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An Arm's Length Evaluation of Octopus

Patrick Law

John Paynter

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Patrick Law
Department of Management Science & Information Systems, The University of Auckland
Auckland, New Zealand, E-mail: plaw019@ec.auckland.ac.nz

John Paynter
Department of Management Science & Information Systems, The University of Auckland
Auckland, New Zealand. E-mail: j.paynter@auckland.ac.nz

ABSTRACT

This paper explores and evaluates the use of Octopus in Hong Kong (HK). There are over 7.4 million cards sold and 7 million of these are active. The study examines how transport and other sectors can enhance their services through Octopus. Six of the forty organisations using the Hong Kong Octopus card were interviewed. A convenience sample of 800 actual and potential Octopus customers was sent a questionnaire.

Unprecedented growth in the use of smartcard devices had been recorded in recent years. They are expected to bring revolutionary changes to businesses, governments and members of the society. The implications from this study would therefore be useful for those organisations that use or plan to adopt and implement the technology.

Results of the survey are discussed, including penetration rate, figures on card ownership and usage, failure rate, results from promotion schemes and loyalty programmes, success factors, users reliance of the system and areas of improvement. The major reasons for not using the system are addressed. Findings obtained from interview sessions were integrated in the discussion.

1. INTRODUCTION

The global growth of electronic transactions shows people are becoming dependent on Smart Cards and similar devices for purchases, communication and services. This is also true in Hong Kong, as more than 90 percent of the population (aged 15 or above) own and use the system [8].

Organisations from different sectors in various countries realise the opportunity of using the Smart Cards as another channel for businesses operation. In Hong Kong, the transport and retail sectors are leveraging the powerful capability of Octopus. Octopus helps organisations maintain profitable growth by enabling them to automate work done by employees, reduce cost and retain customers simultaneously.

The adoption of Automatic Teller Machines (ATM) and Electronic Fund Transfer at The Point Of Sale (EFTPOS) in the 1980s led smart card providers to consider that the uptake of the cards by customers would justify the capital expense of setting up systems. The small transaction cost of Octopus is more than offset by the average of 1% fee charged by the service provider, Creative Star [8].

From the customer perspective, the use of Octopus on the services such as transport, retail and recreation, that they commonly frequent, would bring benefits of convenience and speed. The aim of this study is to explore, and develop an understanding of the existing Hong Kong Octopus smart card use and to ascertain other potential uses and how the system can improve its utilisation and the services provided.

The first section of this paper briefly introduces smartcard technology and the Octopus system. The history and future development of the system will also be addressed in this section. Research methods and the results of the survey would be covered in section three and four respectively before conclusions are drawn in the last section.

2. SMARTCARDS AND OCTOPUS

This section of the paper will give an introduction to smartcard technologies and the Octopus system in Hong Kong. The history and main types of smartcards will be discussed in Section 2.1 while the Octopus system will be addressed in Section 2.2. Section 2.3 will provide background information on Creative Star, the founder of the card and some of the future developments of the card are covered in section 2.4.

2.1 Introduction of smart cards

It has been almost three decades since Roland Moreno invented and patented the smartcard technology in 1974 [11]. It gained widespread acceptance in European and Asian regions [10]. Schlumberger, one of the world leaders in smartcards forecasted that more than 3100 million smartcards would be consumed worldwide by the year 2003 [1].

There are many applications to smartcards and usage is becoming more and more pervasive within our society [10]. The use of smartcard can be found in transits, electronic payments, banking, access control, telecommunications, healthcare, education and more. The power, intelligence, enhanced capacity and the reduced cost provided by the technology attracted acknowledgements from users and organisations worldwide [5] [10] [13] [18].

Smart cards normally appear in the same shape as credit cards and are embedded with a chip or microprocessor that can handle and store up to 10 to 100 times more information than traditional magnetic-stripe cards [4].

They can be found in four different categories: they are contact, contactless, hybrid and combi [5].

Contact cards contain a chip that is mounted on the surface of the card and direct contact must be made with the reader when used. Hence, users must insert their cards into the reader for verification and it would induce a slower speed in the process compared to contactless cards. The Mondex system by MasterCard uses such card technology.

Built in chip and antennas are contained within contactless cards. Instead of direct contact with the card reader, radio frequencies were used each time the card is presented over and in proximity to the reader. The contactless feature provides speed and convenience over the contact cards and is very popular in "high volume" businesses such as the transportation sector where seamless and speedy activities take place. The Octopus system in Hong Kong, and similar projects that were launched after it, use such technology.

