ATTITUDES OF STUDENTS TOWARD ELECTRONIC CASH

A Dissertation Proposal

Submitted to the
Faculty of Argosy University/Sarasota
in partial fulfillment of
the requirements for the degree of
Doctor of Business Administration

by

Rosarito Sánchez-Morcilio

Argosy University/Sarasota

Sarasota, Florida

March 2005

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2005

Chair: Dr. Susan H. Marcus
Co-chair: Dr. Prosper Bernard
Reader: Dr. Kathleen Cornett

Department: School of Business and Information Technology

This research presents a comprehensive view of electronic cash and its role in our society. Its origins, development, implementation, and acceptance are discussed from business, technical, and economic points of view. Electronic cash is compared to other current payment systems. Existing electronic cash systems operating in the business world are also presented, as well as new technological improvements. Current issues regarding electronic cash and future use of electronic cash are examined. In addition, a statistical study regarding the attitudes of students toward electronic cash was done. A cross-sectional design was employed to address four research questions. The survey was conducted at the University of Puerto Rico in Aguadilla. The results were examined using descriptive statistics, comparisons between demographic groups and regression analysis.

Dedication

- To my beautiful daughter Valeria Alexandra Quiles, who provided me all her love and understanding,
- To my great newborn and boy, Antonio Francisco Quiles, who gave me the joy of being a mother again which supported me during my dissertation defense,
- To my husband, Francisco Quiles, who supported me in my decision to pursue the DBA and who has always been my inspiration,
- To my mother, Rosario Morcilio, who helped me and took care of Valeria during my numerous trips to Sarasota and my long hours of study,
- To my father, Angel M. Sánchez, who taught me to be organized,
- To my beautiful niece, Amanda Paola Rivera and my sister Liz M. Sánchez, who gave me words of support, and
- To my aunt, Carmen I. Morcilio, and my grandfather, Benito Sánchez.

Acknowledgements

I offer sincere thanks to my advisor, Dr. Prosper Bernard, who was always available to answer my questions, and also to my chair, Dr. Susan Marcus who supported me in the main chapters of my investigation.

Thanks to Dr. Shanker Menon and Dr. Pete Simmons, who were present at my defense, to Professor Irma Torres who worked on the editing of this edition, to Sra. Lucy Ríos, who helped me secure permissions to do the research, and to Professor Erminia Alemañi who edited the Spanish version of the survey.

I appreciate the support of those at the University of Puerto Rico at Aguadilla who helped me through the process of my program: Professor Miguel González, my advisor; Professor Luis Pabón, another advisor; Professor Juana Segarra de Jaramillo, Dean of the University when I began my study; and Professor Pablo Rodríguez Rosado, the current dean.

Thanks to all the students at the University of Puerto Rico at Aguadilla for filling out the survey and to Sra. Wilma del Valle, the secretary of the Business Administration Department, who helped in the survey process. Special thanks go to Sra. Jenny Román, who has supported me since I started studying in the doctoral program.

Others who deserve recognition are Sr. Jorge Sosa, information technology expert of Baxter, Puerto Rico; Dra. Dafne Javier and her husband, Dr. Pedro Valle; and Dr. José Gerardo Martínez, an alumnus of University of Sarasota. I will always remember and appreciate Dr. Wilfredo Colón, Professor Juan Adrover, and Professor Celeste O'Neil.

A very special thanks is owed to my husband, Francisco Quiles, who has helped me at every phase of this long and involved process.

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CHAPTER ONE: THE PROBLEM

Introduction

This study examines the attitudes towards the use of electronic cash based on a survey taken of Business Administration students at the University of Puerto Rico, Aguadilla Campus. The research study involved frequencies, descriptive statistics, and four research questions. The first three questions compare student attitudes toward electronic cash. A comparison of the means using a t-test is made between students who have lived outside Puerto Rico and those who have not, between daytime students and evening-Saturday students, and by gender. The last research question attempts to predict whether students will accept electronic cash in the future.

Problem Background

A broad review of literature about electronic cash has been conducted, incorporating, through documentation, research from 1997 to the present. This section includes an analysis of the role of electronic cash in electronic commerce. A definition of electronic cash together with its origins, development, and acceptance are some of the many issues discussed in this research. Electronic cash is evaluated from business, technical, and economic standpoints. It is viewed from the customer, merchant, and bank's perspective. Its usefulness for all three parties is discussed and a comparison is made with other current payment systems. Leaders in the field of the electronic cash industry are presented, including Mondex, MasterCard cash, Visa Cash, Quicklink, and Transcard. Technical aspects are discussed, including innovation, design, and operation of electronic cash systems. The economic impact of electronic cash is considered in

relation to issues of money supply, monetary policy, inflation, seigniorage, and counterfeiting.

Literature Review

Electronic Cash Description

Because electronic commerce has successfully emerged, new ways of payment are needed to complement this success (Golicic, Davis, McCarthy, & Mentzer, 2001). Electronic cash is a new way of payment that can be used for physical and for Internet transactions. It provides anonymous and untraceable payment just as regular cash does (Liu, Wei, & Wong, 2001). It functions like a debit card, which stores cash value, but is different from a debit card because it does not identify the user. Unlike a debit card, electronic cash is untraceable because the bank cannot identify the person who performed the transaction. Other differences exist and depend on the type of electronic cash used.

Types of Electronic Cash

Electronic cash can be presented and stored in many ways. For example, it can be stored on a computer's hard drive or on a floppy disk, in which case it could be used for Internet payments. It can also be stored on a smart card, which can be used to pay for physical transactions in stores where the appropriate hardware has already been installed. Electronic cash stored on a card is known as digital money. Electronic cash refers to electronic money stored on a hard disk or floppy disk; the term digital money denotes electronic money that is stored with an audit trail, such as on a card or smart card (Wang & Zhang, 2001). Electronic cash is mostly used to make payments over the Internet while

digital money is mostly used to make payments in physical stores. Both will be discussed in this research.

No matter how electronic cash is stored or what it is called, it can only be processed in one of two ways: on-line or off-line. On-line electronic cash is processed on-line immediately it is offered as payment to ensure that double spending does not occur. *Double spending* means that the same electronic cash has been used more than once. By comparison, off-line electronic cash is accepted as payment without immediate on-line verification. If later a problem is discovered, then today's cryptography is sufficiently advanced to reveal the double spender's identity. Electronic cash is anonymous only for its legal uses (Wang & Zhang, 2001). Off-line electronic cash was developed to accelerate the payment process since sometimes network lines are too crowded to process transactions quickly. Based on this justification, most studies indicate that this type of electronic cash (off-line) should prevail over the on-line process.

How Does Electronic Cash Work?

The protocol of electronic cash consists of three parties: the user, the bank, and the store. Each can make three different transactions: withdrawals, payments, and deposits (Jang & Lee, 2001). First, the user needs to open a bank account. Once it is open, the user converts his/her money into electronic cash. The conversion process protects the identity of the user. This way the bank does not know who is spending electronic cash or where the electronic cash was spent. Electronic cash can be stored on a computer hard disk, diskette, or a smart card depending upon the type of electronic cash being used. The user can make anonymous and untraceable payments for physical or Internet transactions (Liu et al., 2001). When an electronic cash payment is made, the

bank stores the transaction after checking for double spending. The bank database checks that the electronic cash has not been spent previously. In on-line electronic cash payments, a database is searched to ensure that double spending has not occurred. This verification is made at the time the payment is tendered. In off-line electronic cash payments, a check for double spending is made at some time after the payment transaction is completed. In this case, if double spending has occurred, the bank can unveil the anonymity of the user by tracing the transaction. It should be noted that electronic cash transactions can be traced to the user only when double spending is discovered. Once the electronic payment transaction is completed, the store receives its imbursement. With the imbursement available, the store can deposit the electronic cash it has received.

Advantages Over Actual Cash

Cash usage has advantages over credit cards or checks. For example, credit cards reveal the user's identity. Furthermore, by using them, the user incurs debt, and high interest is charged if the overall debt is not met by the end of the billing cycle. Besides, the store cannot convert credit card sales into cash immediately after the transaction has taken place. Credit card numbers and their expiration dates can be copied through illegal means, which is another disadvantage. For these reasons, many people prefer to pay with cash. Credit cards as well as debit cards reveal the card owner's identity whereas regular cash and electronic cash are anonymous. Both credit and debit cards need approval from the bank in order to process transactions. This approval can take several minutes to receive, especially during rush hours. Besides, credit card transactions are not private. Most credit card companies do not keep the customer's information confidential. Instead,

they share their customer information with marketing groups that use customer behavior and preferences to target advertising and sales offers.

Cash eliminates these drawbacks, and is widely used. However, there is no such thing as cash payments for Internet transactions. Goldsborough (2001) discusses buying and selling on the Internet without cash, by using other means of payments such as electronic cash. For electronic commerce to continue to grow, a type of cash is needed which can be used to pay for goods and services on the Internet (Pearson, 1998). Regular cash payments also have disadvantages; there is the time it takes to count it and make change, and cash can be stolen or lost. Electronic cash promises to allow cash payments over the Internet and overcomes some of the disadvantages of regular cash. Electronic cash has many advantages compared to actual cash. It gives exact change, it's hard to steal, and it's faster to process than regular cash. Moreover, it is resistant to money laundering, and (the off-line version) provides a faster and cheaper payment transaction.

Frankel, Patt-Shamir, and Tsiounis (1997) explain the theory of exact change for electronic cash. When electronic cash is used, exact change is calculated and stored in only seconds, as opposed to regular cash, where a cashier can take a while to count and render change. Electronic cash is much more difficult to steal since only the user and family members have access to the hard disk. Although a hard disk can crash with all the electronic cash stored on it, this problem can be avoided by maintaining a floppy disk copy. One can have as many copies of electronic cash as desired as long as it is used only once. To avoid confusion, all copies of electronic cash should be erased as soon as it is spent. Double spenders may be prosecuted.

Money laundering is prevented because electronic cash is withdrawn and deposited from the same bank, which keeps track of the electronic cash transactions, even though they are anonymous. If a case of money laundering is found in the bank, the user's identity can be revealed because today there are technological provisions for that specific purpose (Wang & Zhang, 2001).

Off-line electronic cash provides for a faster and cheaper transaction. Off-line transactions, in contrast to on-line transactions, do not depend on communication lines for authorization at the time the payment is accepted. Communication lines are costly and sometimes too crowded which slows the processing of payments. However, the increased use of the Internet has made possible the emergence of electronic commerce (Golicic et al., 2001). These new ways of doing business demand new ways of payment. Electronic cash is a substitute for regular cash in cyberspace (Tison-Dualan & Gallegos, 2001).

Current Status of Electronic Cash

The present status of smart card electronic cash is that it is still under pilot study as Elliot and Loebbecke (1998) illustrate. The findings of these pilot studies are very useful when trying to forecast the utility and acceptability of electronic cash. The authors present a pilot study that is discussed in this research. There were actually four pilot studies conducted. All took place in Australia because that country has a low level of privacy protection, and regulatory resistance was unlikely during the study. Another reason these pilot studies were conducted in Australia is that the level of interest in new and sophisticated ways of payment is quite high among major national banks and consumers. There were four case scenarios: Quicklink, Transcard, MasterCard Cash, and Visa-Cash. These cards were used in a variety of locations including fast-food

restaurants, trains, buses, vending machines, universities, pay phones, banks, theme parks, cinemas, gas stations, restaurants, and department stores.

Quicklink was introduced in 1994 by the government of New South Wales, the most populous state in Australia, as a trial to increase self-service ticketing efficiency on urban trains and buses. It was also launched in Newcastle in 1997 with reloading terminals for storing anonymous (no link with personal identification) electronic cash. The system even gave refunds for damaged cards. One problem arose when the smart card also functioned as a debit card. This kind of system can reveal the customer's identity and make a profile of purchases, thus infringing upon the user's privacy. This privacy problem can be solved by using the smart card only for storing electronic cash and by not adding a debit card feature to it. Quicklink, which is compatible with the EuroCard, MasterCard, and Visa-Cash smart card standardized system, is claimed to have proven the viability of its technology.

Transcard was established in an outer suburb of Sydney in 1995. Consumers are charged a fee for the use of the card. It is a contactless smart card and has a loyalty scheme. A contactless smart card is a card that exchanges electronic cash by radio wave transmission. This, it is claimed, can reduce the time it takes to purchase a ticket, for example, and thus make transactions faster. This method is quicker to process than the contact smart card that the cardholder needs to insert in a terminal. The user or cardholder only needs to hold the card close to the reader in the terminal, but approval of the transfer value is still required for the payment to be completed. Transcard implementation remains ongoing in Australia. It operates without bank intervention and without being subject to financial regulation. It is not compatible with the EuroCard, MasterCard, and

Visa-Cash smart card standardized system. In terms of loyalty schemes, it has incentives for people to use their Transcard, such as free hamburgers or free bus rides, after making previously determined purchases.

MasterCard Cash is, as Elliot and Loebbecke (1998) describe it, a smart card that was used in Canberra, Belconnen from March 1996 to February 1997. It combined electronic cash, debit, and credit card functions in one smart card. This combination does not allow the use of the MasterCard Cash for purely electronic cash. High costs involved in the pilot study may have been the reason for MasterCard's decision to proceed with the Mondex System, which was under a pilot study in Manhattan, New York in the fall of 1997. Both MasterCard and Visa support the Mondex System.

Visa-Cash was tested in a pilot study in Australia's Gold Coast resort area. It has pre-set values of $5, $10, and $20. Visa-Cash cards were not re-loadable and were purchased at face value with no additional fees. Once the card was exhausted, it was disposable, but people still kept them as souvenirs. The trial was extended to include re-loadable cards. What made Visa-Cash not a truly electronic cash card is that the transaction details are collected by merchants and passed through the system host. Full transaction details are held by the host and not passed to the banks to maintain the integrity of the system. For a smart card to be considered electronic cash, complete anonymity is required. Visa-Cash allows for payments over the Internet. This pilot study was successful in terms of educating consumers and members of financial institutions about a new product. This pilot study was also very effective in testing existing technology and in developing and adjusting the processing infrastructure as needed. Visa

conducted other pilot studies during 1996 in Argentina, Colombia, New Zealand, Canada, Atlanta (in the Olympic games in 1996), and Hong Kong.

As Elliot and Loebbecke (1998) explain, all four smart cards have off-line payment authorization. This means that a communication channel is not required during the payment transaction process. Off-line authorization is very convenient since there is a high cost related to on-line authorization with credit and debit cards. That is the prime motivation for the introduction of these smart cards.

However, MasterCard Cash and Visa-Cash are not truly electronic cash since they do not provide anonymity. All transactions are completely traceable. MasterCard Cash combines electronic cash with a debit and a credit card. Visa-Cash accumulates the transactions in the merchant's host. Even if this information is not passed on to the bank, the fact that someone keeps track of the transactions means that tracing transactions is possible. These types of cards have been included in this research despite the fact that they are not truly electronic cash. The results of the pilot studies conducted can reveal consumer and financial institution behavior and attitudes toward a new way of payment.

Other issues that require attention are tax evasion and counterfeiting. Tison-Dualan and Gallegos (2001) believe that it could become very difficult to keep track of electronic cash circulation for the purpose of taxation. There is also the problem of where to pay taxes since electronic cash can circulate between cities and states as well as from country to country. Another current major problem is counterfeiting (Tison-Dualan & Gallegos, 2001), which is the falsification of electronic money consisting of making copies of electronic cash so similar that it looks real. Technology should provide the tools to avoid this type of problem. The final concern about electronic cash raised by Froomkin

(1996) is that it facilitates money laundering. As the author explains, if electronic cash is completely anonymous, unlawful acts such as money laundering would be undetectable.

Purpose of the Study

The purpose of this study was to explore the demographic characteristics and attitudes of university students toward electronic cash. This was conducted using a cross-sectional design.

Research Questions

Question 1: To compare the attitudes of male students and female students toward electronic cash. The study's intention was to test a hypothesis of difference between the means of males and females regarding their attitudes toward electronic cash.

Question 2: To compare the attitudes of students who have experience living outside Puerto Rico for more than six months and those who do not. The study's intention is to test a hypothesis of difference of means of students who have lived outside Puerto Rico for more than six months and those who have not regarding their attitudes toward electronic cash.

Question 3: To compare the attitude of students who are registered in the daytime program and those who are in the evening-Saturday program. The study's intention is to test a hypothesis of difference of the means of students in the daytime program and those who are in the evening-Saturday program regarding their attitudes toward electronic cash.

Question 4: To predict the attitudes of students toward electronic cash. Multiple regression was chosen because the forecast involves more than one independent (predictor) variable supported by a dependent (criterion) variable. Here, the independent

variables are the marketing, convenience and risk variables, and the dependent variable is the attitude towards merchants who offer electronic cash as a form of payment.

Limitations/Delimitations

There are inherent limitations to the reliability and validity of the data collection instrument and study design common to cross-sectional studies (Bourque & Fielder, 2003). One limitation of the study was that of external validity. The survey sample of 200 was not randomly selected from the target population of 841 students. Only a truly random sample could hope to contain a representative cross section of the target population. The less random the sample, the less its results can be generalized to the whole population. The sample selected is a convenience sample and therefore the findings should generalize with caution to the target population. Therefore, generalizations from this study were made with caution.

Regarding the reliability of the survey, there were several limitations. The survey was written in such a way that students who did not know about electronic cash were still able to answer it quickly and easily. Even though this instrument is common, a very strong limitation of this study is that some students may not want to answer a survey about electronic cash because they may not know anything about it.

Another limitation is that the researcher, as an agent, handed out the survey to the sample population. Each subject used a input sheet in order to complete the survey as it made imputing data into the computer easier.

An assumption was made that the subjects answered without any time pressure, though sometimes students are in a hurry going from class to class or from class to work. They usually took about fifteen minutes to answer the survey. They completed the

survey, as they were about to start class, which may have represented some time pressure for them; this may be a limitation of the study. Another possible limitation is that some people might have felt afraid to answer a survey if they were not familiar with the topic. To avoid this limitation, the survey was designed to be easily understood with self-explanatory questions.

Appendix A shows the pre-test survey that was used to refine the survey questions, with the help of 30 students. However, no further reliability assessment was done.

Content validity determines if the survey is measuring what it is supposed to measure. The researcher made an exhaustive review of literature using many updated references. Also considered were two previous surveys regarding electronic cash taken from Van Hove (2000) and from Szmigin and Bourne (1999). However, no external content experts were involved in reviewing the final instrument.

As a typical of cross-sectional research, this study will not guarantee *internal validity*. This survey does provide an assessment of participant at one point in time, which is the primary limitation of this type of design.

Definitions

The following definitions are used in this research:

- Electronic cash: name for e-cash or ecash.
- Electronic cash: As Lee, Choi, and Rhee (2003) explained, this is an instrument used for payment. It is an electronic form of the common paper money since it provides anonymity and privacy to its user. In addition, these

authors illustrate that electronic cash resolves one problem associated with using credit cards: that they reveal the cardholder's private information.

- Cost: the fee associated with using electronic cash.
- Marketing incentives: customer motivations to use and re-use electronic cash.
- Off-line authorization: the payment authorization is made without the intervention of the bank.
- Real-time payment: the electronic cash payment results in an immediate decrease in the buyer's pocket and an increase in the seller's pocket.
- Double spending: a bad-faith transaction that consists of using exactly the same electronic cash coin two or more times (Panurach, 1996). Since electronic cash can be stored in different media (smart cards, hard disk, floppy disks), double spending can occur, but is, of course, illegal.
- Smart card or digital purse: As described by Berentsen (1998), this is a plastic card with an embedded microprocessor that can be loaded with money value. The card's value is reduced every time a purchase is made. It is reloadable and can be used for different purposes. There is no requirement for on-line authorization when transferring value. It can be used to pay for goods and services that are offered on the Internet or over the counter.
- Anonymity: *Webster's Dictionary* (Webster, 1984) defines anonymity as "nameless or unnamed, of unknown source."
- Private: *Webster's Dictionary* defines private as "restricted to a single person, not for public use or participation, owned or controlled by a single person or group."

Importance of the Study

This study is relevant to the emerging electronic business market, which aspires to become part of a global economy. It is especially useful to banks and other financial institutions that are considering electronic cash as a new financial product. This study will provide information about electronic cash and whether it will be accepted and used in the future as an alternative way of payment.

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

The business world is always changing in surprising new ways. To keep up with this pace of change, every organization needs to continually evaluate each new development and accept it, not as an obstacle but as an opportunity to grow and to improve in its market. Electronic commerce is one example of the many changes that business has undergone (Pearson, 1998). It offers a new medium to reach customers. Electronic commerce is in its initial stages of development. Business plans and strategies need to include electronic commerce so that this new opportunity for growth can be exploited.

One important consideration regarding electronic commerce is the methods available with which to make Internet payment. Credit cards have been used since the Internet started. However, neither credit card payments nor debit cards provide privacy of payment. People value privacy, especially if they fear they will suffer undesirable consequences if it is invaded. Other new ways of Internet payment may not be familiar to most Internet users. Electronic cash is an alternative way of paying for goods and services over the Internet. Electronic cash preserves the users' anonymity and can be used in payment for Web purchases or in the traditional store setting. This research argues that electronic cash will be used mostly for low-value payment, such as accessing newspapers in the cyber world or buying tickets for rapid transport systems in the physical world. Electronic cash is not expected to supplant debit or credit cards, as these will continue to be useful for high-value transactions. Each method of payment has its uses, its advantages, and disadvantages. Electronic cash, especially stored in a smart card, is being

proposed as an alternative method of payment for both the Internet and beyond (the physical world). This research specifically discusses the uses of electronic cash and its benefits and drawbacks, as well as other pertinent issues.

Lack of alternative methods of payment prevents electronic commerce from reaching its potential. Green (1999) and Humphrey, Kim, and Vale (2001) explain electronic payment in detail. Differing from other electronic payment means, electronic cash, as an alternative method of payment for Internet transactions, can facilitate the expansion of electronic commerce since it provides both anonymity and privacy to its users. This research examines electronic cash in depth and also studies its variant, the smart card.

This research discusses the definition of electronic cash, its origins, development, and impact on electronic commerce. Technological, economic, and business characteristics are examined. The discussion examines electronic cash technology focusing on the difference between on-line and off-line electronic cash, how each functions, and its advantages and disadvantages. The work of David Chaum and Stefan Brands, two leading electronic cash experts, is presented. Recent issues regarding electronic cash are discussed. Economic implications such as the influence of electronic cash on money supply, inflation, taxes, and government regulation are examined. Merchants and customers consider electronic cash, which has the potential to change the business environment, in relation to its utility and acceptance. The ideas and opinions of experts are presented in order to expand our knowledge regarding the technical, economic, and business characteristics of electronic cash.

Electronic Commerce

Spar and Bussgang (1996) see electronic commerce as a powerful business tool that can provide services instantly and more cheaply than in the physical world. These authors believe that rules need to be established in order for electronic commerce to develop further. Just as there are rules for automobile drivers in order that all can safely and efficiently use the roads, so Internet users need to have rules in order for business in cyberspace to grow. Property rights are an important concern in electronic commerce. New rules need to clarify ownership issues and provide ways to punish unlawful acts.

Electronic cash facilitates micro-payments, and this is one of the main issues that still needs to be addressed when discussing electronic commerce. Credit cards are not suitable for micro-payments because the transaction itself could cost more than the value of the product acquired. Electronic cash helps micro-transactions take place in a less costly way. Micro-transactions are those that do not involve large amounts of money. Micro-transactions require micro-payments. For instance, buying an article from a magazine or browsing for 5 minutes though the newspaper costs such a small amount of money that using a credit card could be more expensive than the transaction itself. If the micro-payment system using electronic cash proliferates, there will be a need to regulate its use.

Larson (1999) points out that the experts are predicting enormous growth in the volume of Internet purchases. The author also mentions that security is a main concern for customers. In the beginning, First Virtual (FV) provided security for payment over the Internet by using the credit card as the instrument of payment. NetCheque, CyberCash, CyberCoin, and NetBill were other means of making Internet payments that came later in

the mid-1990s. But none has been widely accepted, mainly because they cannot provide the anonymity that real cash can provide. Visa Cash was first used in the U. S. for the Atlanta 1996 Olympic games. Mondex is well known and successful in Europe. Visa Cash and Mondex are known as electronic cash smart cards (electronic cash stored in a smart card). Electronic cash allows consumers to make low value payments cheaply, quickly, and conveniently. At present, these smart cards are still migrating to the Internet. The future of these smart cards is not yet clear. This author provides a reasonable explanation of how electronic cash is operating on the Internet. Other authors have also presented in-depth studies of electronic cash.

Wang, Cao, and Kambayashi (2002) explain that CyberCash (CyberCash, 2001) is not fully anonymous since the bank can track all on-line purchases. It is a very inflexible system that uses a huge database to store electronic cash coins and customer information. NetBill uses only one on-line bank for all its Internet purchases, which can be a big task to handle for just one bank. It increases the amount of encryption required. Even though SET (secured electronic transactions) protocol is used for credit card transactions, it does not provide full anonymity. The authors also rate NetCents. It is an electronic cash system that has been proposed in order to provide a lightweight, flexible, and secure protocol for micro-payments for the Internet. It supports value ranging from a fraction of a penny and up. According to these authors, it provides a high level of anonymity. Molina-Jimenez and Marshall (2001) give an in-depth explanation of anonymity in electronic payments.

