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**SMART CARD TECHNOLOGY  
AND ITS PERSPECTIVE IN HONG KONG**

by

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MBA PROJECT REPORT

Presented to

The Graduate School

In Partial Fulfilment

of the Requirements for the Degree of  
MASTER OF BUSINESS ADMINISTRATION

THREE-YEAR MBA PROGRAMME  
THE CHINESE UNIVERSITY OF HONG KONG

May 1997



**APPROVAL**

Name: Yu Wai-Yip

Degree: Master of Business Administration

Title of Project: Smart Card Technology and its Perspective  
in Hong Kong

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Date Approved: 9/5/97



## TABLE OF CONTENTS

<b>TABLE OF CONTENTS</b> .....	i
<b>LIST OF EXHIBITS</b> .....	iii
 <b>Chapter</b>	
<b>I. INTRODUCTION</b> .....	1
<b>Project Objectives</b> .....	3
<b>Methodology</b> .....	3
<b>II. WHAT IS SMART CARD</b> .....	5
<b>A Brief History of Smart Card</b> .....	5
<b>Classifications of Smart Card</b> .....	7
Categorization by Security Level	
Contact Vs Contactless	
<b>III. EVOLUTION OF SMART CARD MARKETS</b> .....	11
<b>Smart Card Versus Magnetic Stripe Card</b> .....	11
<b>Possible Applications</b> .....	13
Payment Applications	
Transportation Applications	
Healthcare Applications	
Telecommunications Applications	
<b>Global Market Trend</b> .....	22
<b>IV. SMART CARD APPLICATIONS IN HONG KONG</b> .....	25
<b>Transportation Applications</b> .....	27
<b>Healthcare Applications</b> .....	28
<b>Payment Applications</b> .....	30
Mondex Card and Visa Cash Card	
Hong Kong Jockey Club Smart Card	
<b>Identification Applications</b> .....	32

<b>V. ANALYSIS OF THE HONG KONG SMART CARD MARKET</b> .....	33
<b>Smart Card as An Individual Product</b> .....	34
<b>Smart Card as a Form of Monetary Exchange</b> .....	34
<b>Smart Card as a System</b> .....	36
Technological Environment	
Political-legal Environment	
Competitive Environment	
Economic Environment	
Socio-cultural Environment	
<b>Perspertive of All-in-one Smart Card in Hong Kong</b> .....	43
<b>VI SUMMARY AND CONCLUSIONS</b> .....	47
<b>Summary</b> .....	47
<b>Conclusions</b> .....	48
<b>BIBLIOGRAPHY</b> .....	51

**LIST OF EXHIBITS**

- EXHIBIT 1** Classification of Smart Card in Terms of Level of Technology and Security
- EXHIBIT 2** A Comparison of Contact and Contactless Smart Card - Connecting Method and Operating Distance
- EXHIBIT 3** Advantages and Disadvantages of Contactless Smart Card
- EXHIBIT 4** A Comparison of Smart Card and Magnetic Stripe Card
- EXHIBIT 5** General Categorization of Smart Card Applications.
- EXHIBIT 6** General Applications of Smart Card
- EXHIBIT 7** Benefits of Using Smart Card in Public Transport Systems
- EXHIBIT 8** Worldwide Smart Card Market Forecast
- EXHIBIT 9** Forecast of Average Annual Growth (%) of Worldwide Smart Card Market (from 1994 to 2000) by Gemplus
- EXHIBIT 10** A Comparison of Different Smart Card Applications in Hong Kong
- EXHIBIT 11** Implementation of the Patient Card System of the Hospital Authority

## CHAPTER I

### INTRODUCTION

In the opening address to the International Conference on Smart Cards,<sup>1</sup> Mr. Joseph C. K. Yam<sup>2</sup> pointed out that technological innovation is rapidly changing our lifestyle, and that the arrival of the smart card promises another major breakthrough that will revolutionize the way we conduct daily life. On the same occasion, Prof. Mei-yue Wang<sup>3</sup> described smart card even as a Treasure of the Century that can bring benefits to human welfare and society, and contribute much to the world's economic development, peace and progress of human beings. If these claims were not just courtesy puff, then what is the charisma behind smart card that induced these leading figures in Hong Kong to make such commendations?

When we look back in time, money is undoubtedly one of the greatest innovations in the human history. As a medium of exchange, it altered the method of transactions, facilitated the efficient allocation and use of resources, thereby laying the foundation of social and economic progress. The emergence of symbols, pictures and languages, as media of information exchange, further promoted the social and economic development. Nowadays, these basic media of exchange still retain their functions, but more and more convenient and efficient vehicles for the exchange are gradually evolving: from bank

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<sup>1</sup> International Conference on Smart Cards, organized by the Hong Kong Productivity Council in Hong Kong, 29 - 31 May 1995.

<sup>2</sup> Mr. Joseph Yam, JP, the Chief Executive of the Hong Kong Monetary Authority.

<sup>3</sup> Prof. Mei-yue Wang, the Chairman and President of the China Aerospace International Holdings.



deposits, credit cards to electronic fund transfer, and from telephones, televisions to internet, e-mail and teleconferencing.

Although the marriage of telecommunications and computing is giving birth a lot of innovations in information technology which can bring us convenience and efficiency, at the same time people have to face and process more and more information everyday. As Mr. Michael Porter<sup>4</sup> said, "the information revolution is sweeping through our economy." To cope with the growth, technology innovations must go for higher capacity and more intelligence. Not just that, people now know more, and are very conscious about the need for reliability and security.

Technological developments are rarely product of chance. Smart card, which is at the conjunction of three different technics: microelectronics, data processing and cryptography, emerges as a candidate that can align with the required technology innovation dimensions. Bearing the traits of its time, the technological knowledge and the social and economic circumstances surrounding its birth, smart card revolution appears to be an irresistible move.

Smart cards are already in wide spread use in Europe, North America, Japan and Singapore, but how is it getting on in Hong Kong? In fact, the first smart card that operated in Hong Kong was a GSM phone SIM card, brought about by the introduction of the GSM mobile phone network in early 1994. Since then, some forward-thinking operators, such as the Hong Kong Telecom, started to join the market. In 1996, there was about 10 smart card

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<sup>4</sup> Prof. Michael E. Porter. "How Information Gives You Competitive Advantage." *Harvard Business Review* (July - August 1985): 149 - 160.

projects under pilot trial in Hong Kong, and hopefully these will get in full swing in 1997 or 1998.

### Project Objectives

Smart card applications proliferate both worldwide and in Hong Kong. The technology is also said to be an innovation that can affect the social and economic growth of our society. Thus, in view of its significance, the prime objective of this project is to explore the perspective of the Hong Kong smart card market. Moreover, as the market is new to us, one must first know, as a prerequisite, what smart card is, and understand what and how its uses can contribute to the society, before one can fully appreciate how the external environment can affect its future. It is because of this rationale that the prerequisite should form the secondary objective of this project.

### Methodology

The Hong Kong smart card market did not seem to have got its momentum until recently. There were a number of factors that had contributed to the late start, and the learning of these factors is important not just for historical sake but also for understanding their effects on the market's future development.

Smart card is very special in nature in that it can be a kind of product itself (as a piece of card), but can also be a system for a particular application, or when used for payment purposes, it can be a form of monetary exchange. The multiple nature of smart card has made an one-pass analysis difficult. A possible alternative is to conduct an isolated analysis on each of its different roles, with more emphasis put on its most important role as a system.

The detailed analysis examines the five forces that make up the external environment of the market, and uses environmental scanning to identify and interpret potential trends. The goal is to determine whether these trends represent opportunities or threats to the industry. The formation of opinions is based on logical judgements supported by facts and proven data.

This report comprises two main parts. The first part presents details of the smart card concept, including its technical features, characteristics, and some of its major possible applications. The second part gives a brief account of its current applications in Hong Kong, followed by an environmental scanning of the local market conditions. The report then concludes its findings and forms an opinion on the perspective of the smart market.



## CHAPTER II

### WHAT IS SMART CARD

A smart card is a credit card sized plastic card with a special type of integrated circuit (IC) embedded. The integrated circuit may simply contain memory, some hardwired logic or a microprocessor, and holds information in electronic form that can be easily, accurately and securely accessed by various sorts of electronic data processing equipment. In fact, it is the type of information held, and the way this information is controlled and used, that gives rise to an almost infinite variety of smart card uses.

#### A Brief History of Smart Card

The idea of implementing microelectronics devices in a plastic card can be traced back to 1970 when a Japanese inventor, Kunitake Arimura, filed his first patent concerning “a plastic card incorporating one or more integrated circuit chips for the generation of distinguishing signals.” However, the patent focused mainly on the concept of microcircuit embedding rather than the possible functional features of the new card. The idea did not receive too much public interest until 1974 when Roland Moreno, a French journalist, re-addressed the issue and filed a patent on “an independent electronic object with memory.” In this patent, the functional aspects of a plastic card with embedded microelectronics were paid more attention.



Before 1974, almost all card transactions were based on passive data carriers, such as magnetic stripe cards. These passive carriers were unable to process the information stored in them or to forbid any ad hoc reader to read, alter or copy their information. For these reasons, such electronic transaction systems were subject to a high fraud rate. In his patent, Moreno attempted to tackle the problem by reshaping the architecture of data transfer between the two categories of people, the bearers of data carriers<sup>5</sup> and the users of reading terminals<sup>6</sup>, by securing the former and rendering relatively common the latter. The shift of the security requirement to the data carriers implied the need to process information and compute cryptographic algorithms inside them. Moreno suggested accomplishing this by sealing an integrated circuit chip into a plastic card of the size of a name card, and the security of the card was then based on the capacity of the electronic microcircuits to protect the content of the memories against attempts of alteration or counterfeiting.

