Smart-card based Electronic Commerce: Characteristics and Roles*

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Abstract

Based largely on its potential as an electronic cash substitute for low-value transactions, the market for smart-cards has been predicted to be US$9 billion by the year 2000. The numerous international pilot implementations of smart-card systems appear to support this prediction. Compared with the number of pilots, however, there has been remarkably few full scale roll-outs of a broad-based product.

Four diverse smart-card pilot implementations in Australia were investigated and analyzed to better understand the nature of smart-card systems. The objective was to propose a basis for further research into the costs and the benefits and thus the drivers and inhibitors of specific smart-card implementations. The mini cases indicate that the costs and benefits of smart-card implementation may be dependent on the specific characteristics of the system and on the specific roles adopted by the major players. A structure of system characteristics/ features and roles/functions which can be utilized for further research into the drivers and inhibitors of smart-card implementation is proposed. A range of other research issues is also identified.

1. Introduction and Research Objective

The conduct of commerce in electronic marketplaces has been heralded as the source of fundamental change to business practice with the substitution of existing market arrangements by computer-aided buying and selling [1,2,3]. Areas of impact include on-line catalogues, multi-media mail, electronic payment, brokering services and collaborative engineering [2]. Initial implement-ations of electronic commerce have focused on the provision of telecommunications-based infrastructure in support of Internet-oriented services and electronic payment systems.

In the case of electronic payments systems, establishment of such an infrastructure has proven to be extremely expensive. [4,5]. High infrastructure and operating costs have encouraged financial service

providers, i.e. banks, to seek alternative electronic payment systems for the large volume of low value transactions for electronic funds transfer at point of sale (EFTPOS). The potential solution identified in many cases has been an integrated circuit (chip) based card which can be used as a cash substitute - the stored-value card or smart-card. Apart from their low-cost to banks, smart-cards are seen to be able to support merchant loyalty schemes and to provide convenience to consumers. [6].

Smart-card trials or pilot implementations have been conducted in more than 10 countries over the past decade. [7]. In these pilots, the use of smart-cards has generally been limited in some form: by the range of applications (e.g. for use only in telephones); the number of cards involved (as few as several hundred cards may have been issued); or their distribution (issued to pilot-participant employees only). Many of these trials have not, as yet, been rolled-out to complete implementations. This lack of progression may or may not be significant. In several cases, the stated intention of the trial was specifically to experiment and to gain experience with the payment type.

The potential for smart-cards, however, appears significant. One manufacturer, Motorola, predicted in 1996 that over the next five years the overall market for smart-cards would grow to US$9 billion. [4]. This potential coupled with the numbers of pilot studies over a lengthy period and the fact that so few of the pilots have progressed to full scale implementation warrant a more detailed examination of this aspect of electronic commerce.

This paper considers four diverse smart-card pilot implementations in Australia and then analyses the characteristics of these payment systems and the roles of the major players. A basis for further research into the costs and the benefits and thus the drivers and inhibitors of specific smart-card implementations is proposed.

2. What are smart-cards and how to they

work?

In this paper the term 'smart-card' is used inter-changeably with: stored-value cards, chip-cards and integrated circuit cards. All refer to a standard-sized plastic card containing an integrated circuit which gives the card the capability to store and / or process data. The initial standards for these cards date from 1987 [8,9]. Smart-cards differ from magnetic stripe cards in their capability to process data 'on-card' (which will support multiple functions), their increased security (data can be encrypted and the card electronically locked), and their greater capacity to store data [10].

As can be seen in the example in Figure 1, consumers purchase smart-cards and use them as cash substitutes at participating merchants and service providers. Typically, these merchants pass details of their activities through a system host to the bank which issued the card. This bank initiates settlement of funds into the merchants' accounts. The actual settlement is made by the bank which holds the merchant's account. When the value retained on the card has been completely used then the card is either thrown away (if disposable) and a new card purchased or, if the card is reloadable, then additional value can be added to the card - typically by transfer of funds through an EFTPOS transaction.

