

# USER ACCEPTANCE TESTING OF MOBILE PAYMENT IN VARIOUS SCENARIOS

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**Abstract:** Recent studies show that the number of mobile devices has already exceeded the number of personal computers. Contradictorily, the commerce conducted via the mobile devices ("M-Commerce") is far less than that of internet ("E-Commerce"). This paper looks into the context of the mobile commerce from two dimensions. (i) The framework of mobile payment system, the mobile payment model, the classification of mobile payment and mobile service. Spinning out from these discussions, it helps to provide a better understanding of how the mobile payment model is constructed and what m-commerce is all about. (ii) From the user's perspective, the user acceptance analysis of the mobile users and the mobile commerce system, in which the characteristic of the users, the constraints of the system are discussed. With these two dimensions in mind, the application scenarios of the m-commerce system, that is, the situations where m-commerce can put forth to perform required task, are suggested. Our empirical results show that although people in Macau think using mobile phone is an innovative and convenient tool for making payment, the acceptance level is still not very high.

## 1 INTRODUCTION

Mobile commerce (m-commerce) resembles electronic commerce on internet (e-commerce) in many ways. Typically people are used to compare m-commerce with e-commerce in terms of its architectural framework. Over the year the m-commerce is not as widespread as e-commerce. Is the technology being not supported for m-commerce, or the mobile devices limited its capability to develop further? What is the reason or limitation? This makes it an interesting and important topic to look into.

In the context of m-commerce there are several disciplines involved. M-Commerce services and applications can be provided on different mobile networks, via different mobile devices which run on different platforms. There are many aspects of hardware and software combinations. To limit the scope of our study we focus on a generic architectural design of the mobile commerce system using Short Message Entity.

The purpose of this study comes in twofold. We first argue that m-commerce can be readily implemented over the existing infrastructure. Technically it could be relatively easy to implement by mobile service operators. We aim to show technology-wise m-commerce is ready. The other objective of the study is on the user acceptance of the general public, taking a sample of citizens who live a modern lifestyle from Macau, a rising metropolitan urban city lately. From the surveys, we found by surprise that the user acceptance level of m-commerce is not proportional to its readiness in technical development.

## 2 MOBILE PAYMENT SYSTEM DESIGN

The Mobile Payment System [1] is designed operate with existing GSM infrastructure. The architecture stretches from the user handset to the GSM network service node, and in between the components is the

Mobile Payment system we discussed in this paper. It serves as a middleware to handle transactions between the subscribers, the merchants and the network operators. Each component interacts with each other to deliver the function of enabling the consumer-side and the merchant-side to do buying and selling over the wireless platform. There are five components, the Mobile Station (MS), Mobile Network (MN), the Short Message Service Center (SMSC) and the Unstructured supplementary Services Data (USSD) server, both are service nodes within a GSM network, and finally the Mobile Payment System. Figure 1 shows the relationship of these components.

Mobile station is a transmission and receiving end of SMS. In this study, mobile station always refers to a basic mobile phone of a customer. But in the merchant side, it could be a GSM modem inserted with a SIM. When the modem is connected to a personal computer (PC) it could easily be used as a terminal. There are two parts in a Mobile Station, namely the equipment part and the radio part. Equipment part has an input device (keyboard), an output device (screen) and the CPU. The Subscriber Identity Module (normally called SIM card) is inserted into a slot in the equipment part. The SIM card stores the IMSI (International Mobile subscriber Identity) and the secret key Kp which is useful information to be transported during the authentication process to the wireless network. Radio part is a radio transceiver for transmission and reception of radio signal. The GSM network is the wireless network part. In short, the radio sub-system interface with the mobile station, where at the network sub-system which is the HLR, VLR [2] which the information and the gateway that connect to other network. And the operation sub-system which includes the AUC that is responsible for the authentication and also the billing system that stores the charges record for each subscriber [3].

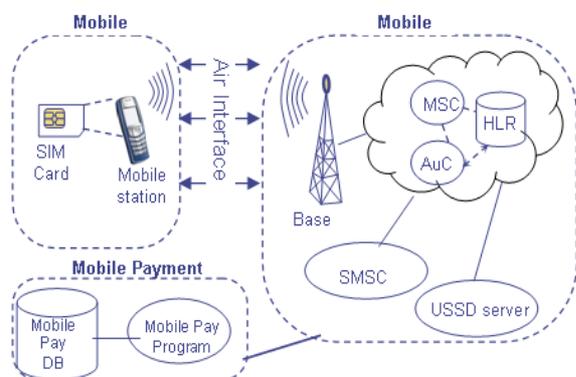


Figure 1: Overview of the System Architecture.