Hybrid card are cards that contain two contact and contactless chips whereas combi cards contain both the chips installed on contact and contactless devices. It is believed that combi cards would ascertain high levels of security and its potential in uses in banking and mass transit application is noted [5].

2.2 What is Octopus

Octopus is a non-contact smart card that is used to serve as a means to a transportation ticketing and payment medium in Hong Kong. It is a "touch and go" electronic payment system that offers users an easy and convenient way to travel. Each Octopus card contains a built-in microchip that stores all the fare information and other applications. Users demanding the supported services would simply "beep" their cards on the fare-processing device and the correct amount for the transaction will be deducted from the card. The card can be identified by the reader without pulling it out from the user's purses or wallets in most cases and transactions are completed in less than 1/3 second. It is easy to use and versatile. The card aims to provide a reliable, cost-effective and convenient payment method to users [19].

The project was officially launched in September 1997; six services in the transport sector were supported initially. Its wide acceptance and popularity caused the number of supporting services to grow and over 40 services are supported. As at the end of May 2001, more than 7.4 million cards were issued and approximately 7 million cards are active. Given the current population of 6.73 million [14], the ratio stands at 1.3 cards per person [8]. Currently the system process on average 6 million transactions daily and the average value per transaction is approximately HKD$7 (just under $1 US). Creative Star processed its 4 billionth transaction since its inception in May 2001 [3].

The card was previously exempted from the definition of "multi-purpose card" under the banking ordinance because of its restricted range of uses and it is also under the supervision of Hong Kong Monetary Authority (HKMA) [6]. Creative Star was authorised to become a deposit-taking company in April 2000. Such arrangement broadens and expanded the use of the medium, including non-transport related services and also as a form of cash card that is expected to enhance convenience for cardholders [6]. Transport services currently accounts for over 95% of the total volume [15].

Octopus cards take two different forms, they are mainly manufactured in a card format, and therefore they can be fitted inside ones wallet just like any other cards such as credit cards and library cards. They are also designed and manufactured in watch format so they appeared in the form of a wristwatch.

Within the two different designs and appearances, they have different categories to accommodate different needs. Five card categories are issued. They are Adult, Student, Child, Elder and personalised Octopus cards.

The Octopus system is the largest and most successful project in the world using contactless smart card technology. Various awards has been received by Creative Star and also by the Energy Research Group (ERG, an Australian based company) for their modeling expertise, success and their creativity.

2.3 The birth of Creative Star

In 1993 MTRC reviewed the costs of maintaining their ticketing system and looked for other opportunities to replace and extend the services. Contactless smartcard technology was seen as the most beneficial option for the future [3]. As a result Creative Star was set up in June 1994. Its aim was to promote the services provided by uniting all the transportation operators to ensure a seamless ticketing system. These other operators now include Mass Transit Railway (MTR), Kowloon-Cantoon Railway (KCR), Light Rail Transit (LRT), Kowloon Motor Bus (KMB), Citybus, New World First Bus, New Lantao Bus, New World First Ferry, Star Ferry, Hong Kong and Kowloon Ferry, Discovery Bay Ferry, Airport Ferry, Green public light bus, peak tram, Hong Kong tramways and some non-franchised buses. The services have been extended further to retail providers such as 7-11, Starbucks café, school tuck shops, fast food restaurants, bakeries and to recreational services (35 in all) owned by the councils as well as other services such as parking meters and car parks.

2.4 Future directions of Octopus

The company is determined to expand to all public transportation services and other "low-value high- volume transaction businesses". They are currently negotiating with other transportation providers such as taxis and minibuses and services such as supermarkets, petrol stations, post offices and working with banks to offer attractive automatic add-value services to their users.

The company also aims to promote Universal Serial Bus (USB) card readers for personal computers so that users can top-up their cards via their card readers installed at home. Facilitating purchases over the Internet is also an

option and a potential area that Creative Star and Octopus will address in the near future [17].

3. RESEARCH METHODOLOGY

A multi-methodology approach was used in this study. A survey was sent to 800 Hong Kong residents to ascertain the pattern of card usage. Interviews were obtained from the organisations using the Octopus card to provide their services. Interviews were also obtained with the operators (e.g. bus drivers). Focus groups were run with potential and current users. The population of this study is anyone in Hong Kong who has been using Octopus, or who could potentially use Octopus. The results to the survey will be discussed in the next section of this paper.