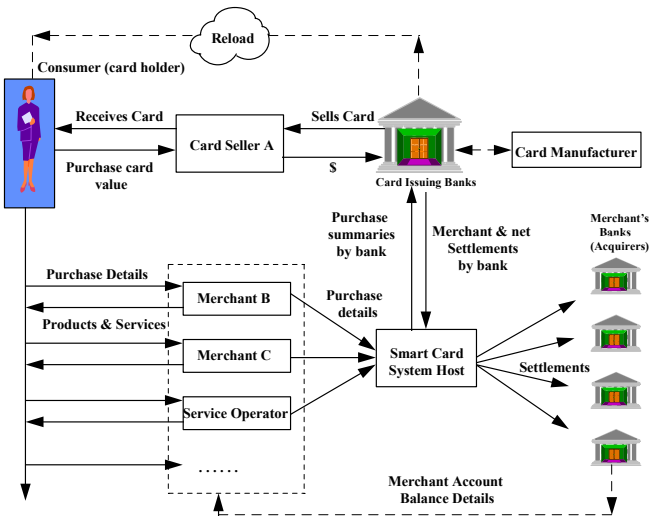

Figure 1. Composite example of a smart-card implementation

3. Research Approach

At this early stage of the investigation, our research is exploratory in approach and interpretative in nature [11,12,13,14,15]. The objective of the research was to propose a basis for further research into the costs and the benefits and thus the drivers and inhibitors of specific smart-card implementations. Four smart-card pilot implementations in one country, Australia, have been investigated based on primary and secondary research. Primary research entailed some fifteen hours of interviews with principals in the participating organisations obtaining internal details on the planning, implementation and pilot evaluation. Interviews were held with B. Horowitz VP Chip Cards MasterCard in February 1996; B. Wilson Senior VP Chip Advisory Service MasterCard and G Pitt, Business Development Manager Chip Cards Visa International in May 1997; P. Flower General Manager Quicklink and S. Treble Director Sales and Marketing CTA Transcard in July 1997. Further interviews were held with industry and consumer groups. Some details are subject to company confidentiality.

Secondary sources include publicity details, presentations and reports of various industry, consumer and regulatory bodies [16,7,17,18]. The publicly available material was sought in order to better understand intentions of the participants and influences on the large numbers of participants.

Considering the broad range of international pilots, the question of why choose four mini-cases in Australia needs to be addressed. Investigation of pilot implementations in one country limits the potential impact of environmental factors which may promote or inhibit specific characteristics or roles. Australia is of interest as it has a diversity of smart-card pilots, including the first pilots from the two largest international card consortiums, MasterCard and Visa. In selecting Australia as the site for its initial pilot, MasterCard was swayed by, 'Australia's sophisticated payment system, the level of interest from the major national banks, consumer acceptance of new technologies (high EFTPOS users, high incidence of early adopters), the fact that Australia is an area of MasterCard regional strength (in market penetration) and strength also in IT capability. [19]. Visa identified similar reasons. [20]. Furthermore, the Australian Consumers Association (1996) states that Australia has comparatively poor privacy protection legislation and therefore the pilots were unlikely to become complicated by regulatory resistance.

Diversity in the pilots was sought by selecting smart-card systems with different ownership (bank and non-bank) and application (theme parks, transportation and general purpose payments).

4. Four Mini Cases

These cases consider the initial implementation of four diverse smart-card pilots: Quicklink, Transcard, MasterCard Cash and Visa Cash.

4.1. Quicklink

Quicklink is currently owned by ERG Limited, an Australian technology group with more than 10 years experience in applications of smart-cards to public transport. In 1994, the state government of New South Wales (NSW), the most-populated Australian state, awarded a tender for the trial of a stored-value card for urban trains and buses to Quicklink Card Systems. The purpose of the government tender was to increase self service ticketing efficiency.

Quicklink launched their trial smart-card system in Newcastle (a city with a population of 130,000 located 150 kilometers north of Sydney) in November 1995. By the time the trial was completed in January 1997, 300 terminals were operational and about 20,000 smart-cards distributed. [21,22,23]. Consumers were able to reload their cards at about 75 of the terminals. Companies involved in the trial included Australia Post, BP, McDonald's, Coca-Cola Amatil, Newcastle University, University Credit Union and licensed clubs. Telstra and Smith's Snackfoods converted payphones and vending machines to accept smart cards. City Rail and the State Transit Authority were core supporters of the trial. Consumers purchased the smart-cards from merchants, e.g. newsagencies or fast food outlets, and were able to charge up to US$360 onto the cards at banks and automated charging machines.

