Understanding Mobile Payment Service in University Campus:
A Context-awareness View

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Abstract—**Mobile payment services have gradually become popular and so drawn researchers' attention. Currently, most research has focused on issues of the technology itself and consumer's acceptance of this technology, but paid little attention to possible social and cultural ramifications. Mobile payment services can be used at various locations by different types of users, resulting in complex contexts and difficult design challenges. This study first examines the context of mobile payment services, and then comprehends how this context affects its implementation. A context-awareness framework is adopted to compare two cases in different Taiwanese university campuses. This framework investigates the significance of contextual factors during the adoption of mobile payment services, such as location, people, objects and their interaction. Our findings suggest that, for mobile payment services, (1) the socio-spatial dimensions of geographical regions affect consumer adoption; (2) the developer's social interpretation of technological artifacts facilitates their innovation; (3) and a deep understanding of contextual interactions enables the creation of a "must-have" mobile payment service, and helps identifies its niche.**

Keywords-mobile payment; context-awareness; location-based services; university campus

I. INTRODUCTION

The growing popularity of mobile payment services has increasingly drawn the attention of academic researchers. Some scholars argue that because mobile payments (MP) allow real-time, cashless, and wireless transactions for buying goods and services at any location or time, these payments will become a successful mobile service [1, 2].

This predicted success of mobile payment services is based upon not one single dimension, but rather considerations of many different aspects. Dahlberg et al. [3] point out that most MP research focuses on issues concerning the technology and consumers. Some researchers have explored the issue at the national level, such as MP environments [4-6], while others investigate MP standardization [7, 8] or provide simple overviews [9]. However, few researchers have adopted multiple perspectives of study [2, 10], and none have addressed the social and cultural influences of MP [3].

The purpose of this paper is to understand the context surrounding MP services. MP designers pay close attention to mobile environments when designed their applications and improving the functionality of MP services [23]. When using mobile technology, rapidly changing environmental factors are an important issue. Thus, development of MP services should not only consider consumers' technological acceptance but also the surrounding context, such as location, time, activity, physical objects, etc. Environmental changes will trigger various needs and activities, and affect the choices of payment services. Some consumers may be interested in MP for reasons beyond payments [11], and if a certain payment scheme is available for multiple purposes and at various locations, consumers will find it more useful [10]. Current research has paid little attention to the impact of situational changes on the implementation of MP services.

Due to this research gap, this paper asks two research questions. First, how does context affect MP services implementation? Secondly, what contextual factors should MP developers and service providers focus on when facing different contexts/environments? In examining these questions and mobile payment services, this paper investigates two case studies with different context environments: two Taiwanese university campuses undergoing MP services adoption.

The paper is organized as follows. Section II reviews the literature related to mobile payments. Section III describes data collection strategies and introduces a context-awareness framework. Section IV explains case background. Section V analyzes these cases. Conclusions and discussion are provided in Section VI.

II. MOBILE PAYMENTS

Customer's acceptance of MP mainly depends on issues of cost, security, and convenience [7]. The technology-based schemes of MP are divided into card-based and phone-based. The card-based scheme remains the preferred scheme for payments [12], and adopts the pre-paid solution [10]. Some successful MP systems match specific customer needs that enhance the convenience of micropayments for daily local expenditures, such as public transportation (e.g., Hong Kong's Octopus is one of the most successful smart cards in

the world), toll booths (e.g., E-ZPass), and fast-food restaurants (e.g., McDonalds) [13]. MP systems are suitable for proximity and micropayments, and should not be limited to mobile commerce [7, 13].

Dahlberg et al. [3] constructed a framework for the literature reviews of two applied theories – the five forces model [14] and the generic contingency theory (73 papers, 1999 - 2006) on MP. The rate of technological study is about 40% of the related researches; these studies mainly focus on conceptual technical constructions, and the proposal of tools or mechanisms for MP transactions and security. The rate of consumer research is about 27%, and these researches explore consumer adoption/acceptance, and focus on ease of use, compatibility, cost, trust, and usefulness for adopted MP services. It is regrettable that there is no research that investigates the effects of social and cultural changes on the development of MP.

Specific social and cultural issues may influence MP adoption, such as demographics, lifestyle characteristics, and cultural differences [13]. Payment services refer to an individual's location. The location factor is one of the essential factors that separates mobile commerce from e-commerce [15]. As individuals remain in different contexts, the various needs of consumption affect their choices of payment services [3]. Under the mobile computing, the application and development of MP services should pay more attention to the context of social influence; however, the current researches neglect this issue.