4. RESULTS

This section of this paper will discuss some of the results collected by the survey. Statistics figures, tables, graphs and comments will be included so that a better understanding of how Octopus is perceived by the respondents can be obtained. Information about (1) card ownership, (2) usage of cards, (3) failure rates, (4) top-up habits, (5) results from promotion schemes and loyalty programmes, (6) satisfaction on number of services supported and suggestion on potential applications, (7) success factors of Octopus, (8) reliance on the system and (9) factors of how the system can be improved are to be addressed in the sections below. Results obtained by interview sessions are also be included with the statistical results to support various claims.

Out of the 800 copies distributed, 507 questionnaires were returned and all of them were useable, yielding a response rate of 63%. Convenience sampling was used in the distribution process. The survey was distributed in May / June 2001.

4.1 Card Ownership

Most (94.3%) people surveyed owned an Octopus card. The 29 respondents who do not possess an Octopus card were asked their reasons for not acquiring one (Figure 1).

A majority (62.1%) of respondents who do not own an Octopus card suggested that the reason was because they do not need to have one or rarely used the services supported by the system. Another 17.2% suggested that they prefer the traditional payment system, that is, physical notes and coins over electronic payments and 13.8% suggested that they were unwilling to pay the HKD$50 deposit on the card. One respondent indicated that a lack of trust in the technology and one "not in the list response" denotes the view of a disabled person who does not frequently travel.

84.1% of respondents are currently in possession of one card and most respondents owned between 1 to 3 cards. 473 respondents owned in all 514 cards. Most people own an ordinary card (Figure 2).

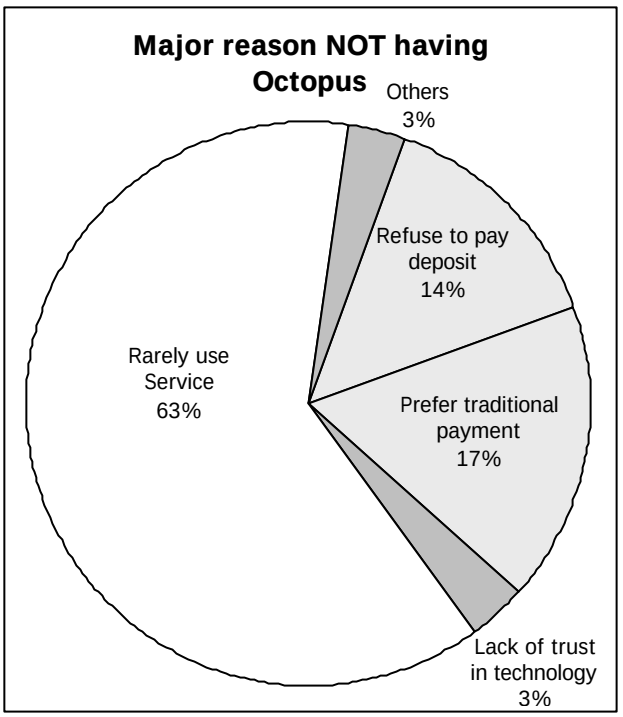

Figure 1: The major reasons for not acquiring an Octopus card.