Quicklink cards were based on a Belgian PROTON 1KB chip card system which was adapted for Australian requirements. Customers inserted the Quicklink card into a card reader / purchase device at the retailer's site. A cash balance was automatically provided. Retailers keyed in the price and customers approved transactions before any amount was deducted from the card-balance. Merchants accumulated transactions and transmitted the details from their card readers to a central system host. Their bank accounts were credited the following day. Consumers reloaded value through a merchant's reload terminal. Payment for the reload was with cash, debit / credit cards or cheques. The merchant's reload terminal contacted the host on-line and downloaded value to the card.

While there was no link with personal identification or account details the transactions could have been accounted for by the system host. There was no mechanism for linking the card and personal or account information, except in a multi-function card with magnetic stripe facilities on the same card. However, the Quicklink system host could fully reconcile the float and refund the value on damaged cards.

During the course of the pilot, a separate co-branded card offering both smart-card functionality and debit-card capabilities based on the magnetic stripe was introduced. This development became controversial, particularly within the university community, as it identified the holder of the cash card and raised the potential for profiling a customer's purchases. In June 1996 a Privacy Code of Conduct based on the Australian Commonwealth Privacy Act (1988) was established which committed the financial institution and Quicklink to maintain separate services. The Quicklink card was totally compatible with the EMV (EuroCard, MasterCard, Visa) smart-card standard.

The pilot is claimed by Quicklink to have proven the viability of the technology and established the business case. Roll-out of the system is dependent on the state government issuing a tender for the full system.

4.2. Transcard

Transcard is joint venture by Transcard Australia (part of a transportation group) and Card Technologies Australia (providing application development and host-processing facilities). The initial pilot was planned for March to November 1995 in an outer suburb of Sydney for 2,500 card-holders and 25 retailers (e.g. fast food outlets like McDonalds, newsagents, a petrol station and liquor outlets), a leisure centre and transportation companies - buses and taxis. About 100 terminals were installed. Consumer fees were waived. Apart from the contact-less transmission of transactions, the major difference between Transcard and other smart-cards is its support for multiple, non-value applications such as loyalty schemes. Up to 12 separate incentive schemes can be supported, for example, a fast-food outlet offered a free burger once US$15 had been spent in their store and the bus company offered every 11th trip free. Reloads could be affected by any agent, on presentation of cash or EFTPOS debit or credit cards. During the trial, reloads were accepted from US$15 to US$150. Transmission of transaction details by merchants to system host was similar to the Quicklink pilot. Settlement on a daily cycle was from the system host to Transcard's bank and hence through inter-bank systems to the merchants' accounts.

The card is based on technology developed by the Austrian firm Mikron. The Transcard implementation contains 1KB of data storage which is divided into areas to support multiple applications. The card contains a chip and an antenna so that a card passed in a zone (within approximately 100mm (4 inches) of a reader) can exchange transmissions by radio waves. The payment terminal incorporates a pressure pad which must be pressed by the card-holder to approve the transfer of value. Power to the card is provided by radio waves from a transmitter located beneath the pressure pad. The purpose of contact-less transmissions was to increase the transaction rate, especially in the context of mass-transit. Trials have shown that it is significantly quicker for a queue of passengers to pass their cards through a zone rather than to have each insert a card into the narrow mouth of a contact-dependent card reader. [24].

The Transcard implementation, which remains on-going, successfully managed to operate without the obligation of bank ownership and without being subjected to financial regulation. [25,26]. The system supporting Transcard is commercially available from the card owner / operator as a bureau service or as large or small licence services (e.g. for use by a university). The Transcard card was not compatible with the EMV (EuroCard, MasterCard, Visa) smart-card standard, although Stephen Treble (Director Sales and Marketing) suggests "EMV compatibility is not a problem. Transcard is multi-functional so it can be included if required".

