Risks of Using NFC Mobile Payment: Investigating the Moderating Effect of Demographic Attributes

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Abstract. Prior studies indicate that perceived risk is an important determinant of the adoption of commerce-related IT innovations. However, little work has investigated how risk perceptions are formulated in consideration of different demographic attributes. Based on a sample of 377 useful responses, this study quantifies how different risk dimensions (privacy risk, performance risk, psychological risk and financial risk) contribute to the perceived overall risk of NFC (near field communication) mobile payment, and elucidates how demographic attributes (gender, age and income) moderates the relationships between the risk dimensions and the perceived overall risk. The results indicate that privacy and psychological risks are the most important risk dimensions of NFC mobile payment and that people of different demographic attributes tend to be concerned with different categories of risks.

Keywords: NFC, RFID, mobile payment, perceived risk, gender, privacy, age

1 Introduction

A number of technologies and platforms have been proposed for mobile payment including SMS (Short Message Service), WAP (Wireless Application Protocol) and NFC (near field communication)-based payment platforms. In particular, Juniper Research predicts NFC mobile payments market will exceed $180 billion globally by 2017, more than a seven-fold increase over 2012 [11]. The leading regions of North America, Western Europe and Far East & China will contribute 90% of this market value as NFC-enabled smartphones become standard [11]. It is expected that more than 1 in 4 mobile users in the US and Western Europe will use their NFC-enabled mobile phone to pay for goods in-store by 2017 [10]. A similar estimation is made by ABI Research, which predicts the total value of NFC mobile payment transactions will increase from $4 billion in 2012 to over $100 billion in 2016 and $191 billion in 2017 [1]. China Telecom has officially launched an NFC service in China using SIMpass [19]. More than 2 million consumers have already used SIMpass in China, of which 97% actively use it daily [19]. Our study is based on an investigation of Chinese consumers' perceptions of NFC mobile payment service.

Most previous studies refer to mobile payment as an umbrella term independent of different underlying technology platforms. While studies on either SMS or WAP-based mobile payment are many, empirical investigations on NFC mobile payment are scarce. This study is among the first to empirically investigate NFC mobile payment based on a random sample of 377 responses. Specifically, we investigate how perception of overall risk of NFC mobile payment is formulated in consideration of different risk dimensions, namely privacy risk, performance risk, psychological risk and financial risk. Further, the study quantifies how demographic attributes (age, gender and income) moderates the effects of risk categories on perceived overall risk.

We structure the paper as follows: the next section presents the literature review and theoretical background, followed by the research methodology section. Research results are discussed in section 4. Section 5 discusses the results while section 6 concludes the paper.

2 Literature review and theoretical background

2.1 NFC mobile payment

NFC is a set of close-range wireless communication standards, which is built upon short range radio-frequency identification (RFID) technology by allowing two-way communication between endpoints. NFC technology enables consumers to exchange payment information, such as between a consumer's mobile device and a merchant's POS (Point of sale) terminal through simply waving the mobile devices close to the terminal (typically under 20 cm) [3, 4]. A user may need to enter a secure PIN or password to approve the transaction. It is estimated that NFC mobile payments can be 15 - 30 seconds faster than swiping a traditional card and signing the receipt or entering a PIN [9]. NFC mobile payment has a number of unique advantages in particular compared to conventional mobile payment solutions [18]. For consumers, benefits of using NFC mobile payment include reliability, security, ease of use and convenience, wallet functionality, acceptance, device deployment and value-add applications [18].

2.2 Effects of demographic attributes on IT diffusion

Empirical evidences have been found that demographic attributes, such as age, gender and race, has significant influences on user perceptions and diffusion speed of innovations [16, 20]. The unified theory of acceptance and use of technology (UTAUT), as an important IS adoption theory, notes that demographic similarities, like age, gender and experience, exert significant moderating effects on how different IT perceptions motivate the adoption of a particular IT innovation [20]. Prior literature has frequently reported the moderating effects of demographic attributes on the relationship between IT perceptions and IT adoption [2, 6, 16].