Nigg (1997) indicates that for electronic commerce to evolve, two things need to happen. First, business standards need to be established. Next, it is essential that secure

and reliable payment infrastructure be well developed. Although credit cards are available over the Internet, physical world commerce will not be replicated unless cash can be used for purchases, especially for low value payments. The author supports his statement by mentioning that in the physical world, the vast majority of people in the U. S. (94 %) pay with cash.

Guidelines for Assessing Electronic Payment Systems

Lee, Yu, and Ku (2001) give guidelines for assessing electronic payment systems. Since electronic cash is part of the electronic payment system, it is important to discuss these guidelines. They also provide a useful resource for the development of an electronic cash survey survey:

- The technical aspect focuses on the security of the transaction.
    - *Authenticity* or *validity* implies that all parties involved can avoid false transactions.
    - Privacy protects the anonymity of the purchaser in the transaction by preventing unauthorized personnel from gaining access to key information regarding the transaction.
    - *Integrity* or *accuracy* refers to the integrity of the data transmitted and the prevention of tampering with data in the transaction in order to avoid transmission errors.
    - Non-repudiation prevents all parties involved in the transaction (customer and merchant) from reneging on the commitment they agreed upon. The transaction is a contract that binds both parties. By

keeping a detailed record of the transaction such as time, date, and quantity, the contract can be tracked.

- The economic aspect emphasizes the business administration part of the payment transaction.
    - Cost of the transaction—the cost that the customer and the merchant have to incur in the transaction.
    - Exchange—the electronic payment system involves a customer who is paying with money or its equivalent in the transaction.
    - User reach—represents the range of users for whom the electronic payment system is available in terms of countries of the world and in terms of ages of the participants.
    - Value mobility—the exchange for currency of equal value no matter the type of currency used in the transaction.
    - Financial risk—potential damages or financial losses that can be incurred by the customer or the merchant. Consumers are concerned about the security of on-line transactions.
- Social aspect—the customer's trust and acceptance of the electronic payment system.
    - Anonymity—protects the privacy of the consumer by preventing companies or financial institutions from tracing the user's purchasing preferences and behaviors.
    - User friendliness—the electronic payment system should be simple and easy to use; otherwise, the public will not accept it.

    - Mobility—the ability to access the electronic payment system through mobile electronic devices. Today, many people are not tied to a PC, but instead use mobile phone, and other hand-held devices for their business transactions.
- Regulatory aspects—government regulation of on-line business transactions.
    - Digital signatures, digital fund transfers, electronic commerce contracts, technical standards, customs, taxation, and international agreements are some of the many areas where government regulation can apply.
    - Regulations must conform to local laws in all the countries where the electronic payment system plans to operate.

Definitions of Electronic Cash

Lee, Choi, and Rhee (2003) define electronic cash as a payment instrument that maintains the value of paper money and its characteristics since it provides anonymity and privacy to its user. These authors show how electronic cash, by preserving the anonymity of the user, overcomes one problem associated with credit card use.

Electronic cash, as Bernkope (1996) defines it, is a digital replacement for banknotes and coins; it is electronic money for small transactions. It is important to understand that e-money is not synonymous with electronic cash. Bernkope (1996) defines electronic money or e-money as including electronic cash, as well as the vast number of other digital funds that can be transferred through national and international payments. Helleiner (1998) gives details regarding electronic money.

Digital money, as Berentsen (1998) defines it, is one of many proposed electronic payment alternatives used by consumers in the retail market. Panurach (1996) defines digital cash as the electronic equivalent of paper cash. Digital cash is also called *electronic cash*. Burdett (1999) sees electronic cash as the instrument that will facilitate low value transactions in electronic commerce. There are many types of electronic cash systems such as Mondex, Proton, GeldKarte, and VisaCash. Mondex is viewed by many as the most promising of these.

Electronic Cash Stored in a Smart Card

Smart cards, as defined by Berentsen (1998), are cards made of plastic material that have microprocessors embedded in them, allowing them to store digital money. The card's value is reduced as each purchase is made. It is reloaded on demand and can be used for multiple purposes and needs. There is no on-line requirement for authorization of value transfer. Another name for a smart card is digital purse.

De Prince and Ford (1997) explain that electronic cash stored in a smart card requiring a personal identification number (PIN) to authorize payment is necessarily an on-line system. This number is used for security purposes so that only the PIN holder can authorize payment. Since the PINs are stored in a database by a third party, an on-line connection for PIN verification, at the time of the purchase, needs to be made. Off-line electronic cash requires no PIN verification because that security feature is not offered by the smart card. In this case, the smart card can interact directly with the merchant's terminal to complete the transaction. A smart card has the potential, according to De Prince and Ford (1997), of being used for more than the storage of digital money. It can store credit card details so that the credit card can be processed off-line, stored in the

merchants terminal, and then be batch-processed later to the host computer. To prevent fraud, the smart card has a tamper-proof antifraud security device embedded in its chip.

Electronic Cash Overview

Panurach (1996) presents a general description of electronic cash. It has anonymity, privacy, and liquidity. *Anonymity* and *privacy* refer to the fact that nobody, with the exception of the seller, will know the identity of the buyer or details of the transaction. *Liquidity* refers to the ease with which electronic coins can be reused. Cash is ready to be used and re-used, and electronic cash needs to provide similar liquidity. Electronic cash is more liquid than credit or debit cards because both require verification through a clearing process. This process is time consuming for the seller who obtains funds with credit or debit cards. However, in order for an electronic cash system to succeed, it will require acceptance by a significant percentage of merchants.

Electronic cash operates in the form of pre-paid rechargeable cards. It can be used to pay in different places in the physical world and in cyber space. In economic terms, electronic cash is considered to be regular cash in the money supply calculation. From the technical point of view, electronic cash is a purely electronic system that transfers its value. This value is usually encrypted by either a public or private key to guarantee that only the recipient can use the cash in the future. Moreover, financial institutions such as banks and non-financial businesses can issue electronic cash. In the case of banks, electronic cash functions just like regular cash. In the case of non-financial institutions, electronic cash functions more like coupons since it can only be used in that same business or its affiliates. For example, airline miles are treated as electronic cash. They can be redeemed only through the issuing airline or its affiliates. Non-bank issued

electronic cash can be riskier for the consumer because, unlike bank issued electronic cash, it is not insured by the Federal Deposit Insurance Corporation (FDIC). It is important to mention that bank issued electronic cash does not yield interest as it would if the money were stored in a savings account.

Ordinary cash deposits are turned into electronic cash through the following process. The customer needs to open an electronic cash account in the bank. He/she can transfer money from the account to a special mint account, which is like a personal buffer. Once in the mint account, only the customer can access it to pay for goods and services. By minting the money, the bank has no way of knowing who spent it or where it was spent since the format of the funds is cryptographically secure and unique. The anonymity of the customer is protected in this way. Electronic cash is secure enough to send through e-mail, which is classified as a data communication channel.

An electronic cash system should incorporate technical safeguards that prevent double spending. Double spending occurs when a customer uses the same electronic cash coin more than once. The system provides for unveiling the customer's identity only if he/she has double spent. McAndrews (1999) provides more explanations concerning the risks associated with electronic cash systems.

From the economic standpoint, electronic cash can lead to an increased speed of transactions, which can cause prices to go up for goods and services. In addition, interest rate margin costs, in the money market, can be reduced substantially because it is an electronic transaction. This could lead to dramatic changes in the structure of the banking industry. Another economic aspect of electronic cash is that consumers must re-examine

their concept of money, cash and value. Giannakoudi (1999) and Yan, Paradi, and Bhargava (1997) give details regarding Internet banking.

From the business perspective, electronic cash fills a niche in the market facilitating micro-payments. Electronic cash might not completely replace traditional means of payment, but it could certainly be useful for those who are involved in businesses that require low value or micro-payments.

Electronic Cash Characteristics

Shy and Tarkka (2002) describe the characteristics of electronic cash in terms of advantages and disadvantages. By analyzing it in this way, we can picture electronic cash more accurately so that it can be compared with regular cash currency.

Advantages of Electronic Cash

Electronic cash presents a whole new dimension of what a means of payment can provide its users. Shy and Tarkka (2002) explain how payments are electronically processed through a special point of sale terminal (POS) as opposed to regular cash in which the process is completely manual. Moreover, electronic cash does not involve the significant bookkeeping or verification costs that are required in credit or debit card transactions. Electronic cash transactions are quicker to process than credit or debit cards because there is no time consumed by verification, which would be an added expense for the merchant. Electronic cash is also quicker to process than regular cash since it does not involve counting and sorting money. It is an electronic transaction that does not involve handling physical money. Electronic cash can be less costly to buyers than credit or debit

cards because there is no annual or per-transaction fee involved with the use of electronic cash.

Birch (1999) presents an innovative approach to electronic cash, stating that our new economy demands an inexpensive, more affordable means for handling small payments. Electronic cash is a very good medium for micro-payments. It is more convenient than handling notes and coins. For example, payment by electronic cash is far easier than searching for the correct number and denomination of coins to pay for parking at a meter.

Lee, Choi, and Rhee (2003) say that electronic cash systems not only facilitate business transactions between customers and merchants, but also between customers, which are also known as customer-to-customer transactions. This transfer payment between individual parties is very useful for people who would like to do business but are not established merchants. Customer-to-customer transactions are very common in the Internet world.

Disadvantages of Electronic Cash

Certain characteristics of electronic cash may place it at a disadvantage when compared to other forms of payment. Shy and Tarkka (2002) state that electronic cash entails certain holding costs. *Holding costs* refer to the cost the consumer has to assume in case of accidental loss, or card failure. *Accidental loss* means that the card is lost. If someone else finds the smart card, he or she can spend its electronic cash unless a pin number has been assigned to the card, in which case only by guessing the secret key could the card be used. *Card failure* refers to the loss of the reading capability of the smart card where electronic cash is stored. There is also a foregone interest associated

with electronic cash. This means that the consumer does not earn interest on the unused balance stored in the smart card. These disadvantages may be the reason why electronic cash has met with consumer resistance.

Shy and Tarkka (2002) believe that if annual fees were levied for the use of electronic cash, they would have to be low enough for the market to accept. Otherwise, there would be no reason to use electronic cash as a means of payment. Standardization is another important concern raised by these authors. Different electronic cash issuers may not be technologically compatible. This lack of standardization can prevent electronic cash being widely accepted as it provides an unfavorable comparison with traditional cash. According to Shy and Tarkka (2002), another important aspect of electronic cash is its profit maximization fee. Determining its profit maximization is a controversial topic since it is very sensitive to the specifications of merchants and consumers.

Characteristics of Regular Cash

The characteristics of regular cash are discussed in order to make meaningful comparison with electronic cash. Shy and Tarkka (2002) provide a detailed list of characteristics.

Advantages of Regular Cash

According to Shy and Tarkka (2002), regular cash has many advantages. It circulates freely. It is legal tender accepted everywhere. It is transferable from the consumer to the retailer and visa versa. It implies an immediate settlement, since no banks or clearinghouses are involved in the process. It is difficult to falsify, and it provides anonymity and privacy for everyone involved in the transactions.

Disadvantages of Regular Cash

Shy and Tarkka (2002) explain that there are also many disadvantages associated with regular cash. First, cash sent by regular mail is not insured, making it very inconvenient to transport to remote places. Second, it is not easily divided; change is not always available. Large denomination notes are not versatile enough for the real world in most cases. Third, the storage and sorting that regular cash involves make it very expensive to handle. Storage refers to keeping cash in a secure place. Sorting time refers to the working hours required for the tasks of counting, checking for counterfeits, and handing out change to the customer. The consumers, retailers, and banks pay for these costs without realizing it. The only time people realize that they are paying a fee for the handling of cash is when they are changing it from one currency to another. Finally, just as with electronic cash, foregone interest can occur with regular cash since unused cash kept in a wallet, register or safe does not yield any interest.

One characteristic that makes cash undesirable is that it is dirty, according to Birch (1999). For example, toll collectors on the New Jersey Turnpike wear latex gloves to handle cash to avoid exposure to soiled money. Also, cash is heavy to transport as well as costly. This author estimates that it costs up to 6% of its value to count, sort, monitor, and transport cash.

Credit and Debit Card Characteristics

Advantages of Credit and Debit Cards

Shy and Tarkka (2002) state that credit and debit card users are insulated from the dangers of accidental loss and card failure. Most card issuers provide replacement for

both loss and failure, and users are offered full guarantees. Unfortunately, electronic cash lacks those fully guaranteed features. Furthermore, for larger transaction amounts, consumers prefer credit cards since most offer additional insurance benefits if the merchandise is stolen or lost.

Disadvantages of Credit and Debit Cards

Shy and Tarkka (2002) explain that credit and debit cards require credit verification. Credit verification is done through telephone lines and takes time. Time is money, and the time spent waiting for credit verification represents a cost for the merchant. Electronic cash does not require verification; therefore, no cost is involved. In addition, some credit card companies charge an annual fee and even a per-transaction fee to their customers. In some cases, the per-transaction fee can be higher than the amount of the transaction itself. There is no annual or per-transaction fee for electronic cash customers. The merchant saves the time spent for credit verification every time electronic cash is used since it does not need to be verified by the bank. Electronic cash transactions take less time to be processed than credit or debit card transactions.

Comparison of Electronic Cash to Other Types of Payments

According to Shy and Tarkka (2002), the size of a transaction will determine whether electronic cash or another means of payment is used. A comparison between electronic cash and the other means of payment is critical for appreciating its advantages and drawbacks.

Comparison Between Electronic Cash and Regular Cash

Shy and Tarkka (2002) show that there is a cost benefit in paying with electronic cash because of the time saved compared with regular cash transactions. Regular cash takes time to count and sort. It also takes time to transport safely from the bank to the store and back to the bank. Since electronic cash is processed electronically, it is a quicker and safer way of payment.

Panurach (1996) explains that electronic cash has the characteristic of being liquid. *Liquidity* is a characteristic shared by both cash and electronic cash. However, whatever type of electronic cash is used, a clearing process is always required to make those funds available for future use. In the physical word, cash is more liquid than electronic cash, while electronic cash is more liquid than credit or debit cards. In the cyber world, real cash cannot be used while electronic cash is a viable method of payment.

Chaum and Brands (1997) describe cash as a traditional instrument of payment. It is an instantaneous person-to-person payment. It is very difficult, even impossible, for a third party to trace cash payments. As a consequence, cash offers privacy. However, cash is very costly for banks to handle, transport, and protect. It is easily lost or stolen. It is heavy in larger amounts. Cash can easily be used in situations of extortion, bribery, and money laundering. Traditional cash, even though it provides privacy of payments, cannot possibly be used as payment in electronic commerce. The physical proximity of the payer and the payee is, in most circumstances, required. That is why electronic cash was invented. It was created to provide for privacy of payments over the Internet. Backhouse

(1998) discusses privacy and the importance of security of payments in electronic commerce.

Comparison Between Electronic Cash and Debit and Credit Cards

Shy and Tarkka (2002) state that debit and credit cards cost the merchant more than electronic cash. While it is true that electronic cash, debit cards, and credit cards all require a special point of sale terminal (POS) to process, it is also true that they differ. Once the POS terminal is paid for by the merchant, electronic cash may only require an additional annual fee for its usage. However, debit and credit cards require not only an annual fee, but also credit card verification costs, which include the rental of the phone lines for communication with the bank and also computer systems costs. Some debit and credit card issuers will not find it profitable to compete with electronic cash and regular cash for small transaction payments.

Panurach (1996) explains that electronic cash has the characteristic of being liquid. Liquidity is not a characteristic present in debit or credit cards. In both cases, the seller will not be able to use the debit or credit card funds unless a time consuming process is undertaken. Funds earned by debit and credit cards are not ready to be re-used as quickly as they would be if the payment were made with electronic cash. The electronic cash clearing process is quicker than the clearing process required by debit and credit cards. Until the clearing process is completed, the seller cannot reuse earned funds. In the physical as well as in the cyber world, electronic cash is more liquid than debit and credit cards.

Backhouse (1998) describes the importance of security of payments in electronic commerce. Chaum and Brands (1997) point out that payment with debit and credit cards

is more expensive because each transaction needs to be verified on-line, which can lead to undesirable delays. In addition, these payments are completely traceable, which can endanger the privacy of the cardholder. Traceability allows unauthorized parties to profile the spending behavior of the individual. It can result in unwanted junk mail or identity theft. Traceability is, in other words, an invasion of the privacy of the payer. That is the main reason why electronic cash can be useful for electronic commerce as well as the physical world. That is the motivation, according to these authors, for the invention of electronic cash.

Usefulness of Electronic Cash

Kelley (1997) explains that electronic cash is particularly well suited for making small payments. Its potential uses are varied among new and old services. New services, as Froomkin (1996) suggests, such as using payment for accessing and reading a Web page, depend upon the development of suitable methods of making micro payments.

Jones (1999) identifies several uses of electronic cash stored in a smart card. The first two uses are interactive television and personal computers, provided that an appropriate infrastructure to accept electronic cash payment is in place. This system consists of a chip-card reader in a set-top box that allows for electronic cash payment. Electronic cash could serve as payment for pay-per-view such as movies and video games on interactive television. It could also serve as payment for Web page, document, or video access. A smart-wired phone could be used for processing electronic cash payment or receiving electronic cash payments. Another important electronic cash use is the pay-as-you-go mobile phone. This author adds that mobile phones will likely have a

special slot to install a personal mobile cash dispenser for electronic cash. Electronic cash can be very useful to children and teenagers, who do not ordinarily have credit cards.

The electronic cash smart card is growing in terms of point-of-sale terminal locations (De Prince & Ford, 1997). This kind of smart card is like a chargeable card that can be re-loaded with more electronic cash as needed. These have been used in several transit systems. For example, electronic cash smart cards have been used in Washington, D. C., the San Francisco Bay Area, New York City, and Toronto; Hong Kong is moving in that direction also. Another use for this kind of card is to purchase telephone service. In addition, this type of card has also been used on university campuses to provide access to dormitories and other buildings or to pay for the library, bookstore, and cafeteria among other services. The authors do not specify if the electronic cash stored in the smart card is electronic cash or if it is simply e-money. To be electronic cash, the smart card has to conserve the user's privacy and anonymity. The smart card can store either electronic cash or electronic money. If it is electronic cash, it can be used for low-value payments and it keeps the privacy and anonymity of its user. On the other hand, e-money does not necessarily keep the user's privacy and anonymity.

Nigg (1997) states that electronic cash, specifically Mondex (Mondex, 2003) electronic cash, can be used for payments in the physical world and on the Internet. For Internet uses, it allows for on-line payments such as accessing newspaper articles, video games, and research. These uses require, in most cases, low-value payment. In the physical world it can be used for payment in restaurants, delicatessens, coffee bars, and stationary stores, to give a few examples.

Burdett (1999) explains that electronic cash can be very versatile provided communication lines are available. The author mentions that electronic cash, specifically Mondex electronic cash, can be used to pay for taxis and newspapers with the condition that telephone lines be available to process the payment.

Lee, Yu, and Ku (2001) explain that electronic cash can be used to charge for as many different Internet services as are available. In the research area, the customer can have access to literature reviews, experts' opinions, market surveys, technical journals, company reports, product catalogs, newspapers, research reports, and magazines. Other payments, such as mobile phone and interactive digital TV bills, and purchases of merchandise, can be made on-line. The system should work well from mobile phones, digital TV, personal computers, and personal digital assistants. As Internet access services globalize, currency exchange in the electronic cash payment process should be facilitated.

Acceptance of Electronic Cash

Jones (1999) says that electronic cash acceptance will take a while in the United States. It is most likely that electronic cash will be accepted first in Europe. In the author's opinion, electronic cash can only grow if it adds real value to a service or product. Otherwise, there is no need to have another type of payment available. Electronic cash acceptance will depend on the merchant's reaction to it and on the customer's uses for it. Technology such as Mondex, which allows for electronic cash payments, is still not available to everybody.

Brands (1995) believes that, in the long run, the advantages of smart card electronic cash will overcome people's initial objections. In the next section, an analysis

of electronic cash acceptance from the perspective of banks, merchants, and customers will clarify and explain how the adoption of electronic cash can result in convenience and return of investment to the parties involved.

From the Bank's Point of View

Jones (1999) states that the new emerging channels of communication will allow electronic cash to be accessed from interactive TVs, PCs, smart wired telephones, and mobile phones. This kind of communication will permit a low-cost means of cash distribution and collection for the bank and its customers. Electronic cash is a low cost technology since it uses existing telephone lines. According to the author, the new technology is not yet in place, but it will be adopted soon by Mondex electronic cash technology.

With regard to emerging channels of communication, Chaum (1997) notes that personal digital assistants (PDAs) have become widely available. The advantage of PDAs is that they could have a tamper resistant feature that would allow owners to control the information that is being transmitted when the electronic cash payment is processed. Today, many mobile phones have a PDA feature. There is plenty of choice in terms of electronic cash and the communication enhancements required to operate and control it. Adi (2000) is another author that explains security in the mobile environment.

From the Merchant's Point of View

Jones (1999) explains that the merchant needs to have a special integrated system for the point of sale device to be able to accept electronic cash payments. This kind of

technology will be arriving soon. In fact, Microsoft's chip card reader will be available in the near future.

Jones (1999) believes that electronic cash can be very convenient for merchants. Since electronic cash involves a whole system, it can be programmed so that price can be time-dependent: an electronic cash system gives the merchant the ability to price in real time. This is especially convenient for a service such as a laundry, where the machines are full Saturday morning and never used on a Friday evening. Price can vary so that heavily used hours such as Saturday morning can be more expensive than on Friday evening to motivate people to save money by using the service at certain times of the week.

Jones (1999) shows that the cost of a debit or credit card payment for low cost transactions is higher than the cost of electronic cash to pay for such transactions. For example, suppose that the price for accessing the U. S. Weather web page is $1.00. It costs $0.07 to pay with electronic cash and $0.25 to pay with a credit or debit card. Clearly, electronic cash offers a more cost-effective way of conducting low-cost transactions.

De Prince and Ford (1997) state that regular merchants have no important reason for electronic cash adoption. Traditional ways of payment such as regular cash, credit cards, checks, and debit cards work well. Besides, electronic cash adoption will require the immediate expense of acquiring a new, adequate terminal such as a special point of sale terminal (POS) that processes electronic cash smart card transactions. The authors think that merchants will eventually acquire new terminals since they are usually changed every 4 to 7 years. In view of the fact that the merchants will change the terminal for new

ones, it would not hurt that the new terminals have the capability of processing electronic cash smart cards. Of course, the cost will be the determining factor. As the authors point out, the lack of standardization in technology can make it difficult for merchants to decide which terminal to choose. Visa, MasterCard, EuroPay, and Mondex are currently trying to achieve mutual technological compatibility. Shy and Tarkka (2002) mention that lack of standardization and annual fees are two factors that negatively impact merchants' attitudes to electronic cash acceptance. Lack of standardization among the different electronic cash issuers is something that needs to be improved. In addition, a possible annual fee imposed on the merchant may not help electronic cash reception. In fact, an annual fee for electronic cash use, if ever charged, needs to be low enough to compete with other types of payment such as credit and debit cards. Otherwise, merchants will not see the advantage of using electronic cash over other means of payment.

Shy and Tarkka (2002) explain that merchants will always prefer electronic cash for transactions involving small sums because credit and debit cards charge a per-transaction fee to the merchant. The per-transaction cost may, in some cases, be greater than the price of the item purchased. That is why electronic cash may be preferred over credit and debit cards for smaller amounts.

From the Customer's Point of View

Kelley (1997) says that the consumer acceptance of electronic cash will likely depend upon the acknowledgement that electronic cash has advantages in circumstances where regular cash is not convenient. Electronic cash can satisfy the demand for a low cost method of payment for small transactions.

De Prince and Ford (1997) establish that the smart card is very convenient for customers, but it offers little advantage over the use of credit cards. This is because most credit cards offer an interest free grace period. There may be no point in using a smart card if the credit card account is settled within the grace period. If banks charged interest from the date of purchase on the credit card, smart card use could greatly increase.

Moreover, De Prince and Ford (1997) state that when a smart card stores both electronic cash and credit card information, people tend to use its credit card portion the most. This may be because not everybody has enough cash to spend and prefers to postpone paying, as the credit card allows. The authors also mention that paying by electronic cash smart card is quicker since the cash is already stored in the card, compared to the time it would take for credit card approval.

In terms of consumer acceptance of electronic cash, De Prince and Ford (1997) summarize by saying that consumer preferences will be an important determinant for the success of electronic cash and the smart card. Smart card acceptance will definitely depend on the price paid to use it.

Shy and Tarkka (2002) found that electronic cash has not yet been adopted and attribute this to the lack of consumer confidence in the card's money storage technology. This kind of technology has certain costs associated with it, such as replacing lost cards, foregone interest, and card failure. That is the reason why it may not replace other means of payment.

On the other hand, an important reason why electronic cash may be preferred by consumers over credit or debit cards, according to Shy and Tarkka (2002), is the fact that electronic cash is faster to process. The waiting time at a counter can be reduced

substantially by paying with electronic cash since it does not require a verification process for the availability of funds. Longer time is usually needed for the required credit verification when using credit or debit cards as ways of payment.

Birch (1999) states that the transition to electronic cash will eventually be reached since there have been other technological advances that were accepted as well. Examples of these technological advances are the direct deposit and the electronic benefit transfer (EBT). This author believes that electronic cash will be accepted just as direct deposit and EBT were in their time.

A key advantage of electronic cash is that it provides anonymity for its user. It does not depend on a central registry as credit or debit cards do. That is why it can keep the anonymity of its user who may find a value in this feature (Shy & Tarkka, 2002).