4.3. MasterCard Cash

The first implementation of MasterCard Cash occurred in Australia from March 1996 to February 1997, with the purpose to develop a business case for this new product. The trial was conducted in Belconnen, a socially and commercially representative town within the nation's capital, Canberra. Much of the shopping by Belconnen residents is local.

In the trial, 2,000 existing MasterCard holders from three major banks had their cards replaced by their banks with re-chargeable, combined debit and credit cards. In response to concerns expressed by consumer bodies and the local regulatory body, consumer fees (of US$0.75 - US$1.10 monthly) were waived for the trial. More than 150 merchants (60 - 75% of all of merchants in the area) had card readers installed at no charge. MasterCard provided the system host facilities.

Customer transactions were accepted by the merchant's terminal on the basis of the value existing on the card, without reference to the system host. Details of transactions were transferred to the host by merchants, generally each evening. The system host computed the settlement details overnight and passed the amalgamated information (i.e. not details of individual transactions) to the banks for payment into the merchants' accounts.

Reload facilities were provided in participating bank branches (over the counter) and also at a special customer service centre set up in the local shopping mall. Card reloads could be paid for only from associated accounts, i.e. cash payments were not accepted. For this reason, reloads had to be performed while on-line to the customer's accounts. Due to necessary upgrading costs (seen to be excessive for a short-term pilot project) vending machines and pay telephones were excluded from the pilot. The participating banks had responsibility for marketing to and supporting their customers and merchants. Initial and on-going training in the system became a considerable cost as some merchants had high staff turnover. The smart-card was a specially designed multi-function card with an 8KB data storage capacity which supported embossed, magnetic stripe and electronic cash transactions.

As a result of the pilot, MasterCard considers the essence of successful use by consumers to be utility (allowing and provoking repetitive transactions) and coverage (can use it in lots of places, and, by the year 2000, plan to incorporate smart-card functions into all of their cards [19].

MasterCard has decided to proceed with the UK Mondex system instead of further development of the Master Card Cash product. A pilot of the non-accountable Mondex system was implemented in New York (Manhattan) in Fall 1997. This involved a consortium of two banks (Chase Manhattan and Citibank) with both MasterCard and Visa. [ibid].

4.4. Visa-Cash

In November 1995, the world-wide pilot of Visa Cash was implemented in Australia's Gold Coast resort area. All four major national Australian banks plus credit unions (savings & loans) participated in the trial. The first product was a disposable card with pre-set values of $5, $10 and $20. Cards were purchased for face value with no fees or commissions. The cards were initially sold by 44 banking outlets, in two theme parks and a cinema complex.

Within six months some 400 payment terminals were operational with 90 located in three large theme parks. Other major terminal concentrations were in department stores, cinemas, petrol stations, restaurants and fast-food outlets and in pay-phones. The trial was subsequently extended to reloadable cards with the smart-card chip added to the magnetic stripe cards of existing customers. After 18 months more than 750 terminals had been installed, 200,000 cards sold and nearly 500,000 transactions processed (at an average value of US$5.06).[20].

The disposable card is a memory-only chip with 416-bits (without a processor). When the card's value has been exhausted it cannot be reloaded. Some of the cards were manufactured with designs of theme park rides. These proved to be popular souvenirs and significant numbers were retained by customers even though they had value outstanding on the card.

The processes involved in use of the disposable cards were basically similar to the other pilots. Transactions were authorized on the basis of the card's remaining value. This value could be augmented by other cards or cash if insufficient for the purchase. Transaction details were accumulated by the merchants and passed to the system host (operated by Visa). The transfer could be initiated by the merchant or by the host polling the merchants' terminals. Full details of transactions are held

by the host (to maintain the integrity of the system) but were not passed to the banks. Settlement details were sent by the host to the card issuer on a daily basis and subsequently passed to the merchants' banks.

Visa expanded its pilot implementations during 1996 to include trials in Argentina and Columbia (February), New Zealand (March), Canada (April), Atlanta (during the Olympic Games in July), and Hong Kong (August). In May 1997 Visa announced a six-month trial of smart-cards for Internet purchases [27]. This is a closed trial for several hundred Visa and Bank of America staff. Initially, three merchants will participate. Visa has also announced it will pursue two different strategies for smart-card implementation: a multi-function card with debit, credit and stored value (similar to MasterCard's product) and an anonymous card which may be disposable or re-loadable. [6].