The very first IC card<sup>7</sup> was fully operational on 21 March 1979. Although the card was far from the edge for commercial production, it had proved the feasibility and convinced potential decision-makers of using the emerging technology. It also played a prominent part in the initialization of applications and in the development of various elements in systems using IC cards. The first publicly used IC card<sup>8</sup> appeared in France in 1983, and was a prepaid memory card for pay phones. Since then, important progress has been achieved. In twenty years, and through the integration of the most advanced semiconductor and microcomputer technology, the IC card has developed into the smart card, which has now become a generic term used to describe any type of credit card sized piece of plastic with an embedded IC microchip.

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<sup>5</sup> Moreno called them "the Portable Objects" in his patent.

<sup>6</sup> Moreno called them "the Transfer Devices" in his patent.

<sup>7</sup> The smart card was jointly developed by CII-Honeywell-Bull and Motorola, and included two chips: a 2716 EPROM memory and an 8-bit 3870 microcomputer.

<sup>8</sup> The memory card was manufactured by Schlumberger.

### Classifications of Smart Card

Smart cards may be classified in different ways based on different criteria. In terms of the level and type of technology used<sup>9</sup>, they may be classified as memory cards, microprocessor cards or optical cards<sup>10</sup>. The memory cards can be further categorized, in terms of security, into free-access cards, protected cards or authenticated cards. Another common criterion for classifying smart cards is by the way of data transfer they adopt. In terms of this, smart cards can be divided into contact type or contactless type.

#### Categorization by Security Level

Security is the cornerstone of any transaction system, and it was the need for security that gave rise to the birth of the smart card idea. While a smart card can be categorized into a memory card or a microprocessor card, it can be further categorized according to the level of security required. The simplest memory cards, such as the phone cards, offer no protection in case of loss. Other memory cards may allow only the right person to access the stored information by incorporating a password. The checking is done by internal hard-wired logic, which can also perform some simple application-specific processing functions. More sophisticated or programmable applications will call for microprocessor cards. In some extreme cases that require very strict security control, a microprocessor card with an added crypto-processor will be required.

Exhibit 1 gives the basic classification of smart cards in terms of level of technology and security required, and suggests for each category the usual applications.

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<sup>9</sup>

Most smart card manufacturers, e.g. Gemplus or Schlumberger, adopt this classification method.

<sup>10</sup>

Some manufacturers, e.g. Mikron, consider only the microprocessor cards as smart cards, though they produce also the other types. For the purpose of this report, all three types of cards are considered as smart cards.



## EXHIBIT 1

## Classification of Smart Card in Terms of Level of Technology and Security

Main Category	Sub-category	Description	Applications
Memory Cards	Free Access	Provide straight-forward, non-volatile, read-only or re-writable memory with no identification or access control mechanism.	For applications that require a portable data carrier in which data security is not a critical issue, e.g. portable data files, electronic marketing.
	Protected	Provide simple memory protection against unauthorized access or alteration through the use of passwords or simple data encryption techniques.	Good for use as prepaid token cards such as phone cards, movie cards, and parking cards.
	Authenticated	With built-in authentication programme to authenticate themselves when challenged by the host terminal (card authentication).	Usually used for low-value disposable <sup>11</sup> applications.
Microprocessor Cards	Regular	With a microprocessor working on a card operating system (COS) to perform a wide range of advanced applications. Sensitive data is protected by security key(s) and multi-stage encryption algorithms <sup>12</sup> .	Dedicated to applications requiring highly secure information management and processing such as banking (e.g. payment cards) and logical access control (e.g. computer security).
	Crypto-processor	With built-in crypto-processor to perform highly sophisticated cryptographic computations, e.g. in verifying biometrics or geometric features such as voice recognition, retina scanning or finger prints.	For identification in very strict access control applications, such as building access or personal identification cards.

<sup>11</sup> The cards are rechargeable but are deliberately made non-rechargeable because the manufacturers still do not have the confidence in making them re-chargeable in payment applications.

<sup>12</sup> Typically the Data Encryption Standard (DES, FIPS PUB 46-1, US) is used for bulk data encryption and the RSA (Rivest, Shamir, Adleman) encryption scheme (RSA Data Security, PKCS#1) is used for key protection.

### Contact Vs Contactless

Smart cards can also be categorized either as the contact type or the contactless type according to the method of information access. The contact type has a metal contact pad with eight contact points on the surface to interface, through direct contacts, with the reader/writer. The contactless type relies on radio frequency (RF) coupling mechanism, and the card communications with the read/write unit via electromagnetic (EM) wave. The embedded IC chip may either be powered by an internal battery (active smart card) or by external power transmitted via RF field (passive smart card). International Standards Organizations (ISO) has set up international standards for IC card applications. The ISO-7816 describes the specifications of IC cards with contacts, and the ISO-10536 describes the specifications of contactless IC cards. Exhibit 2 summarizes the connecting method and operating distance of the two types of smart cards.

#### EXHIBIT 2

##### A Comparison of Contact and Contactless Smart Card - Connecting Method and Operating Distance

Interface	Connecting method	Operating Distance
Contact	Contact	Slot operation
Contactless	Close Coupling	Slot or surface operation
	Remote coupling <sup>13</sup> : 1. proximity 2. hands-free	10 cm (4 inches) 100 cm (40 inches)

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<sup>13</sup>

Source: Mikron, Austria.

Currently, the majority of the smart card market are contact cards markets, especially for those phone and electronic purse applications. On the other hand, contactless smart cards are found widely used in transportation or in building security systems. Out of the two kinds of contactless smart card, the passive one is more dominant as it is more convenient, reliable and robust. Exhibit 3 highlights the major advantages and disadvantages of the contactless smart cards against the contact ones.

### EXHIBIT 3

#### Advantages and Disadvantages of Contactless Smart Card

Advantages	Disadvantages
<p><u>Convenience</u> A contactless smart card can be used in any orientation on or about the read/write unit. It is easier and faster to use than a contact smart card, which can only operate in the correct position in the slot.</p> <p><u>Reliability</u> A contactless interface makes a contactless card more reliable than cards with surface contacts, which are more susceptible to damage, contamination and wear and tear.</p> <p><u>Maintenance</u> The read/write units have no moving mechanical parts and hence require much less maintenance.</p> <p><u>Vandalism</u> In most cases the read/write units have no slots, which may invite vandalism.</p> <p><u>Robustness</u> The read/write units can work in more harsh environments as they can be made in fully-sealed electronic units.</p>	<p><u>Complexity</u> Contactless smart card systems usually require longer time to develop, and are more expensive to build.</p> <p><u>Durability</u> Contactless smart cards may be failed by strong flexing as they consist of a number of linked components rather than a single chip.</p> <p><u>Embossing</u> There are problems in embossing some types of contactless card since embossing may damage some of the components.</p> <p><u>Security</u> Less secure as a result of the higher possibility of coupling a listening device at the card/reader air interface.</p>



## CHAPTER III

### EVOLUTION OF SMART CARD MARKETS

The fast development of telecommunications and computing since early 1970's has been giving birth many new products and services that have revolutionized our style of living, e.g. electronic fund transfer (EFT), and magnetic stripe card has been widely used as a low-cost but secure means<sup>14</sup> for data storage and identification (hence authorization) purposes. Nowadays, the magnetic stripe card is still the most commonly used individual data card in the market - most people have a number of magnetic stripe cards for different purposes, such as pay phone cards, Mass Transit Railway (MTR) stored value tickets and credit cards. However, as technology progresses, manipulating data on magnetic stripe cards has also become much easier, as the explosion in fake-value transit and telephone cards showed. This has forced a rethinking of security systems, in which smart card has emerged as a key to the final solution.

#### Smart Card Versus Magnetic Stripe Card

Although, nowadays, the magnetic stripe card is still the most commonly used individual data card, there are quite a number of intrinsic problems that have limited their versatility and further development - security, reliability, storage capacity and processing capability. Smart card have merits over magnetic stripe cards in all these areas, and provides

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<sup>14</sup> When magnetic strip cards were first introduced, the technology required to make fake copies was complex and prohibitively expensive.

virtually unlimited possibilities of further applications. In this sense, smart card is not just replacing magnetic stripe card, but also augmenting and extending its functions. Exhibit 4 gives a comparison of smart card with magnetic stripe card in terms of the four above-mentioned dimensions.

#### EXHIBIT 4

##### A Comparison of Smart Card and Magnetic Stripe Card

Dimension	Magnetic Stripe Card	Smart Card
Reliability	Data records can be easily corrupted by external magnetic field. Cards are also susceptible to mechanical damages during card reading.	The high reliability of smart card systems will mean higher customer satisfaction and less long term system replacement, maintenance and running costs.
Security	Data records can be easily accessed, altered and copied. Anti-fraudulence devices, such as printing of cardholder's photo on card surface, will add to the cost of the card.	Different levels of security possible for different applications. Its high security in payment applications will reduce chances of fraudulence and hence lower losses.
Storage Capacity	The static and limited data storage have made the relationship between card issuer and customers very one-dimensional. That means it is very easy for a customer to switch from one card to another and enjoy the same basic level of service.	The huge storage capacity is particularly suitable for recording the numerous individual data records. The increased functionality enable issuing institutions to have a multi-dimensional relationship with card holders.
Processing Capability	The lack of processing capability necessitates the connection with the central computer to check the card account status. This process works millions of times a day, creating large phone bills for organizations issuing the cards. Many of these transactions are small enough in value where phone calls would not be necessary if the right technology were in place.	The card does not require a communications network from which to operate. Its multi-purpose functionality will attract more customers and more operators to join the market, further pulling down the cost of operation.

