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Factors influencing the intention to adopt NFC mobile payments – A South African perspective

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Abstract

Near-field communication (NFC) is an emerging technology that is receiving global attention. NFC mobile payments are being deployed by many hardware vendors, technology companies and financial institutions. Their aim is to facilitate the use of mobile phones as a contactless payment device. A problem is the uncertainty around consumer adoption of this emerging technology. In this study we examined several factors from prior mobile payment studies, as antecedents of the intention to adopt NFC mobile payments. We present results from an online survey of 331 respondents, testing our proposed research model. Using the PLS approach to structural equation modeling (SEM) we find that security and trust concerns play a significant role in influencing perceived risk. Social influence and ease of use have a significant positive effect on perceived value. We find that perceived value is the only significant factor influencing the intention to adopt. Our findings support previous studies in the mobile payments domain. Our model can be of practical value in deciding where to invest resources in the marketing and deployment of such technologies.

Keywords

Mobile Payments, NFC, Consumer Adoption, South Africa, and Structural Equation Modeling.

1. Introduction

Research and practical implementations (such as M-Pesa) has shown the potential of mobile payment technologies, especially in developing countries. Such technologies free citizens to transact on their own terms and create opportunities for innovation, thus playing a prominent role in the economic and social development of the economy. In this sector Near-field communication (NFC; or contactless) mobile payments is experiencing increased rollout and marketing by device manufacturers, technology companies and platform owners (Wolff-Mann, 2015). The promise is to enable convenient tap-and-pay functionality leveraging the ubiquity of mobile devices (Fischer, 2009).

The objective of this study is to examine the factors influencing consumers' intention to adopt NFC mobile payments. Despite its promise the acceptance and use of this technology has been slow (Steinmetz, 2015). Several factors have been highlighted to explain this, such as hardware availability, market fragmentation and lack of perceived value (Wolff-Mann, 2015). While surveys show adequate trust in the security of mobile payments the perceived value of this

technology remains questionable. This is problematic as extensive investments to take advantage of these business opportunities may not lead to user adoption (Wang, Lin & Luarn, 2006).

It is suggested to explore consumer adoption factors to discover specific recommendations which can be applied by mobile payment service providers (Dahlberg, Mallat, Ondrus & Zmijewska, 2008). Factors influencing the adoption of mobile payment solutions have received extensive research attention (e.g. Luarn & Lin, 2005; Chen, 2008; Tan, Tan & Ooi, 2011), but mostly focus on non-NFC technologies. The research question posed in this study is: which factors influence consumers' intention to adopt NFC mobile payments? The question is addressed through the development of a research model based on a review of existing literature. The model is tested using empirical data, collected using an online survey.

2. Background

According to Chen (2008) the area of mobile commerce that receives the most attention world-wide is mobile payments. In the context of this study mobile payments refer to contactless payments using a mobile device, such as a smartphone. Mobile payments can be used for various types of transactions, e.g. retail point-of-sale, ticketing, money transfer and online transactions.

Herzberg (2003) claims that the integration of payment systems with mobile devices is a certainty as mobile devices are increasingly effective in facilitating secure and convenient payment transactions. One of the many advantages of integrating mobile phones and payment solutions is the all-in-one approach to consolidating a consumer's day-to-day tasks (Fischer, 2009). Mobile phones facilitate personal information storage, which can be leveraged to make payments convenient. In addition, existing telecommunication service providers already have transaction processing and billing systems in place (Mallat, 2007).

NFC is a new mobile communication technology that allow consumers to make payments by waving a mobile phone above a terminal; mobile phones fundamentally become a 'magic wand' (Fischer, 2009). Although NFC will soon be widely available to consumers it does not imply the successful adoption of this mobile service. Wang et al. (2006) claim that despite extensive investments to take advantage of the business opportunities NFC offers, research in mobile services suggests potential consumers may not adopt NFC even when it is available to use.

2.1 Near-Field Communication

NFC is a short-range wireless communication protocol, which is primarily intended as a location-based service on mobile phones. It is essentially an extension of the radio frequency identification (RFID) technology, developed from a combination of contactless identification and interconnection technologies which provide data exchange between devices across distances of up to 10cm (Suparta, 2012).