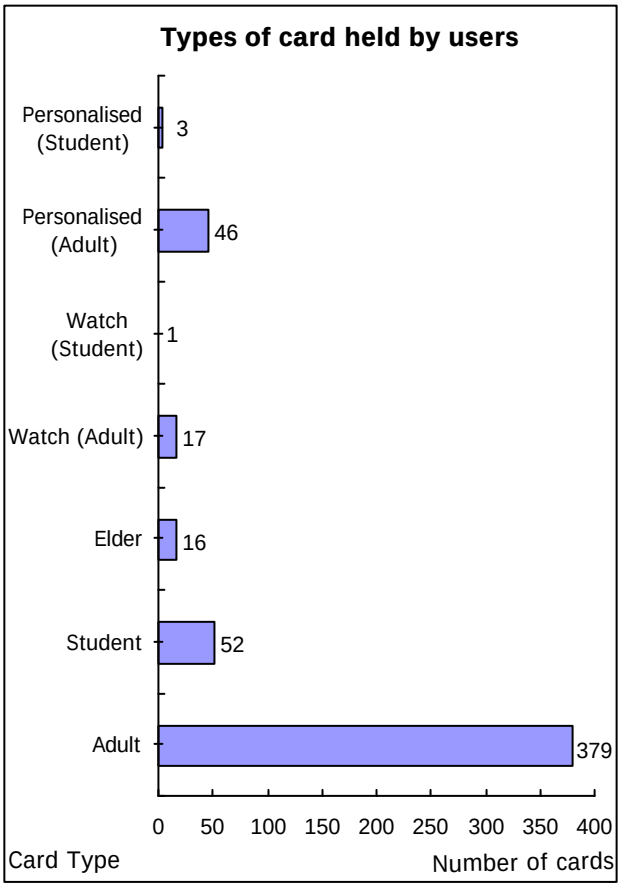

Figure 2: Types of Card owned.

Ordinary cards are anonymous cards unless the user signs with certain services or schemes. Examples include using the card as access control to urban buildings; loyalty programmes with companies that offer promotions or registration for roll check purposes in schools. Users who demand auto top-up services with authorised banks must acquire a personalised card. It is now a popular option since users may link their top-up arrangement with a credit card and benefit from cash rewards and an interest-free period. Users can stop others from using their card if it is reported missing.

4.2 Card usage

This section will describe how people who responded to the survey are using the cards. It captures the frequency with which the respondents used their cards. This question is divided into three parts that separate the major types of application supported by Octopus. They are (a) transportation and transport related services, (b) recreational activities and (c) purchases. A scale from 1 to 6 was used to measure the frequencies that best describe the usage, with 1 being the most frequent and 6 indicating that the users have not used their Octopus cards for the particular service. A presentation of the scale used in the survey is included below.

Coding of Usage Frequencies

	Description
1	More than 10 times a week
2	5 - 10 times a week
3	Less than 5 times a week
4	Less than 5 times a month
5	Have used, but cannot classify
6	Never used

Table 1: Codes used in tables 2 to 4.

4.2.1 Transportation

Octopus originated in the transport sector. Nine major transportation services supporting Octopus were included in the survey (Table 2) and the most frequently used services were bus, MTR and KCR. At present, all franchised bus routes, the entire railway system and some non-franchised routes are equipped with Octopus readers. The major bus companies have promised that the ride is free if the card reader is inoperative.

Transportation Services

	N	Mode	Mean
Bus routes	467	1	2.19
MTR	464	2	2.52
KCRC	422	5	3.88
LRT	401	6	5.42
Mini bus	425	6	4.74
Tram	405	6	5.63
Peak Term	400	6	5.79
Ferry	409	6	5.27
Parking meters	394	6	5.90
Others	0		

Table 2: Usage of Octopus card for transportation services.

The modal values for bus rides, MTR and KCR were 1, 2 and 5 respectively, indicating that most people surveyed would use their cards on those services up to 10 times per week. 58.4% of the respondents use at least one of the transportation services by Octopus more than 10 times a week. A presentation of the scale used in the survey is included in Table 1.

The usage of Octopus in parking meters, mini-buses, tramways, peak trams and ferries are not as high as the other services discussed above. This might have been caused by the fact that the Octopus system has not fully implemented those services. Tramways, for example, only adopted this technology in April 2001 and readers were only installed on 25 of their fleet of 163. The usage of Octopus in parking meters was also under review and not all meters are equipped with the feature. As seen by the reliance of the cards by users on buses and the railway networks, it is expected that its usage would increase.

4.2.2 Recreational services

The introduction of usage of Octopus card outside the transport arena was quite new as the Hong Kong Monetary Authority restricted the use of the system to transport related services. The telephone booth was the first location in the list to be supported by the system in this category (Table 3). Entry to the racecourse was on trial from last year and Octopus payment is accepted in more than thirty-five council-owned recreational venues as at June 2001 after it was trailed in selected swimming pools.

Recreational Services

	N	Mode	Mean
Swimming pool	414	6	5.75
Entry to racecourse	404	6	5.97
Entry to urban buildings	406	6	5.90
Telephone	408	6	5.79
Others	0		

Table 3: Usage of Octopus cards for recreational services.

Table 3 shows that the most used services in this category were telephone and swimming pools. Mean values ranging from 5.75 to 5.97 reflect that users have either used their cards for those services but cannot quantify how often they do so or that they have never used the card for those applications. In general, we could comment that users rarely use those services.

Demand for services in this category is limited to people with similar interest or habit (e.g. swimming and going to the racecourse), or restricted to where they live (as for access controls) and their demand for telephone service. A recent report shows that the registration of cell phones in Hong Kong reached over 5.5 million [2]. However, the Council's move to implement the system at its venues would guarantee wide acceptance and cost savings.