The idea of smart card emerged in 1974, but the first public use memory card<sup>15</sup> did not appear until 1983, and the first microprocessor card<sup>16</sup> not until 1986, only after advances in technology had pulled down the card manufacturing cost to an economic level<sup>17</sup>, and the operators had built up sufficient confidence on the new technology after several successful public trials<sup>18</sup>.

The smart card technology then underwent continuous development. Its storage capacity has increased rapidly with the development in semiconductor technology. The application of microcomputer techniques has also extended its functionality, and many functions that previously could only be performed by main-frame computers, such as high speed encryption, data compression technology, etc., have become standard functions now. Concurrently with the expansion in the scope of application and the increase in number, the price of smart card has been lowered significantly, and the cost of an entire smart card system, for certain applications, can now be less than that of a traditional magnetic stripe card system.

### Possible Applications

Smart card can perform all the functions of magnetic stripe card, and its higher reliability has made it a even better alternative. Its high security, large storage capacity and processing capability also characterize itself for further applications that were once impossible. Nowadays, smart card has already been deployed in a wide variety of projects across many industries. Most applications rely on its large storage capacity (as data carrier) or its high security (for identification), but its even wider application in financial transactions

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<sup>15</sup> "Telecarte", a prepaid card for telephone, issued in France by the General Telecommunication Agency (D.G.T.).

<sup>16</sup> "GIE Carte Bancaire", a payment card jointly issued by banks in France.

<sup>17</sup> After having considered the reduced system maintenance and running costs as well as reduce losses in frauds.

<sup>18</sup> The IPSO experiment from 1982 to 1984 in three different cities in France - Blois, Lyon and Caen - with 125,000 cards and 750 terminals.



has been the synergy of all these attributes as well as its processing capability - smart card can do things for itself without needing to be connected to a central computer at the end of a phone line, and can protect itself against unauthorized intrusion by the inscription of sensitive information, giving the card the anonymous nature of money while maintaining the required security. Exhibit 5 gives the general categorization of smart card applications.

### **EXHIBIT 5**

#### **General Categorization of Smart Card Applications.**

<b>Category</b>	<b>General Applications</b>
Data carrier	used as a convenient, portable and secure means of storing information.
Identification	provides a secure means of identifying the holder so as to allow access to premises or computer systems, etc..
Financial	used in monetary transactions as a replacement for cheques and cash.

Smart card can change its functions by running different programmes, and the functions can be so expanded with only the boundary of imagination as the limit. Therefore, some types of smart card may fit into more than one of the above categories, or may not be restricted to any single application. In fact, different services offered by different providers can share the same card by using independent access control and security features. Exhibit 6 give some common uses of smart card today:-

**EXHIBIT 6****General Applications of Smart Card**

<b>Main Category</b>	<b>Sub-category</b>	<b>Examples</b>
Identification	Protection of Items	Computer Terminals
		Software
		Corporate Cash Management
		Sealed Order
		Weapon Firing Authority
		Control Desks
	Physical Access	Secure Sites
		Sports Stadiums
		Hotel Facilities
		Holiday Complexes
		Car Parks
Financial	Non Pre-payment	Electronic Cash
		Electronic Cheque
		ATM Cash Vending
		Pension Payment
		Trading Stocks & Shares
		Social Security (Welfare) Payment
	Pre-payment	Pay Phone Card
		Public Transport Season Ticket
		Pay TV
		Food Vending
		Electricity/Gas Payments
Data Carrier	Item Data Storage	Car Maintenance Records
		Car Fleet Record Card
		Telephone Call Logger
		Parameter Loading Card
		Equipment Maintenance
		Inspection Records
	Personal Data Storage	Military Records
		Student Records
		General Medical Records
		Driving License
		Electronic Note Pad
		Maternity Card

## Payment Applications

Smart card is currently considered as the only effective technology to fight against fraud and to provide value-added services for the cardholder and the retailer in the payment industry. Credit cards and debit cards are the two traditional payment card programmes, and smart card's on-board intelligence can be used in both these programmes to implement innovative security schemes to reduce fraud. Such schemes include card and terminal authentication, electronic signature, on-line resource management, selective or systematic Personal Identity Number (PIN) control, and balance control. In fact, these techniques have assisted in the emergence of a new type of payment card programme: the electronic purse.

Electronic purse is a stored value smart card, the value of which can be loaded at automatic teller machines (ATMs) or some specific loading points. It can be used for low-value purchases in shops and vending machines as a direct substitute for coins and bank notes, but is not intended for replacing credit or debit cards, which are usually used for higher value purchases<sup>19</sup>. Electronic purse offers various advantages to the issuers (the banks), the retailers and the customers. For the banks and the retailers, electronic purse can solve the problems associated with the use of cash, such as handling costs, security risks and counterfeit risks. The banks also earn interest on the float, which is the total of the balance in all the issued electronic purses. For the customers, the electronic purse is a secure, convenient, and fast method of payment.

Smart card is also an ideal technology for providing value-added services to retailers and cardholders. Loyalty programme, in the form of electronic coupon, is one kind of the value-added services that are often merged with payment applications. The electronic

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<sup>19</sup> According to VISA International, the normal minimum transaction size for credit card payments is US\$30 and that for debit card payments is US\$15. The electronic purse is targeted at transactions of size less than US\$10.



coupon function stores the bonus value awarded to a customer when he/she uses the card to purchase goods. Its major advantages over conventional loyalty programmes are:-

- Customer is rewarded instantly at the Point of Sales (POS).
- Instant customer information at Point of Sales is also possible since there is interactive data exchange, an ideal complement to database marketing.
- When many retailers joint together to provide bonus scheme of wide range of retail products, each partner gains market share from the combined customer base.
- Flexibility and upgradability for companies with similar interests setup to join loyalty schemes.

### Transportation Applications

The most important issue in public transportation, especially in industrialized nations, is to encourage people to use public transport as far as possible so as to ease traffic congestion. This is usually done in two ways. One is to offer more benefits and convenience to users of public transport, and another is to put more burden on regular car drivers, such as getting them pay for road usage or fund road maintenance and construction. The use of magnetic stripe cards in mass transits has once provided the desired convenience but the three- or four-second completion time in crossing the gate is now unable to cope with the ever increasing passenger flows. On the other hand, although the use of Electronic Road Pricing (ERP) systems does provide an effective mechanism for road demand management and collection of toll payments, it also arouses the public's concern on privacy. Smart card technology, however, promises a possible solution to these problems.

The factors which traditionally excluded the use of smart card technology from public transport systems were its high card cost and low transaction speed. The principal developments that enable smart card technology to compete against the magnetic medium

have been the rapid reduction in costs of the cards and the processing equipment<sup>20</sup> as well as the development of contactless (or proximity) operation. The costs per data bit now favours the smart card by at least a factor of ten<sup>21</sup>, and with the use of contactless smart card, inconvenience such as queues at gates caused by delayed slot operation or by ticket sales transaction, need for coins, complex price structure, etc. will become history.

Both users and service providers of public transports can benefit from smart card systems. The most obvious user benefit is the enhanced convenience in using them. For the service provider, smart card represents cost reduction, high system flexibility and better marketing information. On the cost side, it is estimated that 5 to 6 percent<sup>22</sup> of operating cost of public transport operation goes into cash handling, including lost due to theft, cheating, fraud and vandalism. Meanwhile, prepaid contactless smart card system will improve efficiency in coins/notes handling and is essentially fraud-proof. Maintenance cost can be greatly reduced due to the elimination of direct mechanical contact between the card and the point of sales processing equipment. The smart card system can also enhance flexibility of operation as it can easily accommodate specific requirement of or concessions offered by individual mode of operation. Service information as of where do passengers take on and off can be logged for planning appropriate strategies to enhance fleet management and further cost reduction through improved schedule. For traditional company like bus companies, it was almost impossible, or at least not justifiable, to secure such information if smart card technology is not employed. Exhibit 7 lists the benefits of using smart card in public transport systems.

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<sup>20</sup> According to Brian Chamber, General Manager of Creative Star Limited, silicon memory costs have declined over the last 10 years by between 30 to 50 % per annum, while in comparison the plastic magnetic card costs have remained static.

<sup>21</sup> Such comparisons are only relevant if the application can productively use the increased data capacity, e.g. in multi-function or multi-service applications.

<sup>22</sup> Data source: AES Prodata, Australia.



## EXHIBIT 7

### Benefits of Using Smart Card in Public Transport Systems

	Benefits
Users	<p>More convenience and shorter travelling time contributed by:-</p> <ul style="list-style-type: none"> <li>• no need to care about fare structures.</li> <li>• no need for coins.</li> <li>• avoiding waiting times and delays in ticket sales transactions.</li> <li>• no more queues at gates caused by inconvenient slot operation.</li> <li>• easy card handling by presenting the card without having to remove it from the wallet.</li> </ul> <p>Using the same card for a lot of other applications other than public transport.</p>
Service Providers	<p>Benefit from every features that increases the convenience of customers.</p> <p>Reduced cost due to:</p> <ul style="list-style-type: none"> <li>• lower maintenance costs due to elimination of mechanical contacts.</li> <li>• high security that avoid cheating and fraud.</li> <li>• reduced cash handling for filling vending machines, selling tickets, counting coins, transferring cash to bank accounts, and the like.</li> <li>• minimizing cash in vending machines to prevent theft and vandalism.</li> </ul> <p>Programmable functions add flexibility to system operation.</p> <p>Provide system reporting that gives managers a sharper focus on how specific systems are being used and how they can be fine-tuned in various ways.</p>

When smart card is used in Electronic Road Pricing systems, all vehicles will be fitted with a smart card reader which accepts a stored value<sup>23</sup> smart card. Upon entering a pricing zone, the ERP system will automatically transact with the smart card reader using Radio Frequency (RF) communications to debit the appropriate value and log the transaction details onto the card (as a mean of proof). Since only the card owner is able to read the contents of the memory, it is impossible to create profiles of a driver's movements without

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<sup>23</sup>

Post-payment option is also available.

the driver's consent. When compared with tag-based solutions, smart card systems offer a lot of extra advantages such as multi-lane and high-speed operations<sup>24</sup> as well as flexible and secure payment methods.