Jones (1999) points out that customers will have the convenience of accessing electronic cash through three special channels. First, a set-top box chip card reader will be available to access electronic cash from an interactive TV. Second, a PC chip card reader will allow accessing electronic cash from a PC. It permits the PC to be a cash dispenser. Third, a two-slot mobile phone will turn a common mobile phone into a cash dispenser. In addition, the author mentions that electronic cash can be useful for children's needs. It could be used for low cost transactions and provide a maximum authorized amount for children to spend. Mondex electronic cash currently offers the features mentioned. The author says that electronic cash acceptance will take some time, but people will eventually use it as long as it adds value to customers' transactions.

According to Brands (1995), once people become familiar with electronic cash, they will pay with it more frequently. It is easy and safe to use. Its portability makes it feasible to make payments either on-line or off-line.

Privacy and Anonymity

The main purpose of the existence of electronic cash is to provide privacy and anonymity in the electronic transaction. For a complete analysis of privacy and anonymity, both the technical and legal aspects should be considered.

Description of Privacy

Brands (1995) establishes that dealing with personal information is a multi-million dollar industry from the marketing perspective. Internet payments should guarantee privacy. This author describes privacy as Internet payments that are untraceable and unlinkable. Untraceability means that there is an action taken to protect the identity of the payer. Otherwise, the electronic cash system could interfere with the promised anonymity. Watanabe, Yuliang, and Imai (2000) give a detailed explanation of traceable signatures in electronic cash. Unlinkability means that a payment made cannot be related to other payments so as to reveal the user's identity. Even though the bank and the service providers store users' information on a database, electronic cash must guarantee privacy if it is to have the public's trust. In fact, a prerequisite for any kind of Internet payment system is that it should be verifiable (traceable and linkable), but only under certain circumstances, when ordered by the court. In short, these systems guarantee privacy even though the bank keeps all the information about the transaction in its database.

Technical Standpoint

Chaum's (1997) work has been geared towards warranting the privacy and anonymity of the system based on the technical tools of cryptography and blind signatures. Electronic cash assures untraceability of the payment transaction. However, electronic cash does not provide for cookies and other aspects related to Web pages that can reveal the user's steps on the Web. Electronic cash can guarantee privacy and anonymity only for payment purposes. This author covers the technical aspects of electronic cash and these will be discussed, in detail, later in this research.

Legal Perception

As Tanaka (1996) mentions, Michael Froomkin is an expert in the legal aspects of electronic cash. Froomkin discourages full anonymity in electronic cash because it does not allow authorities to detect or combat criminal activities. Froomkin's analysis is very useful and thoroughly covers the legal characteristics of electronic cash. However, his critiques do not cover the technical aspects of electronic cash.

Froomkin (1996) focuses on the legal aspects of electronic cash. The author believes that legislation is needed so that there is more control over payment transactions. This legislation would provide users with rights that can protect them from fraud. These rights may make a contribution towards improving the electronic cash systems so that civil rights are protected. This author believes that electronic cash does not provide the anonymity claimed by electronic cash providers because, when it is used on-line, it is no longer anonymous. On-line transactions (transactions on the Internet) can be traced because a user visiting Web pages leaves "footprints" which can be used by a third party to generate a personal profile of the user. Valuable data can be collected for marketing

purposes. Why pay on-line with electronic cash, if, by just accessing the Web pages, a customer profile can be created anyway. Moreover, if, in fact, electronic cash were to be completely anonymous, money laundering would be easy for unlawful parties. The author suggests the prohibition of completely anonymous electronic cash to avoid money laundering.

From the technical point of view, this research will suggest that there is no such thing as completely anonymous electronic cash since if a wrongful transaction is detected, it can be traced to unveil its author. Watanabe et al. (2000) explain this traceable signature of electronic cash so that any illegal transaction can be traced. Yu and Lei (2001) explain that by providing fair anonymous certificates, anonymous electronic cash payment can be possible.

Bernkope (1996) discusses the opinions of Chris Sandberg, another leader in the area of legal aspects of electronic cash. Sandberg explains in great detail the legal issues that affect electronic cash.

Management and Handling of Electronic Cash

The management and handling of electronic cash is a focal point of discussion when analyzing it from the business perspective. According to Berentsen (1998), there has lately been much emphasis on deregulation and improvement in the efficiency of the financial sector. Consequently, legal restrictions controlling the propagation of digital products such as electronic cash will be complicated to defend. The author points out that central bank currency is a very expensive medium of exchange. In fact, it costs U. S. retailers and banks $60 billion to handle money. This expenditure includes the cost of processing, accounting, storage, transport, and security of physical money. Electronic

cash, either stored in a hard disk for on-line use or stored in a smart card, will cost U. S. retailers and banks less in terms of handling in general. In short, the handling costs of electronic cash are less than the handling costs associated with physical cash. Of course, electronic cash requires the initial outlay for hardware and software. However, once these fees are paid, its users can count on a less expensive system. Electronic cash is a very cost-effective tool to manage due to its characteristics.

Jones (1999) also mentions that handling real cash is much more expensive than handling electronic cash. This is true since electronic cash can be transported as easily as sending e-mail through the phone lines. This characteristic makes electronic cash easier to handle and control.

Business Opportunities with Electronic Cash

Electronic cash could bring rewarding business opportunities. The most notable and important electronic cash capability illustrated by Mondex, according to Jones (1999), is that electronic cash allows for the assignment of real time pricing for low value transactions. This is something new to a payment system that adds value to the current services because of the inherent capabilities of electronic cash.

Jones (1999) argues that real time pricing is possible because of the flexibility of electronic cash systems. For instance, in a Laundromat, the machines can be fitted with an electronic cash slot to accept the electronic cash smart card. This allows the owner of the Laundromat to vary the price of the loads depending on the time. If it is peak time, a higher price can be charged; during off-peak periods, a lower price can be asked, motivating people to use the machinery during off-peak times.

Jones (1999) adds that real time prices can be applied to pay-as-you-go cellular calls, which consist of paying only for the minutes used on a cellular or mobile phone. This is especially useful for people who, for example, are traveling and only using a mobile phone for a limited number of calls. It is very convenient and cheap for the customer because the mobile phone can transmit electronic cash to buy more minutes for the mobile phone. A special chip installed in the mobile phone allows the transfer of electronic cash as payment. A mobile phone, with this capability, becomes a cash dispenser for the customer.

Jones (1999) explains that this same concept can also be applied to vending machines, pay-per-view, rapid transit systems, and so on. Pay-per-view includes movies, CD singles, and music from jukeboxes. In the case of vending machines, a soda can be sold at half price if it is bought at midnight. Variation in price in a rapid transit system is beneficial to ease passenger loads. By varying the price according to time, a better balance in the use of resources is established. This characteristic can be used to smooth the demand curve by encouraging a better balance between demand and supply. Besides, this variation in price could benefit consumers because they can plan on using the services at off-peak times and save money as a result.

According to Burdett (1999), Visa and MasterCard have already recognized the potential for electronic cash use in electronic commerce. Electronic cash transaction costs are lower than other means of payment such as the credit or debit card. The cost of the transaction should be lower than the price of the service or product purchased. Electronic cash is the only system that can provide an efficient processing of micro-payments. Electronic cash business opportunities can be summarized as follows: first, electronic

cash offers real time prices for business transactions; second, electronic cash offers cost efficient low value transactions; and third, electronic cash offers versatility since it can be accessed from different hardware such as a PC, a TV, or a mobile phone.

Issuers of Electronic Cash

Two different parties could issue electronic cash: banks or private non-bank institutions. As Bernkope (1996) explains, for every dollar that a bank issues, it only has to have three cents in its bank reserves. Even though non-bank institutions are free to issue electronic cash, they do not need any reserve requirement. For this reason, these non-bank institutions are not protected by the FDIC (Federal Deposit Insurance Corporation) under current U. S. law.

In the case that electronic cash is issued by a bank, De Prince and Ford (1997) explain that the unused balance of an electronic cash smart card is not insured and belongs to the bank. If the FDIC decides to allow for the unused portion of electronic cash to be insured, then it would belong to the electronic cash smart card holder. That would have two consequences. One is that deposit insurance is needed. The other is that a reserve requirement will also be needed. These may have to be paid for by the electronic cash smart card holder. The bank may pass the costs to the holder because the electronic cash system would become very expensive to manage.

The main incentive for electronic cash issuers is the interest-free debt or low interest debt financing as explained by Berentsen (1998). According to this author, the balance of money kept in the smart card or saved in the hard drive is a form of credit since issuers are liable for its balance. Electronic cash is less profitable for banks since it needs to have high reserve requirements. This fact also negatively affects private issuers

of electronic cash, because reserves are likely to be expensive and difficult to maintain. The author believes that this may be the reason why electronic cash has not developed to its full capacity. Krueger (2001) argues that electronic cash issuers need to hold reserves such as deposits and cash. The author discusses one possible solution to this problem that has held back the development of electronic cash (see the section on economic aspects of electronic cash). According to Kelley (1997), electronic cash issuers who can make innovations to the system will be tomorrow's leaders. New efficiencies in the payment system are always in demand.

De Prince and Ford (1997) say that an important advantage for electronic cash smart card issuers is that they have interest-free use of funds on electronic cards prior to their exhaustion. Issuers do not have to pay interest to electronic cash smart card users for what is stored in the card. The electronic cash smart card user does not receive any interest for the funds in the card as he/she would from a saving account.

De Prince and Ford (1997) explain that as the amount of privately issued (electronic cash) money in circulation grows, the volume of cash needed by the Federal Reserve will decrease and the less it will cost banks and retailers to handle money. The less cash that is handled, the less it will cost.

Electronic Cash Profitability

As for the profits that electronic cash can help generate for businesses, De Prince and Ford (1997) show that electronic cash stored in a smart card represents a non-interest bearing product for the consumer as it would in a checking account. If the consumer decreases his/her deposits in a savings account, for example, in order to increase the

amount held as electronic cash, this could certainly represent profits for the bank since electronic cash does not yield interest.

Shy and Tarkka (2002) state that the electronic cash smart card reduces the handling and storing costs associated with regular cash. Currency (regular cash), payment orders, checks, and debit cards all have high handling costs that include handling and storing of notes and coins. In the case of checks, these require verification and bookkeeping costs. Currency requires the physical handling, transportation, and safety costs that are associated with it. Electronic cash is a new payment system that overcomes these drawbacks by reducing handling and storing costs.

Business Costs Associated with Electronic Cash Adoption

The costs that are involved in electronic cash adoption by the business sector are cited and explained by De Prince and Ford (1997). First, the more profits the bank makes, the higher income-tax revenues paid to the Treasury. Income tax expenses are one major cost of business when electronic cash is implemented. Second, the authors point out that the cost related to marketing the new product—electronic cash—is another expenditure that the business will incur. Marketing costs entail convincing retailers to install more sophisticated and expensive point of sale terminals (POS) to read and charge transactions from either credit cards or the new electronic cash smart cards. There is also the possibility of paying interest on deposits in smart card electronic cash accounts in order to be more competitive in the market.

The establishment of electronic cash involves some costs (Shy & Tarkka, 2002). These expenses are the initial analysis of investment, the setup costs, and the equipment

costs. These costs need to be taken into consideration by the merchant when trying to adopt electronic cash as another way of payment.

The Role of Banks in Electronic Cash Management

Banks are better at managing electronic cash than software companies are (Nigg, 1997). The reasons are varied. First, banks have long- and well-established relationships with their customers. Next, these banks already have experience dealing with financial products, such as issuing credit and debit cards, managing risk, and providing customer service. The author believes that if banks want to stay competitive, they will have to offer new products that meet the demands of the growing electronic commerce sector.

Chaum (1997), who is considered one of the pioneers of electronic cash, says that banks can have digital branches in cyberspace so that they can reach more customers. Electronic cash, as an innovative product, offers them a great business opportunity because banks can promote their franchise, make the first proposal on electronic cash, sell electronic cash, and nurture customer relationships.

Panurach (1996) explains that even though non-financial institutions can issue electronic cash, consumers can be certain that banks are safer to deal with because, as financial institutions, they are insured by the Federal Deposit Insurance Corporation (FDIC). The customer can be certain that even if his/her money is in the form of electronic cash, it is still insured. This advantage can be used as a marketing strategy to promote bank-issued electronic cash. However, it is recommended that banks in that same advertising campaign clarify the fact that bank-issued electronic cash does not yield interest as it would if the money were kept in a savings account.

Industry Leaders

A survey of real situations where electronic cash has been used is presented below. These are important cases to examine because they provide examples of practical applications of electronic cash and how it is integrated into people's lives. The experience of these financial institutions provides valuable insight regarding the market introduction of electronic cash and its expansion. For example, Chase Manhattan Bank, Citibank, MasterCard and Visa account for 50 merchants and 50,000 smart card holders in New York City (De Prince & Ford, 1997), and there are other examples of international industry leaders.

Digicash

Panurach (1996) presents Digicash as the first type of electronic cash launched. It was developed by Digicash Co. of Amsterdam in The Netherlands. In 1996, Digicash was issued by the Mark Twain Bank of Missouri in the U. S. and by the Merita Bank of Finland. The number of merchants accepting this type of electronic cash as of January 1, 1996 was 100 according to a Digicash registry. Lunt (1996) also describes Digicash, which was distributed by Mark Twain Bank.

Digicash Corporation issued Ecash as its electronic cash (Chaum, 1997). Ecash - on-line electronic cash - allows for the privacy of its users in on-line payments. Ecash (eCash, 2001) can be considered the commercial term for the concept that is discussed in this research. However, it did not succeed mainly because of three factors. First, Ecash was launched in the 1980s, before the boom in electronic commerce, and the concept of privacy in electronic commerce was not necessarily appreciated at the time. Second, there was lack of support for such a system because traditionally, business people always try to

get the most out of each transaction. In other words, since privacy of payments prevented the marketing parties from collecting data from the customers, many of the companies that could have supported Ecash simply refused to do so. These companies did not see a profitable business in electronic cash. The micro-payments that electronic cash facilitates did not seem to be a profitable business. Third, Chaum's work on Ecash had focused only on the technical aspects of electronic cash such as cryptography and blind signatures. If the developers of electronic cash had considered the business implications as well, then they would have been aware that the market for micro-payment had not materialized at the time the Digicash Company opened. In addition, the network system that Ecash required created waiting-time problems, which may have contributed to its failure (Brands, 1995). Ecash as an example of an on-line electronic cash system will be explained later in this research. ECash (2001) provides more detailed information about the ecash product.

Mondex

According to the Mondex Website (2003), the company was formed in July 1996 in England. It provides electronic cash solutions to conduct transactions via the Internet, digital TV, mobile phones and the physical world. Mondex electronic cash is an equivalent of real cash. It does not require a bank authorization in order to make transactions and does not require users to give any personal details. It provides security and a convenient method of payment in the real as well as the virtual world. It consists of a smart card, which is a plastic card that can store information in its microchip.

Nigg (1997) defines Mondex as an off-line, chip-to-chip system, in which the electronic cash value can be transferred from the customer to the merchant or person-to-

person. Mondex electronic cash can work successfully for payments on the Internet and in the physical world. Mondex (2003) gives more information regarding the use of Mondex and technology issues. Jones (1999) advocates Mondex as a strong leader in the market. De Prince and Ford (1997) describe Mondex as providing anonymity and privacy (no audit trails), which is the characteristic required for a financial product to be electronic cash. Elliot and Loebbecke (1998) explain that Visa Cash and MasterCard Cash are not as developed as Mondex, which provides better reloadability and anonymity for its consumers. De Prince and Ford (1997) say that Mondex can hold up to five different currencies in electronic cash stored in a smart card. Wells Fargo plans to acquire 40 % of the U. S. Mondex franchise.

Mondex (2003) allows users to pay for goods and services in person or through digital TV, the Internet, or by phone. Used with a digital TV, it can pay for items purchased through home shopping networks or over the Internet. Mondex can be used to send payments by email or to pay for items on the Internet such as music, tickets, gambling, games, and so on. Mondex can be used to purchase airtime for a mobile phone and to act as a personal ATM for accessing funds. In the physical world, it is used to pay for tickets through the vending machines of mass transit systems.

Mondex does not rely on a central recording system (Shy & Tarkka, 2002). Mondex already holds the cash value on the card, which brings an immediate settlement of the payment since it does not have to be approved by a central system, as credit or debit cards have to be. This means that the Mondex system is easier and quicker than other payment systems.

Nigg (1997) explains that Wells Fargo and its partners intend to develop Mondex as an alternative method of payment for goods and services over the Internet. As electronic commerce evolves, new payment methods such as electronic cash will be needed. To remain competitive in this new environment, banks have to offer electronic commerce products and services to their consumers and to business customers. Nigg (1997) further explains that Wells Fargo chose Mondex since they considered it the most advanced and competitive in today's market. Since 1996, Wells Fargo, along with six other major U. S. companies, has been promoting Mondex by investing in it and educating its customers as to its benefits.

Burdett (1999) emphasizes that the transaction cost of Mondex will change. As its adoption and usage increases, the cost of processing it will gradually decrease. However, it requires a global network system to be globally established. In addition, Burdett (1999) explains that the cost of the transaction itself must be low in order to justify using Mondex electronic cash as an alternative form of payment. According to the author, a Mondex smart card costs $6. It can hold not just electronic cash, but as a smart card, it can also store the codes for other information such as medical records, or building access. The cost of Mondex is likely to decrease as time passes and as its use increases. Initially, it will require the spending of millions of dollars to persuade merchants and consumers of the advantages of using Mondex.

Elliot and Loebbecke (1998) report that a pilot study of Mondex was conducted in the fall of 1997 in Manhattan, New York. It was sponsored by a consortium of two banks, Chase Manhattan and Citibank, with MasterCard and Visa as supporters.

Mondex has many favorable qualities. Nigg (1997) establishes that Mondex offers convenience for the most demanding customer. Mondex is a realistic, cost-effective solution to electronic cash payments on the Internet. It is very convenient for micro-payments or low-value transactions in the physical world and over the Internet. Cost-effectiveness refers to the fact that the cost of clearing the transaction is much lower than the amount of the sale. For instance, for low-value payments or micro-payments, paying with credit or debit card, which operate on-line, can be expensive because the cost of the sale is much higher than the value of the sale itself. Furthermore, Wells Fargo sees it as a true option to cash in both the physical world and on the Internet. It offers an off-line, chip-to-chip system in which its value is transferred from consumer to consumer, or person to person. It is not cleared in a central system when it is processed. It is very flexible since its chip can be adapted to advances in technology as they emerge.

Nigg (1997) points out that Mondex needs three parties for its operation to be effective. There are benefits for the customer, the merchant, and the financial institutions that issue it. First, there will be loyalty programs offered, which can bring discounts and prizes for the customers that use Mondex. In addition, there is no waiting in line for coin change; payments are processed in seconds. Second, Mondex has low operating costs for the merchant. There is no need to assign telephone lines for authorizations, since Mondex does not require it. Mondex also eliminates cash handling expenses such as counting, storing, and security. Since Mondex is mostly self-service, it can eliminate some front line labor costs. The merchant also enhances customer service since Mondex processes sales faster. Third, financial institutions, which need to be licensed to operate and issue Mondex technology, can benefit by offering this new service to existing customers and

merchants, and as the number of customers and merchants using Mondex expands, its business will grow. The most remarkable benefit for the financial institutions is the fact that cash-handling expense is reduced since merchants can upload Mondex electronic cash instead of depositing currency and coins. Financial institutions play a major role in Mondex electronic cash acceptance since merchants and customers are able to rely on their support.

Mondex has other advantages. Higgins (1997) adds that Mondex replicates and improves upon the features of regular cash. Mondex is a smart card based technology originally developed in NatWest Bank in England. Improvements are that Mondex adds extra flexibility, control, security, and convenience. There are many new features that improve upon traditional cash. For the user, the advantages are at least threefold. First, the transfer of money can be done over the telephone lines. This is especially useful in the wireless technology environment available to us. Second, Mondex keeps a record of the ten most recent transactions for user reference purposes. This allows the user to keep track of how much money is left in the card. Third, Mondex has the ability to lock its electronic cash in order to prevent unauthorized access. This feature is very useful for security purposes.

As Higgins (1997) explains, Mondex has numerous advantages for the merchant. First, Mondex is very quick to process at the POS terminal since it does not require authorization as credit or debit cards do and the payment is exact. There is no need to give change as there is with regular cash. Second, the Mondex terminal is inexpensive to acquire. This means that Mondex startup costs are very low. Third, Mondex can be used to accept payments, either large or small, because the merchant's transaction costs remain

the same. Fourth, the Mondex system gives the merchant the opportunity to increase sales by implementing the loyalty programs that Mondex provides. Fifth, Mondex terminals can be locked to reduce security risks. It is easier to manage Mondex than to count and transport physical cash. In fact, Mondex electronic cash funds can be transferred to the bank by telephone lines.

As for security features, Higgins (1997) states that the memory chip on the Mondex card not only provides security, but also protects it from physical abuse. Although the author mentions that there is no such thing as perfect security, Mondex is constantly improving and updating its systems for fraud prevention and detection purposes. Mondex is also innovative in its role in electronic commerce. The author says that the Internet population is growing at a rate of 10% each month. Everybody is using it, from individuals to companies, organizations, and the government, for exchanging ideas and information. Mondex can be the payment tool needed for the processing of on-line business operations. Mondex offers secure payment that inspires consumer confidence and trust.

Mondex does not require phone lines every time a payment is processed since the card already holds its cash value. Burdett (1999) explains that Mondex electronic cash is a non-clear system. A clearing system, as opposed to Mondex, would require phone lines to connect to a bank so that the bank could authorize the transaction. Even though it may still be electronic cash, a clearing system would take time since the connection with the bank can take some seconds longer to process. The fact that phone lines are not needed for Mondex electronic cash to be cleared and processed makes it cheaper than other electronic cash systems.

Visa Cash Compared to Mondex

Lee, Yu, and Ku (2001) describe Visa Cash and Mondex as widely used forms of electronic cash that are very similar in many respects. Both cards offer off-line transactions and both require bank accounts. The funds stored in the card, like regular cash, are lost if the card is stolen or misplaced. The transactions are anonymous and the costs are low. They can be used in the virtual or real world. Both require that companies install the smart card reader in order to process the payment transaction and store a limited amount of money.

In addition, these smart card electronic cash systems do not require the maintenance of a large real time database. However, the authors emphasize that even though both systems are classified as smart card based off-line electronic cash, they are not compatible. Each uses its own encryption and decryption method, which is what makes them incompatible. The authors say that since no one can predict which system consumers will opt for, banks are reluctant to adopt either one. Consequently, establishing a standardized technology for smart card electronic cash systems is of paramount importance.

Visa Cash

Elliot and Loebbecke (1998) explain that Visa, one of the largest international card consortiums, chose Australia to conduct a pilot study of their smart card. Australia was chosen because this country has a sophisticated payment system, major national banks showed interest, consumer acceptance of new technologies is high, and the Australian Consumer Association supports its regulatory clauses. In 1995, Visa Cash conducted a pilot study in a resort area of Australia's Gold Coast. Terminals were

available in department stores, cinemas, service stations, restaurants, fast food outlets, and pay phones. The pilot study included reloadable cards and disposable cards. Transfer of funds to the card was possible for the reloadable cards.

For disposable cards, once the funds were exhausted, the card could be thrown away or kept as a souvenir. Visa Cash provided the customer with anonymity of payment just as regular cash does. The funds collected by the merchant were transferred to the bank daily. Other pilot studies have been conducted by Visa in Argentina, Colombia, New Zealand, Canada, Atlanta (during the Olympic Games 1996), and Hong Kong. Visa also offered the use of a smart card for Internet purchases. The purpose of these studies was to educate consumers and financial institutions, and to test the technology with the aim of developing a better infrastructure. Since 1997, Visa has conducted pilot studies only in theme parks.

MasterCard Cash

Elliot and Loebbecke (1998) explain that MasterCard, one of the largest international card consortia, chose Australia to conduct a pilot study on the smart card for the same reasons Visa did. It was first tested in Belconnen, a city in Australia where most of the shopping is local. The type of smart card tested in the pilot study was a reloadable card in combination with a debit card. The card readers for the merchants were installed free of charge in 150 establishments. Merchants' transfer of funds was done in the evening. There were reloadable facilities in local banks and in the shopping malls. The smart card used in the pilot study had an 8KB data storage capability. However, MasterCard has decided to proceed with UK Mondex instead of further developing MasterCard Cash.

Quicklink

Elliot and Loebbecke (1998) describe Quicklink as a smart card dedicated to the public transportation system. It is owned by ERG Limited, an Australian technology company. It was created mainly to increase the self-service ticketing efficiency in the transit system of New South Wales, the most populous state in Australia. It was tested there from November 1995 to January 1997. Quicklink smart cards were reloaded as needed in about 75 available terminals. Besides the transportation system, Quicklink could also be used at Australia Post, McDonald's, Coca-Cola, Newcastle University, University Credit Union, and licensed clubs.

In addition, Telstra and Smith's Snackfoods converted payphones and vending machines to accept Quicklink smart cards. Quicklink used a Belgian Proton 1KB chip card memory. Merchants were credited for the amount of the Quicklink transactions the following day. Quicklink offered anonymity of payments, except for those cards that were multi-function cards, which also held student identifications or drivers licenses. An advantage of Quicklink is that it is compatible with EMV, which is the standardized technology utilized by EuroCard, MasterCard, and Visa smart card.