4.2.3 Purchases

Outlets in the retail sector are slow realising the benefits from adopting the technology (Table

4). With additional services such as supermarkets, petrol stations and post offices aiming to join and support the system in the future, more convenience can be offered to users.

Purchases

	N	Mode	Mean
Vending machine	416	6	5.54
Photo Booth	405	6	5.82
Maxim fast food	415	6	5.49
Maxim bakery	412	6	5.62
7-11 stores	417	6	5.35
School tuck shop	400	6	5.93
Others	4	3	3.75

Table 4: Usage of Octopus cards for purchases.

Seven-Eleven (7-11) stores attract the most customers followed by Maxim fast food and vending machines. The usage in school tuck-shops was the weakest among all other services listed in this category; again, this can be expected, as this service is restricted to a targeted group of users. The respondents nominated three additional services for which they used Octopus - Starbucks Café, Chinese style fast food restaurant and photocopying services.

The mode was '6' for most applications; it indicated that users have never used the services by Octopus. The users do not require the services as much as they do the transportation ones. Lack of promotion and advertising by the service providers might also be a reason why those services are not used extensively [8]. Users' habit might change, as they become more experienced and comfortable with paying for those services with this medium.

Overall, the survey showed that most card owners use their cards on a regular basis and most of them used it for transportation. The failure rates experienced by the users will be discussed next.

4.3 Failure rates of Octopus

There are times and chances where products, technologies or innovations will fail; Octopus is no exception. Respondents of the survey are asked to report if their cards have failed in the past 12 months. The results are presented in Figure 3.

Of the valid responses to the question, 28.4% (132) respondents have experienced card failures in the past year. Considering the scale, volume and the complexity of the project, this failure rate may be considered as acceptable. It is important to note that the definition of a "failure" includes a wide range of incidents where they might have been caused by the user, but not the system itself. Of the 132 respondents who experienced card failures, over half (59.8%) experienced it only once. 81% experienced card failures either 1 or 2 times.

According to the interview with Creative Star, the major reason for card failure was because users have not properly looked after their cards. Putting their cards in the back pockets and using cards without a plastic cover might cause damage to cards. Magnetic fields released by magnets and/or electronic devices, the breach of rules and regulations in card usage may also result in card failure. Creative Star considers that card failures would be reduced significantly if users looked after their cards. Improvement to the failure rate may also be achieved through education. The top-up habit of users will be addressed next.

4.4 Top-up habits

Since cards were frequently used for various applications and services, topping-up is required. This section will report the top-up habits of the users.

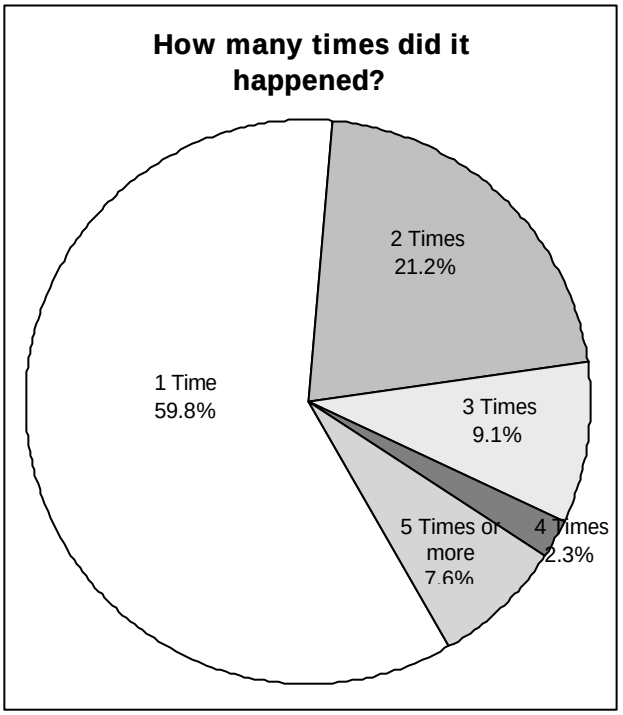

Figure 3: Card failure frequencies in the past year.

