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# Predicting the determinants of the NFC-enabled mobile credit card acceptance: A neural networks approach

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ABSTRACT

The main aim of this study is to determine the factors influencing the adoption of Near Field Communication (NFC)-enabled mobile credit card, an innovation in contactless payment for the future generation. Constructs from psychological science, trust-based and behavioral control theories were incorporated into the parsimonious TAM. Using empirical data and Structural Equation Modeling-Artificial Neural Networks approach together with multi group analysis, the effects of social influence, personal innovativeness in information technology, trust, perceived financial cost, perceived usefulness and perceived ease of use were examined. The significance of indirect effects was examined using the bias-corrected percentile with two-tailed significance through bootstrapping. Gender, age, experience and usage were introduced as the moderator variables with industry being the control variable in the research model. The scarcity in studies regarding the moderating effects of these variables warranted the needs to further investigate their impacts. The mediating effect of perceived usefulness was examined using the Baron–Kenny's technique. The findings of this study have provided invaluable theoretical, methodological and managerial implications and will contribute to the decision making process by CEOs, managers, manufacturers and policy makers from the mobile manufacturing industry, businesses and financial institutions, mobile commerce, mobile telecommunication providers, mobile marketers, private or government practitioners and etc.



## 1. Introduction

With the advancement in short-range wireless technologies such as Near Field Communication (NFC), Bluetooth, Infrared Data Association (IrDA) and Radio Frequency Identification (RFID), consumers have been able to conduct payment "anytime" and "anywhere". A new form of payment has emerged through the integration of these technologies into the mobile phone whereby consumers just need to make payments via their own mobile phones. Known as mobile payment or m-payment, it is anticipated to become an essential application in mobile commerce. One form of m-payment that is gaining popularity is the mobile credit card or m-credit card using NFC-enabled mobile phones. Instead of using the traditional payment methods by cash, cheques or credit cards, mobile phones are widely used now for consumers to submit their payments for a variety of goods and services purchased (Shin, 2010). With m-credit card, consumers just need to 'wave' their mobile phones near a reader for payments to be done. In Malaysia, Maybank through the partnership with Maxis, Visa, Nokia and Touch'n Go has provided the facility for its customers to conduct m-payment using the Maxis FastTap service via the Maybankard Visa payWave Mobile. According to Stuart Tomlinson, "Malaysia was the first place in the world where Visa trialed its Visa payWave technology, so it is only fitting that it is now the first country in the world to offer Visa payWave on an NFC-enabled mobile phone on a commercial basis" (www.maxis.com.my, 2012, p. 1).

Various definitions have been given to m-payment. Dewan and Chen (2005, p. 4) defined m-payment as "making payments using mobile devices including wireless handsets, personal digital assistants (PDA), radio frequency (RF) devices, and NFC based devices". M-payment is also refer to as "payments for goods, services, and bills with a mobile device such as mobile phone, smart-phone, or PDA by taking advantage of wireless and other communication technologies" (Dahlberg, Mallat, Ondrus, & Zmijewska, 2008, p. 165). Besides that, m-payment may be referred to as "using mobile devices to make transactions such as pay bills and perform banking transactions" (Gerpott & Kornmeier, 2009, p. 1). According to Innopay (2012, p. 12), m-payment is defined as "a transfer of funds in return for a good or service, where a mobile phone is involved in

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both the initiation and confirmation of the payment". In this study, we have adopted the definition by Ghezzi, Renga, Balocco, and Pescetto (2010, p. 4) who have summarized the previous authors' view as follows:

> "m-payment is a process in which at least one phase of the transaction is conducted using a mobile device (such as mobile phone, smartphone, PDA, or any wireless enabled device) capable of securely processing a financial transaction over a mobile network, or via various wireless technologies (Bluetooth, RFID, NFC, etc.)".

NFC-enabled mobile phones have enabled contactless payments in a vast variety of businesses with huge potential. It renders numerous benefits including quick purchasing of products and transferring of secure information by just touching devices and this is especially convenient in an environment where the volume of payments are high, for example in restaurants and large retailers. Such a wireless payment method has allowed consumers to eliminate the use of cash while offering the added benefits of user-friendliness and fast transaction speed. Furthermore, the NFC-enabled mobile phones may also read NFC tags that can host a diversity of content such as vouchers, videos, social media pages, competitions, travel information and etc. It also permits users to engage with conventional marketing campaigns and even download promotions and offers through SmartPosters that can be redeemable in-store through the use of the technology (Innopay, 2012). Other benefits of NFC-enable mobile phones include ease of use, simple communication setup and low power consumption (Madlmayr, Langer, Kantner, & Scharinger, 2008). Due to these benefits, the popularity of contactless payments can be seen from the 60,000 and more contactless terminals in the United Kingdom itself and about 130,000 of these terminals across Europe (Payments Cards, 2012).