Transcard

Elliot and Loebbecke (1998) explain that Transcard is a joint venture with Transcard Australia from Australia Transportation Group and Card Technologies from Australia. The pilot study started in November 1995 in Sydney. Retailers such as fast food outlets (McDonald's, for example), gas stations, liquor outlets, leisure centers, and transportation companies such as buses and taxis were all ready to accept Transcard as payment. In addition, Transcard employed loyalty plans to provide incentives for

consumers. Transcard technology was developed by an Australian firm called Micron and the card incorporated a 1KB memory chip. It is a card with an antenna that can transmit and receive information by radio waves. This card was designed so that payment could be processed from a distance. This is useful in the mass transportation system since contactless radio wave payment is quicker to process than having to insert the card in a reader. The cardholder must press a button to approve each payment transaction through radio waves. Transcard operates successfully and has remained ongoing since its implementation. Still, Transcard is limited in its use. Even though Transcard is not compatible with EMV (EuroCard, MasterCard, and Visa), it can easily be adapted for compatibility because it is also a multi-functional card. Multi-functional cards can hold not only currency, but also other documents such as licenses, student identifications, and the like.

Proton

Proton provides an ideal opportunity to study the successful introduction and implementation of smart card technology. Van Hove (2000) describes e-purse (electronic purse or EP) as another term for a smart card. The growth of EP depends on the success of e-commerce. EP needs to be marketed aggressively to encourage its use. It could follow the same path as ATMs and mobile phones, which initially met resistance, but have now gained wide acceptance. The importance of EP is that it carries, in most cases, electronic cash. Sometimes EP carries the appropriate code for accessing buildings. However, EP is mostly used as electronic cash to pay for goods and services in small payments and it is used in physical places such as public phones, laundry machines, and

parking meters, to name a few examples. EP is not a popular means of payment for items purchased over the Internet though it is well suited to this use.

EP has been heavily issued in Europe. The best guide to how popular these cards are is not the number issued but how often they are used as a form of payment. For some reason, people who usually pay with cash do not like to carry a payment card such as EP, and people who carry a credit card do not like to pay with cash even in the form of EP. EP is best suited to those who formerly paid by debit card. The author suggests that low EP usage in stores may be because there are few terminals installed in these locations. As Van Hove (2000) explains, EP can be used for electronic commerce and payments over the Internet. This characteristic of EP is very important for the future development of electronic commerce. EP is more useful for Internet payments than as a replacement for cash in physical transactions.

There are many different smart cards in use around the world. Proton, however, has been the most successful and therefore merits serious study. Of existing EPs available in Europe, Proton (Belgium) is the most widely used and has a large amount of processing terminals. Proton's success may be due to the fact that it was introduced city by city as a replacement for a debit card. Proton was widely used, but it was not used more than regular cash. Van Hove (2000) found that the most popular uses of Proton were paying for public phones and vending machines. It was observed that EP did not replace regular cash. It was mostly used where using regular cash was inconvenient, e.g., for vending machines, parking meters, or subway tickets. In New York City, a similar EP, Mondex/Visa Cash, was introduced with no success. However, another EP pilot study in New York City did have success for laundry machine payments.

Van Hove (2000) reports that in October 1998, Proton cardholders could reload their cards over the Internet. It is very convenient to be able to manage a Proton card from home. This characteristic can only lead to increased use of proton as a form of Internet payment. However, Proton does not work with a secret code, meaning that losing it is the same thing as losing a wallet that carries money in it. Since it is used for low-value payments losing, it would not be considered a great loss. Besides, most people are used to carrying and protecting cards kept in a wallet.

Proton technology is highly regarded and is currently used in Australia, Belgium, The Netherlands, Sweden, and Switzerland. Two of the five major companies utilizing Proton technology are well known in the United States: American Express and Visa International. Other characteristics of Proton are that it can be contact or contactless. Contactless cards are usually used in mass transit systems to reduce the time it takes to purchase or pay for a ticket. It is said to be contactless because it processes payments by the transmission of light without contacting the surface directly. It has features that facilitate payments for electronic commerce (payments over the Internet).

Micro Payment Systems

According to Lee, Yu, and Ku (2001), some of the currently available micro payment systems such as Millicent, MPTP, and IBM Small Payments are designed to pay for transactions that are between $.25 and $10. One drawback of this form of payment is that the consumer has to switch to another type of payment if the amount exceeds $10.

PayPal

PayPal is a familiar term for Internet users (PayPal, 2003). For PayPal to be classified as electronic cash, it has to share the same characteristics as electronic cash. As Panurach (1996) explains, electronic cash is the equivalent of paper cash. For that equivalency to be true, electronic cash should provide anonymity, privacy, and liquidity to its user. Anonymity and privacy refer to the fact that nobody, with the exception of the seller, will know the identity of the buyer or details of the transaction. Liquidity is the ease of reuse of electronic coins. PayPal is not electronic cash because according to its site on the Web, it does not provide privacy. As explained in its privacy policy, the company shares customer history of purchases and other customer information with other companies for marketing purposes. PayPal is not providing privacy to its customers. Although it may be providing a fair service to its members, it is not an electronic cash provider. It may be considered e-money, but not electronic cash. It is privately issued e-money because it allows for on-line payments on the Internet.

According to PayPal (2003), they provide the customers' private information by sharing the PayPal users' cookies file with its marketing partners. Its marketing partners already have an official co-marketing relationship. Sharing personal information should represent financial earnings for PayPal. Its privacy and security policies state that they will not sell or rent personal information to third parties for marketing purposes without consent. Most customers, unless they read the consent form carefully, are not aware that the company shares private information.

PayPal is privately issued money. PayPal is not a bank; it is an agent and custodian of privately issued money to facilitate Internet payments, specifically for

person-to-person electronic commerce. Since the Federal Deposit Insurance Corporation (FDIC) does not insure non-financial institutions such as PayPal, the funds that are kept by the customers in PayPal's accounts are not insured. In fact, Tanaka (1996) argues that since there is no central banking authority on the Internet, FDIC does not insure funds deposited in these accounts. Funds deposited in these types of accounts are not safe in the case of bankruptcy. However, PayPal is a good alternative to credit cards, which are not available for the processing of person-to-person payment transactions. A person-to-person transaction is a variant of electronic commerce. Furthermore, PayPal offers a good service for Internet users and is well accepted by them.

Pre-paid Phone Cards

Chaum (1997) states that customers need to be careful about some false privacy payment cards such as pre-paid phone cards. Even though these cards are bought with cash, it is incorrect to assume that they provide anonymity. They are very useful, especially in public phone booths, but do not provide complete privacy to the user. The way privacy is invaded in these cards is simple. Every time the card is used, a central record is made of the card's unique serial number, the telephone numbers dialed, and the time. It is not difficult to discover that the most frequent phone number dialed is the user's home or office number. So, a relationship can be made between the most frequently dialed number and the serial number on the card. A stranger can draw a profile and match a person to his/her phone card activities. Strangers may represent advertising agencies or other unknown entities.

There are other cards that claim privacy and are advertised as giving privacy and anonymity to the payee, but, in fact, do not provide such privacy. Credit cards are

definitely fully traceable by the operating system even though their issuers claim privacy and anonymity of payments. Before deciding which payment method to use a consumer should be aware of the degrees of privacy offered by the different methods and should opt for the payment method offering the desired level of privacy or anonymity.

Market Entrance of Electronic Cash

Electronic cash has made its market entrance mostly stored in a smart card. It has already been used in Europe, especially France. In the United States, it is in the testing stage. The largest U. S. test was done during the Olympic games in Atlanta, Georgia in 1996 (De Prince & Ford, 1997).

Implementation of Electronic Cash Smart Cards

Elliot and Loebbecke (1998) present some favorable aspects of, and obstacles to, the implementation of electronic cash smart cards. The following can be either a driver or inhibitor depending on its availability in the system.

- Acceptance by consumers.
- Low cost transactions.
- Incentives that include collectable cards for the disposable smart cards or loyalty programs. Taylor (1998) gives more details regarding incentives for electronic cash.
- Perceived cost, charges, and protection of consumer rights.
- Complexity of the electronic cash smart card system for all the parties involved.
- Regulation of smart card issuers (bank or non-bank entities).

- Competitive cost advantage for non-bank issuers, if law applies.
- Versatility of the smart card. (Can it be used to pay for mass transit tickets, entertainment tickets, retail purchases, Internet purchases, and so on?)
- Support for international use through the currency exchange of the different countries.
- Protection of consumer's privacy and anonymity.
- Security from fraud, loss, or theft of the smart card.
- Adequate number of terminals for banking settlement.

Requirements for a Favorable Electronic Cash Market Entrance

Electronic cash has yet to claim its share of the market. Burdett (1999) lists various steps that need to be taken in order for electronic cash to successfully enter and remain in the market. First, electronic cash needs to be advertised. It will involve spending millions of dollars to inform merchants and general consumers about the great possibilities that electronic cash, specifically Mondex electronic cash, could offer as an alternative method of payment. The campaign should concentrate on marketing electronic cash in terms of its convenience and ease of use. Second, electronic cash requires a global network and identifiable brand name. Global recognition of electronic cash is required because electronic commerce, which is one of the ways electronic cash can be used, is wide reaching. Third, to avoid fraud, banks should issue electronic cash. Banks, as financial institutions, are already in the money business and have the expertise needed for electronic cash to be successful. Both Burdett (1999) and Chaum (1997) agree that banks should operate the electronic cash system. In fact, Chaum (1997), also known as one of the inventors of electronic cash, says that banks can strengthen the electronic cash

system. Banks are best prepared to handle and manage electronic cash issues in terms of deposits and withdrawals, either on-line or off-line. Chaum (1997) adds that banks, being an electronic cash intermediary, can provide good customer relationships in the cyber world. Electronic cash requires the valuable customer relationships that banks can provide. This valuable customer relationship is one of the main issues that can help in advertising electronic cash. It leads new and current customers to trust the electronic cash system because they have a bank that supports them.

Burdett (1999) also emphasizes that the globalization of electronic cash is essential for its success. Electronic cash requires the implementation of a global settlement system for its market entrance to be accomplished. If electronic cash is globally recognized, the volume of the transactions will increase. As the number of electronic cash transactions increases, the cost of processing can be significantly lowered. The lower the cost, the cheaper it will be for all parties involved: the bank, the merchants, and the customers.

Mondex and Visa Cash are two smart card systems that are not compatible. Since no one can predict which system will be accepted by the consumers, banks are reluctant to adopt either one (Lee, Yu, & Ku, 2001). As a result, for smart card electronic cash to be successful, one of the critical factors should be to establish compatibility between the different electronic cash systems.

Surveys on Electronic Cash

According to Van Hove (2000), most surveys have focused on college-students not only because they are a captive audience, but also because they reflect the behavior of the future consumer. For Szmigin and Bourne (1999), university students also represent

the consumers of the future, but they are also a great sample to survey since they are more likely to exhibit innovative behavior than other groups.

The Mondex Survey

Szmigin and Bourne (1999) provide important questions to be asked when conducting electronic cash surveys: relative advantage, compatibility, communicability, complexity, trialability, and perceived risk. *Relative advantage* refers to how the product is perceived by its customers. One approach is to compare it to other payment means such as the debit and the credit card and observe what the consumer prefers. *Compatibility* is the extent that the new product is consistent with the consumer's existing usage and preferences. *Communicability* refers to the ease of the product reaching potential consumers. *Complexity* is how the consumer judges the innovation in terms of ease or difficulty of use. *Trialability* refers to the degree that the product can be trialed or tested before it is actually purchased. Another important aspect is the perceived risks—the amount of risk consumers perceive to be present in the purchase decision.

Other more specific concerns to be considered in a survey would be to ask students about their experiences with payment activities on campus and outside the campus. On-campus activities could be payment for photocopies, library, bookstore, vending machines, public phones, for example. Outside payment activities could include pubs, fast food restaurants, public transportation, and online payments (such as for music, software, videos, and so on).

The survey that Szmigin and Bourne (1999) conducted at Exeter University (UK) consisted of comparing Mondex, a type of smart card, to regular cash. The survey sample was composed of second and third year undergraduate and MBA students. The survey

revealed that Mondex lacks visibility of balance and lacks security (if the card is lost, it is like losing regular cash). Since Mondex provided discounts on purchases as an incentive for its use, it was heavily used by students. However, Mondex did not provide any way of knowing how much money was left on the card, so students had to carry both the Mondex to get the purchase discounts and regular cash to use when the Mondex card became short of money. It would have been better to carry only the Mondex card. The only way to know how much cash was left was to use the Mondex card reader, which was too heavy or inconvenient to carry. Because of that, students felt that regular cash gave them a sense of psychological security since tangible money can be easily counted.

A main concern of students was that there was lack of visibility when using Mondex as payment because they did not know if the cashier was extracting the right amount of money or not, especially if a receipt was not given at the time of purchase. There was a psychological relief when paying with regular cash because it allowed them to verify that they were charged correctly and received the correct change. In short, this study concludes that students would not use Mondex unless incentives were given. This survey was very useful because its findings can help to formulate better implementation and improvements to an electronic cash system.

The Electronic Commerce Experiment

Dhamija, Heller, and Hoffman (1999) conducted an experiment with a group of students in a regular academic course. The importance of this experiment is that the students developed a Web page offering products or services, including their own version of electronic cash called Mon-E. The specific lessons drawn from it are that the system was cumbersome and students preferred not to use it at all. However, this result does not

reflect their real-life environment since the students had a time limitation of a semester to complete the whole electronic commerce scenario. They did not have enough time to experiment with their version of electronic cash.

Technical Aspects—Electronic Cash Experts

David Chaum's Initiative

Chaum (1997) and Brodesser (1999) give details about Chaum's contribution to cryptography and the invention of electronic cash. Chaum believes that in order for electronic commerce to be successful, it has to provide privacy to its users. Privacy is, in fact, one of the major issues in electronic commerce. According to a survey conducted by MasterCard, the public's major concerns about electronic commerce were related to the invasion of their privacy. In many cases, when the consumer proceeds with a payment, this transaction is recorded into a database that can be shared with advertising agencies or other entities with or without the authorization of the customer. Invasion of privacy is precisely that a customer's information is shared with other entities without his/her authorization. As Chaum and Brands (1997) describe, Chaum holds more than a dozen patents in the cryptography techniques that make electronic cash possible.

David Chaum is a pioneer of electronic cash. He wrote his dissertation on cryptography protocols and blind signature technology, and their use in providing privacy of payments with electronic cash, at the University of California at Berkeley (Chaum, 1997). Chaum started cryptography in the late 1970s, with untraceable communication. He established a business in Amsterdam called Digicash Corporation, whose product was Ecash. Ecash, Chaum's invention, is a pioneer effort in the area of electronic cash. Lately, his work has been focused on Sure Vote, a company that warranties on-line

voting so that it is private and anonymous. Both privacy and anonymity are characteristics that electronic cash and Sure Vote have in common.

Stefan Brands' Work

Brands (1995) based his work on electronic cash stored in a smart card. The smart card is processed in a tamper-resistant device that avoids the problem of double spending. Double spending consists of spending the same electronic cash more than once. This author believes that the Internet will dramatically change the way business is conducted. The Internet gets many people together that live far away from each other allowing them to conduct business. This allows small companies to reach a large market and compete with big companies, which otherwise would not be possible. The author states that there are 23 million people in over 130 countries with access to the Internet. Based on those numbers, the Internet is a promising way to do business.

In general, a high volume of low-value transactions is expected over the Internet. Those small payments include, for example, access to on-line magazines, reports, newspapers, pictures, shareware, hobbyists' information, weather forecasts, and electronic holiday brochures. Other more expensive services are video on demand and video game rental. The Internet needs new methods of payment for small or large sums that fit the new technology. Since electronic cash seems promising, the author has invested much effort in it. Brands holds many patents in the cryptography that is used by electronic cash systems (Chaum & Brands, 1997). Goh and Yip (2000) give an in-depth explanation of the Brands Digital Cash protocol.

The Electronic Cash Process from the Technical Standpoint

The purpose of this section is to explain electronic cash functioning from a technical perspective as explained by Chaum and Brands (1997). Specific details of the cryptography used for electronic cash are not discussed because they go beyond the scope of this research. Vogler, Moschgath, Kunkelmann, and Grunewald (1999) provide more details regarding Internet payment protocols.

Electronic cash combines the benefits of traditional cash and the benefits of credit and debit cards. Electronic cash is like traditional cash because it can be used for low-value payments. But unlike traditional cash, electronic cash can be used on-line just as credit or debit cards are used. Electronic cash has an advantage over credit or debit cards in that electronic cash provides the privacy traditional cash offers.

There are two types of electronic cash: on-line and off-line cash. Ecash by Chaum (1997) is an example of on-line electronic cash. Mondex is an example of off-line electronic cash. Chaum and Brands (1997) explain that both on-line and off-line electronic cash require the buyer and the seller to have bank accounts. Each of the participants is assigned a mint account by their own bank. The purpose of the mint account is to maintain the anonymity and privacy of payment, which they do through the use of double-blind signatures created by cryptographic programs. When the buyer wants to pay for a service or an item, she/he transfers the money from a bank account to the mint account.

Once the money is available in the mint account, it is considered electronic cash because in that account, it is protected under many cryptographic codes. Due to the anonymity and privacy that electronic cash provides, no one, not even the bank, can

identify or trace the transaction. Only the parties involved—the buyer and the seller—can do so. Even though the bank does not have knowledge of who is paying, it certainly knows that it is liable for that amount to the merchant. The bank accepts the payment from an unknown resource (buyer), and is supposed to transfer the amount of the transaction to the merchant. The buyer cannot pay the merchant directly using electronic cash; bank involvement is required.

Anonymity and privacy are maintained with the authentication of a digital signature. The bank does not automatically transfer the money to the merchant. The merchant is responsible for redeeming the money. Redemption means that the merchant asks the bank to convert the amount earned into re-usable electronic cash coins. Wong and Wei (1998) explain in more detail about electronic cash coins. Electronic cash is not instantaneously re-usable as regular cash is. Electronic cash needs to be redeemed. The redemption process is required so that electronic cash coins are re-usable. An electronic cash coin is re-usable once it is verified that the electronic cash coin has not been used before. When an electronic cash coin has been used before, it is called double spending.

Redemption is the process of checking each electronic cash coin received as payment against a huge database to find out whether that electronic cash coin has been spent before. If double spending has occurred, some electronic cash systems provide for unveiling the identity of the user so that legal action can be taken. The redemption process can be done on-line or off-line. When the redemption process is done on-line, the checking against the huge database through the communication lines is done instantaneously. That kind of electronic cash is called on-line electronic cash, which is

the process used by Ecash. On the other hand, when electronic cash is redeemed off-line, like Mondex, it is called off-line electronic cash.

The off-line electronic cash system stores electronic cash transactions on a tamper resistant device. Later, all the cash that is stored is redeemed through the bank. The main difference between both electronic cash systems is the time of redemption. On-line electronic cash requires redemption immediately. In contrast, off-line electronic cash requires redemption, but this is not done instantaneously. Specific details about each type, on-line and off-line electronic cash, are explained below.

On-line Electronic Cash

Every time a payment is processed, an on-line check against a huge database is done in order to detect double spending. Brands (1995) describes various disadvantages of on-line electronic cash. First, queuing problems may occur in the communication lines of the large-scale central computer where the database is stored. A queuing problem may be caused by a slow communication system or other computer problem. Payment will not be processed if the system is down. In addition, queuing problems can lead to spending the same electronic cash coin in different places at the same time. Second, the central database must be updated at each payment, to prevent double spending of electronic cash coins. Third, an increased cost in the on-line verification is incurred due to the high recurrence of network traffic.

Redemption is always required for on-line electronic cash (Chaum & Brands, 1997). Redemption is what allows the re-use of electronic cash. Chaum invented untraceability for electronic cash coins that have not been spent more than once. But, there is a concept known as “wallet with observers.” The observer keeps track of every

coin spent, and prevents double spending by checking against its database every time a payment is made. This observer is the user's connection to the world. The information kept about each electronic cash transaction is what allows users to avoid spending an electronic cash coin more than once and reveals the identity of the user when this happens. This is called the basic blinding paradigm. This method is not appropriate for off-line use. Ebringer, Thorne, and Zheng (2000) give more details concerning the protection of electronic wallets.

Off-line Electronic Cash

Responding to the problems of on-line electronic cash, Brands (1995) devised an off-line electronic cash system that uses a tamper-resistant device to process and store all electronic cash transactions. This tamper-resistant device protects against double spending. It is portable and based on the use of smart cards. It can be installed on a palmtop computer. Its protocols are not hardware dependant, which means that this off-line electronic cash system is very portable and can work in different platforms. All transactions are processed and stored on it; this means that electronic cash coins are stored there. The only people that have access to that stored electronic cash are the owner and the system manager. Trust in the system manager is essential in this type of tamper resistant architecture. The advantage of this device is that since it stores all processes and transactions, a user can prove to the bank that he/she has not committed double spending. False accusations are not a problem in this off-line electronic cash system. The bank has to trust the information device because it cannot be altered.

Brands (1995) believes that the time it takes for electronic cash to be processed is very important. The advantage of the off-line electronic cash system is its speed of

processing. One of the requirements of electronic cash is that payments should be instantaneous. The tamper-resistant device has an 8-bit microprocessor that takes only a fraction of a second to be processed. Since it works in different platforms and is not hardware dependent, it can be used in both the cyber world and the physical environment.

Other proposed features of this system described by Brands (1995) include currency exchange features. It would be convenient to have a system that is able to convert between different currencies at the time of payment. Another proposed feature is that the system provide for off-line processing of credentials other than electronic cash. Since the system provides for privacy, it can process each credential without revealing any additional information.

Brands invented what is called one-show blinding (Chaum & Brands, 1997). This method relies on a tamper-resistant device that is usually issued by the bank. This device prevents double spending of all electronic cash coins in an off-line payment. However, the user does not guarantee that the device is working properly or that additional information has not been transferred from it. The device, which can be used along with a smart card, can be connected to a PC or laptop computer. It can also be a handheld device for on the street use. According to Chaum (1997), the hand held device can be a mobile phone or a palm computer. Blazevic, Buttyan, Capkum, Giordano, Hubaux, and Le Boudec (2001) explain the mobile technology in detail.

In an off-line electronic cash system, the bank is not involved directly with the transaction since the tamper-resistant device keeps track of the spent coins (Chaum & Brands, 1997). That record does not allow using a coin more than once, thus preventing double spending. This device substitutes for the redemption process that the bank uses. In

the off-line system, the bank is required to provide the bank accounts and to distribute the tamper- resistant device. It keeps unique electronic cash coins and it also keeps records of the ones that have been spent so that double spending is completely avoided. This represents an advantage for off-line electronic cash because telephone lines do not get overused.

Off-line electronic cash has been developed to use with Java. According to the investigations conducted by Hong and Chun (2001), the nature of the Java programming language allows the certification of information that off-line electronic cash requires. In addition, Java uses COS, the same operating system that the smart card uses. This further facilitates programming in Java for the off-line electronic cash process. Java allows for mobile communication, safety, and privacy, which are what smart card off-line electronic cash demands. Specifically, security for the wireless Internet protocol is achieved though the certification of data. Jokela (1999) gives details concerning the wireless anonymous environment for Internet payments such as electronic cash.

As Hong and Chun (2001) explain, the off-line electronic cash process programmed in Java is very similar to the original model proposed. It consists of three parties: the consumer, the bank, and the merchant. Both the consumer and the merchant are required to have an e-mint account. The consumer and the merchant are indistinguishable depending on who is buying or selling at the time. The consumer has to set up an account in the bank. The consumer transfers money to an e-mint account from his/her bank account. Once the money is stored in the e-mint account, that money is considered electronic cash. When the consumer wants to buy from the merchant, he/she just pays with electronic cash. Then, the merchandise is sent to the consumer. The

merchant redeems the electronic cash just received in his/her e-mint account. From the e-mint account, electronic cash is then transferred to the merchant's bank account. Electronic cash redemption by the merchant is needed in order for the system to clear and assign new certifications for those electronic cash coins. If electronic cash is not redeemed, then the merchant cannot use that money to make other payments.

Differentiation Between On-line and Off-line Electronic Cash

The basic difference between on-line and off-line electronic cash is double spending (Wang & Zhang, 2001). On-line electronic cash works directly with the bank's huge database. At the time of the on-line electronic cash payment, the system checks against the bank's database to see if the coin has been previously spent. On the other hand, off-line electronic cash payment is quicker because payments are accepted without reference to bank records and only later redeemed in a batch process through the bank's database.

Brands (1995) claims that off-line electronic cash stored in a smart card is more efficient than on-line electronic cash, providing quicker payment processing. There is no authorization required because the funds are already stored in the card. In addition, double spending is prevented since the hardware/software system that processes the card keeps track of the spent coins.

Double Spending Checking

Double spending checking consists of ensuring that the electronic coins offered as payment in a transaction have never been used before (Chaum, 1997). To ensure those coins have not already been spent, the bank checks its list of spent coins. It is a process

that the bank runs against its huge database. Its database keeps a record of each coin that has been spent. If the coin spent already exists in the database, that means the coin has been double spent. Chaum's system prevents double spending under normal circumstances. In the event that double spending has occurred, the electronic cash coin becomes traceable. Double spending presents the only occasion when electronic cash will be traced. By tracing the double spent electronic cash coin, its user can be found in order to demand payment or to initiate legal action.

Brands (1995) explains that his electronic cash system, which is off-line, also provides a provision for tracing the electronic cash coin. The problem of double spending can be avoided if a special hardware device in combination with the right software manages the use of electronic cash coins. This special equipment works with a smart card. It could take inventory of the electronic cash already spent so that it will not be spent again in the future. His off-line system depends on this device to avoid the double spending issue.