The Mobile Payment System which is intended to interface with two important service nodes exists in the GSM network system. First is the Unstructured supplementary Services Data (USSD) server and second is the Short Message Service Center (SMSC) [4]. It is designed to listen to the incoming calls from the USSD server, translate and extract the information from the USSD calls. Another client gets the information and passes it to a main program. The main program controls the logic of the system, including from receiving the data, sending a request to SMSC, writing the billing record to the database, etc. The schematic diagram below shows the general design.

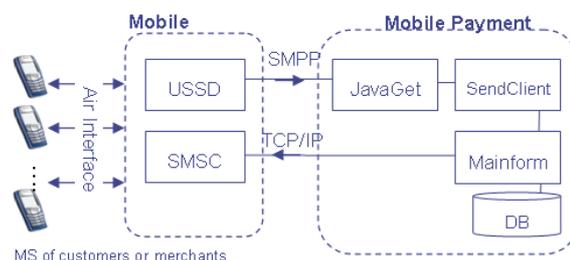


Figure 2: The Architecture Design.

The Mobile Payment system logic is to control the flow. It is designed to listen to request sent from the merchant or the users, and to connect the SMSC for further messaging service. For the payment authorization and the user authentication, it performs the checking function and finally records the transaction log. The idea is depicted below:

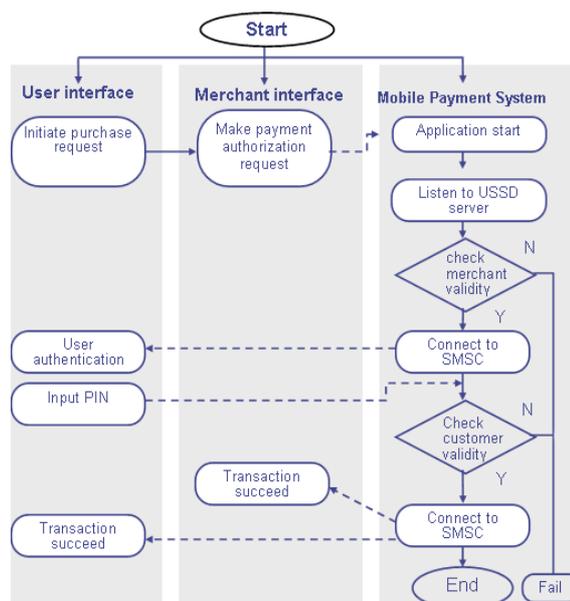


Figure 3: Mobile Payment System Logic.

### 3 APPLICATION SCENARIOS

Application scenario of the m-commerce system is referred to the situation whereas the system can put forth to perform designated task as required by the users. Four typical m-commerce scenarios are looked into in our study, which later will be surveyed in the user acceptance tests:

- Mini-payment at a merchant
- Person-to-person mobile payment
- Mobile Advertising / survey / m-voting
- Web-store Purchase via Mobile Payment

#### 3.1 Mini-payment at a merchant

Mini-payment at a merchant means a mobile customer wants to buy goods or service from a merchant; both of them are equipped with a mobile station. A typical example is a customer who wants to buy a drink from a grocery store or want to pay for a taxi fee. The Sequence Diagram of this scenario is depicted as below. MS(m) means Mobile station of merchant and MS(c) means mobile station of the customer. First the MS(c) initiates the USSD request to the MS(m) and then the mobile payment server listens to the USSD request and checks the validity of the merchant, then sends a request to SMSC which then sends an SMS to the customer to verify his PIN. It also creates a record in the DB.

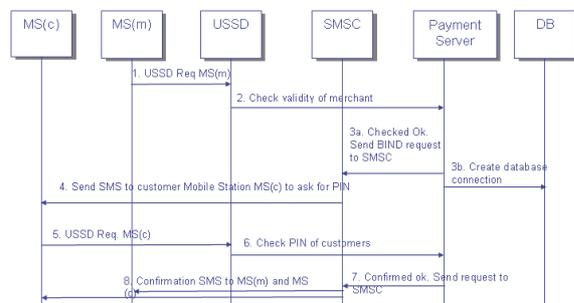


Figure 4: Sequence Diagram of “mini payment at a merchant” scenario.

