card technology. The data collected from this exercise will be compiled, analyzed and presented to Senior Management and will be instrumental in providing Senior Management with a feel for the desirability of this technology.

You will note that you are not required to identify yourself by name or position. All data collected will be held in strict confidence. Generally, there are no "right" or "wrong" answers in this survey, please tell us what you think. Rest assured that you will never be identified by the results obtained.

There are eight sections to this survey. The first section asks you general questions to determine your level of knowledge about smart cards while section B asks you questions about your perceptions regarding the use of smart cards. The third section asks about your desire to use smart cards. Section D asks you about your feelings towards smart cards in general. Section E asks you questions about your exposure to other technologies, while the sixth section is concerned with your perceptions of your ability to put smart card technology to use. Section G is more general and asks questions about you and your work. The final section, section H is more general and asks you about the presentation or document.

SECTION A

This part of the survey asks you general questions to determine how much you know about smart cards and smart card technology. Circle the appropriate number next to each answer.

Q-1 A smart card is:

1 A computer board that plugs into the back of a computer

2 A computer chip embedded in a piece of credit-card sized plastic

3 A strip of magnetic coating applied to a plastic card

Q-2 One way the Smart Card provides information security is by:

1 preventing electronic tampering with the chip

2 employing unique equipment that cannot be duplicated

3 sending audit trails to the main computer

Q-3 The Smart Card's microprocessor is able to:

1 Employ sophisticated encryption/decryption techniques

2 Perform computer logic functions

3 storing and retrieving information on the card

4 All of the above

Q-4 Smart Cards cannot be used to:

1 Eliminate paperwork burden in office procedures

2 Provide electronic signatures

3 Diagnose computer problems and suggest possible solutions

4 Provide Secure portability of information

Q-5 The entry of a valid PIN:

1 Allows access to the data stored on the card

2 Turns on the smart card

3 A PIN is not required for smart cards

SECTION B

This part of the survey asks you about your views towards use of smart card technology. For each statement, please indicate how strongly you agree or disagree with the statement. For each statement please circle only one number.

		Strongly Disagree			Neutral			Strongly Agree
Q-6.	Using a smart card would make it easier to do my job.	1	2	3	4	5	6	7
Q-7.	My use of a smart card would be voluntary (as opposed to required by my superior).	1	2	3	4	5	6	7
Q-8.	Using a smart card would improve my job performance.	1	2	3	4	5	6	7
Q-9.	If smart cards are implemented, there would be many opportunities for me to try various smart card applications.	1	2	3	4	5	6	7
Q-10.	I believe that it would be easy to get a smart card to do what I want it to do.	1	2	3	4	5	6	7
Q-11.	My superiors would expect me to use a smart card.	1	2	3	4	5	6	7
Q-12.	Using a smart card would enhance my effectiveness on the job.	1	2	3	4	5	6	7
Q-13.	Although it might be helpful, using a smart card would not be compulsory in my job.	1	2	3	4	5	6	7
Q-14.	If smart cards were implemented, one would see many people with smart cards.	1	2	3	4	5	6	7
Q-15.	I would have no difficulty telling others about the results of using a smart card.	1	2	3	4	5	6	7
Q-16.	I would have no difficulty explaining why using a smart card may or may not be beneficial.	1	2	3	4	5	6	7
Q-17.	Using a smart card would improve my image within the organization.	1	2	3	4	5	6	7

		Strongly Disagree			Neutral			Strongly Agree
Q-18.	My boss would not require me to use a smart card.	1	2	3	4	5	6	7
Q-19.	Using a smart card would increase my productivity.	1	2	3	4	5	6	7
Q-20.	People in my organization who would use smart cards would have more prestige than those who would not.	1	2	3	4	5	6	7
Q-21.	I know where I could go to satisfactorily try out various uses of a smart card.	1	2	3	4	5	6	7
Q-22.	Overall, I believe that a smart card would be easy to use.	1	2	3	4	5	6	7
Q-23.	The results of using a smart card would be apparent to me.	1	2	3	4	5	6	7
Q-24.	A smart card would be available to me to adequately test run various applications.	1	2	3	4	5	6	7
Q-25.	If smart cards are implemented, they would be visible in my organization.	1	2	3	4	5	6	7
Q-26.	My using a smart card would require a lot of mental effort.	1	2	3	4	5	6	7
Q-27.	Using a smart card would be compatible with all aspects of my work.	1	2	3	4	5	6	7
Q-28.	I think that using a smart card would fit well with the way I like to work.	1	2	3	4	5	6	7
Q-29.	Using a smart card would enable me to accomplish tasks more quickly.	1	2	3	4	5	6	7
Q-30.	If smart cards are implemented, it would be easy for me to observe others using a smart card in my department.	1	2	3	4	5	6	7
Q-31.	Before deciding whether to use any smart card applications, I would be able to properly try them out.	1	2	3	4	5	6	7