Lee, Choi, and Rhee (2003) illustrate that their proposed algorithm supports legitimate users' privacy when electronic cash payment is used. Their algorithm also contains a function that can cancel anonymity if double spending happens when paying with electronic cash. Their system reveals the personal information of someone who is using electronic cash dishonestly. This function provides a secure electronic cash system in which illegally used electronic cash can be traced in order to protect the bank. Their proposed fair signature scheme provides a mechanism in which the system can cancel the user's anonymity under double spending circumstances. Canceling anonymity is only possible if a trusted third party agrees that it is warranted.

Anonymity

Wang et al. (2002) have found that some people are worried about disclosing their identities when purchasing goods or services through the Internet. A solution to this problem could lead to a significant increase in Internet purchases. The authors propose an anonymous certification for electronic cash, which improves security and anonymity. The proposed protocol can also prevent eavesdropping and tampering. On-line electronic cash, such as Digicash, requires the use of a very large database to keep track of every electronic cash coin spent. Managing all these data may go beyond the capability of the most up-dated state-of-the-art database systems. Off-line electronic cash works smoothly with its database since most of its operations are batch. But it has the potential to allow double spending of electronic cash coins. Given this situation, for a new payment scheme to provide anonymity, it should be untraceable, flexible, and require low computation.

The proposed protocol (Wang et al., 2002) employs cash functions and encryption. They based the protocol on the basic model of an electronic cash system in which the consumer withdraws from the bank to pay the store; the store deposits the electronic cash coins in the bank for future use. It is very important to mention that their proposed system is off-line, untraceable, and anonymous. Being off-line, the store does not communicate with the bank during payment. *Untraceable* means that there is no way of identifying the coins' origin even if one has all the information about withdrawal, payment, and deposit transactions. This is due to the capability of TM, which is a probabilistic polynomial-time Turing Machine. *Anonymity* means that the bank in collaboration with the shop cannot trace the electronic cash coin to the customer.

However, in the case of off-line electronic cash, the identity is revealed if double spending has occurred. These authors (Wang et al., 2002) propose that a new agent be introduced into the off-line electronic cash picture. The anonymity provider agent (AP agent) guaranties higher anonymity in off-line electronic cash payments. The AP agent is an electronic notarized participant in the system. It only verifies the consumer's information without needing to know any private information about the customer. The AP agent provides higher anonymity if requested by the consumer, who will never be traced unless double spending occurs. If the consumer wants higher-level anonymity, he/she can contact the AP agent after having withdrawn electronic cash coins from the bank. The AP agent is not part of the payment process. It only assigns new certifications of the electronic cash coin at the request of the consumer. Yu and Lei (2001) also propose fair anonymous certifications.

Wang et al. (2002), new off-line electronic cash payment process consists of the consumer, the bank, the AP agent if requested by the consumer, and the merchant. When the consumer requests electronic cash coins from the bank, the bank gives an encrypted electronic cash coin to the consumer. Encryption guaranties the consumer's anonymity. If the consumer wants a higher level of anonymity, he/she has the option of contacting an AP agent. The AP agent assigns a new encryption to the electronic cash coin given by the bank. It provides new certifications different from the bank's encryption. For a higher level of anonymity, the AP agent splits the coins into smaller amounts. Since the AP agent is the one who creates these new coins rather than the bank or the customer, neither the shop nor the bank will know the identity of the consumer. At the time of payment to the merchant, the electronic cash coin will have a signature stamp on it. If that coin is

used more than once, the same coin will have two different signatures. When one coin has two different signatures, double spending has occurred, in which case the consumer's identity is traced and revealed. The merchant then redeems the electronic cash coin from the bank.

Off-line Electronic Cash Security

Wang and Zhang (2001) propose a secure payment scheme in their new off-line electronic cash system. There are four requirements for electronic cash payments to be secure: unreusable, unexpandable, unforgeable, and untraceable.

- By *unreusable*, the authors mean that one coin can only have one signature. If one coin has two different signatures, it means that it has been used twice, and double spending of the coin has occurred, in which case the identity of the consumer can be computed and revealed.
- By *unexpandable*, the authors mean that no one can compute and reproduce a valid coin, except for the original. This is so because a valid coin has both a secret key and a random number. The consumer's identity cannot be computed because the random number changes at every withdrawal, payment, or deposit of the coin. In fact, the random number changes for every transaction.
- *Unforgeable* means that the coin cannot be made or reproduced for deceptive purposes. By *unforgeable*, the authors mean that the bank and the AP agent remember which coins are valid. Encryption, current time, and secret keys are required to produce a valid coin. The secret key is provided by the user. Even though the bank and the AP agent know the encryption, neither can use the

coin. The only one who can use the coin is the rightful owner since he/she is the only one who knows the secret key by its signature.

- By *untraceable*, the authors mean that since the consumer is the one constructing the secret key by its signature, no one can trace the user through the transaction. Untraceability gives anonymity and privacy to the customer when making a payment. If the same valid coin carries two different signatures, the transaction can be traced to identify the customer because double spending has occurred.

Operating System for Electronic Cash

Wang and Zhang (2001) define the technical aspects of electronic cash. As they explain, electronic cash is a digital message and a certification. In order to manage this process smoothly, the right operating system should support this process. The authors describe RBAC as the ideal operating system for electronic cash. RBAC requires low communication and low computation. Both factors are needed for the operating success of the electronic cash process. Since there are only four major participants (the consumer, the seller, the AP agent, and the bank) in the electronic cash payment scheme, this operating system manages well, reducing administration costs and complexity.

Electronic Cash Cost

Hardware Requirements and Cost

Burdett (1999) explains that there are, of course, hardware requirements for electronic cash to operate. This author is affiliated with Mondex, so he focuses on Mondex electronic cash. However, his discussion gives a clear idea of what an electronic

cash system requires in terms of hardware and software. There are three parties involved: the merchant, the consumer, and the bank. From the merchant's point of view, all traders will have to install a smart card reader, which is the hardware, along with the software that allows its operation. This reader processes the electronic cash transaction and stores all the electronic cash value that the merchant may have. The reader retains all the information about the electronic cash transactions for the merchant, even in the event of power failure.

These readers are specially made to operate on cryptographic processors to validate payments as they are received. They look similar to an ATM processor or to the boxes that process payments right next to the public phone or a public photocopy machine. The purchase of this reader is a one-time cost for the merchant. The cost of the reader includes the hardware and software that are required, the installation of the readers, and the training of the staff that will be operating it in the store. For Mondex electronic cash to be processed, there is no need to have phone lines available. Mondex operates as a non-clearing system. This means that there is no need to communicate with the bank for authorization purposes, as there would be for credit or debit cards. There are some electronic cash schemes that require clearing or authorizing by the bank in every transaction. As a consequence, those systems would require phone lines.

Transaction Process Cost

Burdett (1999) discusses the possible transaction costs involved in the electronic cash process, specifically Mondex electronic cash. There are two different approaches for processing electronic cash. One is called a clearing system and the other is called a non-clearing system. In the clearing system, communication with the bank is necessary for

every single electronic cash payment to be authorized. The cost of the clearing system includes phone line usage and the time that it could take for the communication to be settled. In the non-clearing system, there is no need for bank authorization and no phone line requirement cost involved because the electronic cash value is already stored in the electronic cash smart card. Nevertheless, both systems need merchants and customers to communicate with the bank for other purposes than to authorize a transaction payment with electronic cash.

As an illustration, merchants need to communicate with the bank for redemption purposes. Redemption converts all the electronic cash payments that the merchant has accepted into cash that can be transferred to a checking or savings account at the bank. In the case of customers, they may need to transfer some money from their bank accounts to their minting accounts to have it available for future purchases. A minting account is assigned to the customer by the bank, though the bank has no control or access to it. A minting account provides anonymity and privacy to the customer since the banks cannot manage that account. It is like a safety deposit box for keeping valuables that some banks have for their clients. The customer can transfer available funds from his/her existing checking or savings account to the mint account. Once the funds are available in the mint account, those are considered electronic cash and allow anonymous and private payments.

Burdett (1999) explains the transaction processing cost, which involves connection with the bank from two perspectives: the merchant's and the customer's. From the merchant's perspective, he/she needs to communicate with the bank in order to redeem money. From the customer's perspective, he/she needs to communicate with the

bank in order to transfer money to a mint account from a checking or savings account. The bank, not the merchant or customer, incurs the transaction processing cost. The more transactions processed, the less each transaction will cost the bank. Transaction costs gradually decrease as electronic cash adoption and usage increases. The lower the cost, the cheaper it can be for all parties involved: the bank, the merchants, and the customers.

Current Concerns Regarding the Technical Aspects of Electronic Cash

Anonymity

Huge databases containing personal profiles can be built if all our Internet transactions are conducted without anonymity (Pointcheval, 2000). Anonymity for electronic cash refers to providing transactions that are unlinkable and untraceable. Unlinkability consists of the inability of anyone to relate two transactions that have been made by the same user. Untraceability consists of the inability of anyone to match a transaction with the user. But the system requires that anonymity be broken if overspending occurs. Over spending refers to the fact that the same electronic cash coin is spent more than once. This concept is also known as double spending. There is always room for improvement in the area of preventing fraud and counterfeiting.

The process of maintaining an individual's anonymity or tracing the identity of a double spender involves two main divisions: the Anonymity Provider (AP) and the Revocation Center (RC). The AP helps the user to make transactions in an anonymous way. There are two types of anonymity: strong anonymity and weak anonymity. With strong anonymity, nobody can guess the link in most of the cases. With weak anonymity, some people may know the link, but are unable to prove it in most cases. The RC has the ability to detect a fraudulent action in a transaction. The participants involved in the

electronic cash transactions are the bank, the merchant, and the user. The bank or the merchant has access to personal data such as what the user buys, for example. Since personal information can be sold, trust is sometimes a concern for those wishing to preserve their privacy and anonymity. The RC will have to be trusted however, because the RC is needed to identify those involved in a transaction if double spending occurs. Nonetheless, in case of fraud or suspected fraud, a judge should not trust the bank or the merchant's information unless proof exists. Furthermore, none of the participants should be able to breach the anonymity of the customer unless fraud is proved.

Any attempt to informally present a new candidate to provide anonymity is called a *self-scrambling anonymizer*. The self-scrambling anonymizer is a way of providing anonymity. The AP business is a very profitable industry since the user is charged for anonymity. AP has no risk for the user. But, as anonymity increases, its price also increases. Banks do not pay AP a fee since they are not interested in anonymity. It is only the user who is interested in AP.

Smart Cards

Elliot and Loebbecke (1998) define a smart card as an integrated circuit or chip-based card, capable of storing or processing data. Magnetic cards, on the other hand, can store, but cannot process data. Smart cards can be used as a substitute for regular cash. This type of card has a low cost for banks, merchants, and customers. Besides, merchants can support loyalty schemes and provide convenience to consumers. This type of card can store other data aside from money, such as codes to access buildings, photo identifications, and the like. Smart cards can be reloadable or disposable. Reloadable means that funds can be transferred to the card again and again. These funds can be

transferred either on-line through a bank account, or off-line with regular cash in a physical terminal. Disposable means that once the card is empty of data (money), it can be thrown away.

Vogt, Pagnia, and Gartner (2001) explain that smart card electronic cash is very important for electronic commerce. The anonymity provided through smart card technology cannot be maintained in some transactions, for example when the buyer's name and address is required for shipment of the item purchased. However, with the increased demand for digital items such as music files, newspapers, and other electronic downloadable documents, maintaining anonymity using a smart card is possible because there is no shipment address involved. The concept called "fair exchange protocol" consists of providing a reasonable relationship between the customer and the vendor, where both parties have access to fair treatment, including anonymity, during trading. There are some problems that the fair exchange protocol fails to address, however, such as the delivery of time sensitive data. This is data that loses value over time, for example share prices from the stock exchange. Stock exchange data changes almost every second, and if it is not received in a reasonable time, that data becomes useless to the consumer. It is not fair to charge for data that has arrived later than expected. Another example is when a prospective buyer asks for restaurant recommendations. If the recommendation takes too long to arrive, it becomes irrelevant and no payment should be required. Paying for a service that was not received on time is unfair treatment of the buyer

The fair exchange protocol requires that a third party act as an intermediary between buyer and seller. Tamper-proof hardware is required to fulfill this role and this, together with a trusted processing environment, ensures a fair exchange between the

customer and the vendor. Suitable hardware, such as the IBM 4758 PCI card, is expensive (Vogt et al., 2001). These authors examine whether the fair exchange protocol can be used in the mobile computing environment. There are some situations that will require solutions in order for the fair exchange protocol to operate at its best capacity. First, regular smart cards have little processing power because of memory limitations. Second, the mobility of the user can lead to temporary disconnections from the network. The author' have invented the tamper-proof smart card that solves these problems. This device is the trusted intermediary that allows the interchange of information about a sale in a trusted environment using a special smart card.

The fair exchange protocol has several characteristics (Vogt et al., 2001). First is effectiveness: both parties, the vendor and the customer, agree to use the protocol. The second characteristic is termination, which means that the protocol will terminate for each party that behaves according to the protocol. The communication line will close to avoid links and traces. Third is fairness, which consists of the assurance that no party will win or lose if one of them does not behave according to the protocol, for example, if a purchased item does not match its description. Fair exchange protocol relies on the services of a trusted third party (TTP). Both participants trust TTP. The TTP receives the two items, checks them, and forwards them to the respective parties. Both the payment and the service are stored in the TTP. When its software verifies that the exchange is correct and fair, the payment is transferred to the merchant and the service is transferred to the buyer. Checking includes that the service is what was ordered and that it is sent on time. Bottlenecks are likely to occur in the TTP environment, but both parties can complete the exchange on their own so that the overuse of communication lines is

avoided. A mobile phone, a personal digital assistant (PDA), a laptop computer, or specialized hardware like a car navigator system can be used for the TTP environment. Secure communication is provided in the TTP environment since the creation of a digital signature protects its data from being deleted or modified. Another built-in safeguard is that the smart card does not lose data by being shut down by a power failure

Smart cards must meet the following requirements in order for the TTP environment to function correctly (Vogt et al., 2001). First, the smart card should be tamper resistant, which means that secret data is protected and it is impossible to change the behavior of the card. Second, the authenticity of the messages on the smart card must be trusted: both the customer and the vendor must be certain that the card is correctly processing all requests. For security purposes, the card should have the capacity of generating a digital signature through a private key. Third, the smart card should hold all of its information in a reliable state. No data stored on it will be lost in the case of power failure or the shutting down of the device.

Vogt et al. (2001) believe that the fair exchange of time-sensitive data is provided for in the TTP. It allows the quick processing of the customer's request to avoid network failures. In addition, it allows for revocable payments if the item or service does not arrive on time because of a network failure. Revocable payments also exist if the customer does not receive the item or service. Thus, *revocable payment* refers to the fact that the customer does not have to pay for an item or service not received on time, or not received at all. This is possible since all data is processed inside the TTP instead of over communication lines. In this system, communication lines are used as little as possible to avoid bottlenecks and the loss of information. In short, the TTP allows for a fair

exchange protocol in which both parties involved, the customer and the buyer, will receive fair treatment in the exchange or business transaction.

According to Elliot and Loebbecke (1998), there are five key characteristics of smart cards:

- *Anonymity* denotes the customer's concern for privacy. If personal identification is available in the card, there can be cases of linkage between the customer and his/her transactions. This linkage should not exist in order to provide anonymity to the cardholder.
- *Accountability* refers to keeping track of all details of the transactions from the merchant system's host in order to avoid fraud, to monitor transactions for auditing and reconciling processes, and to calculate the value of any damaged cards. These transaction details could benefit marketing research but if used in that way, could work against the anonymity that the consumer was promised when the smart card was issued.
- *Authorization* of transactions implies that there are two ways of processing the transactions. They can be either on-line or off-line. On-line authorization is similar to the process that is used with credit and debit cards. Although this kind of process can prevent fraud, it may be incompatible with customer anonymity. Off-line authorization, on the other hand, supports the anonymity of the user since it is based on the retained value of the card without having to make references to the system host. Off-line authorization takes less time to process, which is very useful in most cases, for example when paying for the

mass transit system. Anonymity is the main difference that smart cards have with respect to credit and debit cards.

- *Reloadability* indicates whether or not the card can be reloaded. If the card is disposable, it is not reloadable. Once the card is empty of money, it can be thrown away or kept as a souvenir. If the card is reloadable, additional funds (more money) can be added to the card. A card reload facility should exist for this purpose. Reloading the card can be done on-line from the customer's bank account or off-line in a special terminal with regular cash. The NSW (New South Wales) Privacy Committee has some doubts regarding the anonymity of reloadable cards.
- *Technical capability* describes how the card is processed from the hardware standpoint. There are two ways of processing: contact processing and contactless processing. A contact-dependent smart card must be processed in a special reading device. A contactless smart card has an antenna that a special device reads from a distance. Contactless smart cards are quicker to process than contact-dependent smart cards. This is why contactless smart cards are better for the mass transit system since it takes 25% percent less time to process the payment.

Elliot and Loebbecke (1998) describe the different roles played by those involved in the implementation and operation of smart cards. These are the card owner, the card issuer, the acquirers, the merchants, and the cardholders.

- The card owner or operation host is the person or entity that plans, develops, formulates, advertises, signs up issuers, implements, and operates the smart

card. This entity operates the system host and should provide a fast and reliable service to customers with a high degree of confidentiality. In addition, this entity is responsible for preventing fraud. Examples of card owner organizations are MasterCard and Visa or any other entrepreneurial venture like Quicklink or Transcard.

- The card issuer can be any organization that issues smart cards to consumers. There are places where the law requires that only banks can be card issuers. The card issuer designs the product to be reloadable or disposable. If the card is reloadable, the card issuer provides the appropriate terminals for fund transfer. If the card is disposable, the card issuer is responsible for selling the cards through card-selling channels.
- The acquirer is the financial institution that provides the merchant with the facilities for the smart card transactions. It also provides the merchants with the equipment, training, and support for the smart card payment operation. The acquirer, of course, charges the merchant for its services unless the merchant gets free service during a promotion.
- The merchant is the entity that provides goods and services to consumers in exchange for the value stored in the smart card. The merchant may also be the seller of disposable smart cards. The merchant has to transmit all transactions to the operation host (card owner) for clearance, or redemption. For the earned funds to be available to the merchant, he/she is required to clear or redeem these funds.

- The cardholder is the consumer who purchases goods and services with his/her smart card. He/she acquires the smart card from a card seller or from a card issuer.
- The card manufacturer designs and assembles the smart cards. The design includes the hardware and software needed to fully process the payment. The fabrication of the smart card includes the plastic and the memory chip that it carries as well as the reading device that is needed to process the smart cards.

Blackmailing

Kugler and Vogt (2002) explain the concept of blackmailing. Unconditional anonymity provides a perfect environment for criminal misuse of electronic cash. If the electronic cash blind signatures are removed, these coins can be used without the owner or the bank knowing about it. These authors propose a new online payment scheme, which consists of unconditional anonymity but avoids blackmailing. It is suitable for payments over the Internet by cellular phones. This system claims to minimize the risk of fraud and losses that may be caused by over spending. To avoid blackmailing, they propose that all coins are valid only in the customer's account. The technique, based on blind signatures, involves marking coins that are withdrawn for payment by the customer. The marking is based on blind signatures.

This system has many advantages. First, all unspent marked coins can be invalidated and refunded to the customer if blackmailing occurs. Second, all spent marked coins can be detected at the deposit point, which permits tracing of the blackmailer. Third, marked coins cannot be misused to trace honest users. In this on-line system, the bank can only check the validity of the coins. This system assumes that the

customer will always try to inform the bank about blackmailing. It is assumed that the blackmailer cannot remove the mark on the coins. This system allows for the removal of anonymity in order to combat criminal activity, like blackmailing. In short, this system, based on a complex cryptographic scheme, protects honest users against blackmailing.

Off-line Payments

Anonymous payment systems protect customer's privacy, but in cases where criminal activity is suspected, the system must have some means to unmask the wrongdoer (Kugler & Vogt, 2002). Tracing systems, however, must be properly controlled if they are not to become a threat to anonymity. There are two tracing mechanisms: the coin tracing mechanism that removes anonymity and recognizes coins when they are deposited, and the owner tracing mechanism which removes anonymity to identify the withdrawer. A coin can be traced if the bank knows the private tracing key of the customer withdrawing the coin. This key links the payment and withdrawal of coin through the use of a database that keeps track of every single coin spent. This system does not use a trusted third party for tracing, but it uses tracing keys for encrypting identifying information. For tracing to be allowed, the permission of a judge is required in this system.

Coins that have already been spent cannot be traced. However, if there is a suspicious withdrawal, the bank can proceed to mark those coins and trace them as long as the bank has the permission of a judge to do so. The bank can lose its license if it conducts illegal tracing. The judge is the only one who determines if tracing is reasonable. Cases where a judge determines that a trace should be conducted would be when there is a suspicion of money laundering or trafficking in illegal goods. Because

this system has the advantage of a reduction in computational anonymity, off-line payment is possible. Off-line payments also allow tracing with a judge's permission. The system also provides for self-removal of anonymity if the customer needs to trace his/her own coins at any time, before or after the withdrawal. This feature is especially useful for self-detection of suspected blackmailing in off-line payments. This system can detect bank theft since the bank will always be able to identify all those coins that were issued in an irregular way. This system is known as the "fair tracing mechanism." As presented, this system provides for the detection of money laundering and bank theft. It only requires a simple and inexpensive device and does not require a trusted third party, thus avoiding additional cost. This system does not guarantee unconditional anonymity.

On-line Payments

Kugler and Vogt (2002) explain that on-line payments have the same characteristics as off-line payments, except that they provide a higher level of security in terms of anonymity. On-line payment warranties coin- and owner-tracing capabilities as in off-line payments but provide stronger privacy. As in off-line payments, illegal tracing can be prosecuted. This system is different from off-line payment because it uses two different tags to mark the coins. One is used at the beginning and the other is used at the end. None of these can be used to identify the customer. The tags only allow for tracing in the case of double spending of coins. A database is used to search for spent coins, so that a used coin cannot be used again. The use of two tags is an example of a perfect blind signature scheme. The tracing of coins helps to identify blackmailing. These coins can be identified as misused, and the customer can get his/her money back from the bank. The bank will not allow these stolen coins to be used as payment again.

Origins of Cash and the Entrance of Electronic Cash

Kelley (1997) relates the history of money from barter to the digital age. In the primitive age, barter was the means of exchange in which some item, a pig for example, might be used as payment for a dissimilar item such as clothing. This had certain limitations at the time of payment. There were times when the exchange for payment was not necessarily fair to one of the parties because the items being bartered were not equal in value. In light of this problem, people, depending on the place where they lived, started to use shells, special stones, or pieces of metal as the payment medium. Later, those pieces of metal were mostly gold or silver and were converted into a coin shape. The development of printing allowed for paper notes. Then, checks allowed for distance payments. The invention of the telegraph made possible remote payments, and transfer became practically instantaneous.

Today, money is transferred by the modern technology of computer networks. Kelley (1997) emphasizes that the money transfer is not new, but a new way of accessing it has emerged. Electronic cash, which is money stored in a smart card or hard disk, is an emerging type of money since it represents an alternative to government-issued or guaranteed instruments. Electronic cash acceptance will depend on its ability to serve a new purpose that physical cash is not serving. As a natural law, money will continue to change as technological advances progress. Dehong (2001) gives in details of recent advances in electronic banking and how they can help in the management of electronic cash.

Chaum (1997) believes that even though cash operating costs are high, paper money will not necessarily disappear with the advent of electronic cash. However, the

electronic cash system seems promising because it is seen as a move to technologically influence the evolution of paper cash. Zhong, Feng, and Yang (2000) discuss electronic cash technology in detail.

History of Cash in the United States

The United States had many different types of currency in circulation until the Civil War. Those different currencies circulated at a discounted rate from their face value. Many states abused their money-issuing power, and, as a consequence, inflationary rates were very high. In 1789, the Constitution of the United States assigned the federal government the role of issuing a uniform currency (Rolnick, 1999). In 1913, the Congress decided that the Federal Reserve would serve as a clearing-house system for a single, uniform currency for the United States. In 1980, Congress required the Federal Reserve to price its check-clearing system services and earn a competitive return under the passage of the Depository Institution Deregulation and Monetary Control Act.

History of Electronic Cash

According to Bernkope (1996), Samuel F. B. Morse used the telegraph in 1844 as the first supporter of electronic fund transfer (EFT). Western Union made its first EFT in 1860. This transfer was done by a telegraph and was an analog rather than digital payment, but it was still done by electronic means. Although it was not a truly private transaction as electronic cash requires, it certainly was one of the first steps towards it. Fedwire started a Federal Reserve telegraph system as early as 1918.

Regular Cash versus Electronic Cash

Some important characteristics of regular cash make electronic cash a feasible alternative (Panurach, 1996). First, regular cash is at a high risk from theft. It must be kept safely in special places and be guarded. The more cash held, the riskier it is to keep and transport. Second, regular cash involves the high cost of transporting it. Transportation costs could be $60 billion a year in the United States. Third, counterfeits are very common nowadays since the arrival of high quality color copiers. Counterfeit money, if used, can be dangerous to the economy since it destabilizes the national financial system.

