Adoption of Near Field Communication for Mobile Payment: Evidence from Macau

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Abstract - **The proliferation of mobile banking is creating increased opportunities for seamless businesses processes. The advent of Near Field Communication (NFC) could facilitate the future of mobile payment. Even though NFC has been adopted in several countries, this new technology has not been adopted by individuals in Macau, where the tremendous economic growth is greatly dependent on the gaming industry. This paper presents a study on consumers' attitudes towards adoption of NFC enabled mobile payment technology in Macau. By using Technology Acceptance Model (TAM) and related literature, an evaluation model is designed to analyze users' adoption of NFC in Macau. The results reveal academic and practical implications for future development and implementation of NFC in Macau.**

Keywords - **Near Field Communication, mobile payment, contactless payment, TAM, DOI, adoption of NFC**

I. INTRODUCTION

Due to the emergence of the Internet, mobile payment has become very common in several developed countries. W2F research shows the estimated mobile payment market to be worth €55 billion by 2006 in the key markets of Japan, USA, UK and Germany [1]. Although buyers or sellers may fear the losses related to authentication, non-repudiation, illegal use of credit/debit card information, etc. [2], a survey from Accenture found that nearly half (45%) of the most active mobile device users would welcome the opportunity to pay for goods and services using their mobile phone, despite the fact that 73% expressed significant privacy and identity theft concerns [3]. Hence, mobile payment is expected to become one of the important applications in today's business world.

A. Near Field Communication (NFC)

One popular form of mobile payment is Near Field Communication (NFC), a special type of communication occurring at short distances (10 cm), it exploits RFID technology [4]. To a certain extent, NFC is the fusion of a contactless smartcard (RFID) and mobile phone technology [5]. According to Massoth and Bingel [6], NFC is the fastest mobile payment method, as consumers only need to touch an RFID tag, which automatically starts the authentication application on the phone. Based on ABI's research [7], NFC mobile payments will hit $100 billion by 2016.

B. Trends of mobile payment and NFC in Asia

According to the Frost & Sullivan Research Service [8], the Asia Pacific will become the largest market installing NFC mobile handsets. Accenture's survey [3] revealed that consumers in Asian countries are the most enthusiastic about mobile payments, with China (76%) being at the top. In-Stat suggested that the Asia Pacific would dominate the mobile payment market throughout the forecast period, representing 41% of the transactions by 2016 [9]. Asian areas such as Singapore, South Korea, China, Japan and even Hong Kong have already adopted NFC [10, 11, 12].

C. Macau

After the return of sovereignty from Portugal to China, Macau, known as the "Las Vegas of Asia", has been transformed into a world class tourism destination. With the booming tourism and gaming industry, retail sales rocketed to 53,517 million Patacas in 2012. The advent of near field communication is the best technology to serve the public in terms of convenience and to expand capacity for more business transactions in Macau.

This study focuses on analyzing consumers' perceptions on the adoption of NFC in Macau. The purpose is to provide a vision for mobile phone manufacturers, credit card agents, banks and mobile phone app designers to utilize the technology for a better life.

II. RESEARCH MODEL

Research has focused on the adoption factor of mobile payment mainly involving issues such as security, convenience, speed of transaction, privacy and system quality [13]. As a result, several external variables are used together with PEOU and PU in our proposed model shown in Fig. 1.
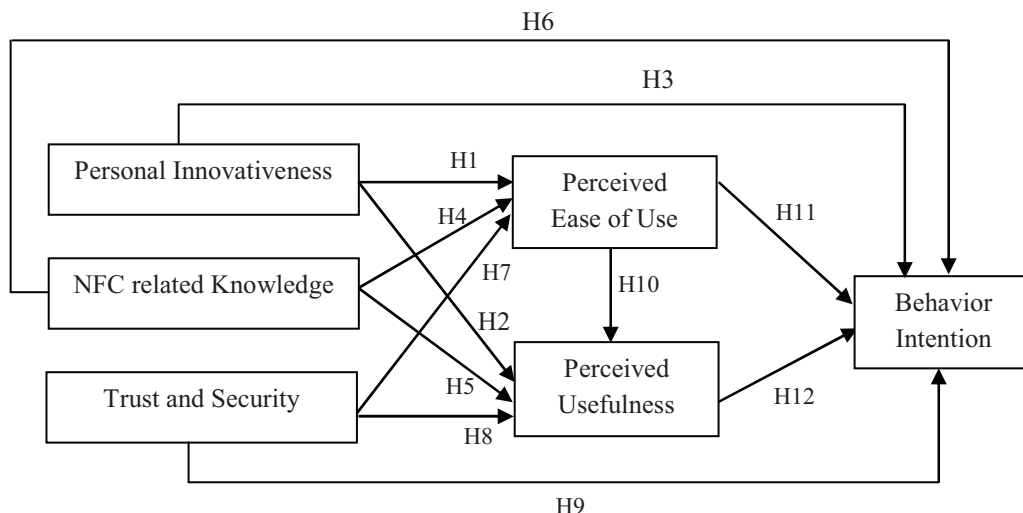
Fig. 1. Research Model.