University campuses promote card-based MP services, which are used as a payment tool as well as for student ID cards and access to buildings [16, 17], these functions that enhance administrative efficiency [16], reduce administration costs, and increase incomes [18]. Mirza and Alghathbar investigated smart card applications in universities around the world, including North America, West Europe, and Asia. They surveyed 20 universities with 34 applications, and generalized the most popular four applications, which are student ID cards, book borrowing, and access to libraries and photocopies [17]. Related applications can be generalized into three categories, namely, (1) student ID card as identification; (2) entrance cards for libraries, buildings, parking lots, etc.; and (3) e-purses for consumption (e-purses is a prepaid card which can be used for payment instead of coins [26]). This paper explores the impact of contexts on MP services and elaborates on the multiple-purpose applications of MP.

III. RESEARCH METHOD

A. Data Collection Strategies

This paper adopts a case study approach, allowing the researcher to connect the research phenomenon with actual situations [19], in order to recognize the dynamics of these phenomenon. Primary data collection methods include participant observation, in-depth interviews, secondary data, and questionnaires (see Table I). Adopting these multiple sources of data collection helps ensure data authenticity and repeatedly validity.

TABLE I.   DATA COLLECTION STRAGEGIES

Data type	Two Cases	
	TU	**CU**
Participation observations	Observation period: 2008.07-2010.05	Observation period: 2006.03-2010.05 One author works in CU
In-depth interviews	11 person-interviews.	10 person-interviews.
	Each interview lasted 90 to 120 minutes. Participants included mobile payment team leaders, developers, merchants, etc.	
Secondary data	14 copies	32 copies
	Proposals, project reports, meeting minutes, etc.	
Questionnaires	1,852 users, such as students, staffs, and teachers	--

B. A Context-Awareness Framework

Mobile services focus on the "anywhere, anytime" method of development, as mobile computing does not occur at a single location in a single context, but rather spans a multitude of situations and locations [20]. The greatest challenge is to design successful mobile services that deal with multiple contexts. Individuals engaged in related activities may trigger individual payment situations and other MP services, such as photocopying, overdue fines on library books, etc. As MP services face dynamic environments, MP developers must be aware of the context of MP services, and be able to design an MP system that satisfies consumers' needs.

Schilit and Want [20] defined context as "*a constantly changing execution environment.*" Context can include computing, users, physical location [20], and even social situations [27]. Dey, Abowd and Salber [21] defined context as "*any information that can be used to characterize the situation of entities (i.e., whether a person, place, or object), that are considered relevant to the interaction between a user and an application, including user and application themselves. Context is typically the location, identity, and state of people, groups, and computational and physical objects*." In this paper, three entities were identified—places, people, and things [21, 22].

- People include individuals or groups.
- Places apply to geographical spaces, such as rooms, offices, buildings, or streets.
- Things refer to physical objects, software components, or artifacts, etc.

In order to describe these entities, four characteristics of context are listed, as follows.

- Identity refers to assigning a unique identifier to an entity.
- Location includes position information and spatial relationships between entities.
- State (or activity) identifies the observable properties of an entity.

- Time characterizes a situation, either as a timestamp or as a time span.
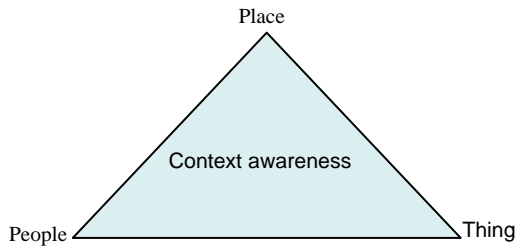

Figure 1.   A context-awareness framework sourced from Dey, Abowd, and Salber [23]

In order to develop MP applications that satisfy consumers' needs, this study constructs a context-awareness framework based on the definition of context described by Dey, Abowd and Salber [21] (see Figure 1). The primary advantage of their approach is its inclusion of a complete but generalized scope of context, that can then be applied to different applications [22]. Application designers choose what context best fits an application upon an in-depth understanding of their contextual options. Similarly, application designers also determine what context-awareness behaviors are required to support their applications, through an in-depth understanding of how a given context is used [23].