		Strongly Disagree			Neutral			Strongly Agree
Q-32.	Using a smart card would be frustrating.	1	2	3	4	5	6	7
Q-33.	I believe I could communicate to others about the results of using a smart card.	1	2	3	4	5	6	7
Q-34.	If smart cards are implemented, I would see what others do using their smart card.	1	2	3	4	5	6	7
Q-35.	Learning to operate a smart card would be easy for me.	1	2	3	4	5	6	7
Q-36.	Overall, I believe that using a smart card would be advantageous in my job.	1	2	3	4	5	6	7
Q-37.	Using a smart card would fit into my work style.	1	2	3	4	5	6	7
Q-38.	Using a smart card would improve the quality of work I do.	1	2	3	4	5	6	7
Q-39.	People in my organization who use a smart card would have a high profile.	1	2	3	4	5	6	7
Q-40.	If smart cards are implemented, I would be permitted to use a smart card on a trial basis long enough to see what it could do.	1	2	3	4	5	6	7
Q-41.	Having a smart card would be a status symbol in my organization.	1	2	3	4	5	6	7
Q-42.	Using a smart card would give me greater control over my work.	1	2	3	4	5	6	7
Q-43.	Using a smart card is completely compatible with my current situation.	1	2	3	4	5	6	7
Q-44.	I believe that a smart card would be cumbersome to use.	1	2	3	4	5	6	7

SECTION C

This section of questions is interested in your general attitude towards smart cards. Please circle only one number for each pair of words.

Overall My Using a Smart Card would be:

		Extremely	Quite	Slightly	Neither	Slightly	Quite	Extremely	
Q-45.	Pleasant	1	2	3	4	5	6	7	Unpleasant
Q-46.	Good	1	2	3	4	5	6	7	Bad
Q-47.	Likable	1	2	3	4	5	6	7	Dislikable
Q-48.	Harmful	1	2	3	4	5	6	7	Beneficial
Q-49.	Wise	1	2	3	4	5	6	7	Foolish
Q-50.	Negative	1	2	3	4	5	6	7	Positive
Q-51.	Valuable	1	2	3	4	5	6	7	Worthless

SECTION D

This section of the survey will ask you questions about your intentions to use smart card technology.

	Strongly Disagree			Neutral			Strongly Agree
Q-52. I see myself using a smart card as part of my daily work.	1	2	3	4	5	6	7
Q-53. I would volunteer to pilot test smart cards and smart card applications.	1	2	3	4	5	6	7
Q-54. If the applications were made available I would do whatever I could to ensure that funds were available for purchasing smart card equipment	1	2	3	4	5	6	7
Q-55. I would contribute to the creation of a justification paper for the purchase of smart card equipment.	1	2	3	4	5	6	7
Q-56. I would support the creation of a justification paper for the purchase of smart card equipment.	1	2	3	4	5	6	7
Q-57. I would use the smart card if I were given the proper equipment and access to smart card applications.	1	2	3	4	5	6	7
Q-58. I am eager to start using the smart card and smart card applications.	1	2	3	4	5	6	7
Q-59. I would support the purchase of smart card equipment in my organization.	1	2	3	4	5	6	7

SECTION E

This part of the survey asks you general questions about your awareness of other technological innovations and your exposure to mass media communications.

Below is a list of technological innovations that apply to many aspects of our lives. Please indicate your awareness of each innovation by circling the appropriate number beside each entry.

		I don't know what it is		I think I know what it is		I Know what it is
Q-60.	CD-ROM	1	2	3	4	5
Q-61.	Optical Cards	1	2	3	4	5
Q-62.	Notebook Computers	1	2	3	4	5
Q-63.	Pen-Based Computers	1	2	3	4	5
Q-64.	Virtual Reality	1	2	3	4	5
Q-65.	Digital Compact Cassette	1	2	3	4	5
Q-66.	Optical Disk	1	2	3	4	5
Q-67.	HI-8 Camcorders	1	2	3	4	5
Q-68.	ABS braking systems	1	2	3	4	5
Q-69.	Bubble-jet Printers	1	2	3	4	5
Q-70.	Halogen Gas Ranges	1	2	3	4	5
Q-71.	High Definition Television	1	2	3	4	5
Q-72.	SVGA monitors	1	2	3	4	5
Q-73.	Digital Audio Tape	1	2	3	4	5
Q-74.	Bulletin Board Systems	1	2	3	4	5
Q-75.	Universal Remote Controls	1	2	3	4	5

The following list describes various sources of information that people may use to gather information. For each of the sources please indicate how often you refer to it.