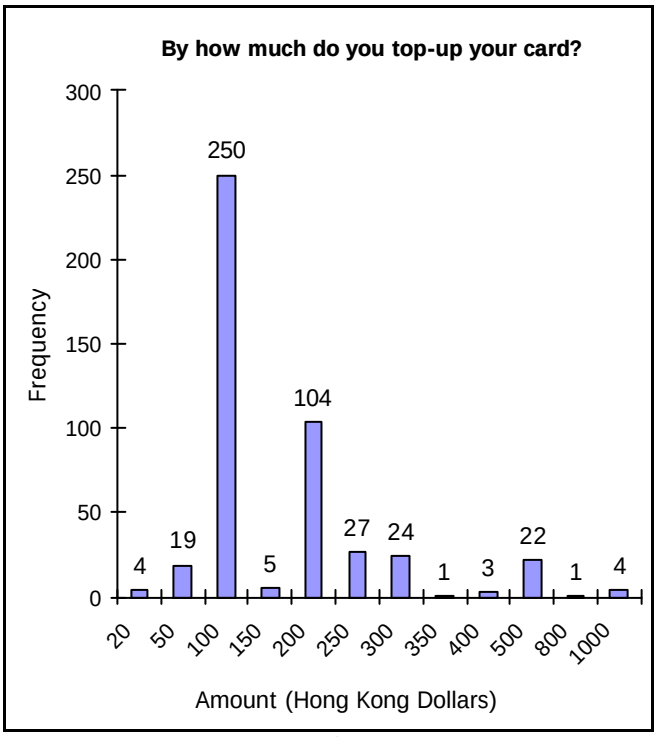

Figure 4: Top-up amounts ($).

Most people (53.8% of all respondents) top-up their cards by $100. HKD$200 and HKD$250 are also two common amounts by which people top-up their cards. They accounted for 22.4% and 5.8% of users respectively. HKD$250 is the standard amount to be added to cards if the auto top-up service is arranged with authorised financial institutions by personalised cardholders.

The result suggested that 28.6% of the respondents top-up their card twice a week and 25.2% top-up their cards every fortnight. 39.6% of the respondents top-up their cards at least once every week. 5.7% of the respondents adopt the auto-top-up service.

Figure 5 reflects the location where the users surveyed top-up their cards. Most people top-up their cards at Railway (MTR/KCRC/ LRT) stations and VAM (Self value added machines) located at the stations. 7-11 stores are also a common place for top-ups. Ferry Piers (also recorded on the survey) recorded responses.

28.6% (130) of the respondents top-up their cards from VAM in railway stations, where they can top-up their accounts by two different methods (by cash or by Electronic Payment System (EPS)). 121 out of 130 people answered and 82.6% loaded cash into the machine and 17.4% used EPS. Cash remains the main payment method even when a cashless alternative was provided.

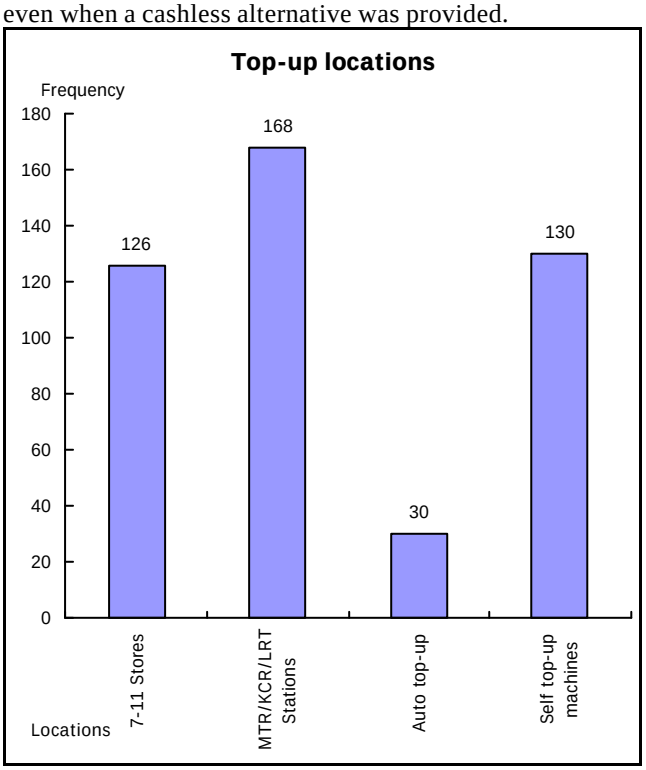

Figure 5: Users' top-up locations.