A. Personal Innovativeness

Personal innovativeness is explained as the inclination of an individual to try out any new information systems [14]. Consumer's personal innovativeness has been included in a study on wireless Internet in the United States [15]. In addition, in a study examining the simultaneous effects of influences from individual, institutional and social contexts on beliefs about usefulness and ease of use in the context of a contemporary technology, Lewis et al. [16] found that personal innovativeness has significant relationships with perceived usefulness and perceived ease of use. Meanwhile, since individuals with higher personal innovativeness tend to be more risk-taking, it is also reasonable to expect them to have more positive intentions towards the use of wireless Internet services via mobile technology [15]. Hence, we have the following hypotheses:

H1: Personal innovativeness has a direct positive impact on the perceived ease of using NFC.

H2: Personal innovativeness has a direct positive impact on the perceived usefulness of NFC.

H3: Personal innovativeness has a direct positive impact on behaviour intention to use NFC.

B. NFC related knowledge

In recent years, with the advent of smart phones, significant numbers of people have already started to use their mobile phones to pay for products online such as Amazon or TaoBao. It was found that mobile payment users with significant m-payment knowledge do not have difficulty in adopting m-payment [13]. Thus, we have the following hypotheses:

H4: Knowledge related to NFC has a positive impact on the perceived ease of use.

H5: Knowledge related to NFC has a positive impact on the perceived usefulness of NFC.

H6: Knowledge related to NFC has a positive impact on behaviour intention to use NFC.

C. Trust and Security

Just like other wireless communication technologies, the NFC system is also under the threat of security attacks and privacy problems. Hence, trust and security has already been examined to have a significant impact on the adoption of m-commerce [17, 18]. Hsee and Weber [19] stated that the Chinese are in general, unwilling to take a risk. It was supported by Dai and Palvia [20] who stated that Chinese consumers in general have a high uncertainty avoidance culture. Thus, we have the following hypotheses:

H7: Trust and security has a positive impact on the perceived ease of using NFC.

H8: Trust and security has a positive impact on the perceived usefulness of NFC.

H9: Trust and security has a positive impact on behaviour intention to use NFC.

D. Perceived Ease of Use

PEOU has significant impact upon various technology adoptions such as online banking [21] and online shopping such as air ticketing [22]. When an information system is considered to be less complicated to use, the rate at which such technology is adopted will be higher [23]. PEOU was also found to have a positive influence on M-Banking adoption in Iran [24]. Meanwhile, a few studies examined the effect of perceived ease of use on perceived usefulness [25, 16], but reached quite different

conclusions. Hence, the following hypotheses are proposed:

H10: Perceived ease of use has a positive impact on perceived usefulness of NFC.

H11: Perceived ease of use has a positive impact on behaviour intention to use NFC.

E. Perceived usefulness

PU is defined as the degree to which an innovation is perceived to perform a task more easily, quickly and with good quality, productivity and effectiveness. Jeyaraj et al. [26] in their meta-analysis of the predictors of IT adoption found that perceived usefulness is one of the five most important predictors of consumer decisions to adopt an IT technology. Studies from Chong, Ooi and Chan [17] have shown that perceived usefulness plays an important role in determining consumer adoption decisions on m-commerce or mobile internet activities. Hence, we have the following hypothesis:

H12: Perceived usefulness has a positive impact on behaviour intention to use NFC.

III. RESEARCH METHODOLOGY

In order to know the behaviour intention of individual's in Macau regarding NFC, we distributed the questionnaire among the campus of the University of Macau and received around 200 respondents' feedbacks. Among 200 valid responses, 129 of them were female (64.5%) and 71 (35.5%) were male. Each item was measured on a five-point Likert scale" from strongly disagree to strongly agree. Using the Varimax Rotation method, we obtained the factor scores on each component shown in Table 1, which categorizes 19 items into 6 factors, although a few items have been removed due to their low factor loading values. Cronbach alpha values are also computed and shown in Table 1 in order to test the reliability of each factor. From Table 1, almost all factors' Cronbach alpha values are acceptable except for the NFC related knowledge item. Since NFC related knowledge has a Cronbach alpha value of 0.518, therefore it has been eliminated from the research model. In order to test the proposed model, three multiple linear regressions have been performed: one for the dependent variable PEOU (Model 1), one for the dependent variable PU (Model 2) and one for the dependent variable BI (Model 3).