	Seldom		Sometimes		Very Often
Q-76. Television	1	2	3	4	5
Q-77. Radio	1	2	3	4	5
Q-78. Newspapers	1	2	3	4	5
Q-79. Magazines	1	2	3	4	5
Q-80. Books	1	2	3	4	5

SECTION F

The following questions ask you to indicate whether you could use smart card technology under a variety of conditions. For each of the conditions, please indicate whether you think you would be able to complete the job using the smart card (circle either "yes" or "no"). Then, for each condition that you answered "yes" please rate your confidence about your first judgment, by circling a number from 1 to 10, where 1 indicates "Not at all confident", 5 indicates "Moderately confident", and 10 indicates "Totally confident". If you circle "no", do not circle a rating number.

I COULD USE SMART CARDS...

		Not at All Confident			Moderately Confident					Totally Confident
Q-81.	If there was no one around to tell me what to do as I go.	YES..... 1	2	3	4	5	6	7	8	9 10
		NO								
Q-82.	If I had seen someone else using it before trying it myself.	YES..... 1	2	3	4	5	6	7	8	9 10
		NO								
Q-83.	If I could call someone for help if I got stuck.	YES..... 1	2	3	4	5	6	7	8	9 10
		NO								
Q-84.	If someone else had helped me get started.	YES..... 1	2	3	4	5	6	7	8	9 10
		NO								
Q-85.	If I had a lot of time to complete the job for which the smart card was provided.	YES..... 1	2	3	4	5	6	7	8	9 10
		NO								
Q-86.	If someone showed me how to do it first.	YES..... 1	2	3	4	5	6	7	8	9 10
		NO								

SECTION G

This section of the survey asks for some information about yourself. This information is important to allow us to study the effects of differences between people regarding their feeling towards the use of smart card technology.

Q-87. What is the level of your position? (Circle Number)

1. DIRECTOR OR ABOVE
2. CHIEF OR EQUIVALENT
3. OFFICER or SPECIALIST IN SOME DISCIPLINE
4. SUPERVISOR
5. CLERICAL OR SECRETARIAL
6. OTHER

Please specify _____

Q-88. What is your age?

_____ YEARS

Q-89. Which is the highest level of education that you have completed? (Circle the last category that applies)

1. SOME VOCATIONAL OR HIGH SCHOOL
2. COMPLETED VOCATIONAL OR HIGH SCHOOL
3. SOME COLLEGE OR UNIVERSITY
4. COMPLETED COLLEGE OR UNIVERSITY
5. SOME GRADUATE WORK
6. A GRADUATE DEGREE

SECTION H

This section asks questions to determine the usefulness of the presentation. For each statement, please indicate how strongly you agree or disagree with the statement. For each statement please circle only one number.

		Strongly Disagree			Neutral			Strongly Agree
Q-90.	I better understand the impact of using smart cards as a result of attending this presentation.	1	2	3	4	5	6	7
Q-91.	This presentation improved my understanding of how the smart card could help me in my daily work.	1	2	3	4	5	6	7
Q-92.	My attitude towards the use of smart cards has changed as a result of attending this presentation (has become more favourable or unfavourable).	1	2	3	4	5	6	7
Q-93.	I found the presentation to be an effective way to personally communicate the virtues of using smart cards.	1	2	3	4	5	6	7
Q-94.	This presentation has served to stimulate my interest in how other advanced information technologies can help me to become more productive.	1	2	3	4	5	6	7
Q-95.	I support the use of presentations before a technology is implemented into a department.	1	2	3	4	5	6	7

SECTION H (for control group)

This section asks questions to determine the usefulness of the 1 page smart card document which you received with your invitation. For each statement, please indicate how strongly you agree or disagree with the statement. For each statement please circle only one number.

		Strongly Disagree			Neutral			Strongly Agree
Q-90.	I better understand the impact of using smart cards as a result of receiving this document.	1	2	3	4	5	6	7
Q-91.	This document improved my understanding of how the smart card could help me in my daily work.	1	2	3	4	5	6	7
Q-92.	My attitude towards the use of smart cards has changed as a result of receiving this document (has become more favourable or unfavourable).	1	2	3	4	5	6	7
Q-93.	I found this document to be an effective way to communicate the virtues of using smart cards.	1	2	3	4	5	6	7
Q-94.	This document has served to stimulate my interest in how other advanced information technologies can help me to become more productive.	1	2	3	4	5	6	7
Q-95.	I support the distribution of documents like this before a technology is implemented into a department.	1	2	3	4	5	6	7

END

01-06-95

FIN