### Healthcare Applications

In the healthcare industry, there has been a shifting from the previous focus of "institution-centred" care to a new focus of "patient-centred" care. Experience from western countries has demonstrated the possibility of increased "shared care" with the help of distributed processing. However, the growing informatization of the administration activities and of the care processes makes available a large quantity of patient's data, and demands for efficient information exchange networks among remote medical centres. In the absence of a global telematics infrastructure, health card results to be a physical support for data communications.

However, the traditional paper or even magnetic-stripe type health card offers limited storage capacity, and usually record only the patient's identity or demographics information. The use of smart card technology cuts right into the core of the problem, and provides a portable but highly secure and detailed patient-centred medical file in the hands of the patient. It not only provides patient identification that facilitates registration and information retrieval, but also supports life-long patient medical record for diagnosis, therapy and prognosis.

Smart health card also offers several added advantages. The most basic one is the improvement on quality of care and the standardization of medical documentation. It allows the medical information to travel together with the patient so that at every interaction with

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According to CTS Pacific Technology Limited, the current technology can support vehicle speed of up to 150km/h.

the medical centre, the information is updated or exchanged with other centres in need of particular examinations. The health card also carries the patient's vital information and allergies especially useful in emergency situations. It yields the health operators the data at the right moment in providing immediate and accurate information on previous treatments and test, which can eliminate unnecessary duplicative procedures. The health card also takes care of the data security and privacy, and can differentiate the (read and write) access rights of different type of persons (e.g. patient himself, doctor, reception nurse) to different data areas through PIN control or cryptographic systems.

### Telecommunications Applications

Telecommunications is a fast growing industry and very much technology driven with a healthy appetite for innovative applications. With the use of smart card, more new telecommunications products and services are possible, and may be via the use of the same card. Currently, smart card has been used individually as calling card, prepaid phone card and subscriber's SIM (Security Identity Module) card:-

*Prepaid telephone card.* The smart card is purchased with a number of pre-stored calling units, in the same way as existing telephone payment cards. The phone has a read/write unit which deducts the units as the phone call progresses. However, unlike a conventional phone card, the smart card can be recharged. The new phone card offers obvious advantages to the service providers. On one hand, smart cards are difficult to forged and can reduce losses due to fraud, and on the other hand card-operated pay phones contain no coins and can reduce theft and vandalism.

*GSM phone SIM card.* A GSM (Global System for Mobile Communication) subscriber is usually delivered with a smart card, which is the key to the whole system. The



smart card supports two key functions: secure access to a service and portability of data. When the user inserts his SIM card into any GSM mobile phone, the card runs an authentication algorithm to validate the user's identity. That telephone will also appear as his own personal phone in the sense that the bill will be sent to him afterwards, as the information about the GSM subscription is held in the smart card, not in the telephone. Personalization is also made possible because the SIM card supports storage of abbreviated dialing numbers and pre-defined short messages.

With the successful application of smart card in cellular phones, ample opportunities are expected for wider use of smart card in other areas of telecommunications, such as fixed networks, personal numbering<sup>25</sup> and number portability<sup>26</sup>. All of these developments point to the potential success of smart card in the telecommunication industry as the worldwide trend towards greater liberalization is both fueled by and fueling technological change.

#### Global Market Trend

Smart card technology was invented in the 1970s and developed in early 1980s. After a 20-year gestation, the technology is set to take off and is now growing to maturity and with sufficient momentum. Some 2 billion<sup>27</sup> smart cards for different usage have been sold world-wide and the market has grown to 420 million a year in 1994.

According to Gemplus' estimation in early 1995, the market was expected to enjoy an average annual growth rate of 30 percent throughout the end of this century, to hit a two-

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<sup>25</sup> Personal numbering allows one telephone number to be used to access a customer on whatever device the customer chooses. For example, to allow calls to be routed to a pager, cellular phone, fax, fixed telephone, electronic mail-box or any other device as instructed, say, in priority order or by some time of day sequencing.

<sup>26</sup> It is the ability for customers to retain their telephone numbers when moving location (geographic portability) or changing the telecommunication service provider to which they subscribe service (operator portability).

<sup>27</sup> Jolly Wong. "The All-in-one Smart Card: Opening a New Era to Information Technology." *Asia Engineer* (August 1995): 13-14.

billion world-wide annual sales by 2000. Gemplus revised their forecasts upwards in July 1995, just a few months after making their last estimate, putting forward the figure of 3.8 billion of smart cards<sup>28</sup> worldwide sales in the year 2000, representing a 44-percent yearly growth. This estimate is significantly higher than those made by other manufacturers: Philips and CP8 Transac suggested a figure of 2,000 millions and 1,830 millions<sup>29</sup> respectively for 2000, and Orga Kartensystems' forecasters put the figure at 1,812 million<sup>30</sup> cards in 1999. Exhibit 8 tables the sales forecasts estimated by various smart card manufacturers.

### EXHIBIT 8

#### Worldwide Smart Card Market Forecast

Applications	1994 (Actual)	1998 (Forecasts)	2000 (Forecasts)				Annual Growth (%)
	Gemplus	Philips	Philips	CP8	Gemplus		Gemplus 5/95 & 11/95
		11/95*	11/95*	11/95*	5/95*	11/95*	
Phone card	310	970	1334	900	1200	1400	25/29
GSM	9	47	61	50	60	50	28/33
Health	62	122	157	200	280	400	29/36
Bank & Loyalty	20	113	185	250	150	500	40/71
Pay - TV	10	62	110	50	20	100	12/47
Transportation	1	**	**	200	70	200	81/142
Identity	1	**	**	100	200	400	142/171
Gaming	1	**	**	**	10	500	47/182
Metering	2	**	**	**	20	50	47/50
Access Control	4	4	10	50	10	200	31/92
<b>TOTAL</b>	<b>420</b>	<b>1362</b>	<b>2000</b>	<b>1857</b>	<b>2000</b>	<b>3800</b>	<b>30/44</b>

Notes: (1) All figures represent annual sales volume in million cards.

(2) \* Publication dates of the estimates.

(3) \*\* no figure provided.

<sup>28</sup> "3.8 billions smart cards by the year 2000." *Smart Cards & Systems Newsletter* vol.2 no.12 p.1.

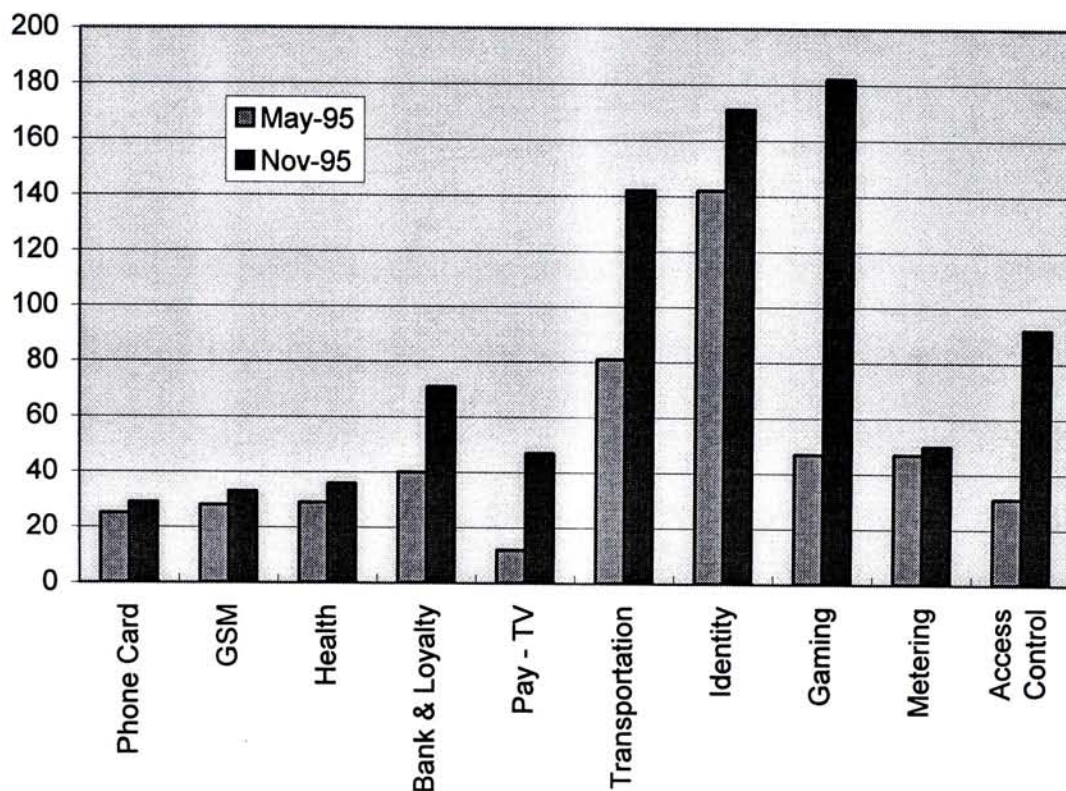
<sup>29</sup> "Smart Card Market Forecasts According to CP8 Transac, Gemplus, Philips and Solaic." *Smart Cards & Systems Newsletter* vol.2 no.15 p.12.