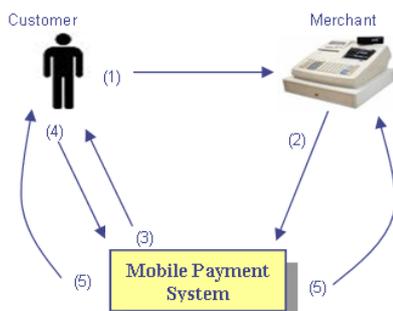


Figure 5: Service flow illustration of a merchant scenario

The service flow of the “mini payment at a merchant” scenario is described below.

Step 1: The customer shows his intention to buy a product from the merchant.

Step 2: The merchant asks the customer for his mobile phone number. Then the merchant uses a mobile station to send a USSD request to the Mobile Pay system, including the type of goods and the price in a USSD command as

*[USSD Code] \* [Customer mobile number ] \* [transaction type]\*[Product ID] \* [Amount] #*

Example: \* 137 \* 6381234 \* MP\*01 \* 1200 #

Explanation: The command interprets into that the merchant wants to charge a customer 6381234 who wants to buy the product ID=01 (e.g. Drinks) at the price \$12.00 (the last 2 digit denote the decimal place, so 1200 = \$12.00)

Step 3: The Mobile Pay system gets the request from the merchant. After verifying if it is a valid merchant, it then extracts the mobile phone number of the customer and sends an SMS notice to ask the customer to verify the transaction. A message “Please enter your PIN to verify the payment request at ABC shop for Goods01 at a price \$12.00”

Step 4: The customer input his PIN number via a USSD command: *[USSD Code] \* [Customer PIN] #*  
For example: \* 137 \* 98765 #

Step5: If the PIN is correct, the Mobile Pay system sends a notifying SMS to both parties to confirm the transaction succeed.

#### 3.2 Person-to-person payment

This is a scenario when two mobile customers who want to transfer money from one account to another account. An example is such that a parent who wants to control the usage of their child’s expenditure can transfer a certain amount of money to their prepaid account. Another example is a bidder transferring money to the seller upon winning an auction. The Sequence Diagram of this scenario is depicted as in figure 6. MS(a) is Mobile station of user A and MS(b) is mobile station of the user B. First the MS(a) initiates the USSD request to the MS(m) and then the mobile payment server listens to the USSD request and checks the validity of the merchant, then send a request to SMSC which then send SMS to the customer to ask for the PIN. On the other hand it creates a record in the DB.

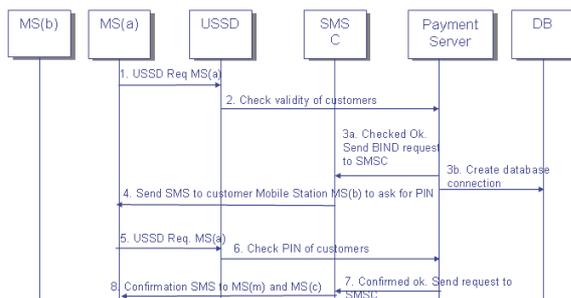


Figure 6: Sequence Diagram of “P-to-P” scenario

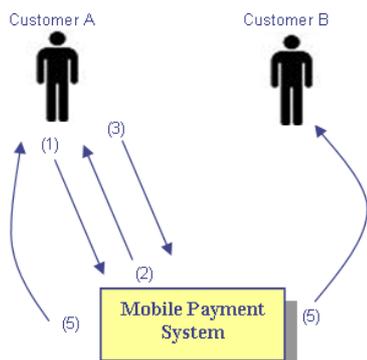


Figure 7: Service flow illustration of “P-to-P” scenario

The service flow is described below.