The business potential of m-payment is enormous. According to IE Market Research Corporation (IEMR, 2012), the revenue for the global mobile payment is anticipated to increase from USD47.2 billion in 2011 to USD998.5 billion in 2016; meanwhile, Compound Annual Growth Rate (CAGR) is expected to increase to 83.7% from 2012 to 2016. The m-payment transaction in the US is anticipated to reach USD56.7 billion in 2015 from USD5.2 billion in 2009, a CAGR of 49.19% and constituted 10.6% of the global m-payment transaction (ResearchandMarkets, 2010). Global Information Inc. (2011) reported that the global m-payment users stood at 158.1 million in 2011 and is anticipated to increase to 1 billion at the end of 2016 while m-payment volumes stood at USD159.3 billion in 2011 and are estimated to reach USD1 trillion by the end of 2016.

Although there is availability of advanced technologies to support m-payment systems, their adoption and penetration rate is relatively low in comparison to other mode of cashless or contactless payments like credit cards and e-payment systems (Dahlberg et al., 2008). Besides, there have been hardly any major success stories of m-payment adoption elsewhere in the world except maybe in Japan and to certain level in South Korea (Bradford & Hayashi, 2007). Therefore, there is indeed a need to investigate the antecedents of m-payment adoption in the context of m-credit card in order to provide more insight into the determinants that affect the intention of consumers to adopt m-credit card. There has been paucity in the research of NFC-enabled mobile phones and limited researches (Chidembo, 2009; Madlmayr et al., 2008) have been conducted so far. Although there were many studies on technological innovations, very few were done pertaining to the use of innovative NFC technology in mobile payment. Hence, this study will serve to narrow the research gap by examining the determinants of m-credit card adoption using a trust-based Technology Acceptance Model (TAM). It will also investigate the moderator effects of age, gender, usage and the experience while investigating the causal relationships of these determinants. Therefore, the research questions for this study are:

RQ1: What are the determinants of mobile credit card adoptions?
RQ2: Do gender, age, experience and usage moderate the causal relationships between these determinants?

The structure of this paper is as follows. The next section will present the literature review of the past studies. Then, we proceed with the factors that influence mobile credit card adoption and followed by the hypothesis development of these factors. After that, the methodology and data analysis are elucidated before the discussion of the research findings. Finally, we present the limitations, implications and future directions of this study.

## 2. Literature review

### 2.1. Overview of NFC-enabled mobile payment

NFC is "a wireless communication technology that enables transfer of data over distances of up to 10 cm by combining technologies from RFID and contactless smart cards" (Madlmayr, 2008, p. 563). It was the brainchild of Sony and Philips which founded the NFC Forum. NFC uses the 13.56 MHz carrier frequency enabling devices to transfer data at 424 kbps (Chidembo, 2009). An NFC device may operate in three modes, i.e., read/write, peer-to-peer and card emulation mode. The read/write mode enables the NFC devices to passively read and exchange data store on NFC compliant transponders like tags while the card emulation mode enables the NFC devices to function as a smart card in which data can be read using an external reader. Last but not least, the peer-to-peer mode allows the sending and receiving of data between two NFC devices actively or simultaneously. NFC technology may be applied in a variety of industries including manufacturing, transportation, financial institutions, automobile, medical, advertising and etc. NFC-enabled mobile payment has been initiated in several countries as shown in Table 1.

In Malaysia, Visa launched its world's first commercial application of NFC-enabled mobile payment solution named Maxis FastTap in 2009. It was a partnership between Maxis, Visa, Nokia, Maybank and Touch n' Go. Maxis FastTap uses the Visa's payWave solution and allows NFC-enabled Nokia 6212 classic mobile phone to download the Maybank Visa payWave credit card over the air (Chidembo, 2009). This has enabled m-credit card to be used in 1800 merchant outlets throughout Malaysia (Near Field Communications World, 2012). Some of these outlets were shown in Table 2.

### 2.2. Factors influencing the adoption of NFC-enabled mobile payment

In order to investigate consumers' intention to use a new technology, many models have been developed and proposed. This include Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), Diffusion of Innovation (DOI), TAM model 2 (TAM2) and the Unified Theory of Acceptance and Use of Technology (UTAUT).

#### 2.2.1. TRA

TRA (Fig. 1) was conceptualized in 1967 to investigate the relationship between attitudes, subjective norm and behavioral intention. Behavioral intention is influenced by one's attitude whether favorable or unfavorable in the performance of a behavior and also the social influence that can significantly affect one to think whether he or she should perform or not perform the behavior.