IV.   CASE BACKGROUND

This study examines two universities in Taiwan (anonymous: TU and CU) as case subjects. TU is a public university, while CU is private. After some time, both schools adopted the same card service as their campus MP system. This paper compares the consequences of MP implementation in distinct settings in order to understand the significance of contextual factors for the adoption of MP.

A.   Case Study: TU TCard

TU is one of the top national universities in Taiwan. In 2007, TU replaced their student ID cards (TCard) with contact-less and store-value smart cards, namely, the EasyCard, in order to provide more convenient services for faculty and students. The new smart TCard is used not only for identification and entrance access to locations, but also as a payment card. Since September 2008, there have been 16 campus shops that provide MP services. In June 2009, TU disseminated an on-line questionnaire to investigate usage of the TCard among faculty and students, in response to decreasing MP consumption.

B.   Case Study: CU UPass

In 1998, CU was the first university to issue MP cards (UPass) in Taiwan, and three well-regarded versions of MP cards have been used in the development of MP applications. Since 1998, CU has attempted to develop more services for

the UPass. In 2005, CU again served as a pioneer and cooperated with the largest transportation card system (EasyCard) in northern Taiwan. CU changed the UPass from a debit card into an RFID smart card, which then provided various store-value services with contact-less Mifare standards. Since the School of Continuing Education (SCE) at CU operates independently of the university, the MP card application was first implemented by the academic centers of SCE, initiated under the planning of the IT Department of SCE.

In 2006, SCE introduced 12 campus services for UPass, including student identification, entrance access to specific locations, libraries, parking lots, venue reservations, photocopying, vending machine use, services for school administration, and intelligent management of classrooms in integrated academic buildings. As a result, numerous universities asked the SCE of CU to help promote MP systems in their own universities.

TU and CU eventually both selected the EasyCard as their campus MP system. EasyCard is utilized by northern Taiwan's largest transportation systems, and its development is similar to Hong Kong's Octopus card. Since April 2010, EasyCard has extended its service to transactions at over 10,000 locations, including four major convenience store chains, coffee shop chains, drug store chains, restaurants, fast food stores, and parking lots. Thus, the MP services of TU and CU expanded beyond their campuses to incorporate public transportation and other MP services.

On the whole, CU UPass adoption was more successful than the TU TCard. This is surprising, because UPass has fewer users and a more complex e-purse mechanism. Using a context-awareness framework (Figure 1), this study examines the differences between MP implementation in these two university campuses, and determines the significance of contextual factors during the adoption of MP services.

V.   ANALYSIS

This section analyzes the development and adoption of MP services in TU and CU, and employs a context-awareness analysis framework (Figure 1) as the analytic lens.

A.   The Context of Places

TU is a comprehensive university with an open campus environment designed for leisure and public use. This campus includes academic and administrative buildings, libraries, dormitories, a post office, bank, museums, lakes, stadiums, arenas, etc. For consumption, there are over 50 retail stores on campus including cafeterias, coffee shops, restaurants, convenience stores, bookshops, a souvenir store, etc., but only 19 of these are equipped with MP services where patrons can use their EasyCard. TU is located near a famous shopping area and an MRT (subway) station. When interviewed, students offered several responses to this situation: *"It would be better if all stores on campus accepted the TCard, otherwise it is inconvenient;" "after school, I used to have dinner off-campus and not shop on*

campus." Furthermore, some complained, "*there is no obvious signage at stores to identify shopping with the TCard.*"

In contrast, the SCE of CU is a closed environment, with eight academic centers located at the center of the city. However, the space for student activities is limited, as most space is utilized for classes, studying, discussions, and administration. Students can shop in campus stores with UPass, such as coffee shops, convenience stores, and photocopy centers.

B. The Context of People

After students at TU and CU register, they are issued a smart student card, which is embedded with an MP mechanism. According to our investigations and observations, the age and origin of TU and CU students are very similar. These students can quickly accept and easily use the card. Investigation of Lee, Cheng and Depickere [18] points out university's students generally accept using their university smart card.