In July 1997, Visa declared the pilot to have successfully met its objectives of educating consumers / member financial institutions, testing the technology and developing infrastructure and that a business case for national roll-out had been made. This pilot would be 'wound down' and restricted to disposable cards in theme parks. [28].

5. Analysis of mini-cases

During our interviews with the major players in these pilots the costs and benefits of smart-card implementations appeared to be complex, volatile and variable depending on several factors. These factors were: the objectives of the pilots, the particular features of the systems and also the roles in the system consortia of each player.

All four pilot implementations had a common objective - to develop experience with the use of smart-cards and to establish the business cases. All pilots were declared by their card owners to have successfully met this objective.

Analysis of the pilots will, therefore, focus on the other two factors which appear to be pre-requisites to investigation of costs and benefits: the distinct characteristics of each the smart-card systems and on the roles of the major players in their initial pilot implementations.

5.1. Characteristics of smart-card pilot systems

Based on the mini-cases, five distinguishing smart-card system characteristics which may influence costs : benefits and the successful implementation of the system are identified: (1) anonymity (card-holders being identifiable or anonymous); (2) accountability (transaction details being accountable or non-accountable); (3) authorization (of transactions) being on-line or off-line); (4) disposability (cards being disposable or re-chargeable when the value is exhausted) and (5) technical capability.

Anonymity is an issue of concern to privacy and consumer bodies and, as shown in the Quicklink case, may be a significant factor in consumer adoption of smart-card systems. [16,18]. A card-holder's transactions may be *identifiable* through linkage of the smart-card with specific bank accounts or by personal identification. Alternatively, card-holders and their transactions may be *anonymous* if these links cannot be made.

Accountability is where full details of transactions are passed from the merchant to the system host. In the pilots, the system host operators maintained that accountability was necessary to prevent fraud, to monitor operations (e.g. auditing and reconciling the float) and to enable calculation of the value balance on damaged cards. Transaction details may also be invaluable for market research. There is an apparent potential for conflict between consumer requirements for anonymity and an operator's insistence on accountability.

Authorization of transactions may be on-line or off-line. *On-line* authorization may be by the consumer's bank (i.e. based on availability of funds in an account - similar to a debit card) or by the system host (based on the card identification number - to reduce fraud - without being linked to a any bank accounts). *Off-line* authorization of transactions is based on the retained value of the smart-card without reference to system host or card issuer and, therefore, supports consumer anonymity. If consumer acceptance of smart-card applications is subject to guarantees of anonymity then off-line authorization will be a major supporting feature. The minimal processing time taken for off-line authorizations is also important in applications requiring rapid throughput, e.g. in a mass transit application.

With *disposable* smart-cards the face value of the card may not be increased at any point. When the value is exhausted then they can be thrown away. In case of *reloadable* cards, additional funds may be added by transfer from the consumer's accounts at the card issuing bank or by paying the required value to a merchant with a card re-load facility. The NSW Privacy Committee says it is "yet to see a rechargeable smart-card which offers true anonymity'. [16].

Table 1. Mini-cases: smart-card system characteristics in pilot implementations.

Characteristics	*Feature*	*Q L*	*TC*	*MC*	*VC*
Anonymity	**Anonymous**	**X**	**X**		**X**
	Identifiable			**X**	
Account-ability	**Accountable**	**X**	**X**	**X**	**X**
	Non-accountable				
Authorization	**Off-Line**	**X**	**X**	**X**	**X**
	On-Line	**a)**		**a)**	
Reloadability	**Reloadable**	**X**	**X**	**X**	
	Disposable				**X**
Technical capability	**Contact-dependent**	**X**		**X**	**X**
	Contact-less		**X**		

a) on-line only for reloads

Technical capability is a characteristic where the type of technology utilized by the smart-card system enables the application. The Transcard system utilized contact-less technology particularly for a mass transit application where speed of throughput by passengers was a key element in the application. C*ontact-dependent* smart-cards require the card to be placed in contact with a card reading device. Trials show that passenger throughput using contact-less systems for ticketing can take less than 25% of the time taken for contact-dependent ticketing. [24]. A key contributing feature for high volume throughput is off-line authorization of transactions.