<sup>30</sup> "Orga: From Smart Card production to Systems Integration." *Smart Cards & Systems Newsletter* vol.2 no.9 p.8.



### EXHIBIT 9

#### Forecast of Average Annual Growth (%) of Worldwide Smart Card Market (from 1994 to 2000) by Gemplus



The manufacturers' forecasts, though not in full concert with each other, do illustrate that the worldwide smart card market is growing and will continue to grow rapidly. Exhibit 9 illustrates that the smart card market in all sectors is expected to grow at double digits in the coming years. In fact, smart card systems have already been widely used in Europe, North America, Japan and Singapore, in various applications, and there are even more pilot systems under trials.

## CHAPTER IV

### SMART CARD APPLICATIONS IN HONG KONG

Hong Kong has just started moving onto its way to a “smart” world, where people can use smart card to shop around, get access to buildings or computers, or store and retrieve information, etc.. Many people believe that smart card’s versatility will have great effects on the socio-economic development of Hong Kong, and can bring improvements to our quality of living. Although this allege may not be proved shortly, we cannot deny that smart card has already taken a noticeable part in our daily lives. Since 1994, when the GSM mobile phones network brought us the first operating smart card, the SIM card, a large variety of smart card products appeared in the market - Hong Kong Telecom’s calling cards and prepaid phone cards, electronic coupons such as the Compass Card and the Esso Card, the Chase Golden Harvest Movie Card, and more. These cards share some common features: simple logic, small memory and low security. It is not to our surprise that they could be launched to the market within a relatively short period of time.

On the other hand, some other types of smart card system may need a large supporting infrastructure and customer base, or call for very stringent security requirements, so that it takes quite a long period of time to test and develop the systems. Mondex Card, Visa Cash Card, Octopus Card, Patient Card or even the HKJC Card, all belong to this category. Exhibit 10 summarizes the various smart card applications being used in Hong Kong, and the paragraphs that follow give details of the more important systems.



## EXHIBIT 10

## A Comparison of Different Smart Card Applications in Hong Kong

Application	Name	Type	Summary
Electronic Purse	Mondex Card	contact	A reloadable electronic purse developed by National Westminster Bank. Hongkong Bank had acquired the Hong Kong franchise to issue, and launched the service in 1997.
	Visa Cash Card	contact	Issued by Standard Chartered Bank and Bank of China Group. It was once a throw away type electronic purse but has just been changed to reloadable in April 1997.
	HKJC Smart Card	contact	Used to pay for the Club's services, including betting. Pilot scheme conducted in 1995.
Electronic Coupon	Compass Visa Card	contact	Issued by OTB Card Company Ltd. and Hutchison Whampoa Ltd. in October 1995. The card stores the bonus value known as Compass Dollars, which can be used as cash to purchase items in particular shops.
	Esso Master Card	contact	Launched in August 1995 by Bank of China, Esso and Master Card.
Stored Value	Chase Golden Harvest Movie Card	contact	Issued by Chase and Golden Harvest Movie Company. Used for purchasing movie tickets.
Telecom	SIM Card	contact	Used in GSM phones to identify the user to the telephone system.
Health Care	Patient Card	contactless (optical)	Issued by the Hospital Authority to store patients' demographics and allergies as well as life-time medical care data. Pilot trials started in late 1994, and full implementation expected in 2000.
Transportation	Octopus Card	contactless	Developed and operated by Creative Star Limited, a consortium formed by MTRC, KCRC, KMB, HYF and Citybus. Public trials in progress, and public use targeted at first half of 1997.

### Transportation Applications

Hong Kong is in the way of constructing an ambitious multimodal transport ticketing project, using the contactless smart card technology, which involves five major public transport companies - the Mass Transit Railway Corporation (MTRC), the Kowloon-Canton Railway Corporation (KCRC), the Kowloon Motor Bus (KMB), Hongkong and Yaumati Ferry (HYF) and Citybus. The new ticketing system is also open to other companies who may wish to join the card operating network in the future.

In 1992, three of the companies<sup>31</sup> commissioned an independent consultant to conduct a market study to find out what exactly the average consumer wanted from the public transport systems<sup>32</sup>. The results showed an overwhelming demand for a convenience card which could be used to pay for public transport facilities as well as other public services, such as the telephone system, thus doing away with the need to carry around large amounts of coins. Based on the survey, the three companies investigated into the best possible means of achieving these ends, and culminated in the idea of introducing a contactless smart card ticketing system. In 1994, the other two companies also expressed their interest in the project, and joined with the three companies to form a consortium, the Creative Star Limited, for the purpose of developing and operating a new ticketing system

In the new system, contactless smart card will be used to replace the conventional magnetic stripe tickets in the railways and coins in the buses and ferries. The smart card will enable information about each cardholder and his ticketing details to be stored and processed at turnstiles every time it is utilized. Transport hoops and hurdles, like wrong combination or

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<sup>31</sup> The three companies are MTRC, KCRC and KMB.

<sup>32</sup> Conducted by Coopers & Lybrand Management Consultants Limited in October 1992.



shortage of coins, turnstile jams and long waiting queues<sup>33</sup> etc. will hopefully be overcome through the new system.

Its multifunctional capability will enable the cardholder to direct debit his account to pay for fares. Both the passenger and the transport companies will have complete information about the card's stored value and the cost of each transaction being made. A passenger will be able to add value to his card via an automatic or a manual procedure using cash or electronic funds transfer (EFT) facilities provided at prominent locations.

In relation to security and data capacity, the smart card offers significant advantages over the magnetic stripe card, which has limited data capacity and may be easily duplicated. The new system is capable of undertaking data encryption and card/processor authentication. System data trails will be maintained such that any security breaches or fraud attempts may be identified, and automatic blacklisting and blocking of card usage carried out. In establishing these data trails, system security and data confidentiality will be maintained.

The implementation of such large and complex system is a demanding task, particularly given the extensive hardware and software development requirements. Customer trials have begun since late 1996, and it is anticipated that the progressive roll out of equipment for public operation will be in the first half of 1997.

#### Healthcare Applications

The Hospital Authority is also trying out a smart card system to store life-long medical care information of patients. There have been two pilot schemes, one at the Queen Mary Hospital's Radiotherapy and Oncology Department (since December 1994), and

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<sup>33</sup> The system is capable of initiating, processing and concluding transactions in less than 350 msec.

another at the Queen Elizabeth Hospital's Department of Medicine (since March 1995). This is the first part of a four-phase programme to integrate the smart card system into the Hong Kong health care network. Full implementation, in both public and private sectors, is planned for the year 2000. Exhibit 11 gives details of the phasing of the project.

### EXHIBIT 11

#### Implementation of the Patient Card System of the Hospital Authority

Stage	Scope of Works
Phase I	Pilot trials at Radiotherapy and Oncology Department of Queen Mary Hospital and Department of Medicine of Queen Elizabeth Hospital.  Optical card readers are installed at Accident and Emergency (A&E) Departments of all Hospital Authority hospitals.
Phase II	All acute hospitals of Hospital Authority.  Optical card readers are installed at Admissions Departments of all Hospital Authority hospitals.
Phase III	All convalescent and rehabilitation hospitals and specialist out-patient clinics of Hospital Authority.
Phase IV	All general practitioners.

The system will use optical card in preference to IC card because the former has much larger memory capacity<sup>34</sup> and higher durability, being resistant to heat, chemicals and magnetic fields. All these are particularly important for storing life-long medical data of patients. The new patient card will store two categories of data: the common data refer to the

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<sup>34</sup>

The optical card has a memory size of 4 megabytes, while a normal IC card has 8 to 64 kilobyte capacity.



patient's demographics and allergies, and the clinical data include the details of patient's diagnoses, medication and management summaries, investigation results as well as images and voices, such as X-ray images or voice recording of doctors' diagnosis.

The optical card is contactless, but is read by a laser beam. This makes the reader considerably more expensive, but the cost of the card itself is so much lower<sup>35</sup> that it is still the more economical alternative.

### Payment Applications

#### Mondex Card and Visa Cash Card

For a couple of years, the salespeople from three international smart card programmes have been doing their rounds to persuade bankers in Hong Kong (and indeed worldwide) to sign on either MasterCard Cash, Visa Cash or Mondex, all three being essentially about the use of smart card as electronic purses. Two of them, Visa Cash and Mondex, have succeeded in finding their partners<sup>36</sup> here, and have launched their pilots to the market in August and October last year respectively.

Mondex is a reloadable card proposition. It can be loaded with money from a bank account through telecommunication channels<sup>37</sup>. Visa Cash was a throw away card, like a telephone card today, but has just been changed to reloadable in April 1997. Each of these propositions offer different benefits and weaknesses. The reloadable cards are more useful

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<sup>35</sup> According to Joycelyne Cheung, Systems Manager of Hospital Authority, the price of each optical card (HK\$30 - 50) is approximately one third of the price of an IC card (HK\$110 - 170).

<sup>36</sup> The Mondex card is issued by the Hongkong Bank Group, while the Visa Cash card is issued by the Standard Chartered Bank and the Bank of China Group.

<sup>37</sup> This can be done either through Mondex ATMs or Mondex-compatible-telephones.

for the bank to develop relationships with its customer base, while the three away cards enable bankers to tap a very different market - those who are not their customers.

Mondex card also allows cash to be transferred between cardholders, with the help of a Mondex wallet, instead of only at the point of sale (POS). This makes it impossible to audit trail a Mondex card, and hence it is a closer emulation of cash.