Economic View of Electronic Cash Acceptance

Kelley (1997) views the acceptance of electronic cash as a natural step in the evolution of money. First, the cost of electronic cash is very important for its approval. The costs include the engineering design of the product, software creation and maintenance, terminals, the cost of the storage medium such as smart card or hard disk, and the profit margin. Technology expenditures are expected to decrease and become steady over time, which would indicate a decrease in electronic cash cost in the long run.

Convenience is another factor to consider in electronic cash acceptance (Kelley, 1997). From the merchant's point of view, a fast and easy transaction is desired. Safety is another important issue. Stored information, such as the smart card, should be error-free and easy to manage. In addition, engineers have made reliable technical improvement in solving the common problems that arise from the use of electronic cash. Highly developed cryptographic techniques are integrated into the electronic cash system to make it safer.

Some factors that are an impediment to electronic cash acceptance are distrust of electronic cash issuers and the possible crimes associated with electronic cash such as money laundering and fraud. The financial stability of the electronic cash issuer is important because issuer insolvency may lead to a worthless asset. Privacy and security would be the aspects to improve in order to improve acceptance (Kelly, 1997). Chan (2000) gives more details about computer crimes related to electronic cash.

Kelley (1997) says that public acceptance of this new payment method will depend mostly on the acknowledgement that electronic cash can fill a special niche for small transactions. De Prince and Ford (1997) mention that as the electronic cash smart card evolves, it will eventually gain market acceptance.

Privatization of Money and Electronic Cash

F. A. Hayek, the 1980 Nobel Prize winning economist, argued that private institutions should compete fairly to provide currencies rather than allowing the government to monopolize the issuance of money (Birch, 1999). His thesis focused on how a government can create economic instability by trying to manage the markets, instead of the markets driving the economy. By liberating the economy, stability of the whole system is achieved. He believes that private companies competing for profit would make money that would better retain its value. Birch (1999) adds that issuing private money would work well with loyalty schemes for customers. For instance, airlines issue frequent flier miles in order to promote customer loyalty to their airlines. These frequent flier miles are electronic money that is only accepted by the issuing airline. This loyalty scheme has proved popular with customers who use this “money” to buy tickets and upgrades. In short, private money promotes customer loyalty. In addition, private money

can flow by the natural laws of the market in contrast to the central government money supply that is controlled by just one entity, which sometimes makes it unstable.

Effect of Electronic Cash on the U.S. Treasury

According to De Prince and Ford (1997), smart card electronic cash may affect the

U. S. Treasury. First, it will reduce the Federal Reserve's income and, as a consequence, its substantial annual transfer of compensation to the Treasury. Second, it will increase the Treasury's obligation service costs. Third, it will increase the taxes that the Treasury collects from the electronic cash issuers as a result of the privatization of money.

Regulation

Though still in its infancy, it is likely that electronic cash will soon attract the attention of lawmakers. There is a danger that regulation may retard the development of the market. The role of the government in the process of electronic cash is to set up a straightforward and consistent regulatory structure. This may require a new set of rules to replace the existing regulatory norms tailored to current means of payment. In the U. S., current regulation is directed toward the payment products themselves, while in Europe, more regulation is directed toward the banking institutions (Birch, 1999).

One of the main concerns regarding electronic cash regulation is who should be allowed to issue electronic cash. There are those who think that only banks and other financial institutions should be permitted to issue electronic cash. Others believe that electronic cash might be issued by anyone with the permission of the Federal Reserve (Birch, 1999).

United States Government Policy

According to Bernkope (1996), the U. S. government has adopted a wait-and-see attitude toward electronic cash. This can lead the private sector to develop new payment techniques and technologies. Greenspan (1996) claims that this action will allow electronic cash to grow and flourish.

Kelley (1997), who worked for the Federal Reserve System in the 1990s, says that disruption of electronic cash evolution could occur if the government intervenes with regulations. Public policy regulations from the government can distract the natural forces of the market, preventing the private sector from participating and contributing to electronic cash development. The electronic cash system is too new to be regulated. Perhaps government involvement will be acceptable in the future. The government has not intervened with the electronic cash process allowing market forces to determine development and growth. Macintosh (1999) gives more details regarding legal and policy aspects of global commerce (electronic commerce).

Economic Perception of Electronic Cash Today

Today, as Rolnick (1999) mentions, a re-examination of the role of the Federal Reserve is under way since technological advances have brought about changes that may affect the national currency. Due to technological advances, banks now have the ability to issue and offer electronic currency, also known as electronic cash, which may compete with Federal Reserve notes. This raises many concerns such as loss of seigniorage, the effectiveness of monetary policy, and the overall stability of the monetary system. The probability that electronic cash will circulate at a discount is very high creating an overall

instability of the monetary system. New currency issued by banks may not exchange at the same rate.

Electronic Cash Development

Krueger (2001) discusses the development of electronic cash and he believes that standardization will be of critical importance. For optimum efficiency, economic agents need to share a common means to lower electronic cash transaction costs. For example, electronic cash issued in Europe can be converted from different denominations to its single common currency, the Euro.

De Prince and Ford (1997) explain that the policy of the Federal Reserve Board is to let the markets manage electronic cash without government regulation so that the system can evolve. One result of this is that uninsured electronic cash smart cards will not be subject to reserve requirements.

According to Spar and Bussgang (1996), electronic cash is like any other type of currency. Demand will be determined by market conditions. For its demand to increase, this kind of currency will need to be broadly accepted.

Monetary Policy

Krueger (2001) says that electronic cash has no effect on the real economy or interest rates since cash holdings substitute for electronic cash holdings. An electronic cash system will have little effect on the existing monetary system or on monetary policy. The efficacy of monetary policy will not be diminished by the development of an electronic cash market because cash and electronic cash are the same in the economy: they are interchangeable.

Inflation

As Krueger (2001) notes, electronic cash would create difficulties with regard to monetary policy if it were credit driven. If electronic cash is issued based on loans instead of a cash interchange, this could exert inflationary pressure on the economy. Interest rates would be difficult to control and this would make electronic cash more expensive.

Foreign Exchange

Electronic cash can noticeably reduce the cost of foreign exchange transactions (Bernkope, 1996). This is an advantage that electronic cash brings to the consumer. As for investment, someone living in a country having a weak currency can effortlessly move his/her savings to another, stronger currency, resulting in a better foreign exchange rate thanks to this new technology. In the long term, this could lead to the demise of weaker currencies.

Seigniorage

Bernkope (1996) defines *seigniorage* as the margin between the face value of the currency issued and the cost of issuing that same currency. It could represent billions of dollars for the total transactions. The U. S. Treasury will lose a considerable amount of seigniorage if private currency such as electronic cash becomes popular. De Prince and Ford (1997) explain seigniorage much more simply by defining it as the currency's face value minus its cost of production. They note that privately issued electronic cash can result in the private sector earning profits through seigniorage. As electronic cash stored in smart cards replaces currency, the demand for Federal Reserve cash will decrease. This situation negatively impacts the Federal Reserve's seigniorage, but it can have a positive

impact on the government in general. Government income will increase due to the fact that private electronic cash issuers, profiting through seigniorage, will pay more taxes.

Counterfeiting

Counterfeiting consists of fabricating fake electronic cash. Berentsen (1998) sees counterfeiting as a major problem because it threatens the security of the electronic cash system. The author adds that this problem can lead to instability of the system.

Money Laundering

Birch (1999) does not believe that the criminal activity of money laundering will prove to be any greater problem for law enforcement with the growth of electronic cash because this crime existed long before the introduction of electronic cash. The real problem that electronic cash creates is that it facilitates the flow of money across borders. Banks are already filing transactions of $10,000 or more for certain types of businesses. The question of whether electronic cash should be anonymous is still debated. Anonymity may be blamed for the laundering of electronic cash, but it is not likely that electronic cash will cause as many crimes as real currency already has.

Taxes

There is an advantage in using electronic cash from the tax collector's standpoint. As Chaum (1997) explains, even though the users' privacy and anonymity is assured, banks can keep tax authorities informed about the electronic cash revenues of its customers. An electronic cash system is especially useful for tax collection when payments are made with electronic cash.

Birch (1999) believes that taxation for electronic commerce is a very serious concern. It can be considered one of the barriers to the development of global electronic commerce. Electronic cash may become the most popular form of payment for electronic commerce. This author states that electronic cash will not bring new taxes but that taxes will always be around. To avoid tax evasion in electronic commerce, tax collectors suggest that companies, doing business over the Internet, may become the tax collectors of the future. The author describes tax implications as affecting not only electronic cash versions, but also other variations such as air miles. For instance, the U. S. government has imposed a 7.5% tax when consumers buy frequent flier miles from airlines.

Cases of Extensive Use of Electronic Cash

Electronic cash has been tested and used in many different countries around the world. Two important cases, highlighted here, will help clarify the electronic cash process and its impact when it is used in real life. The examples chosen are Europe in general and the case of Finland.

Europe

The political momentum for a single currency in Western Europe is evident (Bernkope, 1996). The CEO of Mondex, Tim Jones, believes that Mondex, which is a smart card that holds electronic cash, can be the ideal vehicle to test electronic Euros. Krueger (2001) says that a unity in the account medium, such as the Euro currency is for Europe, can help in the standardization of the electronic cash system since different currencies can have convertibility to Euros. According to De Prince and Ford (1997), the

use of an electronic cash smart card has not spread in Europe because the processing cost of the point of sale terminals is too high. That is a major barrier to its expansion.

De Prince and Ford (1997) believe another reason the use of electronic cash smart cards has not spread yet in Europe is the lack of standardization. Lack of standardization in the processing technology is a major obstacle for electronic cash growth. Fortunately, Visa, MasterCard, EuroPay, and Mondex are trying to standardize among themselves.

Birch (1999) states that the Eurodollar converted to e-euro (electronic cash representing the same currency) is evaluated in terms of its cost. The e-euro should be less costly than using different currencies and converting them. In addition, the cost of the e-euro should not exceed the cost of manufacturing and distributing paper or metal. By adopting one currency, e-euro, the consumer has the convenience of paying for payphones, for example, without the inconvenience of having to get change for their notes and coins.

Finland

Finland has the highest per-capita use of ATMs in Europe; 88% of the population holds an ATM card, and 60% access the Internet regularly. This represents twice the U. S. per capita rate. Finland also has the world's highest per capita use of cellular phones. There are around 500,000 Avant e-purses (a smart card that can contain electronic cash) in circulation. By the year 2000, the amount of traditional cash in circulation had been reduced by half. Finland has the lowest rates of cash in circulation in Europe. Salaries are paid directly into the worker's account. Electronic transfers make social benefits payments. Even a soft drink can be bought from a vending machine by using a mobile phone. The cellular phone stores the electronic cash needed for payment. Finland is

becoming a weightless economy, i.e., an economy that has no physical means of exchange such as cash or checks. In the weightless economy, for example, electronic cash is the normal medium of exchange and frequent flier miles can be as liquid as dollar bills (Birch, 1999).

Future of Electronic Cash

Bernkope (1996) believes that the United States will eventually accept electronic cash as equivalent to an official unit of account, the U. S. dollar, because the U. S. Treasury will lose interest payments if private currency, such as electronic cash, has to be exchanged for physical dollar bills. Besides losing interest, the U. S. Treasury could lose a considerable amount of seigniorage amounting to billions of dollars for total transactions.

Future Research

Rolnick (1999) suggests that research should be conducted on the economic future of electronic cash. The lack of a uniform medium of exchange is a major concern for researchers because privately issued money is mostly exchanged at a discount. Another topic would be the role of government intervention to ensure a uniform medium of exchange. Last, new economic models can be designed to show why money is used and what form it should take.

Technical innovations are needed in order to provide better security measures and improve electronic cash performance. New insight regarding legal aspects of electronic cash can be very valuable if electronic cash is to be accepted and developed (Tanaka,

1996; Bernkope, 1996). If the legal aspects are well defined, people will start to trust the system.

Birch (1999) believes that money laundering will not increase much through increased use of electronic cash, but the question of whether electronic cash should be anonymous is still debated. Anonymity might be the principal reason electronic cash would be attractive to money launderers.

Spar and Bussgang (1996) mention that the electronic cash system is difficult to manage due to a lack of control by a central party. A good research area would be the advantages and disadvantages of a central party that would control electronic cash. Another related question would investigate how service providers could control the Internet in terms of micro payments. Buttyan (2000) gives more details about the security of micro payments.

Elliot and Loebbecke (1998) hope that pilot studies similar to those already conducted in Australia will be undertaken in other countries. In addition, the authors would like to see future research focus on the drivers and inhibitors of electronic cash smart card implementation. Specifically, future studies should emphasize the true motivators for electronic cash smart card use. Also, researchers should examine implementation strategies for the different types of smart cards, taking into account consumer preferences and needs.

CHAPTER THREE: METHODOLOGY

Research Design

The purpose of this study was to explore the attitudes of students toward electronic cash. A cross-sectional design was employed to address the four research questions. The survey was conducted at the University of Puerto Rico in Aguadilla, and the sample consisted of students from the Department of Business Administration. Two hundred surveys were completed. The results were examined using descriptive statistics, comparisons between demographic groups and regression analysis.

Selection of Participants

The participants of this study were students who were in their third or fourth year of college and were from the Business Administration Department. This was a convenience sample. This is one of the limitations of this study. However, research has shown that University students are a good sample to test when trying to find the tendencies of usage of a product innovation (Szmigin & Bourne, 1999): in this case electronic cash is the product innovation. College students seem to exhibit the diverse behavior toward the product innovation that electronic cash represents (Van Hove, 2000). Their acceptance or rejection of the product is important since they represent a new generation of consumers.

The Business Administration Department, from the total University population of 3,497 students enrolled in the fall semester 2003-04, was the only group participating in this study. This department had a total of 841 students, of which 691 were registered in

the day program and 150 in the night/weekend program. Two hundred students completed the survey: 164 day students and 36 night/weekend students.

Instrumentation

As detailed in chapter 2, an extensive literature review was done in order to formulate each of the 22 questions. Data was organized in terms of the business, technological, and economic aspects of electronic cash.

Participants were asked to respond to each of the 22 questions using a scale from 1 to 5, where 1 represents *strongly disagree* and 5 represents *strongly agree*. The scale was made up of five points to avoid the ceiling effect, which consists of motivating people to answer the highest in all the questions.

Thirty students in a class in the business department were asked to pre-test the survey. Appendix A contains the questions that students answered to provide feedback. Students were asked whether the survey instructions were clear, whether the wording of each question was appropriate, whether each question had mutually exclusive answering alternatives, and the like. The feedback was incorporated into the final survey that is presented in Appendix A (English version of the survey) and Appendix B (Spanish version of the survey).

Limitations

There are inherent limitations to the reliability and validity of the data collection instrument and study design common to cross-sectional studies (Bourque & Fielder, 2003). One limitation of the study was that of external validity. The survey sample of 200 was not randomly selected from the target population of 841 students. Only a truly

random sample could hope to contain a representative cross section of the target population. The less random the sample, the less its results can be generalized to the whole population. The sample selected is a convenience sample and therefore the findings should generalize with caution to the target population. Therefore, generalizations from this study were made with caution.

Regarding the reliability of the survey, there were several limitations. The survey was written in such a way that students who did not know about electronic cash were still able to answer it quickly and easily. Even though this instrument is common, a very strong limitation of this study is that some students may not want to answer a survey about electronic cash because they may not know anything about it.

Another limitation is that the researcher, as an agent, handed out the survey to the sample population. Each subject used a computer input sheet in order to complete the survey as it made imputing data into the computer easier.

An assumption was made that the subjects answered without any time pressure, though sometimes students are in a hurry going from class to class or from class to work. They usually took about fifteen minutes to answer the survey. They completed the survey as they were about to start class, which may have represented some time pressure for them; this may be a limitation of the study. Another possible limitation is that some people might have felt afraid to answer a survey if they were not familiar with the topic. To avoid this limitation, the survey was designed to be easily understood with self-explanatory questions.

Appendix A shows the pre-test survey that was used to refine the survey questions, with the help of 30 students. However, no further reliability assessment was done.

Content validity determines if the survey is measuring what it is supposed to measure. The researcher made an exhaustive review of literature using many updated references. Also considered were two previous surveys regarding electronic cash taken from Van Hove (2000) and from Szmigin and Bourne (1999). However, no external content experts were involved in reviewing the final instrument.

Regarding internal validity, as in a typical cross-sectional research design, this study will not guarantee internal validity. This survey does provide an assessment of participant at one point in time, which is the primary limitation of this type of design.

Procedures

The procedure to conduct this survey involved requesting permissions, data gathering, and recording procedures.

Permissions

The chancellor of the University of Puerto Rico in Aguadilla was contacted by a formal letter to ask for permission to conduct the survey. In that letter, it was specified that confidentiality of the obtained results of the survey was assurance by the researcher. The signed letter from the chancellor authorizing to conduct the survey was sent to Argosy University in Sarasota for the review of its Institutional Review Board (IRB). The IRB approved the researcher to conduct the survey.

Data gathering

A group of professors from the University gave their consent to be visited during their class period by the researcher to conduct the survey. Twenty class sections were visited during the fall semester of 2003-04. It was assumed that each section would have approximately 20 students in order to meet a sample of 200 students. Each student received the Spanish version of the survey (Appendix C) along with the survey cover letter (Appendix D), which stated that their responses would be treated confidentially, and all raw data was be kept in a secured file by the researcher. The English version of the survey is shown in Appendix B.

Recording procedures

Once all the data was collected, the researcher did input the data into SPSS format. The researcher kept the answered surveys in a locked cabinet for confidentiality purposes. Each of the reports that show the results of the survey was processed in SPSS.

Data Processing and Analysis

The study was a cross-sectional design with statistical analysis consisting of descriptive statistics and inferential statistics including t-test and regression analysis. SPSS was used as the statistical package to calculate the analysis for each of the research questions (SPSS, 2001). Appendix E shows the list of the dependent and independent variables used to conduct the survey. Electronic cash as an alternative way of payment in the future was taken as the dependent variable. The rest of the questions were taken as the independent variables. The regression model in SPSS provided a model summary, an ANOVA table, a coefficient table, and an excluded variable table.

Research Hypotheses

Question 1: To compare the attitudes of male students and female students toward electronic cash. The study's intention was to test a hypothesis of difference between the means of males and females regarding their attitudes toward electronic cash.

Question 2: To compare the attitudes of students who have experience living outside Puerto Rico for more than six months and those who do not. The study's intention is to test a hypothesis of difference of the means of students who have lived outside Puerto Rico for more than six months and those who have not regarding their attitudes toward electronic cash.

Question 3: To compare the attitude of students who are registered in the daytime program and those who are in the evening-Saturday program. The study's intention is to test a hypothesis of difference of the means of students in the daytime program and those who are in the evening-Saturday program regarding their attitudes toward electronic cash.

Question 4: To predict the attitudes of students toward electronic cash. Multiple regression was chosen because the forecast involves more than one independent (predictor) variable supported by a dependent (criterion) variable. Here, the independent variables are the marketing, convenience and risk variables, and the dependent variable is the attitude towards merchants who offer electronic cash as a form of payment.

CHAPTER FOUR: FINDINGS

Introduction

This chapter presents the results and the statistical analysis of the data collected on students' perceptions and preferences for using electronic cash. Descriptive statistics are presented and discussed first, followed by the results of the inferential statistics to answer the four research questions.

Restatement of the Purpose

The purpose of this study is to explore the attitudes of students toward electronic cash. A cross-sectional design was employed to address the four research questions. The results were examined using descriptive statistics, comparisons between demographic groups and regression.

Results

Descriptive Statistics

Two hundred and ten usable surveys were analyzed. There were no missing values. Table 1 shows the frequency distributions of the demographic variables, which are survey questions one to seven.

Table 1

Frequency Distributions of the Demographic Variables (n = 210)

Variable Name	Category	Frequency	Percent
Gender	Male	110	52
	Female	100	48
Age	Less than or 18	111	53
	19 to 21	61	29
	22 to 25	24	11
	26 to 33	14	7
	34 to 45	0	0
	Over 45	0	0
Education	First year	17	8
	Second year	45	21
	Third year	58	28
	Fourth year or more	90	43
Major Field of Study	Accounting	25	12
	Marketing	34	16
	Finance	9	4
	IS	62	30
	Human Resources	40	19
	Other	40	19

Table 1 (continued)

Frequency Distributions of the Demographic Variables (n = 210)

Variable Name	Category	Frequency	Percent
Program of Study	Day time	154	73
	Evening	33	16
	Both	23	11
Work	Full-time	58	28
	Part-time	81	38
	Not working	71	34
Lived outside of PR for more than 6 months	Yes	47	23
	No	63	77

As noted in Table 1, almost half of the sample is male and a little less than a half of the sample is female. Most students in the sample are between 18 and 21 years old. In terms of education, most students are in their third year of study. Some students are in their second or fourth or more years of study, and a small number were in their first year of education. Most students who participated are information systems majors. The other majors are accounting, marketing, finance, information systems, human resources, and *other*, which is comprised of mostly electronics majors. Most students are from the daytime study program. More than a third of the students (38%) work part time. In terms of experience living outside Puerto Rico, most students (77%) have no experience living outside Puerto Rico.

Table 2

Descriptive Statistics of Survey Items (n = 210)

Questions	Mean	Standard Deviation
Electronic cash accepted due to marketing and publicity	4.10	.973
Electronic cash accepted because of monetary incentives	4.10	.939
Electronic cash payment more practical than bills and coins since those are heavy to carry	4.01	.998
Electronic cash payment for food at campus cafeteria	3.93	.931
Electronic cash payment for copier machine	3.89	.984
Electronic cash payment for tolls on the highway	3.83	.966
Electronic cash payment for a peer-review paper	3.81	.968
Electronic cash payment for a refreshment from vending machine	3.80	1.059
Electronic cash payment for public transportation	3.80	1.028
Willingness to pay with electronic cash if the student were to buy something	3.80	.821
Electronic cash payment for pay-per-view	3.79	.975
Electronic cash payment for public washer and dryer	3.77	1.011
Electronic cash payment for public phone call	3.76	1.058

Table 2 (continued)

Descriptive Statistics of Survey Items (n = 210)

Questions	Mean	Standard Deviation
Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security	3.74	.886
Electronic cash payment more practical than debit card in terms of anonymity and privacy	3.72	1.045
Electronic cash payment for adding more minutes to a mobile phone	3.71	1.044
Electronic cash payment for parking	3.70	1.021
Electronic cash accepted by merchants as long as students accepted it	3.70	.898
Willingness to accept electronic cash as payment method if the student were to sell something if the student were to sell something	3.60	.908
Electronic cash payment for music	3.53	1.146
Electronic cash payment for daily news	3.48	1.086
Security consideration for Internet payment	3.22	1.030
Willingness to carry electronic cash even if it can be lost just as regular cash	3.15	1.274

Table 2 presents the descriptive statistics for the survey items eight to 30, where 1 represents *strongly disagree*, 2 represents *disagree*, 3 represents *neutral*, 4 represents *agree*, and 5 represents *strongly agree*.

The items with a mean of 4 (*agree*) in the list are "Electronic cash accepted due to marketing and publicity"; "Electronic cash accepted because of monetary incentives"; and "Electronic cash payment more practical than bills and coins since those are heavy to carry." The standard deviations of around .94 are considered low. This means that the variation in the responses was small and most students answered 4 (*agree*).

The items which a mean ranging from 3.93 to 3.80 (almost 4, which is *agree*) are "Electronic cash payment for campus cafeteria"; "Electronic cash payment for copier machine"; "Electronic cash payment for highway"; "Electronic cash payment for a peer-reviewed journal"; "Electronic cash payment for a refreshment in the vending machine"; "Electronic cash payment for public transportation"; and "Willingness to pay with electronic cash if the student were to buy something." The standard deviation was low in most items, from .821 to 1.059. "Willingness to pay with electronic cash if the student were to buy something" has the lowest (.821), which reflects low variability among the answers. The highest standard deviation was found in the "Electronic cash payment for vending machine" and "Electronic cash payment for public transportation", 1.059 and 1.028, respectively. This means that a large variation occurred in the responses to those items.

"Electronic cash payment for pay-per-view"; "Electronic cash payment for public washer and dryer"; "Electronic cash payment for public phone"; "Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security";

"Electronic cash more practical than debit card in terms of anonymity and security"; "Electronic cash payment for adding more minutes to a mobile phone"; "Electronic cash payment for parking"; "Merchants will accept electronic cash as long as students accept it"; and "Willingness to accept electronic cash as payment method if the student were to sell something" are next in the list according to their means, which range from 3.79 to 3.60.

However, there is some variability in the answers. Two of the items ("Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security" and "Merchants will accept electronic cash as long as students accept it") also have small standard deviations, .886 and .898. This means that most students were in agreement with those items.

"Electronic cash payment for pay-per-view" and "Willingness to accept electronic cash as payment method if the student were to sell something" had somewhat low standard deviations of .975 and .908. The highest standard deviations were found in "'Electronic cash payment for public washer and dryer"; "Electronic cash payment for public phone"; "Electronic cash more practical than debit card in terms of anonymity and security"; "Electronic cash payment for adding more minutes to a mobile phone"; and "Electronic cash payment for parking" with 1.011, 1.058, 1.045, 1.044, and 1.021, respectively. This implies large variations among the responses.

The last items in the list are "Electronic cash payment for music"; "Electronic cash payment for daily news"; "Security consideration for Internet payment"; and "Willingness to carry electronic cash even if it can be lost just as regular cash". The means range from 3.53 to 3.15. Using the standard deviations, which run from 1.030 to

1.146, the conclusion can be drawn that the variation in the answers was very high ranging from *strongly disagree* to *strongly agree*.