The diversity of system characteristics in the initial pilot implementations may be seen in Table 1. Only two features were common to all systems: off-line authorization and accountability. Since the cost of on-line authorization of credit and debit cards is a prime motivation for the introduction of smart-cards it could be expected that off-line authorization would be universal. Accountability of transaction details could also be expected in pilot systems with the objective of gaining experience with the technology. In potential conflict, three of the four systems featured anonymity for consumers in their pilots and the fourth card-owner (MasterCard) has subsequently adopted a system with anonymity as a feature. Similarly, three of the four featured reloadable systems and the fourth (Visa) has adopted this feature in its most recent pilot. The final feature, contact dependency, may be application dependent and so maintain its diversity. The diversity of the other features also may be maintained through multiple systems offered by multinational card-owners.

5.2. Roles of major players in smart-card implementations

Implementation of a smart-card system requires a consortium of card owner, card issuer, acquirers, merchants and card-holders. A composite example of the interaction between the major players can be seen in Figure 1. A summary of roles and functions in the mini-case pilots is shown in Table 2.

Card owners need to devise, advertise, sign-up issuers, implement and operate a fast, secure and reliable service which maintains the confidentiality of the consumer's purchases. As system operators, they provide a smart-card system host which accepts transaction details from merchants, passes summary details to card issuers and affects transfers to the acquirers for settlement in the merchants' accounts. Card-owners may be established international providers of debit / credit cards (such as MasterCard and Visa) or may be an entrepreneurial venture by local business, (e.g. Quicklink and Transcard). Card-owners are responsible for ensuring a credible, secure, low risk cash substitute which is protected against fraud. They should be able to gain the confidence of both merchants (e.g. for trouble-free operation / settlement) and end-consumers (e.g. regarding privacy).

Unless required by law to be banks *card issuers* may be any organization which issues smart-cards to consumers. If the card is re-loadable by electronic funds transfer (EFT), issuers facilitate such an EFT transaction from the consumers' accounts. If the card is disposable, issuers may place cards for sale with a card-selling merchant.

Table 2. Mini-cases: roles and functions in pilot implementations.

Role	*Function*	*QL*	*TC*	*MC*	*VC*
Card Owner (co)	**Devise, market**	**co**	**co**	**co**	**co**
	Operate system host	**co**	**a)**	**co**	**co**
Card Issuer (ci)	**Design products**	**co**	**co**	**co**	**ci**
	Issue cards	**co**	**co**	**ci**	**ci**
	Reload value	**b)**	**-**	**ci**	**-**
	Initiate settlement	**co**	**co**	**ci**	**co**
Acquirer (acq)	**Operational support (merchants)**	**co**	**co**	**acq**	**acq**
	Settlement	**c)**	**c)**	**acq**	**acq**
Merchant (m)	**Supplies cards**	**m**	**m**	**ci**	**m**
	Reload value	**m**	**m**	**ci**	**-**
	Transmit transactions	**m**	**m**	**m**	**m**
	Provide goods & services	**m**	**m**	**m**	**m**
Card Holder (ch) consumer	**Acquire cards**	**ch**	**ch**	**ch**	**ch**
	Use cards	**ch**	**ch**	**ch**	**ch**
Manufacturers (mf)	**Design, develop, manufacture cards**	**mf**	**mf**	**mf**	**mf**

a) outsourced by card owner.

b) payment for reload is direct to from consumer to merchant. The reload terminal requests a reload and the system host downloads value to the card.

c) card owners send settlement details to their bank and these are then completed by inter-bank transfer.

Acquirers are financial institutions which provide merchants with the card facilities and credit the merchant's nominated account with the proceeds of smart-card transactions. Typically, acquirers (of the merchant's smart-card business) market the service to merchants, provide the equipment, training and support for the service, and charge merchants fees. The merchants' nominated accounts need not be held by the acquirer, in which case settlement is affected by inter-bank transfer.