Example NFC use cases include health care and fitness (remote monitoring and health condition awareness), consumer electronics (ease of connecting smart appliances to a network), retail (marketing and loyalty), security (identity and access tokens), social networking (sharing contacts, multimedia, files and games), smartphone automation with smart tags (phone

application launch with location-based self-configurable phone settings) and business cards for redirecting a user to a website, similar to QR codes.

One of NFC's popular use cases is to perform contactless payments by waving a mobile phone above a point-of-sale or ticketing terminal (Chen, 2008). Industry forecasts predict a rapid adoption of NFC, stating that one in five consumers globally would own a NFC-enabled mobile device by the year 2014 (Halaweh, 2012). Results from a NFC user experience trial showed that "89 percent of users rate NFC as faster than payment in cash, 95 percent as more comfortable, 40 percent as more secure, 90 percent as better, 90 percent as more user friendly, and 95 percent as trendier" (Fischer, 2009, p. 26). Therefore there is strong interest in the continued adoption of NFC mobile payments.

2.2 Research Model and Hypotheses Development

According to Davis (1989) consumers tend to use technology to the extent they believe it will help them perform their job better. Based on this the technology acceptance model (TAM) suggests that the intention to use technology is influenced by two factors, namely perceived usefulness and perceived ease of use. However, the fundamental constructs of TAM do not completely reflect the specific influences of technological and usage-context factors that may change user acceptance. Studies have argued that TAM doesn't take into account additional factors that could be important in predicting the acceptance of a system: "while the TAM has many strengths, including its specific focus on IS use, its basis in social psychology theory, the validity and reliability of its instruments and its parsimony, one of its limitations is the assumption that its use is volitional; in other words, there are no barriers to prevent an individual from using an IS if he or she chose to do so" (Mathieson, Peacock and Chin, 2001).

This study examines factors predicting technology adoption, focusing on mobile payment technologies. Within this domain we conducted a literature review of articles in which intention to adopt was the dependent variable. Through this review we identified multiple occurrences of factors, as summarized in Table 1. In the following subsections we develop our hypotheses and research model, based on these factors.

	Perceived Risk	Security Concerns	Privacy Concerns	Trust Concerns	Perceived Value / Usefulness	Social Influences	Perceived Ease of Use	Perceived Financial Resources
Davis (1989)					x		x	
Kaasinen (2005)				x	x		x	
Luarn & Lin (2005)		x	x		x		x	x
Wang et al. (2006)		x	x		x		x	x
Chen (2008)	x	x	x		x		x	
Gupta et al. (2008)						x	x	
Tan et al. (2011)					x	x	x	

Table 1: Mapping of Factors Predicting Adoption

2.2.1 Perceived Risk

Chen (2008) found perceived risk to be an important determinant of consumers' intention to transact online, suggesting that reducing uncertainty is imperative in an online payment environment. Perceived risk is defined as the extent to which a prospective consumer expects

mobile payment to be risky (Chen, 2008). With NFC as an emerging technology a potential user will consider the level of (perceived) risk she will be taking in using the technology, compared to the convenience that it offers. In our research model perceived risk is influenced by a consumer's security, privacy and trust concerns.

Within the mobile payment space Chen (2008) claims that consumers have security concerns, such as authentication, confidentiality of data and non-repudiation. Chen (2008) further posits that security issues related to electronic payment via a wireless network create environmental risks. This negatively affects consumers' intention to adopt such technologies. Security concerns are applicable to NFC mobile payments as consumers are increasingly aware of hackers and identity theft. Potential users will be cautious to adopt an emerging payment technology, of which security has not been proven.

Kaasinen (2005) reports that consumers have privacy concerns with regards to data collection, unauthorized access, errors and secondary use. Privacy concerns are applicable to NFC mobile payments due to the NFC reader that could potentially collect personal information from the mobile phone, without the consumer's knowledge. This personal information could then be used for purposes other than what was intended by the consumer (Chen, 2008). Wang et al. (2006) defines perceived credibility as the extent to which a consumer can be certain that using mobile service will be free of security issues and privacy threats. It can be argued that NFC mobile payments has not yet built of credibility, due to limited adoption.