Research Questions

The first three research questions address differences in attitudes toward electronic cash with regard to selected demographic characteristics. A *t* test for independent samples is computed. A nondirectional hypothesis is used because the direction of the outcome is not specified. The null hypothesis will be stated for the three questions since a nondirectional approach is chosen. The null hypothesis predicts no difference between the two groups. For the fourth question, a multiple regression measure will be calculated to predict the attitudes of students toward electronic cash. The Statistical Package for the Social Sciences, version 12 (SPSS, 2003) was used to conduct all analyses.

Research Question One. This question compares the attitudes of male students and female students toward electronic cash. The study's intention is to test a hypothesis of difference.

Null hypothesis: $H_0 : Mean_F = Mean_M$

Alternative hypothesis: $H_A : Mean_F \neq Mean_M$

A *t* test for independent samples is used.

Table 3 shows that there is no significant difference between the attitudes of male students and female students. As a result, the null hypothesis is accepted.

Table 3

Gender Differences in Response to Item 9: "Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security"

	Gender	N	Mean	Standard Deviation	Std. Error Mean
Provides anonymity, privacy, and security	Male	110	3.76	.957	.091
	Female	100	3.72	.805	.081

t = .356 (df = 208), p = .722

Research Question Two. This second question compares the attitudes of students who have had experience living outside Puerto Rico for more than six months and those who have not. A t-test for independent samples was calculated. The results are presented in Table 4.

Null hypothesis: $H_0 : Mean_{outsidePR} = Mean_{insidePR}$

Alternative hypothesis: $H_A : Mean_{outsidePR} \neq Mean_{insidePR}$

Table 4 shows that there is no significant difference between the attitudes of students who have had experience living outside Puerto Rico for more than six months and those who have not. As a result, the null hypothesis is accepted.

Research Question Three. The third question compared the attitude of students who are registered in the daytime program and those who are in the evening-Saturday program. A t-test for independent samples was computed.

Null hypothesis: $H_0 : Mean_{daytime} = Mean_{evening\text{-}Saturday}$

Alternative hypothesis: $H_A : Mean_{daytime} \neq Mean_{evening\text{-}Saturday}$

Table 4

Location Differences in Response to Item 9: "Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security"

	Location	N	Mean	Standard Deviation	Std. Error Mean
Provides anonymity, privacy, and security	In PR only	163	3.74	.872	.068
	Lived outside of PR	47	3.74	.943	.138

t = -.016 (df = 208), p = .987

Table 5

Day vs. Night Student Differences in Response to Item 9: "Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security"

	Program	N	Mean	Standard Deviation	Std. Error Mean
Provides anonymity, privacy, and security	Daytime	177	3.78	.854	.064
	Evening-Saturday	33	3.55	1.034	.180

t = 1.397 (df = 208), p = .164

Table 5 shows that there is no significant difference between the attitude of students who are registered in the daytime program and those who are in the evening-Saturday program. As a result, the null hypothesis is accepted.

Research Question Four. This question tests the hypothesis that attitudes of students will predict the preference for use of electronic cash. The variable MERCHANT

(Q28) was chosen as the dependent variable because it asks students to consider their use of electronic cash from the merchant's perspective. The independent variables were chosen because those questions tested about the student's perspectives toward electronic cash. Two hypotheses were tested.

Hypothesis 1

Null Hypothesis: The linear combination of independent variables does not predict the variation in the dependent variable.

Alternative Hypothesis: The linear combination of the independent variables does predict variation in the dependent variable.

Hypothesis 2

Null Hypothesis: None of the independent variables are significantly predictive.

Alternative Hypothesis: At least one of the independent variables is significantly predictive.

A stepwise linear regression model was used to determine which attitudes were most predictive of the preference for electronic cash. Table 6 presents the regression model with the item describing each variable.

Examination of the correlations of the independent variables (Table 7) shows that there is low risk of multicollinearity. Correlations ranges from lowest, which is SECURY with .176 to the highest, which is MARKETIN with .371.

Table 6

Multiple Regression Model

$$MERCHANT = a + b_1 * SECURE + b_2 * CONVENIE + b_3 * ACCEPT + b_4 * PAY + b_5 * PRACDEB + b_6 * PRACBILL + b_7 * RISKY + b_8 * INCENTIV + b_9 * MARKETIN$$

Where:

a = the intercept (a constant), it is the minimum value for the dependent variable even if all the independent variables are zero.

$b_{1\text{-}9}$ are the coefficients of each predictor,

And the predictors include:

MERCHANT = Q28, Electronic cash accepted by merchants as long as students accepted it

SECURE = Q8, Security consideration for Internet payment

CONVENIE = Q9, Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security

ACCEPT = Q10, Willingness to accept electronic cash as payment method if the student were to sell something

PAY = Q11, Willingness to pay with electronic cash if the student were to buy something

PRACDEB = Q25, Electronic cash payment more practical than debit card in terms of anonymity and privacy

PRACBILL = Q26, Electronic cash payment more practical than bills and coins since those are heavy to carry

RISKY = Q27, Willingness to carry electronic cash even if it can be lost just as regular cash

INCENTIV = Q29, Electronic cash accepted because of monetary incentives

MARKETIN = Q30, Electronic cash accepted due to marketing and publicity

Table 7

Intercorrelations between Predictors and Dependent Variable

Subscale	1	2	3	4	5	6	7	8	9	10
					Students (n = 210)					
1. MERCHANT	___	.176*	.262**	.257**	.334**	.265**	.281**	.304**	.341**	.371**
2. SECURE		___	.376**	.236**	.220**	.088	.100	.182**	.102	.192**
3. CONVENIE			___	.450**	.555**	.324**	.365**	.285**	.335**	.470**
4. ACCEPT				___	.583**	.286**	.210**	.218**	.303**	.318**
5. PAY					___	.265**	.323**	.166*	.310**	.355**
6. PRACDEB						___	.539**	.212**	.247**	.330**
7. PRACBILL							___	.304**	.408**	.453**
8. RISKY								___	.052	.311**
9. INCENTIV									___	.503**
10. MARKETIN										___

*p < .05. **p < .01.

As shown in Table 7, the dependent variable MERCHANT is most strongly correlated with MARKETIN (r = .371, p < .01), followed by INCENTIV (r = .341, p < .01) and PAY (r = .334, p < .01), and RISKY (r = .304, p < .01). Moderately significant

correlations were found for: PRACBILL ($r = .281$, $p < .01$), PRACDEB ($r = .265$, $p < .01$), CONVENIE ($r = .262$, $p < .01$), and ACCEPT ($r = .257$, $p < .01$). The smallest correlation was with SECURE ($r = .176$, $p < .05$).

Table 7 also reveals strong associations between PAY and ACCEPT ($r = .583$, $p < .01$), PAY and CONVENIE ($r = .555$, $p < .01$), PRACBILL and PRACDEB ($r = .536$, $p < .01$), MARKETIN and INCENTIV ($r = .503$, $p < .01$), MARKETIN and CONVENIE ($r = .470$, $p < .01$), MARKETIN and PRACBILL ($r = .453$, $p < .01$), and ACCEPT and CONVENIE ($r = .450$, $p < .01$). In addition, Table 7 shows moderately strong associations between INCENTIV and PRACBILL ($r = .408$, $p < .01$), CONVENIE and SECURE ($r = .376$, $p < .01$), PRACBILL and CONVENIE ($r = .365$, $p < .01$), MARKETIN and PAY ($r = .355$, $p < .01$), INCENTIV and CONVENIE ($r = .335$, $p < .01$), MARKETIN and PRACDEB ($r = .330$, $p < .01$), PRACDEB and CONVENIE ($r = .324$, $p < .01$), PRACBILL and PAY ($r = .323$, $p < .01$), MARKETIN and ACCEPT ($r = .318$, $p < .01$), MARKETIN and RISKY ($r = .311$, $p < .01$), INCENTIV and PAY ($r = .310$, $p < .01$), RISKY and PRACBILL ($r = .304$, $p < .01$), INCENTIV and ACCEPT ($r = .303$, $p < .01$), PRACDEB and ACCEPT ($r = .286$ $p < .01$), RISKY and CONVENIE ($r = .285$, $p < .01$), PRACDEB and PAY ($r = .265$, $p < .01$), INCENTIV and PRACDEB ($r = .247$, $p < .01$), ACCEPT and SECURE ($r = .236$, $p < .01$), PAY and SECURE ($r = .220$, $p < .01$), RISKY and ACCEPT ($r = .218$, $p < .01$), RISKY and PRACDEB ($r = .212$, $p < .01$), and PRACBILL and ACCEPT ($r = .210$, $p < .01$). Lastly, Table 7 illustrates weak associations between MARKETIN and SECURE ($r = .192$, $p < .01$), RISKY and SECURE ($r = .182$, $p < .01$), SECURE and MERCHAN ($r = .176$, $p < .01$), RISKY and PAY ($r = .166$, $p < .01$), INCENTIV and SECURE ($r = .102$, $p < .01$), PRACBILL and

SECURE (r = .100, p < .01), PRACDEB and SECURE (r = .088, p < .01), and INCENTIV and RISKY (r = .052, p < .01).

To test hypothesis 1, the coefficient of determination (R^2) and F statistic for each step of the regression analysis was computed. The results are presented in Table 8.

Table 8

Summary Table of the Stepwise Regression of Student Attitudes on Use of E-Cash

Model	R	R Square	F Change	df1	df2	Sig. F Change
1	.371	.138	33.191	1	208	.000
2	.430	.184	11.900	1	207	.001
3	.468	.219	9.086	1	206	.003
4	.499	.249	8.207	1	205	.005

a Predictors: (Constant), MARKETIN

b Predictors: (Constant), MARKETIN, PAY

c Predictors: (Constant), MARKETIN, PAY, RISKY

d Predictors: (Constant), MARKETIN, PAY, RISKY, INCENTIV

e Dependent Variable: MERCHANT

In the first model, MARKETIN is entered and accounted for 13.8 % of the variance, *F* (1, 208) = 33.191, p < .000. In the second model, the inclusion of the variable PAY increase the amount of variance accounted to 18.4 %, *F* (1, 207) = 11.900, p < .001. The third model adds the variable RISKY and it accounts for 21.9 % of the variance, *F* (1, 206) = 9.086, p < .003. The fourth and final model includes the variable INCENTIV and it accounts for 24.9 % of the variance, *F* (1, 205) = 8.207, p < .005. While this is

statistically significant, it does indicate that 75.1% of the variance is unexplained, suggested that this model is far from fully specified.

Table 9

Analysis of Variance for the Regression Model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.187	1	23.187	33.191	.000
	Residual	145.308	208	.699		
	Total	168.495	209			
2	Regression	31.086	2	15.543	23.415	.000
	Residual	137.409	207	.664		
	Total	168.495	209			
3	Regression	36.891	3	12.297	19.249	.000
	Residual	131.604	206	.639		
	Total	168.495	209			
4	Regression	41.957	4	10.489	16.993	.000
	Residual	126.538	205	.617		
	Total	168.495	209			

a Predictors: (Constant), MARKETIN

b Predictors: (Constant), MARKETIN, PAY

c Predictors: (Constant), MARKETIN, PAY, RISKY

d Predictors: (Constant), MARKETIN, PAY, RISKY, INCENTIV, PAY, RISKY, INCENTIV

e Dependent Variable: MERCHANT

As shown in Table 9, the ANOVA for the regression model presents the results for the four different models generated. The stepwise method tests the dependent variable with each independent variable one at a time. The most important model to examine is model 4 because it includes all of the independent variables selected by the stepwise method. The final this model, F (4, 205) = 16.993, $p < .001$, suggests is that this linear combination of variables explains a significant amount of variation in the dependent variable. Therefore, the null hypothesis of hypothesis 1 is rejected. Further, at the bivariate level, there does not appear to be any risk of multicollinearity (Hair, Anderson, Tatham, & Black, 1998).

Table 10 presents the coefficients associated with the final model. As shown, RISKY is the most important predictor with $\beta = .221$ ($t = 3.437$, $p = .001$). The next most important predictor is INCENTIVE with $\beta = .205$ ($t = 2.865$, $p = .005$). The last most important predictor is PAY with $\beta = .0187$ ($t = 2.837$, $p = .005$). Even though MARKETIN is included as one of the predictors with $\beta = .132$ ($t = 1.747$, $p = .082$), it is the least important predictor since it does not appears to be significant at all.

It is interesting to note that in the final model MARKETIN went from being the strongest predictor (in Model 3) to the weakest predictor (in Model 4). Referring back to Table 7, the correlation between MARKETIN and INCENTIVE, $r = .503$ suggests that the variance common to MERCHANT, MARKETIN and INCENTIVE was reapportioned once INCENTIVE was entered into the equation, resulting in INCENTIVE increasing in importance and MARKETIN decreasing in importance. Therefore, the null hypothesis of hypothesis 2 for the regression model is rejected.

Table 10

Standardized Coefficients and Collinearity Statistics for the Regression Models

Model		Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance
1	(Constant)		9.131	.000	
	MARKETIN	.371	5.761	.000	1.000
2	(Constant)		5.302	.000	
	MARKETIN	.289	4.300	.000	.874
	PAY	.232	3.450	.001	.874
3	(Constant)		4.766	.000	
	MARKETIN	.232	3.389	.001	.808
	PAY	.219	3.323	.001	.870
	RISKY	.196	3.014	.003	.900
4	(Constant)		3.430	.001	
	MARKETIN	.132	1.747	.082	.638
	PAY	.187	2.837	.005	.845
	RISKY	.221	3.437	.001	.882
	INCENTIV	.205	2.865	.005	.713

a Dependent Variable: MERCHANT

The results of this regression suggest that students' receptivity to merchants who offer electronic cash as an alternative payment is influenced by their willingness to carry

and use electronic cash even if it is as "risky" as paper money; and the presence of monetary incentives from the merchant.

In conclusion, no significant differences were found in selected demographics when comparing students' responses to issues anonymity, privacy, and security. However, when examining their attitudes towards using electronic cash at receptive merchants, risk was perceived as no greater than that of regular cash, and students were open to monetary incentives for using electronic cash.

In all these cases, the results only apply to this sample, and any implications for the target population of students should be made with caution.

CHAPTER FIVE: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to explore the attitudes of students from the University of Puerto Rico at Aguadilla toward electronic cash. Descriptive statistics of the sample were presented. Four research questions (research hypotheses) were posed.

The first three questions tested for selected demographic differences on the item assessing students' perceptions of "anonymity, privacy, and security." T-tests were conducted using gender, living location (inside vs. outside of Puerto Rico), and college program (daytime vs. evening), and no significant differences were found.

The fourth research question assessed the ability of selected items (SECURE, CONVENIE, ACCEPT, PAY, PRACDEB, PRACBILL, RISKY, INCENTIV) to predictive students attitudes' towards merchants who offer electronic cash as a payment alternative (MERCHANT). These predictor variables were selected because, according to Szmigin and Bourne (1999), those represent some of the major characteristics that describe electronic cash. In the final model, the results of a stepwise multiple regression analysis revealed that four of the eight items (RISKY, INCENTIV, PAY, MARKETIN) formed a linear equation with an $R^2 = .249$, $F(4, 205) = 16.993$, $p < .01$. This suggested that, if merchants offer electronic cash as a form of payment, students' preferences for using this alternative increases as it is perceived as (in order of importance): having no additional risk over regular cash; including incentives to encourage use; a viable means of payment for desirable items; and is marketed and promoted.

Conclusion

This study is relevant to the business world because electronic cash can be a convenient alternative method of payment for consumers, according to the research documented in the review of literature. This study also suggests directions for how to marketing this value-added service to a market (college students) who reported a willingness to use electronic cash. This research suggests merchants needed to focus on incentive-based strategies coupled with good merchandising. Further, it is suggested that marketing efforts did not have to include a "reassuring" message that electronic cash is "safe." For this market, the riskiness of electronic cash was not perceived as an obstacle.

This study also has implications for banks and other financial institutions, as electronic cash is another potentially lucrative financial product. It contributes to the rapidly emerging electronic business market, which is approaching the status of a global economy. In addition, this study suggests that, for the student market, electronic cash would be accepted and used in the future. Technological provisions already exist for the establishment of a successful electronic cash operation. A study like this may contribute to the development of programs that focus on features acceptable to potential consumers.

Descriptive Statistics

Demographics. Most students in the sample were from 18 to 21 years old, although students from the ages of 22 to 33 were also present. Not many students were aged 26 or older. The number of males and females were roughly equal.

In terms of education, most students were mature enough to answer the survey since most of them were in their third and fourth year of college. The fewest number of students was in their first year. Most students who filled out the survey were information

systems majors. The data set was spread out across the different majors, who were accounting, marketing, finance, information systems, human resources, and others, mostly electronics.

Most students were from the day time study program even though the evening-Saturday program also participated. There was not much variability in the responses were found. As for working experience, most students work part time. The variability was somewhat low, which means that some other students work full time or do not work at all. Considering experience living outside Puerto Rico, most students have no experience living outside Puerto Rico.

While this study was based on a convenience sample and may have limited external validity (this is discussed later in this Chapter), the descriptive statistics did reveal a fairly normative representation of the young adult college population living in Puerto Rico. Future studies are encouraged to replicate this effort on other student populations in and outside of Puerto Rico to enhance external validity.

Survey items. The items with the highest mean (i.e., that students most strongly agreed with) were "Electronic cash accepted due to marketing and publicity;" "Electronic cash accepted because of monetary incentives;" and "Electronic cash payment more practical than bills and coins since those are heavy to carry." The standard deviations were low. This meant that variability in the responses was small and most students answered 4 (*agree*).

These results implied that students value the marketing and publicity of electronic cash. These campaigns are necessary for success because they allow students to learn about the product. Marketing campaigns should focus on monetary incentives and the

practicality of electronic cash. Monetary incentives to use electronic cash may also help students accept it. Electronic cash was viewed as more practical since it is stored in a smart card and is lighter to carry than bills and coins.

The next items receiving the strongest agreement (almost 4, *agree*) were "Electronic cash payment for campus cafeteria;" "Electronic cash payment for copier machine;" "Electronic cash payment for highway;" "Electronic cash payment for a peer-reviewed journal;" "Electronic cash payment for a refreshment in the vending machine;" "Electronic cash payment for public transportation;" and "Willingness to pay with electronic cash if the student were to buy something." The standard deviations were low, indicating low variability among the answers, except for "Electronic cash payment for vending machine" and "Electronic cash payment for public transportation," which had a higher standard deviation (high variability).

Students seemed to be willing to use electronic cash to pay for food in the campus cafeteria, for copier machines, for highway tolls, for a peer-reviewed journal, for refreshment from a vending machine, and for public transportation. This implied that if the University were to think about electronic cash as a means of payment, these items were the most important ones to consider. Items like highway tolls and public transportation were the responsibility of governmental agencies and they would have to decide if electronic cash would be a viable means of payment or not. However, those two items affected the whole population, not only students. Concluding that the whole population would accept electronic cash as a way of payment for highway tolls and public transportation goes beyond the scope of this study. Therefore, if the Government were to consider electronic cash as a way of payment for such items, another study would

needed to make sure that the general public would accept electronic cash. For the question of willingness to pay with electronic cash if the student were to buy something, in general, most students answered *agree.* This item can be considered a "global" item representing overall willingness, whereas the other items specified purchase-specific willingness.

In the study, there were item questions for which the mean was 4 (*agree*). However, the standard deviation indicated variability in the answers so the disparity among the answers cannot lead to the conclusion that *agree* was the most common answer. These items were: "Electronic cash payment for pay-per-view;" "'Electronic cash payment for public washer and dryer;" "Electronic cash payment for public phone;" "Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security;" "Electronic cash more practical than debit card in terms of anonymity and security;" "Electronic cash payment for adding more minutes to a mobile phone;" "Electronic cash payment for parking;" "Merchants will accept electronic cash as long as students accept it;" and "Willingness to accept electronic cash as payment method if the student were to sell something."

Two of the items from this particular list, "Convenient way of payment (electronic cash) since it provides anonymity, privacy, and security" and "Merchants will accept electronic cash as long as students accept it" were the ones with the lowest standard deviation. Most students recognized that electronic cash would be a convenient method of payment since it provides anonymity, privacy, and security. Indeed, this implies that they recognize anonymity, privacy, and security as a value added to electronic cash as a way of payment.

Also, "Electronic cash payment for pay-per-view" and "Willingness to accept electronic cash as payment if the student were to sell something" had somewhat low standard deviations. This suggests that students are fairly consistent in their attitude towards using electronic cash to pay for pay-per-view and are willing to accept electronic cash as a payment method from other people who need to pay them.

A large variation in responses (a high standard deviation) was found in "Electronic cash payment for public washer and dryer;" "Electronic cash payment for public phone;" "Electronic cash more practical than debit card in terms of anonymity and security;" "Electronic cash payment for adding more minutes to a mobile phone;" and "Electronic cash payment for parking." This indicates considerable variability in their attitudes towards these questions. For example, the use of public washer and dryer may not apply if most of the students still live with their families or if they wash their clothing at home. Perhaps, students do not use public phones, debit cards, and mobile phones as much as expected. Parking in this particular University is free. This may be the reason students did not give much importance to the use of electronic cash as payment for parking. It can reasonably be concluded that there are other factors affecting the students' willingness to accept electronic cash as a payment method than the ones featured in the survey. These alternative explanations suggests that these questions may not be reliably measuring preference for electronic cash; rather measuring function issues of access and use. This is further discussed in the section on Limitations.

The items with the lowest mean ranging from *neutral* to *agree* are "Electronic cash payment for music;" "Electronic cash payment for daily news;" "Security consideration for Internet payment;" and "Willingness to carry electronic cash even if it

can be lost just as regular cash." Nevertheless, the standard deviations suggested that variability in the answers is very high ranging from *strongly disagree* to *strongly agree*.

Students may not have enough experience in downloading music from the Internet or in buying the daily news to consider electronic cash as a payment for those services. Again, these alternative explanations suggests that these questions may not be reliably measuring preference for electronic cash; rather measuring function issues of access and use. This is further discussed in the section on Limitations.

Research Questions

Research questions one, two, and three examined differences in selected demographics in their response to the statement: "Electronic cash is a convenient way of payment (electronic cash) since it provides anonymity, privacy, and security." These demographics included gender, residence location, and daytime/evening program. No significant differences were found in any of these examinations. This suggests that the electronic cash marketing campaign can focus on students as a broad "niche market", rather than segmented. However, these findings must be interpreted with caution.

Research question 4 attempted to examine the predictive relationship of certain marketing and consumer behavior characteristics with student attitude towards merchants' use of electronic cash ("Merchants will accept electronic cash as long as students accept it" – the dependent variable). A stepwise multiple regression procedure was chosen to determine (1) if these independent variables could account for a significant proportion of variance in the dependent variable; and (2) which of the independent variables were most important (Hair et al., 1998).

The data provides strong evidence that the final model with four independent variables used was successful in predicting variations in students' attitudes towards merchants' use of electronic case. Almost 25% of the variance in the dependent variable was accounted for.

Further, the final model revealed that there are some important predictors to take into consideration when trying to forecast attitudes towards merchants' use of electronic cash. These are, in order of importance: "Willingness to carry electronic cash even if it can be lost just as regular cash;" "Electronic cash accepted because of monetary incentives;" "Willingness to pay with electronic cash if the student were to buy something;" and "Electronic cash accepted due to marketing and publicity."

This suggests that marketing the "availability" of electronic cash became less important than creating an incentive-based marketing program to promote use. If an incentive were identified, then students would be likely to carry and use electronic cash if they found something they want to buy.

These results also reveal a potentially important implication regarding the relationship of incentives, risk, marketing, access, and product purchasing. When an incentive was added to the marketing mix, this study suggests that the risks associated with electronic cash became less relevant, allowing the customer then to focus on the features and benefits of the product of interest, rather than on the method of payment. For merchants, this implies that while advertising the availability of electronic cash may draw students to their business, their desire to purchase is still linked to the products' features and benefits. Thus, incentives to use electronic cash plus good product merchandizing can work together. These results need to be taken with caution however, as this study is

exploratory, and analyses of the sequence and significance of these linkages (i.e., via path analysis) were not explored.

Marketing and publicity of electronic cash are important to familiarize consumers with a new product. The electronic cash marketing campaign can be based on incentives to use electronic cash and make emphasis in its convenience since it is less heavy to carry than bills and coins. Students seemed to be willing to pay with electronic cash as an alternative way of payment. Students were concerned about their willingness to carry it if it can be lost just like regular cash.

In addition to the regression analyses, the preliminary item intercorrelations also offered some potential insights about how these variables could clarify specific aspects of using electronic cash. For example, the high correlation ($r = .583$, $p = .01$) between PAY and ACCEPT illustrates the student's positive attitude toward electronic cash because they were willing to accept it as an alternative way of payment. Similarly, the correlation ($r = .555$, $p = .01$) is between PAY and CONVENIE suggests students would use electronic cash as a payment method because they recognized its convenience. The correlation ($r = .539$, $p = .01$) between PRACBILL and PRACDEB shows again that students were willing to accept electronic cash as an alternative way of payment since they considered it to be more practical than carrying bills and coins and that it provides anonymity and privacy. The correlations between MARKETIN and INCENTIV ($r = .503$, $p = .01$), MARKETIN and CONVENIE ($r = .470$, $p = 01$), and MARKETIN and PRACBILL ($r = .453$, $p = .01$) show that electronic cash marketing campaign can be focus on monetary incentives for using electronic cash as a payment method, on its convenience, and on its practicality since it is less heavy to carry than bills and coins.