Step 1: User A want to transfer money from his account to user B. Then user A uses a mobile station to send a USSD request to the Mobile Payment system, including the amount in a USSD command as

*[USSD Code] \* [target Customer mobile number ] \* [transaction type]\* [Amount] #*

example: \* 137 \* 66381234 \* PP\*5000 #

Explanation: The command interprets into that the user A wants to send user B 66381234 the amount \$50.00 (the last 2 digits denote the decimal place, so 5000 = \$50.00)

Step 2: The Mobile Pay system gets the request from the customer, after verifying if it is valid, then send an SMS notice to ask the customer to verify the transaction. A message “Please enter your PIN to verify the payment transfer request of \$50.00”

Step 3: The customer input his PIN number via a USSD command *[USSD Code] \* [Customer PIN] #*  
example: \* 137 \* 98765 #

Step 4: If the PIN is correct, the Mobile Pay system sends a notifying SMS to both parties to confirm the transaction is successful.

### 3.3 Mobile Advertising / survey / m-voting

Mobile advertising /survey / m-voting is an one-to-many mechanism, meaning the advertiser or surveyor makes use of the a customer base of the mobile network operators, to promote their products or service, or doing a survey. Usually content providers are very often to use this platform when there is news to be broadcasted of a new ring-tone, mobile games or some events. On the other hand, market researcher also makes use of this mechanism to study the customers preference. But the mechanism needs to co-operate with MNO because due to the privacy ordinance, MNO are not allowed to disclose the user mobile number list to outside parties as a matter of privacy protection. The advantage is that sending a SMS is a low cost communication and it is an impulsive channel, the response rate sometimes is far higher than sending an email or postal mail by our experience.

The Sequence Diagram of this scenario is depicted as below. Terminal is the web interface of the mobile payment server. In this case advertiser or researcher needs to pre-register in the MNO so that the money could charge to their phone bill accounts. After login, server sends SMS to the targeted list of users. When mobile users receive the message, they follow the instruction to perform the next step, which either needs them to reply an SMS or login a website to proceed to further steps.

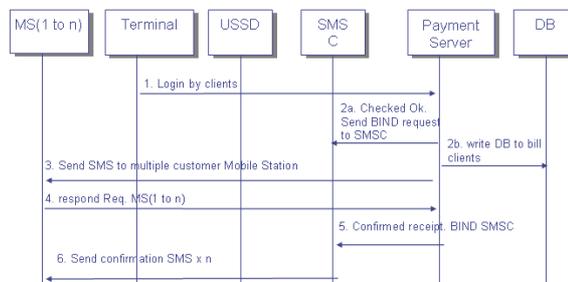


Figure 8: Sequence Diagram of “mass-users” scenario

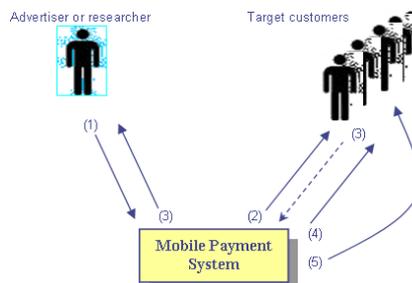


Figure 9: Service flow illustration of “mass-users” scene

The service flow of mobile advertising and survey is described below.

Step 1: The advertiser or researcher login the web terminal of the server. Upload the text message and the target customers list.

Step 2: The server checks ok. Send SMS to target list.

Message Example: "There is a new batch of pop singer music tones available, please press \*\*137\*10001# to download."

Step 3: The mobile users response according to the instruction.

Step 4: The server performs next step, the music download for the customers.

Step5: A notifying SMS to customers to confirm the transaction succeed.

### 3.4 Web-store Purchase via Mobile Payment

Web-store Purchase via Mobile Payment is a combination of mobile payment and internet shopping. In many cases the payment method of internet browsing is by credit card or pre-stored value account. Mobile payment is offering an alternative method for the internet shopping. This is applicable to small amount purchase like buying digital content from a website, example, accessing to a document, mobile games, etc.

The Sequence Diagram of this scenario is depicted as below. MS(c) is Mobile station of customers. First the MS(c) browses the website of the web-store, intends to buy goods or service, so he enters the mobile number. Web-store passes the request to server; server sends a validating code to the customer, which uses the code to validate the transaction. A confirmation SMS is sent to customer and a record is created in the DB.