The students of TU's main campus exceed 33,000. On-campus activities at TU are broad, and include studying, research, dining, living, sports, and entertainment. Additionally, many tourists enter campus for fun and shopping. According to our survey questionnaire, 70% of respondents agreed that the TCard is more convenient than paying by cash, and 62% of respondents were willing to use the TCard for payments. In fact, for 80% of respondents, average expenses per week are lower than 100NT dollars (approximately 3US dollars). Most students must pay administration service fees, such as photocopying (83%), vending machines (61%), overdue book fines (59%), and stadium rentals (55%). Respondents suggested that "*I want to use the TCard for all of photocopy machines and vending machine on campus.*" They want "*more discounts or reward mechanisms,*" and noted that the "*TCard just pays for bus and MRT.*"

The SCE of CU is actively devoted to the adult education market, and types of students include undergraduate students, part-time students with jobs, and senior learners. Thus, the campus activities of SCE's students focus on studying and discussions at the academic center.

C. The Context of Things

TU and CU adopted the same MP card system (Easy Card). This MP card is a RFID smart card, which then could provide store-value services with contact-less Mifare standards. Its usage is easy and convenient.

The TU TCard has only one e-purse: basic store value. The TU campus has only three convenience stores for adding value to their MP cards, and the minimum total amount for each value transaction is at least 500NT dollars. Students can also add value to their cards at MRT stations. Students responded that "*setting up more cash-to-card machines is good, but you cannot limit the amount of money I can add*"; and "*it would be helpful if the Internet could provide services for tracking purchases.*" Some complained that "*it is not that much faster if students shop with their*

TCard, and this decreases overall shopping;" "*there is a receipt when paying with the TCard, which is a waste of paper and increases check-out time.*"

In contrast, the CU UPass has three e-purses: off-line dollars, on-line dollars, and store value. Off-line dollars and on-line dollars are only used on campus. Off-line dollars pay for photocopying, overdue book fines, and vending machines, while on-line dollars pay for net-printing and school services applications. Unlike TU, SCE's academic center has kiosks for adding value and checking balances, and students can also ask service center personnel to add value to their cards.

Here, the different contexts of MP services result in different implementation consequences. Table II shows the summary of the context-awareness dimensions for TU's and CU's MP cards.

TABLE II.   CONTEXT-AWARENESS DIMENSIONS ON TU AND CU FOR MP CARDS

Context	TU	CU
Places	● Identity: open environment ● Location: research centers, academic buildings, shops, lakes, museums, arenas, etc.	● Identity: closed environment ● Location: SCE's academic buildings, convenient stores, coffee shops, photocopy centers, etc.
People	● Identity: students, faculty, staff, and tourists ● Activity: studying, reading, teaching, research, sports, shopping, living, traveling, etc. ● Time: all day	● Identity: students, faculty, staff, and tourists ● Activity: studying, reading, teaching, discussions, shopping, etc. ● Time: business hours
Things	● Identity: MP card ● State: MP card has just one e-purse ● Activity: payment, entrance access to buildings	● Identity: MP card and kiosks ● State: MP card has three e-purses; kiosk has value-added and balance functions ● Activity: MP card and kiosks are multi-purpose/ multi-function

VI. DISCUSSION

Students of TU and CU generally accept MP cards, and recognize their convenience. However, while the two cases have similar organizational contexts, the development and implementation of MP services in both are very different from each other. From our research findings, the additional dimensions of contextual factors influence the development direction of MP services and their implementation.

A. Socio-spatial dimensions of MP card adoption

The use of technological artifacts by individuals depends not only on their convenience, cost, and the user's technology acceptance, but also the context of their use [7]. Aoyama [24] suggested that socio-spatial dimensions, such as urban form, consumer preference, and cultural attributes all shape the patterns of technology adoption. Our observational results support Aoyama's findings.

The TU campus is an open environment surrounded by a famous shopping area, which means that there are many places for dining, shopping, and entertainment. Most sales of TCards are from the EasyCard issuer, and off-campus stores can also have this type of sale. Thus, it is difficult to attract students shopping with the TCard. Moreover, not all stores on campus accommodate TCards, which influences both the ability and willingness of students to use the card. Unsurprisingly, TCard purchases are decreasing.

In contrast, SCE's academic center of CU is a closed environment. All stores at CU provide shopping services with UPass. When shopping for vending machines, photocopying, and paying overdue book fines, UPass is an all-in-one card, and is convenient throughout the entire campus.

In other words, the interactions between places (e.g. socio-spatial dimensions) and consumer preferences affect the usage of MP. TU students have more opportunity for shopping in the famous shopping areas, not on their campus, and even though the TCard provides some payment convenience, students have alternative choices for purchases in this open environment, which results in uncertainty for MP usage. In a closed environment, the CU UPass serves as a payment tool in addition to other campus functions, which facilitates its continued use.