"Trust is an indicator of a positive belief about the perceived reliability of, dependability of, and confidence in a person, object or process" (Kaasinen, 2005, p. 74). Trust related concerns will significantly affect a consumer's acceptance when financial resources are at stake. In addition, trust in the service provider becomes an important factor when a consumer is making use of a mobile service based on an emerging technology (Kaasinen, 2005). The complexity of mobile networks may introduce consumer uncertainty regarding whom is being transacted with. Another trust concern is that rapidly developed services could be prone to errors. Wang et al. (2006) suggest that trust and resource-related constructs be considered as critical factors in user acceptance and adoption. This leads to the following hypotheses:

H1a: Security concerns will increase the perceived risk of NFC mobile payments.
H1b: Privacy concerns will increase the perceived risk of NFC mobile payments.
H1c: Trust concerns will increase the perceived risk of NFC mobile payments.
H2: Perceived risk will decrease the intention to adopt NFC mobile payments.

2.2.2 Perceived Value

From a consumer perspective Zeithaml (1988) defined perceived value as a "consumer's overall assessment of the utility of a product (or service) based on perceptions of what is received and what is given." A perceived value assessment is usually a comparison of the benefits and costs involved. Perceived value can occur at various stages, including the pre-adoption phase, and does not depend on having experience of using a product or service (Sweeney & Soutar, 2001). From a development perspective Kaasinen (2005) posits that, in an environment where values are not considered, each requirement is deemed as equally important and developed in this manner. This type of development could result in a product that is made up of a collection of useful features,

but as a holistic unit it might not offer considerable value to the consumer. This leads to the following hypothesis:

H3: Perceived value will increase the intention to adopt NFC mobile payments.

2.2.3 Social Influence

Venkatesh and Morris (2000) defined social influence, also known as subjective norm or image, as the degree to which an individual believes that people who are important to her thinks she should perform the behavior in question. Gupta et al. (2008) also found that social influence positively affects the intention to use a system, with no difference between males and females.

Tan et al. (2011) proposed that social influence, a psychological science construct, will positively influence an individual's intention to adopt a mobile credit card. Social influence is regarded to influence a consumer's intention to use positively, due to the trendy nature of NFC. Similarly a positive association has been found between social influence and perceived value (Yen, 2013). This leads to the following hypotheses:

H4: Social influence will increase the perceived value of NFC mobile payments.
H5: Social influence will increase the intention to adopt NFC mobile payments.

2.2.4 Perceived Ease of Use

According to Kaasinen (2005) location based mobile services (such as NFC) can be challenging to use while moving around due to personalization dialogues. Luarn and Lin (2005) claim that while a technology is still emerging the majority of consumers may opt not to adopt the technology due to a lack of know-how, skill and ability to use it. The perceived ease of use construct is derived from TAM and refers to what extent a consumer believes NFC mobile payments will be effortless (Davis, 1989). If a consumer perceives NFC payments to be easy to use she is likely to accept and adopt the service. Davis (1989) defines ease as "freedom from difficulty or great effort", with effort as a finite resource which a person will allocate to various actions for which she is liable. Over the past decades research proposed that perceived ease of use will positively influence a consumer's intention to use mobile payments (e.g. Wang et al., 2006). In addition Kaasinen (2005) proposes that ease of use also affects perceived value. This leads to the following hypotheses:

H6: Perceived ease of use will increase the perceived value of NFC mobile payments.
H7: Perceived ease of use will increase the intention to adopt NFC mobile payments.

2.2.5 Perceived Financial Resources

Mathieson et al. (2001) claims that perceived resource is the extent to which a consumer believes that she has the personal and organizational resources required to use a system. For example, this can include purchasing a NFC-enabled mobile device or subscribing to a NFC mobile payment system (Wang et al., 2006). The perceived financial resource construct was proposed by Wang et al. (2006) as an antecedent of an individual's behavioral intention to use a mobile service. With NFC as an emerging technology, the transaction fees and the acquiring costs of the device can be unavoidably high. Wang et al. (2006) posits that a consumer with increased financial resources,

such as income, will be positively influenced to use a mobile payment system. This leads to the following hypothesis:

H8: Perceived financial resources will increase the intention to adopt NFC mobile payments.