The Visa system has their inherent advantages in marketing in that they have already had their own centralized system operators and retailer's networks. Mondex has no such off-the-shelf system, and they have to start from the ground up. Currently, the retailers' network of Visa has 1100 members while that of the Mondex has just above 400. Both systems set the maximum stored value of their electronic purse to HK\$3000.

#### Hong Kong Jockey Club Smart Card

The Hong Kong Jockey Club (HKJC) started investigating the concept of smart card technology seven years ago, to find a means of providing a more efficient and secure service for its customers. The main purpose behind the technology initiative is to reduce the use of cash in the system, to improve processing transactions and improve security.

HKJC is an organization that sees large volume of cash rapidly passing to and from across the counters of its racing track offices and off-course branches, and there are, on average, more than 7 million transactions per racing event<sup>38</sup>. With the smart card system, ticket issuing processes will be replaced by software applications, so reducing the amount of cash handled, paper used as well as human errors. In terms of security, the processing

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<sup>38</sup>

Data source: The Hong Kong Jockey Club.

capability of the smart card allows the verification details, such as the corporate security data and personal identity number, to be stored and checked every time the card is used.

HKJC has started its first pilot scheme since 1995, in which selected participants<sup>39</sup> were given a smart card that could be used to deduct the cost of purchases from any club's facilities (racing, betting, lotteries and membership services). A preliminary review conducted in May 1995<sup>40</sup> indicated that, on average, 47 percent of the total number of the issued cards were active during each racing event, and there were 5.7 transactions per each active card per event. HKJC expressed that they were very satisfied with the result<sup>41</sup>, but they would only proceed with the full conversion process until the new services are completely satisfactory from its customers' point of view.

#### Identification Applications

Hong Kong Immigration Department has also already reached the stage of asking smart card producers to come up with proposals for an electronic passport. When considering that there are about 100,000 people per day passing through the Lo Wu border checkpoint, the smart card would be an effective media for fast-track processing and alleviate the under-staff problem of the Department to a great extent.

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<sup>39</sup> These refer to the clientele who are already adept at using the self vending terminals available on Jockey Club sites.  
<sup>40</sup> Conducted by the Hong Kong Jockey Club.  
<sup>41</sup> Stated by John Markwell, Director of Information Technology of Hong Kong Jockey Club, in his presentation to the International Conference on Smart Cards 1995, Hong Kong.



## CHAPTER V

### ANALYSIS OF THE HONG KONG SMART CARD MARKET

Smart card is by no mean a new idea, but its prevalence in the worldwide market has only been a matter in the past ten years. Hong Kong's market has started up late in 1994, but seems to pick up speed now. There were a lot of reasons that had hindered the smart card market from setting off in the region, but there were equally some other reasons that had supported its recent growth. Therefore, for a forecast of its future in Hong Kong, we must first fully understand the environment it is now in, and see if the competing factors will favour its further development.

Due to its very special nature, smart card market should be viewed and analyzed from three different angles, and very different results and conclusions may be obtained. When smart card is seen:-

1. as a product, it competes with its rivals (e.g. conventional magnetic stripe card).
2. as a means, it is a new form of monetary exchange<sup>42</sup> (e.g. electronic purse) that supplements or competes with, the existing forms (i.e. cash, cheque, credit cards, debit cards, EFT, etc..)
3. as a system, it provides services that either replaces existing services (e.g. ticketing system) or explores into some new territories (e.g. patient card systems) that were once impossible.

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<sup>42</sup> Money is the "medium" of exchange, and can be transacted in the "form" of cash, cheques, credit cards or debit cards.

### Smart Card as An Individual Product

Chapter III of this report gives the advantages of smart card over the conventional magnetic stripe card in terms of reliability, security, storage capacity and processing capability. The only factor that prohibits a total replacement of magnetic stripe card with smart card at the present moment is its higher cost of production. However, in certain applications that require simpler logic (e.g. phone cards) and very large volume of production, the cost advantage of magnetic stripe card has already become less apparent. In fact, with continual advances in silicon technology and people's soaring demand for higher security, it is anticipated that the cost advantage will eventually diminish with most, if not all, applications. Smart card, as a product itself, is expected to dominate the market in a few years.

### Smart Card as A Form of Monetary Exchange

Smart card, when used as stored value card, such as electronic purse, acts as a new form of monetary exchange<sup>43</sup>. When we look back in history, throughout monumental advances in technology and progress of civilization worldwide, cash has remained the most widely used form of monetary exchange, and currently accounts for 75 percent<sup>44</sup> of the world's total financial transaction volume<sup>45</sup>. On the other hand, credit card or debit card can simplify transactions at the point of sale, but its charge on both retailers and customers (annual fees) has, to certain extent, limited their further growth. History tells us that, because of their own pros and cons, no one form of monetary exchange can totally displace the

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<sup>43</sup> This is different from replacing magnetic stripe card with smart card, say in credit card applications, which is to substitute an existing "product" with a new "product" for an existing form of monetary exchange. Its use as "stored value card" is a new form of monetary exchange (pre-payment) as contrasted with credit cards (post-payment) and debit cards (at-the-payment).

<sup>44</sup> Data source: Hongkong Bank. Cheques account for 12%, credit cards 10% and debit cards 3%.

<sup>45</sup> Excluding ATM withdrawals, automated payments, paper credits and cash acquisition at counters.

functions of the others. By the same token, smart card, having its own merits<sup>46</sup>, should be able to find its own share in the market.

The only possible hindrance to the use of smart card in this front is the attitude of the local government. As Joseph Yam<sup>47</sup> said before, the government has the responsibility over the integrity, stability and efficiency of the payment systems in the economy. As smart card has the potential of playing a significant role as a medium of transaction, the government have to maintain a close interest in developments in this area. Yam also pointed out the three main concerns of the Monetary Authority on the use of smart card as a form of monetary exchange similar to banknotes:-

- (1) the soundness of the issuer and the instrument itself must be ensured<sup>48</sup>.
- (2) the banknotes have a special, macro monetary function in that they are issued and redeemed against the US dollar at a fixed rate, and the assured convertibility of the banknotes into a foreign currency at a fixed rate is an important anchor for currency stability, and the growing acceptance of smart card may undermine the effectiveness of the banknotes in playing this function.
- (3) the Exchange Fund earns interest on the corresponding US dollar assets backing the banknotes, and smart card may reduce the use of banknotes, thus reducing the profits of the Exchange Fund.

Regarding the first concern, the Monetary Authority have indicated in many occasions<sup>49</sup> that if smart card is used in a closed environment where the issuer is also the

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<sup>46</sup> The advantage of smart stored value card over the credit cards or debit cards is that it charges only 0.5% of the transaction value, which is lower than the 2% for credit cards and 0.75% for debit cards.

<sup>47</sup> In his opening speech to the International Conference on Smart Cards in Hong Kong, May 1995.

<sup>48</sup> Banknotes in Hong Kong are issued by the three note issuing banks of high reputation under very strict arrangements, and the banknotes themselves are highly secured pieces of paper backed 100 percent by US dollars held at the Exchange Fund.



provider of goods and services on which the smart cards can only be used, just like the Compass Card or the Octopus Card, then the government may not intervene in the affairs. However, for multi-purpose smart card, particularly when they are prepaid, then its issue will constitute the business of taking deposits, and thus falls within the ambit of the Banking Ordinance. This is important because if the issuers are not required to maintain cash reserves or adhere to other monetary regulations, then bad investments made with the float money can have catastrophic results.

Regarding the last two concerns, Yam personally believes that the effect should not be too exaggerated, though the monetary aggregates should be carefully monitored and measured. In fact, he does not feel that profits to the Exchange Fund should stand in the way of technological progress if it promises to produce a safer and more efficient medium of transaction than banknotes.

#### Smart Card as A System

The market analysis becomes complicated and more important when smart card is seen as a system, due to its almost infinite variety of possible applications. And, because of this, the analysis cannot be conducted on an application-by-application basis. Instead, an environmental scanning has been performed to collect information about the whole external environment of the industry in order to identify and interpret its potential trends. The goal is to analyze the information and determine whether these trends represent opportunities or threats to the development smart card systems in Hong Kong.

#### Technological Environment

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<sup>49</sup> Joseph Yam, "By limiting the issue of multi-purpose smart cards to authorized institutions under the Banking Ordinance, our concerns on the soundness of the issuer and the soundness of the instrument would seem adequately addressed." *Ming Pao Daily News*, 21 November 1995. David Carse and S.T. Pang, both Deputy Chief Executive Officers of Monetary Authority, also said the same to the public media in different occasions.

Smart card is a technological innovation itself when seen as an individual product. However, it is the numerous possible applications of the technology across various industries that make a real impact on the society, giving operators competitive advantages on one hand and better customer service on the other.

Smart card had started its development in France since 1977, and was first made fully operational in March 1979, after a strong cooperation between CII-Honeywell-Bull (France) and Motorola (US). Since then, different manufacturers from various countries<sup>50</sup> found their positions in the market, and many of them developed also into system integrators. As a result, these companies dominate not only the technology but also the “system” market worldwide, though some computing giants<sup>51</sup> are also playing an important role in the competition.

Hong Kong has neither smart card manufacturers nor system integrators on its own, and both the technology and its innovations have to be imported from foreign countries. The lack of internal thrust in the first instance has made Hong Kong a late starter. The overhead costs<sup>52</sup> and higher profit mark up will also make the new systems less attractive to the local market. There is no sign indicating that Hong Kong will be developed into a high technology centre to the stage of being able to compete with the foreign manufacturers. However, the keen competition among the key players and the globalization of the market will one day prohibit super profits and drive the card and equipment costs down to a sufficiently low level for the local market.