4.5 Results from promotion schemes and loyalty programmes

Octopus does make use of database technology to provide benefits and rewards to their customers. As a marketing strategy, certain service providers have introduced loyalty programmes and special promotions to attract customers and increase revenue. This section explores the results from the various schemes that were launched. Table 5 shows the respondents' benefits from the current schemes.

Loyalty Programmes

	N
Interchange Services	44
Half Fare discount on citybus	27
$1 Elderly discount	9
MTR Exclusive Discount	76
MTR/ 7-11 Website	5
KCRC Loyalty programme	7
KCRC Exclusive Programme	12
Others	7

Table 5: Usage of Octopus cards in loyalty programmes.

The loyalty programmes offered by MTR and Bus-Bus Interchange (BBI) were the top two most popular schemes. Over half (67.2%) of the respondent did not benefit from any of the schemes. Only 153 respondents claimed to benefit from at least one promotion project. The maximum number of schemes from which users benefited was three.

Creative Star is planning to implement new cards in the near future to allow more service providers to run more promotions simultaneously. At present, due to memory constraints, limited storage space is being assigned to the cards and it is not possible to allow for large marketing projects [8].

MTRC reported that the promotion exercise does increase ridership and benefits their business. By getting the users' information, by registration with their site and their card number, the marketing department can now get more information on the travelling patterns of their commuters. "This helps a lot in the development of promotions and other business initiatives" [9].

City bus and KMB responded in interviews that the results for Bus-Bus Interchange (BBI) schemes were not all successful (private conversations with KMB and City Bus). Both companies are enthused that possible arrangements of new schemes can induce extra cost savings and revenue to the firm. However, the establishment of new schemes is inhibited. For example, the railway companies complain of the threat of reduced market share in some schemes. Citybus commented that the result of the $1 discount for the elderly was a big success and enhanced the firm's image. The discount was extended due to its popularity [7]. MTR stated that it would make use of database technology to provide services that add value to their customers [9].

4.6 Satisfaction on number of services supported and suggestion on potential applications

This section will measure user satisfaction with Octopus regarding its prevalence. Octopus is now supporting more than 40 services. Of the 465 people (from a possible total of 478) who have responded to this question, 60% are satisfied with the number of services that are currently supported by Octopus. The 40% of respondents who are not satisfied with the number of services that are currently

supported by Octopus were given the chance to select or suggest the services that they think should be supported by the system. A list of services selected from the "high transaction, low value" category were included. Only responses that are from an unsatisfied user were included. The services suggested by the respondents are shown in Table 6.

Potential Services (Ranked)

	Score	%
1. Supermarkets / Chinese market	135	74
2. Newspaper stand and magazine stand	110	60
3. Road Toll	90	50
4. Snack/ food stand	73	40
5. Stationery Shop	55	30
5 Video games centre	55	30
7. Transportation	46	25
8. Other services	12	7

Table 6: Potential services to be supported by Octopus as suggested by users.

The count column sums up the total of respondents who have selected the related services. The percentage column represents the percentage of the respondents choosing the service. Other services suggested by respondents include cinemas, clothing boutiques.

The use of Octopus in supermarkets and Chinese markets were the most popular services that respondents would like the system to support.

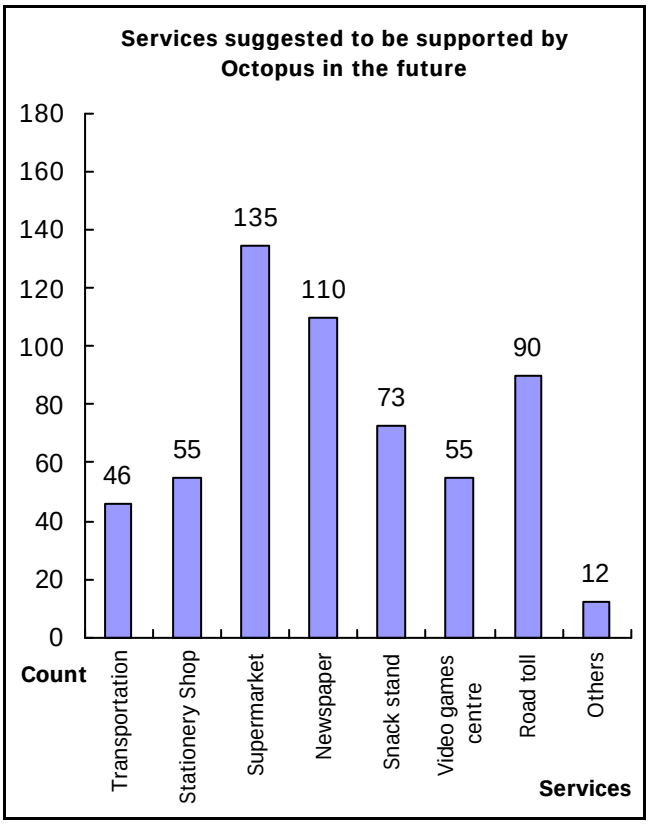

Figure 6: Potential services to be supported by Octopus as suggested by users.