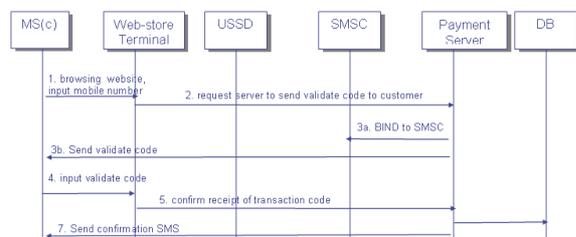


Figure 10: Sequence Diagram of "Web-store Purchase via Mobile Payment" scenario

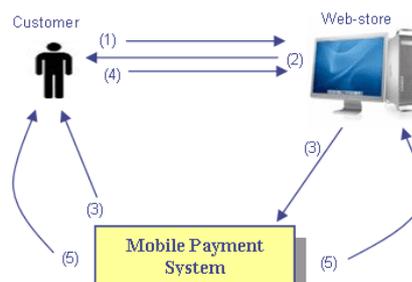


Figure 11: Service flow illustration of "Web-store Purchase via Mobile Payment" scenario

## 4 MARKET SURVEY

In order to better understand how much people know about the mobile commerce and how much do they accept the mobile payment methods, a user acceptance survey was carried out. The survey is a questionnaire based survey and was conducted in June 2007. There are 3 parts in the questionnaire, first is the demographic information like the gender, age range, education level and income level. Second part investigates on the mobile users' behaviours, especially on how what kinds of tools they perceive their mobile devices are, as well as their experience in using internet shopping. In part 3 we are going to question the participants about their awareness towards mobile commerce and whether they will participate in mobile commerce in each of the four specific scenarios. The statistics are presented in the next section.

A total of 250 copies of questionnaires were sent out. 56% of the respondents are male, and 44% are female. Most of them (64%) are young adults aged between 26-45, while 20% are teens and 34% are elders. Approximately 30% of the respondents have a university degree and more than 75% has completed their secondary level. Majority of the respondents have a monthly income within the range of HKD10,001 to HKD20,000; this income level is considered above average in Macau. 17% earn more than HKD20,000 and only 5% earn less than HKD5000. 7HKD approximately equals to 1USD.

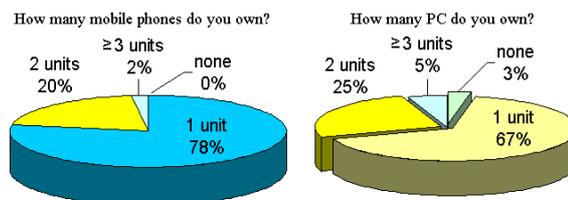


Figure 12: Percentages of mobile phone/PC ownerships

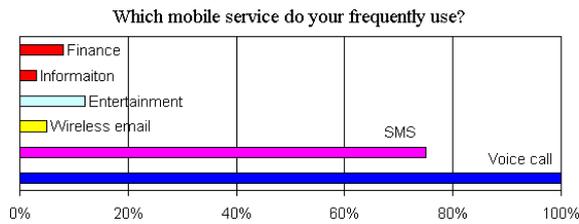


Figure 13: Percentages of popular mobile service

For those who own a home PC which can access internet, 35% of them had the experience of purchasing product or service online. The major activities from this online shopping experience are from buying air tickets and reserving hotel rooms. This may be in conjunction with the rise of budget airlines landing at Macau airport in recent years. Nevertheless, most of them choose credit card as payment method. From this group of respondents who have online shopping experience, we asked them if they have heard of mobile payment. Many of them never used it at all. Only a few has the experience of using it.

Another question is to ask how respondents rank the importance of commerce, communication and content on both mobile and internet platforms. The purpose of this question is to observe the perception of people what the major function of mobile and internet in their mind is. It is noticed that mobile phone, generally, is perceived only as a piece of communication tool. Many people are reluctant to relate it as an instrument for conducting commerce.

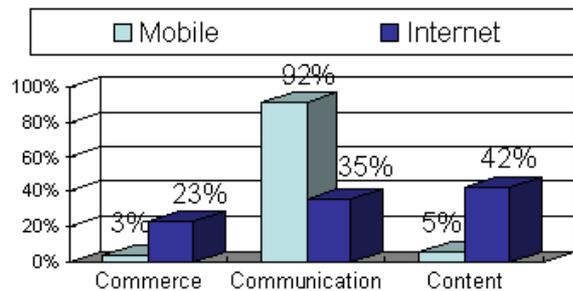


Figure 14: Importance of mobile phone/PC usage

In the section of awareness and willingness, about one-fourth has no idea on what role do a mobile phone plays as a payment platform. And almost half of them think mobile phone payment is only for a limited range of services such as downloading service. 18% think it is a new payment method to support all types of online shopping, 12% people thinks mobile phone payment is an innovative paying method that will influence all the aspects of our lifestyles.