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<sup>50</sup> Most of them originated in Europe, mainly in France, and one or two in each the US, Australia and Japan.

<sup>51</sup> IBM and Unisys are examples.

<sup>52</sup> Such as travelling costs, equipment transportation costs, staff accommodation costs, etc..



Hong Kong is a modern city that encourages innovations and, in fact, the smart card market did grow rapidly during the last two years. The soaring local demands have attracted some of the foreign system integrators to set up their teams in the region to seek for opportunities. It is expected that local system integrators will also take part in the smart card market sooner or later, as the market gets sufficient momentum, as this falls within their technical strength<sup>53</sup> ambit. The Hong Kong Productivity Council (HKPC) will assist here<sup>54</sup> in setting up a basic facility for the system integrators, providing them information on suppliers, card applications as well as government and international standards.

#### Political-legal Environment

Hong Kong is famous for its open and free market environment, and the arrival of smart card technology should not invite too much public criticism. Hong Kong Government long adopts the laissez faire policy, and have yet imposed any regulation or restrictions on the use of smart card, though in view of the many systems being operated in the region. In fact, the government is expecting a keen competition for the business, and thus will leave technology and market forces to play their appropriate roles<sup>55</sup>.

The Hong Kong Government indeed welcomes the arrival of smart card technology. According to Chee-hwa Tung<sup>56</sup>, to develop high technology is one of his major governing policies, and the government of the future Hong Kong Special Administrative Region will both encourage investment and invest itself into the industry. The government's support is also reflected by their active participation in using the new technology in various government

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<sup>53</sup> Laschinsky, Bernhard. "The Role of the Independent Smart Card Systems Integrator." International Conference on Smart Cards, 29 - 31 May 1995.

<sup>54</sup> "Introducing a Smarter Card." Productivity News (May 1995): 2.

<sup>55</sup> According to Joseph Yam in his opening speech to the International Conference on Smart Cards in Hong Kong, May 1995.

<sup>56</sup> Chee-hwa Tung, Chief Executive - Designate of the Hong Kong Special Administrative Region.



facilities. Two of their main concerns in the past<sup>57</sup>, security and privacy, have been solved by the smart card solutions. In these ends, Michael Leung<sup>58</sup> quoted two current government projects that are going to use smart card technology to illustrate the idea - the On-street Electronic Parking Meters (for its security) and the Electronic Road Pricing System (for privacy).

However, these two attributes have also made the government worry about the widespread use of smart card in future. First, the infringement of human rights is one of the main concerns by the general public. A service provider is able to capture the history of every transaction of his customers, and can analyze or trace the every activity of any individual from its database. Therefore, the government have to play an important role in protecting smart card users against abuse of customers' information by the issuers. Secondly, as smart card can store values and secret information, inevitably there must be attempts to break its security. Reports of success<sup>59</sup> were received from both US and UK, though most claims were dismissed as either too theoretical or time-consuming. The government should have the responsibility to ensure that the smart cards are secure enough, and should have a contingency plan to handle emergency situations<sup>60</sup> in which the public's confidence or the integrity of the monetary system may be ruined. However, to what extent should the customers be protected and what actions should be taken by the government is a quite controversial question that may not have a unique answer.

### The Competitive Environment

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<sup>57</sup> According to K.C. Leung, Electronics Engineer in the Electrical & Mechanical Services Department of the Hong Kong Government, in his presentation to the Application of Smart Card Seminar, 24 April 1997, Hong Kong.

<sup>58</sup> Michael T.H. Leung, Chief Electronics Engineer in the Electrical & Mechanical Services Department of the Hong Kong Government, in his presentation to the Application of Smart Card Seminar, 24 April 1997, Hong Kong.

<sup>59</sup> "Industry Review 1996." Smart Card News (January 1997): 7.

<sup>60</sup> In an interview with Ming Pao Daily News, David Carse, Deputy Chief Executive (Banking) of Monetary Authority, said that the whole electronic purse system should halt if more than 30% of the electronic cards are under security hazard.

Although smart card is always said to be a technology waiting for innovations, most of its current applications in Hong Kong are for replacing existing products, services or systems by offering cost benefits to operators or enhanced convenience and security to customers (e.g. the contactless smart card ticketing system replacing the conventional magnetic stripe card ticketing system). As a new technology of high versatility, smart card systems are good substitutes for many existing systems, but receive not much threats from new entrants<sup>61</sup>.

On the other hand, the initial investment in smart card systems are usually high, and they can only find competitive advantages in applications with a wide customer base<sup>62</sup>. Hong Kong is a good place for smart card development because it is highly populated. The almost failure of GSM mobile phone in UK<sup>63</sup> but great success in Hong Kong gives an illustration.

The industry also receives research and development (R&D) subsidies from the government. In 1996, the Industry and Technology Development Council (ITDC) of the Hong Kong Government granted a R&D fund to the Hong Kong Productivity Council (HKPC) and the Hong Kong Electronic Industries Association (HKEIA) to carry out a study with an initial aim of providing information to the industry. In the long term, HKPC will extend its services to helping providers.

### Economic Environment

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<sup>61</sup> New entrants of higher versatility or lower costs will require another technology breakthrough, which may take tens of years to occur.

<sup>62</sup> This is similar to the use of computer technology in automation.

<sup>63</sup> The two major smart card schemes in UK, motorway road toll trials and electronic ticketing for London Transport were in danger of collapsing. See "Industry Review 1996." *Smart Card News* (January 1997): 5..



To develop a whole smart card system is usually very expensive, and in most cases are only viable in places where there is a good economy<sup>64</sup> as well as a wide customer base. Hong Kong provides a very good economic environment for smart card system operators to explore their markets for a lot of reasons:

1. Hong Kong is densely populated, thus providing a wide potential customer base<sup>65</sup> for lowering the per capita cost of operating a smart card system.
2. The disposable income level of Hong Kong people have been high, and most of them are quite willing to pay for more for premium products or services. Although smart card systems can provide extra convenience and security to customers and long-term cost benefits to operators, they require heavy initial investments. The development costs may be transferred to customers in form of short-term high prices or refundable deposits. Experience<sup>66</sup> shows that Hong Kong people can accept these arrangements quite well<sup>67</sup>.
3. Hong Kong is a modern city with a well established infrastructure in many respects, such as communications, transportation, retailer networks etc. To the smart card system operators, these can provide them opportunities (existing systems, e.g. transportation systems) or offer them advantages in terms of reduced construction cost (existing networks, e.g. retailer terminals for Visa Cash) or marketing efforts (existing customers, e.g. pay phone cards).
4. Hong Kong Government runs a surplus budget, and now maintains a huge amount of monetary reserves. Part of the reserves are to be used for upgrading or developing the government's public facilities, and some of the projects have declared the use of smart card technology, such as Electronic Road Pricing System and Electronic Public

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<sup>64</sup> Boone, Louis and Kurtz, David. "Environment for International Marketing." in Contemporary Marketing, pp.133-143. The Dryden Press, 1995.

<sup>65</sup> The size of the customer base attained will depend on the effort of marketing.

<sup>66</sup> Mobile phones and personal computers are examples of initial high prices, while express terminals for betting require HK1,000 as a refundable deposit.

<sup>67</sup> According to an internal survey conducted by MTRC on the issue of Octopus Card in 1997, only 18.4% preferred no deposit while 58% considered a deposit of HK\$50 or over was reasonable.



Parking Meters. Some other government projects are also considering the use of smart card technology, e.g. personal identity cards. These provide a big potential source of funds for smart card markets.

### Socio-cultural Environment

More than 95% of Hong Kong citizens are Chinese. One of the problems faced by card issuers in Hong Kong is the preference among the older Chinese population to pay for goods and services with cash. The experience with credit card markets provides an example. Of the 4 million people in the region who would qualify for a credit card, only 2 million actually hold them. The average number of cards held is around 1.8, compared to 2.5 in Singapore and 4.5 in the US<sup>68</sup>. According to Neil Hockaday<sup>69</sup>, credit cards had been in Hong Kong for quite some time<sup>70</sup> but the market did not really welcome them until around five or six years ago. He said that security, or crime, is one of the major concerns. Smart card applications are in a much better position than credit card because of their higher security. Moreover, the emergence of a more-educated younger set in Hong Kong over the past few years, who are more receptive to western style and new products or services, can also help speed up the adoption process.

Hong Kong is also renowned for its fast pace of living. Anything that offers efficiency or provides convenience will have a good chance of being accepted. Fast-food, mass transit, electronic banking are examples. Bearing convenience as one of its main attributes, smart card uses should see a wide spread in Hong Kong in the near future.

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<sup>68</sup> Data Source: *Asia Cards 1996*. (Dublin: Lafferty Publications Limited [1996]), p. 46.

<sup>69</sup> Neil Hockaday, Senior Manager of Card Products Division of Hongkong Bank.

<sup>70</sup> The Bank of East Asia and the Bank of America jointly introduced the first credit card in Hong Kong in 1975.

Hong Kong people also desire much for privacy. The government abandoned the Electronic Road Pricing System project years ago because of the strong public protest against the possible infringement of this important human right. In fact, similar traceability is possible if many card issuers join together, though the effect is minimal when they work alone. Smart card systems offer the option of no audit trail by storing all transaction details into the card memory instead of the operators' terminals, thus providing an effective means for ensuring privacy. This should add merits to smart card in forecasting its future in Hong Kong.