Both newspaper stands and road toll attracted over half of the respondents. Note that the desire of expended use of Octopus in transportation services was the bottom of the list. This might have been caused by the reason that most of the transportation in Hong Kong is supported by the system. Respondents were asked to indicate which transportation service they would like Octopus to support if it was selected. Most of them suggested that all public transport should support Octopus. Taxis and minicabs were the two popular choices.

4.7 Success factors of Octopus

Octopus is the world's largest and most successful contactless smart card project. With more than 7.4 million cards issued and a population of 6.8 million, the wide diffusion of the system is unchallenged. The survey reports the penetration for people aged 15 and over was 94.3%, close to the result of 91% recently reported by Creative Star.

Respondents were asked to rank the three most important success factors, with the weight of three given to the most important factor, two to the next and one to the third. The reasons contributing to its success are presented in Table 7. The score in the first column gives the sum of the column. That is, the higher the score, the more importance or weight that is attributed to the related factor. The second column counts the total number of responses recorded for each factor. There were 458 valid responses. The third column shows the percentage of respondents who have chosen each factor.

Factors that lead to success of Octopus

	Score	Count	%
1.Quick payment service	937	384	84
2.Easy to carry compared to notes & coins	740	343	75
3.Versatile -support wide range of services	443	265	58
4.Allows for negative balance	190	115	25
5.Accurate	142	186	19
6.Savings over traditional methods	105	59	13
7.Loyalty programme	85	52	11
8.Low failure rates in readers and cards	79	49	11
9.Other benefits	5	3	1

Table 7: Factors that lead to success of Octopus.

4.8 Reliance on the system

Respondents were asked if there are any services for which they would not use Octopus. This reflects their opinions and the level of reliance of the system. 29.2% of the 448 who responded would pay for all conceivable services by Octopus card. Of the 62.5% respondents that would be discouraged from doing so, the reasons are listed in Table 8.

The major reason (36.7% of the responses) for not using Octopus for the payment was because it would be difficult to stop a payment or to get a refund. People were worried about the security of the system that might cause financial loss to them. Other reasons included "fear about insufficient funds".

Major reason not to use Octopus for all purchases

	Score	%
1.Difficult to stop payment/ get a refund	102	37
2.Worried about security / financial loss	74	27
3. No statements to keep track of expenses	71	26
4.Does not benefit from interest free period	22	8
5.Other reasons	9	3
	278	100

Table 8: Major reason not to use Octopus for all purchases.

4.9 Improvements and future development

In spite of Octopus success, on-going improvement is essential, as for all other systems. Table 9 identifies improvements that the users perceive as being most important. Improving security was seen as the most important factor for Octopus to consider, with 83.9% of the respondents including it in their top three. The second factor is to increase the number of services supported (82.1% of the respondents).

Factors that Octopus can improve

	Score	Count	%
1.Improve security features	878	379	84
2.Increase number of supported services	782	371	82
3.Improve accuracy rate	620	329	73
4.Improve maintenance of card readers	359	225	50
5.Others	19	13	3

Table 9: Factors that Octopus can improve.

The usage of smartcard devices is now expanded to national identity cards in Malaysia and Hong Kong [12] [16]. This study therefore provides some of the essential background characteristics important to the adoption of such technology."

5. CONCLUSION

This paper explores the Octopus payment system and results of the survey were discussed in detail. Information on card ownership, usage of cards, failure rates, top-up habits, results from promotion schemes and loyalty programmes, satisfaction on the number of services supported and suggestions on potential applications, success factors of Octopus, reliance on the system and factors of how the system can be improved were addressed.

It is clear from the results that most Octopus card owners are satisfied and reliant on the system. This paper allowed us to explore how and why the system was successful. It also revealed that companies could make use of database as a strategic weapon and new marketing techniques allow them to benefit from savings and increased revenues.

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