And finally, the correlation (r = .450, p = .01) between ACCEPT and CONVENIE, indicates that if students were to sell something, they would recognize the convenience of electronic cash in terms of anonymity, privacy, and security.

The next pairs of independent variables were moderately correlated. First, the correlation (r = .408, p = .01) between INCENTIV and PRACBILL illustrates the willingness of students to use electronic cash if incentives were provided since they recognized that it is more practical to carry than bills and coins. Next, the correlation (r = .376, p = .01) between CONVENIE and SECURE exhibits those students gave value electronic cash convenience for Internet payments. The correlation (r = .365, p = .01) between PRACBILL and CONVENIE suggests that students were consistent in answering the survey because of the convenient factor that electronic cash is more practical than bills and coins. The correlation (r = .355, p = .01) between MARKETIN and PAY points out that a marketing campaign would be needed to make awareness that electronic cash payments are available. The correlation (r = .335, p = .01) between INCENTIV and CONVENIE shows that students could test electronic cash's convenience if monetary incentives to use it were offered. The correlation (r = .330, p = .01) between MARKETIN and PRACDEB displays that the marketing campaign can have as one of the main focuses the similarities of electronic cash just as regular cash since it provides anonymity and privacy in payments as opposed to debit cards. The correlation (r = .324, p = .01) between PRACDEB and CONVENIE specifies that electronic cash is more convenient since it is more practical than debit cards in terms of anonymity and privacy. The correlation (r = .323, p = .01) between PRACBILL and PAY proposes that students were enthusiastic to pay with electronic cash due to its practicality

against bills and coins, which are heavier to carry. The correlation (r = .318, p = .01) between MARKETIN and ACCEPT demonstrates that there was a positive relationship between the acceptance of electronic cash as a payment method by students if a marketing campaign focus on its awareness. The correlation (r = .311, p = .01) between MARKETIN and RISKY reveals that one of the focuses of the marketing campaign can be to address the fact that electronic cash is as risky as regular cash. Riskiness refers to the fact that if electronic cash is lost, it cannot be recovered. The correlation (r = .310, p = .01) between INCENTIV and PAY implies that students were willing to pay with electronic cash if incentives were offered to use it. The correlation (r = .304, p = .01) between RISKY and PRACBILL indicates the knowledge among students about the two-fold sides of electronic cash. It is very practical because of its lightness to carry in the wallet. On the other hand, it is as risky as regular cash because if it is lost, who ever else that finds it can pay with it. Then, the correlation (r = .303, p = .01) between INCENTIV and ACCEPT suggests the consistency in the answers of the survey in terms of the acceptance to use electronic cash if incentives are provided. The correlation (r = .286, p = .01) between PRACDEB and ACCEPT shows that if students were to sell something, they would accept electronic cash as a payment method since it is more practical than debit card in terms of anonymity and privacy. Since these two variables are medium-to-low correlated, the risk of multicollinearity is eliminated. The correlation (r = .285, p = .01) between RISKY and CONVENIE exhibits the understanding of students about both characteristics of electronic cash, its convenience and its riskiness. The correlation (r = .265, p = .01) between PRACDEB and PAY illustrates the compliance of students to buy something by paying with electronic cash since they considered it to be more practical

than the debit card in terms of anonymity and privacy. The correlation (r = .247, p = .01) between INCENTIV and PRACDEB specifies the willingness of students to use electronic cash more than their debit card, especially if monetary incentives to use it were offered. Next, the correlation (r = .236, p = .01) between ACCEPT and SECURE points out the compliance of students to accept electronic cash as a payment method if they were to sell something considering the security it would offered for Internet payments. The correlation (r = .220, p = .01) between PAY and SECURE demonstrates the enthusiasm of students to pay with electronic cash if they were to buy something taking into account the security it would offered for Internet payments. The correlation (r = .218, p = .01) between RISKY and ACCEPT exhibits the acceptance of electronic cash as a payment method if they were to sell something regardless of its riskiness. The correlation (r = .212, p = .01) between RISKY and PRACDEB shows the conformity of students to pay with electronic cash because it is more practical than debit cards in terms of anonymity and privacy in spite of its riskiness. Finally, the correlation (r = .210, p = .01) between PRACBILL and ACCEPT implies the responsiveness of students to believe in electronic cash as a payment method if they were to sell something since it is more practical considering that bills and coins are heavier to carry.

Lastly, there were some pairs of independent variables that illustrate weak association. First, the correlation (r = .192, p = .01) between MARKETIN and SECURE indicates that the marketing campaign for electronic cash should suggest in certain way the kind of security this kind of payment offer. Next, the correlation (r = .182, p = .01) between RISKY and SECURE suggests that students were aware of both characteristics of electronic cash. It can offer security for Internet payments, but it is as volatile as

regular cash. The correlation (r = .176, p = .05) between SECURE and MERCHAN shows that the merchant can be benefit of the security aspect of electronic cash for Internet payments. The correlation (r = .166, p = .01) between RISKY and PAY demonstrates the recognition of the riskiness (volatility) when paying with electronic cash. Then, the correlation (r = .102) between INCENTIV and SECURE points out that if incentives to use electronic cash were offered, security for Internet payments is an added value. The correlation (r = .100) between PRACBILL and SECURE reveals that electronic cash was perceived by students as more secured than regular cash, especially if it is used for Internet payments. The correlation (r = .088) between PRACDEB and SECURE displays electronic cash was viewed to be more practical than debit cards to perform Internet payments. Finally, the correlation (r = .052) between INCENTIV and RISKY exhibits if monetary incentives to use electronic cash were offered, its riskiness becomes less important.

Limitations

There were three major limitations to the study. First, this study had limited external validity. The method of finding participants was done using convenience sampling. A probability sampling method was not feasible. This means that the conclusions drawn from the sample cannot be generalized to the whole population or can be made with caution. It was not known how well these results can generalize to the Puerto Rico student body, or to the larger populations of students. It was not known how representative these students' knowledge or use of electronic cash was compared to students in other geographic location.

Second, the reliability of the survey instrument was not known. There were no attempts to assess the psychometric properties of the instrument. Further, the researcher's familiarity with the items and with the student body acknowledged that many of the items may be misinterpreted by the students; or may not be relevant.

Therefore, it is not clear how stable these results might be over time. Further, threats to reliability included that most students were not familiar with electronic cash, and that the students may have had time pressures when they answered the survey.

Third, the internal validity of the study was in question as this was designed as a cross-sectional study. The regression analysis did not include examination of partial and semi-partial correlations to statistically explore the relationships of the significant independent variables, so that the interpretations of these results may be based on inaccurate assumptions about the strength and direction of these relationships. Further, stepwise regression analysis was limited in its ability to reveal the temporal relationships of the variables in question (Hair et al., 1998).

Recommendations

Comparison with Other Surveys.

The Mondex survey by Szmigin and Bourne (1999) provides important questions that need to be asked in an electronic cash survey. The authors concluded that Mondex would not be used unless incentives were given. This survey was relevant because its findings contribute to the future improvement of electronic cash. In comparison, the Mondex study was different from the study discussed in this research because students had the chance to use electronic cash before they were asked about it. On the other hand,

its results were somewhat similar in that both surveys suggested that monetary incentives were very important to encourage students to use electronic cash.

Overall Recommendations

This survey can be improved to increase its reliability. First, a test-retest strategy to evaluate reliability can be used. Next, this survey can be reviewed by content experts to reduce confusion and errors in some of the items of the survey. Lastly, the distribution of the survey can be improved. For instance, samples can be collected from comparison groups of students that belong to other Universities in Puerto Rico or outside the Island.

Similar studies could include merchants around the University instead of just students. These surveys could include local banks, other financial institution from the area, those who provide vending services and copier machines, and owners of other local businesses.

In terms of replicating the results, there are several recommendations to be made. Research indicates that a higher degree of familiarity with electronic cash needs to be established before asking participants about it. A seminar about electronic cash can be offered to the students. Once, the discussion group is over, the surveys can be distributed among the audience. Alternatively, it is suggested to have the participant test electronic cash before participating in a survey. The support of an electronic cash company, such as Mondex (Szmigin and Bourne, 1999), would be necessary in order to place electronic cash among the student body. Once most students have tested it, then the survey can be circulated. These variations would allow the student to answer survey questions based on their experience rather than their imagination.

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APPENDICES

APPENDIX A

Survey for the pre-test study

APPENDIX A

Survey for the pre-test study

Survey: Attitudes of students toward electronic cash

Instructions: Please, make sure you answer the survey instrument (questionnaire) before answering this one. The purpose of this test is to significantly improve the survey. That is why your sincerity in criticizing the survey is always appreciated. This test takes place in most surveys as part of the process in order to minimize error and improve in the reliability and validity of the study.

1- Are the instructions for completing the survey clearly written?
2- Are questions easy to understand by everybody?
3- Do respondents know how to indicate responses (for example, circle or mark response; use special pencil or special mark)?
4- Are the response choices mutually exclusive?
5- Are the response choices exhaustive?
6- If an incentive is given for completing the survey, do respondents understand how to obtain it?
7- Is privacy respected and protected?
8- Do respondents have any suggestions regarding the addition or deletion of questions, the clarification of instructions, or improvements in format?
9- Are proper wording, grammar, and vocabulary used?
10- Is the level of vocabulary appropriate?

APPENDIX A - *Continued*

11- Are good paper, proper dark ink, and extra copies present?

12- Is any question a motivation for someone to react to it, in terms of being an offensive or improper question? Is third person used in each question in order to avoid reactivity?

13- Are there any yes/no questions hidden in the 5-scale alternatives?

14- Are there two questions in one (by using *and*) in any of the questions?

15- Are there any leading questions like *highest, most, greatest*, or the like?

16- Is there ambiguity in any of the questions?

17- Does the survey start with the simplest question and become progressively more difficult?

APPENDIX B

Survey

APPENDIX B

Survey: Attitudes of Students toward Electronic Cash

Instructions: Select the answer that bests suits your belief. Observe that the scale goes from *strongly disagree* to *strongly agree*. Please, do not forget to fill out the answer sheet also.

Electronic Cash

Electronic cash, as defined by Bernkope (1996) is the digital replacement of banknotes and coins. In addition, electronic cash is an alternative way of payment that offers anonymity and privacy, just as regular cash would, in purchase transactions. According to the Webster's dictionary, *anonymity* means "nameless" and *privacy* means "known by only its participants" Electronic cash is not like a debit or credit card, in which the business transactions are shared with other parties for marketing purposes. Electronic cash can be used to pay in the Internet world as well as in the tangible (physical) world. Electronic cash is usually stored in a smart card. The smart card is a plastic card that has a magnetic strip and a memory chip. The memory chip is where electronic cash is stored. As electronic cash is being used, the software installed on its memory chip reduces the amount accordingly. There should be nearby terminals where you can easily charge or recharge (with more money) your electronic cash smart card. This electronic cash smart card needs to be read by a special portable device. Notice that the money you keep at the electronic cash smart card can be simply converted as desired to regular cash at the bank that offers that service. Electronic cash has been used in United States (Atlanta's Olympic Games 1996), Australia, England, Belgium, The

Netherlands, Finland, Canada, and other countries. Assume that you have access to a near bank (on-campus bank) that offers electronic cash service for all the questions.

1- Your gender is:

a) Male b) Female

2- Your age is:

a) less than or 18 b) 19-21 c) 22-25 d) 26-33 e) 34-45 f) over 45

3- Your education is:

a) Undergraduate (first year) b) Undergraduate (second year)

c) Undergraduate (third year) d) Undergraduate (fourth year or more)

4- Major field of study is: (Dual majors, choose just one)

a) Accounting b) Marketing c) Finance

d) Information Systems e) Human Resources f) Other _____

5- Program of study:

a) day-time b) evening-Saturday program c) both programs

6- Do you work?

a) Yes, full-time b) Yes, part-time c) Not working

7- Have you ever lived outside Puerto Rico for more than six months?

i. Yes, in the US Northeastern (for example: New York, New Jersey, Connecticut)

ii. Yes, in the US Southeastern (for example: Florida, Georgia)

iii. Yes, in the US Western (for example: California, Texas)

iv. Yes, in US Central

v. Yes, in Latin America (for example: Dominican Republic, Mexico)

vi. Yes, in Europe

vii. Yes, in other part of the World

viii. No

8- You would think the Internet is secure to make payments.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

9- You would consider a method of payment such as electronic cash that provides anonymity, privacy, and security for Internet purchases.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

10- You would accept electronic cash as payment from a potential buyer, if you have the chance to sell your used printer over the Internet. Assume the potential buyer is from another country. Also, assume that the electronic cash service that the bank provides takes care of the currency exchange conversions, if necessary.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

11- If you have the chance of buying a slightly used digital camera that you have always wanted at a reasonable price over the Internet, you would consider paying with electronic cash, if accepted by the seller. Assume the potential seller is from another country. Assume that the electronic cash service that the bank provides takes care of the currency exchange conversions, if necessary.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

12- If you find a Web site that offers your favorite music that you could listen to while working on the computer for a reasonable fee, you would pay with electronic cash, if accepted.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

13- You would use electronic cash to pay for a pay-per-view movie on your interactive TV.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

14- You would use electronic cash to pay for downloading a peer-reviewed paper (relevant information) that has a topic that you are investigating.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

15- You would use electronic cash to pay for adding more minutes to your mobile phone, if available in the mobile phone company that you are subscribed to.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

16- You would use electronic cash, instead of regular coins, to pay for calling in a public phone, if available in your neighborhood.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

17- You would use electronic cash, instead of regular cash, to pay for public transportation, if available in your neighborhood.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

18- You would use electronic cash, instead of regular coins, to pay for the copier machine at your library, if the copier machines provides for that kind of payment.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

APPENDIX B - *Continued*

19- You would use electronic cash, instead of regular coins, to pay for your favorite drink at the vending machine, if the vending machine provides for that kind of payment.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

20- You would use electronic cash, instead of regular coins, to pay for the public washing machine, if that machine accepts that kind of payment.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

21- You would use electronic cash, instead of regular cash, to pay for food at the campus cafeteria, if it is accepted.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

22- You would use electronic cash, instead of regular cash, to pay for tolls on the highway, if it is accepted.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

23- You would use electronic cash, instead of regular cash, to pay for the daily newspaper, if it is accepted.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

24- You would use electronic cash, instead of regular cash, to pay for parking at a parking lot.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

25- If you compare electronic cash with a debit card, you think that electronic cash is more practical since the debit card does not offer the anonymity and privacy that electronic cash provides?

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

26- If you compare electronic cash with regular cash, which includes bills and coins, electronic cash is easier to manage since in one card you can keep as much as you would like without the heaviness of carrying bills and coins in your wallet.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

27- Electronic cash is as risky as regular cash since if you lose it, you would lose whatever is saved inside its memory chip. You are willing to use it as a way of payment despite this reality.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

28- You think that merchants (owners of copier machines, vending machines, and the like) will incur the expense of installing electronic cash processing machinery as long as students agree to pay with it.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

29- You think that monetary incentives could help to bring electronic cash to be accepted by people.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

30- You think that marketing of the electronic cash product is a main concern to bring it to be accepted by people.

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

The end. Thank you very much.

Reference: Bernkope, M. (1996). Electronic cash and monetary policy. *First Monday*, *1*(1).

APPENDIX C

Survey in Spanish

APPENDIX C

Encuesta: Actitudes de los/as estudiantes con respecto a electronic cash

Instrucciones: Seleccione la respuesta que más se acerque a sus creencias. Observe que la escala va de completamente en desacuerdo a completamente de acuerdo. Por favor, recuerde llenar la hoja de respuestas.

Electronic Cash

El "electronic cash", abreviación de dinero electrónico, como lo define Bernkope (1996) es el reemplazo digital de notas bancarias y monedas. Además, el electronic cash es una alternativa de pago que ofrece anonimato y privacidad, tal como lo hace el efectivo, para transacciones de compra en Internet o fuera de Internet (mundo real). De acuerdo con el diccionario Webster, *anonimato* significa sin nombre y *privacidad* significa sabido por sólo los participantes. El electronic cash no es como la tarjeta de débito o de crédito, en la cual las transacciones de negocio son compartidas con otras entidades para fines de mercadeo y publicidad. El electronic cash puede ser usado para hacer pago en Internet y en el mundo real. Normalmente, el electronic cash se almacena en una tarjeta llamada "smart card" o tarjeta inteligente. La tarjeta inteligente es de plástico como cualquier otra tarjeta. La diferencia es que ésta, además de tener cinta magnética, también tiene un circuito de memoria o "memory chip". En el circuito de memoria es donde precisamente se guarda el electronic cash. Esta memoria tiene un programa "software" que maneja el uso del electronic cash. A medida que el electronic cash es usado, el programa instalado en la memoria reduce la cantidad de acuerdo a lo gastado en cada compra. Es importante que existan terminales cercanos a los/as usuarios/as para poder facilmente cargar y recargar más dinero de tipo electronic cash en la tarjeta inteligente. La tarjeta inteligente

debe ser leída por un aparato especial que muchas veces es portátil. Note que el dinero electronic cash guardado en la tarjeta inteligente se puede volver a convertir en efectivo, si así su usuario/a lo desea, en todo banco que ofrezca ese servicio. El electronic cash ha sido utilizado en Estados Unidos (Olimpiadas 1996 en Atlanta), Australia, Inglaterra, Bélgica, Holanda, Findandia, Canadá y otros países. Asume que tienes acceso y uso al electronic cash desde un banco cercano (que esté dentro de la misma Universidad).

1- Edad:

a) 18-21 b) 22-25 c) 26-33 d) 34-45 e) más de 45

2- Género:

a) Masculino b) Femenino

3- Educación:

a) primer año b) segundo año c) tercer año d) cuarto año o más

4- Área de concentración de estudios: (Si estas estudiando dos áreas de concentración, por favor, sólo escoje una).

a) contabilidad b) mercadeo c) finanzas d) sistemas de información

e) recursos humanos f) otro _____

5- Programa de estudios:

a) programa diurno b) programa nocturno y sabatino

c) participa en ambos programas de estudios

APPENDIX C - *Continued*

6- Usted trabaja:

a) Sí, a tiempo completo (40 horas semanales o más)

b) Sí, a tiempo parcial (menos de 40 horas semanales)

c) no trabajo en la actualidad

7- Has vivido fuera de Puerto Rico por más de seis meses?

a. Sí, en el área Noreste de Estados Unidos (por ejemplo: Nueva York, Nueva Jersey, Connecticut)

b. Sí, en el área Sureste de Estados Unidos (por ejemplo: Florida, Georgia)

c. Sí, en el área Oeste de Estados Unidos (por ejemplo: California, Texas)

d. Sí, en el área Centro de Estados Unidos

e. Sí, en Latinoamérica (por ejemplo: República Dominicana, Mexico)

f. Sí, en Europa

g. Sí, en otra parte del mundo

h. No

8- Pienso que Internet es seguro para efecturar pagos.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

9- Considerarías a electronic cash como un método conveniente de pago, ya que provee anonimato, privacidad y seguridad para hacer compras en Internet.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

APPENDIX C - *Continued*

10- Considerarías aceptar electronic cash como pago si alguien te comprara tu impresora usada a través de Internet. Asume que quien te comprará es de otro país y que el banco asume el cambio de moneda de ser necesario.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

11- Considerarías utilizar electronic cash como método de pago al comprar un artículo usado en Internet. Asume que el/la vendedor/a acepta electronic cash como opción de pago y que es de otro país. También asume que el servicio de electronic cash del banco se encarga de hacer los cambios apropiados de moneda, si así es necesario.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

12- Asume que encuentras un lugar en Internet que, a un precio razonable, ofrece tu música favorita que escuchas mientras trabajas en la computadora. Estarías dispuesto/a a pagar con electronic cash para escucharla, si éste es aceptado como método de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

13- Considerarías pagar con electronic cash una película de "pay-per-view" a través del televisor interactivo. Asume que electronic cash es aceptado como método de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

14- Considerarías pagar con electronic cash para obtener ("download") un documento importante acerca del tema que estás investigando para un proyecto especial. Asume que electronic cash es aceptado como método de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

15- Considerarías pagar con electronic cash minutos adicionales a un teléfono celular, si es aceptado como modo de pago en la compañía de celular a la que estás suscrito/a.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

16- Usarías electronic cash, en vez de efectivo, para pagar una llamada telefónica de un teléfono público, si este servicio estuviera disponible donde vives.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

17- Usarías electronic cash, en vez de efectivo, para pagar por transportación pública, si este servicio estuviera disponible donde vives.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

18- Usarías electronic cash, en vez de efectivo, para pagar por foto-copias, si la máquina de la biblioteca de la Universidad así lo permitiera.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

19- Usarías electronic cash, en vez de efectivo, para pagar por tu refresco favorito en la máquina de refrescos de la Universidad, si la misma lo aceptara como alternativa de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

20- Usarías electronic cash, en vez de efectivo, para pagar por el lavado o secado de tu ropa en una lavandería pública "laundromat", si así este servicio estuviera disponible.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

21- Usarías electronic cash, en vez de efectivo, para pagar por el almuerzo, si la cafetería de la Universidad lo ofreciera como opción.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

22- Usarías electronic cash, en vez de efectivo, para pagar por el peaje en el expreso, si el mismo fuera aceptado como método de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

23- Usarías electronic cash, en vez de efectivo, para pagar el periódico, si fuera aceptado como método de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

24- Usarías electronic cash, en vez de efectivo, para pagar por el estacionamiento del auto, si este fuera aceptado como modo de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

25- Si comparo el electronic cash con la tarjeta de débito, podría preferir el electronic cash debido a que la tarjeta de débito no ofrece anonimato ni privacidad a la hora de efectuar pagos.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

26- Si comparo el electronic cash con el efectivo, que incluye billetes y monedas, podría pensar que el electronic cash es más fácil de manejar y transportar debido a que éste está contenido en una sola tarjeta delgada de tamaño accesible.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

27- El electronic cash es tan arriesgado de llevar en la cartera como el efectivo debido a que si lo pierdes, no hay forma fácil de recuperarlo. Estarías dispuesto/a a utilizar electronic cash, considerando esta premisa.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

APPENDIX C - *Continued*

28- Crees que el comercio invertiría en maquinaria para procesar el pago de electronic cash si tuvieran la seguridad de que el estudiantado estaría dispuesto a utilizarlo como modo de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

29- Crees pensar que los incentivos monetarios ayudarían a que la gente acepte el electronic cash como modo de pago. Los incentivos monetarios podrían ser, por ejemplo, que por cada dólar de electronic cash gastado, se gane una peseta para el próximo pago con electronic cash.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

30- Crees pensar que una buena campaña de mercadeo motivaría al público a considerar electronic cash como modo de pago.

a) totalmente en desacuerdo b) desacuerdo c) neutral d) de acuerdo e) totalmente de acuerdo

Fin. Gracias sinceramente.

Referencia:

Bernkope, M. (1996). Electronic cash and monetary policy. *First Monday, 1*(1).

APPENDIX D

Survey Cover Letter

APPENDIX D

March 3, 2004

Dear student:

The purpose of this research is to examine the attitudes of students towards electronic cash. By completing and turning in this survey, you are giving your consent for the researcher to include your responses in her data analysis.

Your participation in this research is strictly voluntary. You may refuse to participate at all, or choose to stop your participation at any point in the research, without fear of penalty or any negative consequences of any kind.

If you decide to participate, each individual response will be treated confidentially, and all raw data will be kept in a secured file by the researcher. Results of the research will be reported as aggregate summary data only, and no individually identifiable information will be presented.

You also have the right to review the results of the research if you wish to do so. A copy of the results can be obtained by contacting the researcher at: Rosarito@centennialpr.net.

If you participate in this research, you will be asked to select the answer that best suits your beliefs. Your participation will take approximately 30 minutes. Thank you for your cooperation and the very best wishes to all.

Sincerely,

Prof. Rosarito Sánchez

APPENDIX E

List of the Dependent and Independent Variables

APPENDIX E

List of the dependent (DV) and independent variables (IV s)

Dependent Variable:

- Electronic cash accepted by merchants as long as students accepted it

Independent Variables:

- Demographics
    - 1- Age (covariance)
    - 2- Gender (covariance)
    - 3- Education (covariance)
    - 4- Major (covariance)
    - 5- Program of study (covariance)
    - 6- Working (covariance)
    - 7- Experience living outside Puerto Rico (covariance)
- 8- Security consideration for Internet payment
- 9- Consideration of electronic cash as a convenient way of payment since it provides anonymity, privacy, and security
- 10- Willingness to accept electronic cash as payment method if the student were to sell something
- 11- Willingness to pay with electronic cash if the student were to buy something
- 12- Electronic cash payment for music
- 13- Electronic cash payment for pay-per-view
- 14- Electronic cash payment for a peer-review paper

APPENDIX E - *Continued*

- 15- Electronic cash payment for adding more minutes to a mobile phone
- 16- Electronic cash payment for public phone call
- 17- Electronic cash payment for public transportation
- 18- Electronic cash payment for copier machine
- 19- Electronic cash payment for a refreshment from vending machine
- 20- 'Electronic cash payment for public washer and dryer
- 21- Electronic cash payment for food at campus cafeteria
- 22- Electronic cash payment for tolls on the highway
- 23- Electronic cash payment for daily news
- 24- Electronic cash payment for parking
- 25- Electronic cash payment more practical than debit card in terms of anonymity and privacy
- 26- Electronic cash payment more practical than bills and coins since those are heavy to carry
- 27- Willingness to carry electronic cash even if it can be lost just as regular cash
- 29- Electronic cash accepted because of monetary incentives
- 30- Electronic cash accepted due to marketing and publicity