TABLE 1.
THE LOADINGS OF EACH FACTOR

Factor and corresponding items	Loadings
Factor 1-Percevied Usefulness (α = 0.854)	
Using NFC installed mobile devices in my life would enable me to accomplish tasks more quickly. (PU1)	0.716
Using NFC installed mobile devices in my life would increase my productivity. (PU2)	0.746
Using NFC installed mobile devices would enhance my effectiveness on the job. (PU3).	0.765
Using NFC installed mobile devices would make it easier to do my job. (PU4)	0.791
I would find NFC installed mobile devices useful in my job. (PU5)	0.651
Factor 2-Perceived Ease of Use (α = 0.826)	
Learning to operate NFC payment function would be easy for me.(PEOU1)	0.680
I would find it easy to get NFC to do what I want it to do. (PEOU2)	0.680
My interaction with NFC would be clear and understandable. (PEOU3)	0.693
I would find NFC to be flexible to interact with. (PEOU4)	0.754
It would be easy for me to become skillful at using NFC installed devices.(PEOU5)	0.624
Factor 3-Personal Innovativeness (α = 0.688)	
If I heard about a new information technology, I would look for ways to experiment with it. (PI2)	0.723
Among my peers, I am usually the first to explore new information technologies. (PI3)	0.681
I am interested in exploring new information technology. (PI4)	0.765
Factor 4-NFC Related Knowledge (α = 0.518)	
Knowing more NFC related knowledge would increase the chances that I use it.	0.452
Lack of NFC related knowledge would reduce my chances to use the new technology.	0.708
Factor 5-Trust and Security (α = 0.662)	
My trust and security concerns will affect my decision to adopt NFC enabled mobile payment. (T&S 2)	0.611
Receiving a SMS confirmation after every NFC enabled mobile transaction will alleviate my privacy and security concerns. (T&S 4)	0.702
I would adopt NFC mobile payments if there is third party protecting me against fraudulent transactions. (T&S 5)	0.748
Factor 6 Behaviour Intention	
I recommend using NFC to people around me. (BI2)	0.437

IV. RESULTS

The R-square values of the three regression models (Model 1: 0.203; Model 2: 0.301; Model 3: 0.328) are shown in Table 2, indicating that 20.3%, 30.1% and 32.8% of the total variance can be explained by Model 1,

2 and 3 respectively. In Table 3, Personal Innovativeness has a positive impact of Perceived Ease of Use (B=0.216, p<0.05) and Trust & Security also has a positive impact on Perceived Ease of Use (B=0.334, p<0.05) for Model 1. Hence, H1 and H7 are supported. In addition, for Model 2,

Personal Innovativeness does not have a positive impact on Perceived Usefulness (B=-0.025, p=0.673) and thus H2 is rejected. On the other hand, Trust and Security has a positive impact on Perceived Usefulness (B=0.169, p<0.05) while PEOU also has a positive impact on PU (B=0.542, p<0.05). Hence, H8 and H10 are supported. Finally, for the dependent variable behaviour intention, Table 3 shows that Personal Innovativeness (B=0.229, p<0.05), PEOU (B=0.246, p<0.05) and PU (B=0.437, p<0.05) have a positive impact on behaviour intention except Trust and Security (B=0.02, p>0.05). Hence, H3, H11 and H12 are supported while H9 is rejected.

TABLE 2.
R-SQUARE VALUES

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1[a]	.450[a]	.203	.194	.61345
2[b]	.548[a]	.301	.290	.65229
3[c]	.573[a]	.328	.314	.76162

a. Predictors: (Constant, T, PI; Dependent variable: PEOU

b. Predictors: (Constant), PEOU, PI, T&S; Dependent variable: PU

c. Predictors: (Constant), PU, PI, T&S, PEOU; Dependent variable: BI

TABLE 3.
RESULTS OF HYPOTHESES TESTING

Hypothesis	Predictor	Dependent	Model	Coefficient	Sig.
H1	PI	PEOU	1	0.216	0.000***
H2	PI	PU	2	-0.025	0.673
H3	PI	BI	3	0.229	0.001**
H7	T&S	PEOU	1	0.334	0.000***
H8	T&S	PU	2	0.169	0.017*
H9	T&S	BI	3	0.02	0.81
H10	PEOU	PU	2	0.542	0.000***
H11	PEOU	BI	3	0.246	0.014*
H12	PU	BI	3	0.437	0.000***

Note: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

V. CONCLUSION

Mobile payment has gained significant attention in Asian markets. In this study, the factors affecting users' adoption of NFC for mobile payment were analyzed. Regarding perceived usefulness, personal innovativeness does not have a positive impact on it, which indicates users' exploration of NFC technology does not mean NFC technology is useful to them. On the other hand, Trust and security and PEOU have a positive impact on the perceived usefulness of NFC. Regarding PEOU, PI has a positive impact on it, which means exploring NFC is positively linked with its ease of use. In addition, trust and security also has a positive impact on PEOU, indicating that using NFC will be easy as long as they don't need to consider the issues about security and trust. Finally, for behaviour intention, perceived ease of use and perceived usefulness have a positive impact on the behaviour intention of individuals in Macau. At the same time, personal innovativeness also has a positive impact on the behaviour intention. However, trust and security does not have a positive impact on behaviour intention, which indicates that high security and trust on NFC does not have any relationship with recommending NFC technology to other users. This fact is compatible with the survey results from Accenture [3]. There are limitations to this study as well. In this study, the sample is restricted to students in the University of Macau, which might not be representative of the whole user population. Although, NFC is still mainly used for mobile payment; researchers can include other NFC functions into the empirical study. The results can provide guidance for mobile phone manufacturers, credit card agents, banks and mobile phone app designers for customizing NFC technology for Macau.

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