Merchants provide goods and services to consumers in exchange for value from their smart-cards. They may also be a seller of (disposable) smart-cards. *(End-) consumers or card-holders* purchase goods or services from merchants in exchange for value from smart-cards. They previously obtained the smart-card from a card seller or from a card-issuer. In addition, a *card manufacturer* designs and / or manufactures the smart-cards.

6. Conclusions and discussion

Investigation of four diverse smart-card pilot implementations in Australia indicates that the costs and benefits of smart-card implementation may be complex, volatile and dependent on the specific characteristics of the system and on the specific roles and functions adopted by the major players. Based on these pilots a structure has been proposed of system characteristics / features and roles / functions which can be utilized for further research into the drivers and inhibitors of smart-card implementation. The innovation and intention-based literature [e.g. 29,30,31,32] suggests that perceptions of costs and benefits are critical for the future adoption and diffusion of smart-cards.

Each of the four pilot systems was declared by the card owners to have been successful. Not one of these trials, however, has been extended to full roll-out. The Quicklink trial has been completed and is waiting for a state government tender for a full system. Transcard is slowly expanding its implementation but remains in limited use. The future of Quicklink and Transcard may be linked as direct competitors in the state government tender for mass transit ticketing. Both MasterCard and Visa have implemented trials with a different smart-card - the Mondex system - which includes characteristics of reloadability and anonymity.

Several strategic conclusions relating to smart-card systems as a whole may be drawn from these mini-cases. Firstly, that there is acceptance by consumers and organisations of the utility of cash substitutes for low-value transactions, especially if accompanied by additional incentives such as collectable cards or loyalty programs. Longer term acceptance issues require further investigation and may be related to perceived costs, charges and protection of consumer rights. Secondly, based on the pilots investigated, the drivers / inhibitors to full roll-out of smart-card systems appear to be quite complex and not merely limited to arguments over the 'division of spoils' in a business case. This degree of complexity emphasises the importance of further investigation into not only the general but also the specific motivations for implementations of smart-cards. Thirdly, the Quicklink and the Transcard implementations

illustrate that, in the absence of regulation, it is no longer necessary for the owners of general purpose card payment systems to be banks. The integrity of the pilot implementations was accepted by consumers, by merchants and by the banking system. Barriers to entry in such a de-regulated banking environment are minimal. Non-bank competitors may experience a competitive cost advantage as they would be able to target particular (i.e. highly profitable) payment services without having to support a full range of banking services with all of their overheads. A plethora of general and specific purpose payment entrants and applications may be expected, e.g. mass transit payment systems may be used to purchase sport / entertainment tickets and retail purchase systems may be extended to Internet-based purchases. Finally, arising from the previous point is the increasing necessity for improved regulatory oversight as new applications move outside the traditional areas and safeguards provided by the local and international banking systems. Issues which may become critical include: support for international use of smart-cards in low value trade and tourism; protection of consumer privacy; security exposures arising from loss, theft and fraud; prudential protection for consumers and merchants; and increased access to banking settlement systems.

7. Future Research

The outcome of the initial research is proposal of a structure of system characteristics / features and roles / functions which can be used in further research into the complexity of costs : benefits and drivers : inhibitors of smart-card implement-ations. The next step is to apply this research structure. Investigations of the four pilot implementations were deliberately undertaken in a single country. It is anticipated that the research structure proposed will provoke investigations concerning smart-card implementations in other countries where different environmental issues may arise, e.g. the telecommunication infrastructure or regulatory requirements. Future research questions include:

- what is the impact on specific card characteristics of more stringent privacy regulations and what are the subsequent implications for the cost and benefits of owners, issuers, acquirers, merchants and consumers?
- are there particular implementation strategies for different types of cards?
- will international card owners implement different systems in different countries (and if so, why)?
- to what extent are some card-specific applications dependent on the particular features of a smart-card, e.g. are mass transit applications reliant on features such as contact-less cards and off-line authorization?

At a later stage, answers to these questions should then help us to determine whether smart-cards are completely consistent with current adoption / diffusion theory or whether, perhaps due to their complexity or consortia requirements, they represent a special case.

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