2.3 Perceived risk theory

Individuals face risk when a particular decision or action brings about social and economic consequences associated with uncertainty [23]. Thus, research on risk disciplines include economics, psychology, decision sciences, management, risk and insurance, public policy, and finance [for a review see 6]. In recent years, perceived risk theory has been widely applied to commerce-related IT innovations, in which consumers' behavior of IT adoption can be viewed as an instance of risk-taking [14]. Consumers' perceived risk has been widely regarded as a kind of a multi-dimensional construct [i.e. 8, 12]. For instance, Lee [12] employs five sub-dimensions of perceived risk in studying Internet banking adoption, including performance, social, time, financial and security risk. Featherman and Pavlou [8] adopts performance, financial, time, psychological, social, privacy and overall risk as the key facets of perceived risk to predict the e-services adoption. However, little prior work has investigated how perceived risk of NFC mobile payment is formulated in terms of different risk dimensions. Further, little prior research has quantified the moderating effects of demographic attributes on risk formation. Hence, this exploratory study seeks to investigate the risk formation process of NFC mobile payment in terms of different demographic features. Based on the above discussion, we propose that:

H1: Risk dimensions, including perceived privacy risk, performance risk, psychological risk, financial risk, positively relate to perceived overall risk of NFC mobile payment.

H2: Demographic attributes, including age, gender and income, moderates the relationships between risk dimensions and perceived overall risk of NFC mobile payment.

   The research model is graphically presented, as shown in Figure 1. Based on prior studies [13, 21], we investigate four risk dimensions of NFC mobile payment:
1. Financial risk: The possible unreasonable financial loss caused by using NFC mobile payment.
2. Privacy risk: The possible loss caused by private information of consumer individuals exposed in NFC mobile payment.
3. Psychological risk: The possibility that consumers bear mental stress of using NFC mobile payment.
4. Performance risk: The possibility that NFC mobile payment does not work properly or can be used for only a short period of time.
5. Perceived (overall) risk: The nature and amount of risk perceived by a consumer in contemplating a NFC mobile payment behavior.
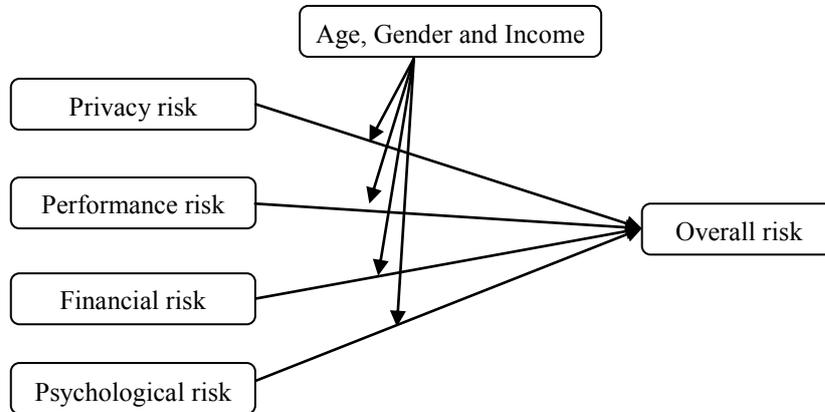
Fig.1. Research Model.

3 Research methodology

3.1 Sample and measurement development

A questionnaire survey was conducted to collect empirical data and evaluate the research model. The measurements of perceived overall risk and risk dimensions are adapted from the works of Lee [12] and Featherman et al. [8]. 5-point likert scale ranging from 1 (disagree) to 5 (agree) is utilized to evaluate each item. The empirical data was collected in China in the summer of 2012. 20 student volunteers from the department helped the researchers to collect responses during their summer vacation. Before the survey, researchers gave training to the volunteers and elucidated the research purpose. Thereafter, the volunteers visited public spaces (i.e. street, railway stations and shopping malls) of their resident cities (16 different cities) across China and invited strangers to participate in our study. The volunteers were requested to explain NFC mobile payment carefully to respondents if the respondents did not have prior knowledge on the technology. Each volunteer recruited about 15-20 respondents. Finally, 377 validated samples were collected, which are used as the sample base of the study. The sample consists of 190 males and 187 females, and their demographic information is presented in Table 1.

3.2 Measurement model

SmartPLS 2.0 was used to evaluate the research model. First, we evaluate the validity and reliability of measurements of basic model. As the demographic factors (age, gender and income) are one-item factor, they are not included in the basic model.

As shown in Table 2, factor loading (FL) and cronbach's alpha (α) values are all above the threshold of 0.7. The values of composite reliability (CR) and average variance extracted (AVE) of all the constructs satisfy the recommended level of 0.8 and 0.5 respectively, indicating good internal consistency. As shown in Table 3, the square roots of AVE of all constructs are greater than the correlations estimate with the other constructs. This reveals that each construct is more closely related to its own measures than to those of other constructs, and discriminant validity is therefore supported. A principle component analysis was performed via the use of SPSS 21 and no substantial cross-loadings were reported, as shown in Table 4. This further confirms the validity of the questionnaire measurement.