B. The service-oriented developments of MPcard

The MP card has physical limitations such as sending, receiving, or presenting information. However, the application developments of MP card are different between TU's and CU's. The information service for payment is taken as an example. The TU TCard provides an immediate paper receipt for each transaction, but students regard it as a waste of paper and prefer online inquiries. The SCE of CU applies multi-platforms to provide information services for students to check their balance, namely kiosks and the Internet. Jacob [12] points out that customers might be interested in MP for reasons beyond the payments themselves. In sum, UPass services broaden and have greater usefulness than the TCard.

The IT Department of SCE suggested that, other than the access control of buildings and parking lots, the entrance access of the UPass should also include venue reservations and spatial management. The IT manager of SCE stated: "*the purpose of UPass entrance access is not to control the people coming in and going out; it is about spatial management.*" Teachers and students may directly reserve classrooms or discussion rooms online and access locations through the UPass. Security personnel monitor the states of classrooms and also manage campus safety by the PDA. The CU UPass is more than just a payment tool; it is also an all-in-one card, with multiple purposes and functions. These outcomes are the result of contextual interaction among people, places and things, and thus not simply due to any single contextual variable. Moreover, it is based on service-oriented approaches to apply multi-platforms, e.g., kiosks, internet, and PDA, to extend the scopes of UPass services.

The schemes of MP card can not actively capture the information of its involved environment in comparison with the phone-based MP schemes. MP card designers must pay more attention to the possible contextual interactions before they create new services. Furthermore, this study finds that a designer has more understanding on the contextual interactions, and then he/she would give more social interpretation of technological artifacts to develop specific innovations of MP services. The service-oriented development of MP card would more closely fit into the customer's specific needs; accordingly, it enhances the usability and functionality of the MP card..

C. The niche of MP services

In a mobile environment, the key successful point of MP services is that it is a "must-have" rather than "nice-to-have" service [25]. There are some failed cases [28], of which most fell into the "nice-to-have" strategy.

The TU TCard adoption has a "nice-to-have" strategy, as its MP services are just an alternative choice, but not necessary. For example, TU students expect to use the TCard for payment specific to the school's activities, such as photocopying and overdue fines for library books, and stadium space rental. .They also suggest adding more cash-to-card machines on campus. However, these expected shopping services have not been introduced, which also causes low usage of the TCard.

In contrast, the adopted strategy of the CU UPass is "must-have", such as photocopying, net-printing, venue reservation, payment listings, and access control to buildings, etc. These functions must use the MP card and fit with user's specific needs. CU provides two kiosks with cash-to-card machines in each building, which generates positive reactions from students, makes the CU UPass necessary on campus, and enables students to continually use the card. In summary, the innovative services of CU UPass consider all possible contexts of campus activities and integrate campus information, cash flows, and resources together. This all-in-one card is a result of strong linkage among contextual factors, i.e., people, place and things, which represents a niche for MP services.

VII. CONCLUSION

Consumers can use MP technology anywhere at anytime, which opens the technology up to a host of potentially complex contexts and renders the MP design process increasingly difficult. Complex contexts affect not only the implementation of MP services, but also determine the development of MP services. Here, two case studies adopt the same MP card in similar organizational settings, but with very different consequences of implementation, illustrating the interaction effects of contextual factors.

- The contexts of place include not only identity, location, state and time but also socio-spatial dimensions, which affect the adoption of consumer's MP services. In an open environment, the lack of boundaries of geographical regions raises more uncertainties for MP services, even though consumers may accept these services and agree to their convenience.

- The developers must have more awareness of involved contextual interactions for MP card during development. Designing MP applications must go beyond MP card's physical limitations, which is to base upon service-oriented contexts and apply multi-platforms to extend service scope. The developers' social interpretation of technological artifacts facilitates the creation of new MP services, and enables MP services beyond simple payment options.

- A strong linkage of contextual interactions among people, places and things, shapes a "must-have" strategy for MP development, and then identifies niches for MP services. MP services provide a positive impact on consumer's lives, which in turn helps ensure consumers continue using MP services.

This study selected university campuses as its research settings, which provided successful and failed experiences on MP service implementations. These findings can serve as reference for future studies, which may apply multiple in-depth cases to explore closer cooperation with users and merchants in a different natural setting to create more possibilities for MP services.

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