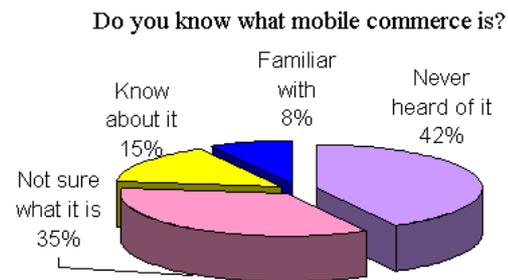


Figure 15: Familiarity about mobile commerce

Finally after asking many questions regarding the mobile payment, it is however observed that more than half of the respondents have a rough idea on what mobile payment looks is about though may not be sure in details. So it comes to the question regarding the adoption of mobile payment at various scenarios. The questionnaire is designed to check on their likelihood of using the mobile payment at each scenario, assumed that has become securely and widely available by the operators. One example is to guide the participant to imagine a city where such technology and service have already been prevalent. This is to eliminate the effect of peer group or cultural influence; they are guided to share with their individual view purely on the acceptance level of such mobile service in the scenarios. They were asked in a sequence of scenarios: the mini payment at merchant, people to people mobile payment, mobile advertising or survey and web-store via mobile payment. The findings are shown in figure 16. Many people fall into the “not sure” and “not likely” zone. However, adding up the “not likely” and “never” the statistic amounts to approximately 40% of the total score, which implies people are not very willing to use mobile payment. Those who show a positive attitude towards mobile payment occupies a small percentage.

However there are two scenarios that show a somewhat better acceptance. They are the web-store and mini-payment at a merchant. For the scenario of web-store mobile commerce, it is speculated that it may resemble the common experience of internet online shopping which the participants are accustomed to. They probably would perceive the risk level of using a mobile phone for transaction similar to that of using an online payment gateway. And for the mini payment at merchant, it echo with the benefit of using cashless convenience for fast and relatively low risk in mini-payment. Person-2-person seems like a strange way of exchanging money with a convenience of pressing a button; people usually prefer to hold onto something tangible like money tenders instead of a digital SMS.

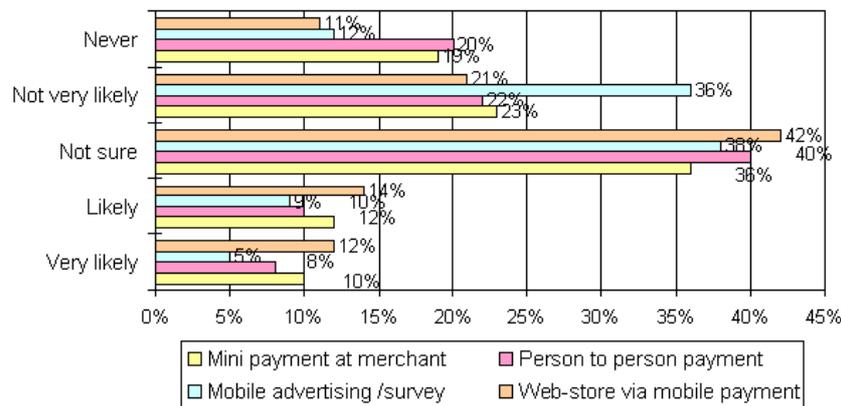


Figure 16: Likelihood of Using Mobile Payment Service at Various Scenarios

## 5 COMPARATIVE ANALYSIS

### 5.1 Benefit of using SMS in Mobile Payment

Text-messaging has played a central role in facilitating the growth of m-commerce. That is likely to continue as SMS and succeeding mobile-messaging standards bring full sets of m-commerce data sets similar to those e-commerce platforms. Originally established as part of a series of the global system, SMS has come to play a pivotal role not only in the evolution of personal mobile communications but in the development of m-commerce as well.

The simplicity of SMS makes it easy to use, fast, highly flexible, scalable and cheap - all of which have been keys to its broad adoption. Text messaging is also the most widespread and user-friendly means of charging for mobile transactions. Therefore in this study, the mini payment at merchant, person to person mobile payment, mobile advertising or survey and web-store via mobile payment scenario are also run on SMS basis.