Table 1. Demographic information

Demographic profile	Items	Frequency	Percent (%)
Gender	Male	190	50.4
	Female	187	49.6
	Total	377	100
Age	18-24	164	43.5
	25-30	69	18.3
	31-35	35	9.3
	36-40	37	9.8
	41-50	60	15.9
	Over 50	12	3.2
	Total	377	100
Monthly cost of phone usage (RMB)	Less than 50	92	24.4
	50-99	153	40.6
	100-199	103	27.3
	200-399	21	5.6
	Over 400	8	2.1
	Total	377	100
Monthly Income (RMB)	Less than 2000	166	44
	2000-3000	75	19.9
	3001-5000	49	13
	5001-8000	31	8.2
	8001-15000	26	6.9
	Over 15000	30	8
	Total	377	100

Table 2. Reliability and convergent validity statistics

Construct (no of items)	**α**	**CR**	**Minimal. FL**	**AVE**
Privacy risk (3)	0,923	0,951	0,918	0,867
Performance risk (3)	0,898	0,936	0,907	0,830
Financial risk (3)	0,809	0,887	0,824	0,725
Psychological risk (3)	0,888	0,930	0,882	0,818
Overall risk (3)	0,897	0,936	0,899	0,829

Table 3. Discriminant validity (The bold diagonal are the square roots of the AVEs of the individual constructs; off diagonal values are the correlations between constructs)

	PRR	PER	FR	PSR	OR
Privacy risk (PRR)	**0,931**				
Performance risk (PER)	0,629	**0,911**			
Financial risk (FR)	0,535	0,525	**0,851**		
Psychological risk (PSR)	0,517	0,415	0,459	**0,904**	
Overall risk (OR)	0,650	0,571	0,509	0,582	**0,910**

Table 4. Results of principle component analysis

	Component				
	1	2	3	4	5
Financial risk 1	,230	,145	,253	,177	**,802**
Financial risk 2	,118	,132	,006	,222	**,834**
Financial risk 3	,232	,226	,304	,056	**,682**
Performance risk 1	**,831**	,156	,248	,164	,202
Performance risk 2	**,834**	,168	,190	,204	,204
Performance risk 3	**,803**	,099	,249	,254	,174
Privacy risk 1	,319	,138	**,744**	,382	,155
Privacy risk 2	,251	,195	**,850**	,234	,195
Privacy risk 3	,255	,297	**,783**	,209	,221
Psychological risk 1	,187	**,808**	,236	,167	,116
Psychological risk 2	,133	**,844**	,133	,246	,190
Psychological risk 3	,084	**,853**	,141	,229	,174
Overall risk 1	,271	,287	,240	**,741**	,151
Overall risk 2	,199	,256	,253	**,826**	,162
Overall risk 3	,213	,227	,225	**,786**	,230

4 Model testing and results

Bootstrapping analysis was performed to assess the research model by setting subsample and resample sizes to equal the original sample size. The interaction effects are calculated by using standardized indicator values before multiplication. As shown in Table 5, the four dimensions of risks significantly contribute to the perception of overall risk even if in different demographic settings, and the research model interprets over 54% of the variance of perceived risk. Therefore, hypothesis 1 is supported.

Hypothesis 2 is partly supported. The influence of demographic factors of age, gender and income are tested. Age is found to have significant direct influence on perceived overall risk ($\beta=-0.082$, $p<0.05$), but gender and income do not have. In addition, age has a significant moderator effect on the influence of psychological risk on perceived overall risk ($\beta=0.148$, $p<0.01$).

The results did not show any significant direct influence of both gender and income on perceived overall risk. However, gender significantly moderates the effect of perceived privacy risk on perceived overall risk (β=-0.206, p<0.001), while income significantly moderates the impact of perceived financial risk on perceived overall risk (β=0.146, p<0.01). Note that, for moderating effect analysis, a small effect size does not necessary imply an unimportant effect, if the resulting beta changes are meaningful [5].