#### Perspective of All-in-One Smart Card in Hong Kong

The growing proliferation of smart card functions permits both vertical and horizontal integration of different applications into one single card. The Compass Card, issued in October 1995, provides an example of vertical integration of payment services<sup>71</sup>. However, while this type of integration starts first, the horizontal integration across different industries is likely to have more significant impact on the society, in particular, the synergy of combining financial services and other services sectors in an attempt to change the way we access and pay for these services. It is still uncertain about which move the industry is going to take, but, for no conjecture, we must analyze those underlying determining factors as well as the circumstances that Hong Kong is currently in before we can make a reasonable forecast of the future.

The first pushing force for a horizontal integration of smart card is the derived demand from customers' demand for convenience<sup>72</sup>. Although in many applications smart card can offer extra convenience, in one form or another, to customers, say, by displacing

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<sup>71</sup> The Compass Card combines a Visa card which replaces Park'N Shop's current credit card and a loyalty card that accumulates bonus values.

<sup>72</sup> Just like the demand for ATMs is derived from consumers' demand for banking convenience.

coins, the benefits cannot be fully reaped if the same type of convenience does not apply to all services. That is, in this case, the customer still has to bring with him coins for other services, despite holding a smart card for a particular service. This can only be solved by multi-function cards which are designed for a particular purpose, say for displacing coins, but not for a particular service. The customers' demand for convenience will eventually push the operators to come together to sort out themselves.

Another pushing force comes from operators' benefits. Card consolidation will bring less risk to card issuers, as risk can be diversified to different co-resident providers. Moreover, bundling functions on the same card can lower costs and make projects not individually viable possible. All overhead charges, advertising cost and fixed asset cost etc. can be shared, and, with more financial support, series of marketing campaigns can be launched. This can increase competitiveness and market power of a smart card. Card consolidation can also extend the reach of services. One card can be used in many different places and becomes so convenient that more and more customers will like to become a member. As a result, card providers can enjoy large customer base and hence economies of scale.

On the other hand, there are also barriers that the industry must surmount before a full integration of smart card can become possible. One of the major restrictions comes from the local government. As discussed in previous sections, Hong Kong Government considers that the issue of multi-purpose smart card, particularly when they are prepaid, will constitute the business of taking deposits, and thus falls within the ambit of the Banking Ordinance. The restriction will reduce operators' desire for a consolidated system, and will bring out the



need for a central clearing house<sup>73</sup> for the management of the float, settlement of accounts and liaison with the government for all member service providers.

The setting up of a central clearing house presents another problem, which becomes more complicated when the number of service providers increases. Transaction processing by third party companies<sup>74</sup> is a possible solution, but the idea has yet to take off in the region. In fact, the possibility of a third party transaction processing business is still virtually unexplored in any part of Asia.

Another important issue that must be tackled with before full integration can be possible is the standardization of the technical specifications for smart card to ensure interoperability. Since recent years, ISO has been doing a lot of work in establishing a series of world standards for smart card, and has now set the mechanical and electrical rules for the actual implementation of smart card applications, thus establishing a sound basis for further development. Other outstanding works include application interfacing requirements, security by encryption algorithms etc.. A good example that illustrates the importance of standardization is the development of the EMV Joint Specification<sup>75</sup> in the banking industry before the relevant ISO standards were in place. According to Robin Townsend<sup>76</sup>, the aim of the joint specification was to set a standard for interoperability (for risk aversion), and then compete for services on top of the common flexible technology platform. Neither the ISO

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<sup>73</sup> According to "Trouble-free Travel." *Productivity News* (May 1995): 8., one of the major reasons for setting up a consortium for the Creative Star project is to avert the dispute on the management of the float that would inevitably have occurred had a single provider been designated as the clearing agent.

<sup>74</sup> Transaction processing by third party companies is a very large business in the United States. *Asia Cards 1996*. Dublin: Lafferty Publications Limited [1996], in 1996, the largest third party processor in the US, First Data Corporation merged with First Financial Management Corporation, the country's largest merchant processor to create a business with annual merchant processing volume said to be worth at least \$100 billion a year.

<sup>75</sup> Europay, Mastercard and Visa came together at the end of 1993 to set basic standards for the development of smart cards, referred to as the EMV Joint Specification. These specifications have been drawn up and completed in October 1994, and were updated in 1995 and 1996 respectively.

<sup>76</sup> Robin C. Townsend, Senior Vice President for Chip Card Technology, New York, Mastercard International.

standards nor the EMV specifications is complete on its own, and standardization in other areas are still in worldwide progress<sup>77</sup>.

Townsend's saying brings out another issue that may hinder smart card integration - the need to compete for service. Although card consolidation, as said, can reduce development, overhead and marketing costs, it may also violate the service provider's original intention in using a smart card system, e.g. to reinforce customer relationship through employing enhanced customer-loyalty programme, which helps to discourage customers from switching to a competitor's network. In this case, card consolidation can ruin the whole purpose.

We have seen that although the integration of smart card applications offers certain benefits to both customers and operators, at the same time there are also a lot of obstacles that are hindering its progress. It is envisaged that the standardization problem will one day be solved, but for the others, the way is still too long. A more probable outlook will be a piece-meal integration, both vertical and horizontal, across services that have no acute competitions, with the formation of giant alliances to compete with each other eventually. It is also anticipated that, due to their common (personal, non-commercial) nature, personal identity card will be combined with health card to form a social security card, which will remain separated from other commercial applications.

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An example is the development of the Java Application Programming Interface (API) as the standard programming language and interface.

## CHAPTER VI

### SUMMARY AND CONCLUSIONS

#### Summary

The idea of smart card evolved in early 1970's, essentially as a possible means for increasing security of transaction systems. It was first realized in 1979, but was not put into public use until 1983, after the operators had built up sufficient confidence on the new technology.

Smart card bears the traits of high reliability, high security, large storage capacity and strong processing capability. It represents one of the most exciting technologies available today, not just because it is a superior substitute for magnetic stripe cards, but also because of its infinite variety of possible uses that produce effects far beyond those of the plastic itself.

Nowadays, smart card has already been deployed in a wide variety of projects across many industries, providing customers with different utilities - security, convenience, privacy, etc.. In Hong Kong, the smart card market started just a few years ago but then has been growing very rapidly. Currently, there are more than ten smart card projects operating or being tested in the region.



The environmental analysis reviewed that Hong Kong provides a very favourable environment for the smart card market, and it is anticipated that the market will continue to grow at a fast pace.

Although the integration of smart card applications offers benefits to both customers and operators, there are also obstacles hindering its progress. A piece-meal integration, across services that have no acute competitions, will be a more probable outcome.

### Conclusions

When we discuss the future of smart card today, we cannot afford not to talk about its effect on human development. As it is commonly known, nowadays people's social contact can be seen as the exchange of information, and language, words and pictures are the forms of information exchange, while communications facilities, like telephones and televisions, have become the most common vehicle for information exchange. The birth of smart card provides a new vehicle for information exchange.

The promotion of the use of smart card in banking and finance is particularly encouraging. It can be recalled that in human history, the appearance of currency changed the method of transactions and contributed to the change of society from an agricultural-based to one based on industry and commerce. Today, smart card is gradually replacing paper money and other monetary documents, and takes the form of electronic money. Apart from eliminating much inconvenience related to issuance, storage, circulation and recycling, and many problems related to counterfeits, it may also bring about unprecedented reformation in transaction methods and consumer habits. Hence, the social consequences are significant, as we shall see:-

In many applications, smart card systems provide enhanced convenience to customers. As time goes by, customers will soon accustom to the new standard of services, and raise their expectations. For example, in the banking sector, customers would like to make access to their accounts anywhere and at any time. They no more have to wait, in line or on the phone, no more have to make a trip to a branch, no more have to write another cheque, and no more have to carry cash. They want all these services right at their finger tips. In order to establish themselves well in the pace of competition, the banks will have to launch new services or new forms of old services to meet the ever-increasing demands of customers. The role of retail banking will also change, and retail banking will no more be solely a manufacturer or a distributor of financial services. Its main job will be to facilitate access to customers' funds anywhere, anytime, and at low cost and user friendly channels.

Smart card will replace all personal identification documents, such as driving licenses, passports, identity cards and insurance cards. The personalized smart card will also record one's habits. It can instruct a computer to call upon the game or application you usually play with and set up the environment for you. It can switch on the electrical appliances that you usually turn on when you are back home, and it can adjust a car's seat to your accustomed settings and load up the processor with your driving habits. All these will be done by just one card. There will be no difference whether you are using your own computer/car or using somebody's.

In tourism and transportation services, electronic charging system will become popular. Electronic pricing systems and traffic management system using smart card will provide citizens with a better traffic environment. Smart card will change the charging pattern, and charges will be more on a usage basis. Public transport, for example, can be charged for exact distance travelled. Flat fare or zone fare may become a history.

In health and insurance sectors, smart card enables one to process the perfect personal data bank. The personal medical condition and history, medical documents and charging records will also be filed. This will bring much convenience to personal health and medical care. It will also facilitate medical practitioners to provide medical service in emergency situations.

For the service providers, the benefits and convenience of the smart card attribute significantly to the number of participants. To gain enough momentum to market or sustain in the industry, they have to recruit a large number of shops or retailers to join their services. However, only those companies that are currently operating with large existing customer base will have a niche for growing. Eventually the market will consolidate with only a few large companies remained. The high initial investment and the need to prove to the public or to the regulatory bodies its sound financial management experience and stability also provide a barrier that permits only those big guys to enter.

We can now visualize how “smart card will revolutionize the people conduct daily life,” as what Yam said. In fact, it is believed that, along with technical development and increase in social demand, the functions and areas of application of smart card will continuously expand, its use in daily living will be more and more widespread, and its magical effect better and better felt.



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