In comparison to e-commerce, m-commerce offers a number of advantages:

- Ubiquity – the end user device is mobile, that is, the user can access m-commerce applications in real time at any place;
- Accessibility – it is related to ubiquity which is a freedom that the end user is able to access to a service from anywhere at any time. Accessibility is probably the major advantage by comparison with e-commerce applications that require connections to the internet, often from a fixed location;

- Security – mobile device offers a certain level of inherent security from the mobile network. SIM card in a mobile phone is a smart card that stores the confidential user information;
- Convenience – the handheld size, light weight of mobile devices and their ubiquity and accessibility make them an ideal too for performing personal tasks;
- Personalization – mobile devices are usually not shared between users. This makes it possible to adjust a mobile device to the user’s needs and wishes. On the other hand, mobile network operators are offering personalized services to its users recently.

### 5.2 Difference from e-Commerce

Mobile devices are also constrained by a number of disadvantages comparing to e-commerce. Mobile devices offer limited capabilities such as relatively small display windows [5]. Between mobile devices these capabilities vary that end user services will need to be customized accordingly given different manufacturers and different display format.

The heterogeneity of devices, operating system, and communication technologies is a challenge for achieving a uniform end user platform (in contracts to IBM PC-compatible, popular Windows or Linux OS). For this reason, standardization bodies consisting of telecommunication companies, device manufacturers, and value-added service providers try to work differently in solving this difference. For example many current mobile devices implement a common portable application (e.g. J2ME) for heterogeneous devices.

Mobile devices are more prone to theft and destruction. Cases of handset being stolen are on the rise. Since mobile phones are highly personalized

and contain confidential user information, they need to be guarded accordingly to the highest security standard. The communication over the air interface between mobile device and network introduces additional security threats (e.g. Eavesdropping).

### 5.3 Obstacles of m-Commerce

According to our survey it seems that users generally are not having a high level of trust on mobile commerce. This is a major obstacle that somehow needs to overcome. The low level of trust could be attributed into several areas.

*Stability* of the mobile network – mobile network is a wireless network configuration and sometimes exposed to certain threats in the events of network failures. A good example is during some peak seasons or festivals, the upsurge usage of the network will cause a great latency or even failure in the network delivery. Sometimes severe weather or thunderstorm can affect antenna reception.

*Standardization* Challenge – one of the hurdles facing the expansion of SMS and mobile messaging for m-commerce currently is a lack of officially approved standards. Even though SMS is a documented standard, it's not meant to be used in a commercial context. Some telecommunication operators would resort to their de-facto approaches in implementing mobile payment as a value-added service. Different operators would code for instance, different header fields and different message envelopes in different ways, proprietarily.

User experience – the buying process of m-commerce is not as convenient as that of internet in terms of usability, which has flexible and presentable visual and audio aid. In terms of user-experience, it is still preferable to shop over e-commerce websites on internet. Mobile phones however are used mainly as a communication tool.

## 6 CONCLUSION

This paper showed a comparative study on m-commerce applications in various scenarios, and some designs on the implementation. By making use of the existing resources a Mobile Payment system can be developed to handle the payment logic with a reasonably low investment. In terms of security, it resides on the security of the GSM network [6]. The GSM standard has defined the security measure to protect the customer confidentiality and the customer identity authentication. PIN is checked at every attempt of transaction. Moreover, financial

institution is able to participate in providing payment service no more complex than that for an e-commerce payment gateway. Mobile Network Operators can readily modify the existing billing logic to incorporate with m-commerce billing. In terms of easiness and convenience, it is based on the existing subscribers and merchant's mobile stations, and they simple USSD that almost every handset supports, the potential of acceptance by the users should already be there.

However, given the statistics from the survey conducted, people are unlikely to adopt mobile phone payment method; although they agree that the method is convenient. Most importantly they stereotype a mobile phone mainly as a piece of communication device, as if they consider internet as a vehicle for e-commerce.

SMS is believed to be suitable for developing mobile commerce applications which is proved to be true in some other countries. Locally, however, the pace is not picking up fast. In most people's mindset, mobile commerce is a risky luxury that optionally adds on to the usual communication purposes. With the arrival of 3G applications, this mindset may change. It still has nevertheless a lot to do in educating the public that mobile commerce is relatively secure. To the mobile service provider, this paper may serve as a beacon on highlighting the user acceptance issues as well as how m-commerce could be technically designed in various scenarios.

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