Table 5. Results (Dependent variable: perceived overall risk)

Predictors	Basic model	Age as moderator	Gender as moderator	Income as moderator
PRR	0,325***	0,318***	0,329***	0,340***
PER	0,195***	0,187***	0,199***	0,193***
FR	0,101*	0,089*	0,102*	0,091*
PSR	0,287***	0,306***	0,283***	0,270***
Moderator	N.A.	**-0.082***	N.S.	N.S.
PRR×M	N.A.	N.S.	**-0.206***	N.S.
PER×M	N.A.	N.S.	N.S.	N.S.
FR×M	N.A.	N.S.	N.S.	**0,146***
PSR×M	N.A.	**0,148***	N.S.	N.S.
R^2	54.1%	56.5%	56.8%	56.2%

(M: Moderator; *: p < 0.05; **: p < 0.01; ***: p < 0.001; N.A.: Not available; N.S.: Not significant)

5 Discussion

Consistent with prior risk research, the results show that the four risk dimensions significantly contribute to the perceived overall risk of NFC mobile payment. The four risk dimensions help explain more than half of the perception of the overall risk. Interestingly, of the four risk dimensions, privacy risk has the strongest influence on perceived overall risk, followed by psychological risk. This indicates that consumers have serious concerns to protect their personal information when evaluating the risks of using NFC mobile payment. Also people are concerned whether they can properly use the technology without bearing too much psychological stress. Furthermore, people have relatively weak concerns about financial risks compared to other risk dimensions. This result is partly explained by the work of Lu et al. [15]. They report a trust transformation phenomenon whereby people who trust the use of Internet payment are more likely to trust and adopt mobile payment. In this regard, consumers who are confident of the financial security of Internet payments may easily transform their trust toward the financial security of mobile payment. As a result, instead of financial risk, consumers are concerned more about the features of NFC mobile payment they are unfamiliar with, such as whether the use of NFC technology makes it easier to leak personal information, whether they can easily learn to perform the new payment behavior and whether the system will work properly or not.

Consumers with different demographic features are found to emphasize different dimensions of risk. The results indicate that senior people worry less about the overall

risk of using NFC mobile payment, but have stronger concerns on the psychological stress of using the technology. Prior work indicates that old adults are less confident in their ability to acquire new technological skills [i.e. 17]. It seems that similar concern arises in the use of NFC mobile payment: senior consumers are worried about their ability to learn to use NFC mobile payment, resulting in stronger influence of psychological risk.

An unexpected finding is the moderating effect of gender on the influence of privacy risk on overall risk. Prior studies reported that females have a stronger concern on privacy risk than males [22]. Similarly, females reported a higher perceived privacy risk (Mean = 4.1; S.td = 0.95; N = 187) than males did (Mean = 3.9; S.td = 1.09; N = 190) in our study. Analysis of variance (ANOVA) shows that the difference is statistically significant ($p<0.001$). However, the moderating effect analysis indicates that females' perceived privacy risk only makes a weak contribution to the formulation of their perception of overall risk of using NFC mobile payment, despite the degree of perceived privacy risk being stronger for females than males. The moderating effect of gender on the relationship between perceived privacy risk and perceived overall risk is statistically strong and highly significant (β=-0.206, $p<0.001$). Therefore, the moderating effect analysis of this study contributes to new insights on the risk formation process, which complements ANOVA analysis reported in prior studies. More studies on this phenomenon are needed in order to deepen our understanding on the risk formulation process of different gender groups.

Furthermore, income is found to be a significant moderator on the effect of financial risk on overall risk. This suggests that people with higher income are concerned more about their financial security of using NFC mobile payment than low-income respondents. As high-income users may put more money in their payment platforms for both daily and business use, this may cause them to be more sensitive to the financial security of the new NFC mobile payment solution.

6 Conclusion, contribution and future research

With regard to the body of empirical studies on NFC mobile payment, the study contributes to the literature by elucidating the risk formation process. We distinguish and quantify how four risk dimensions help establish the perceived overall risk of NFC mobile payment. For practitioners, this study identified the risk categories that consumers care about in the context of NFC mobile payment. In this light, business communities need to consider the different concerns of different user groups in both service design and service personalization process. The study enriches risk theories by empirically integrating the theory in the context of NFC mobile payment. The research findings suggest that people of different demographic attributes tend to weigh different categories of risk. Therefore, future risk studies should pay attention to the deviations of risk perceptions between different user groups, because effective strategies to alleviate consumers' feelings of risk depend on an accurate understanding on what sorts of risk are really concerned by the targeted user groups.

While the research model helps interpret approximate 55% of the variance of perceived overall risk, there is about 45% of the variance left unexplained. This

indicates the future research is needed. Also, future research may focus on evaluating the effect of overall risk on the adoption of NFC mobile payment. The study is based on studying NFC mobile payment in Chinese market and China is one of the emerging countries to use the NFC mobile payment. Hence, audience should be cautious with the result generalizations on different market environments.

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