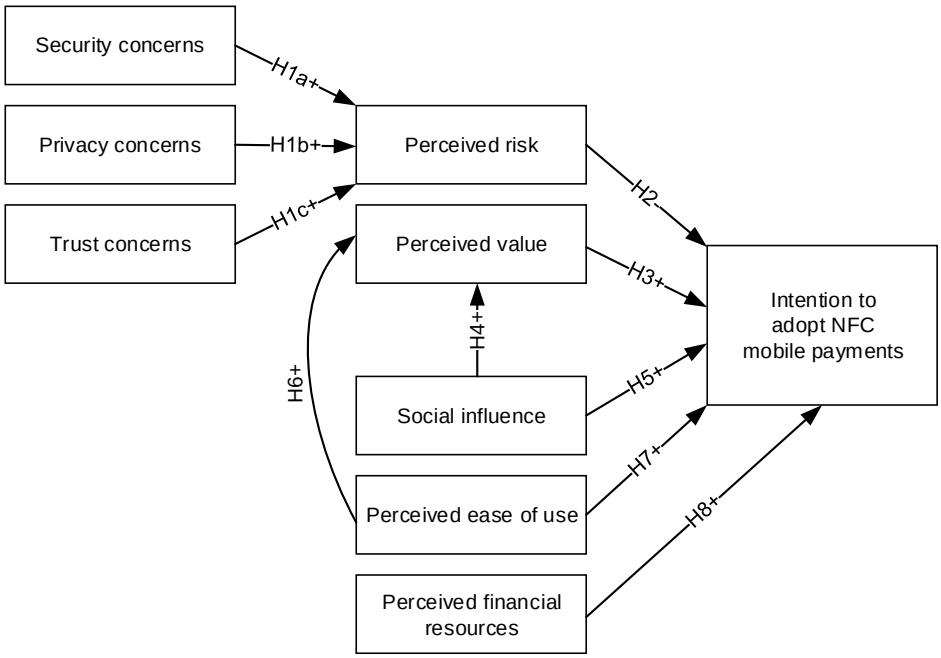

Figure 1: Research Model

The resulting research model is depicted in Figure 1. The model is a novel combination of previous research on mobile payments (as shown in Table 1).

3. Methodology

In order to test the model an online survey was administered to students at a large research university in South Africa. To increase responses alumni students were also targeted (using professional online networks such as LinkedIn.com). Respondents completed items supporting the latent constructs of the research model, as well as demographic questions. All respondents completed the same items, regardless of any experience using NFC mobile payments. A brief explanation of NFC mobile payments preceded the questions to explain the research context.

H1c (-) H3 (+) H4 (+) H5 (+)

Data was collected over a period of two months during 2013. Respondents were sent an email invitation to participate in a survey through Qualtrics.com. Participation was voluntary. Respondents who completed the survey and provided their contact details were included in a random draw to win a small monetary prize. The final sample after screening for missing data, unengaged responses and outliers consisted of 331 responses. Demographic characteristics of the sample is presented in Table 2.

Demography	Category	Frequency	Percentage (%)
Age	18-29	272	82.2
	30-39	38	11.5
	40-49	14	4.2
	50-59	3	0.9
	60-69	4	1.2
Gender	Female	194	58.6
	Male	137	41.4
NFC-enabled Phone Owner	Yes	87	26.3
	No	94	28.4
	Not Sure	150	45.3
Subscriber Type	Pre-paid	149	45
	Contract (Post-paid)	182	55

Table 2: Respondent Demography

Measurement items were adapted from several sources; where required items were adapted to the NFC context. All items were gathered using a five-point Likert-type scale. Table 3 presents a consistency matrix linking latent constructs with relevant prior studies, survey items used in this study, and the mean responses for each construct.

Construct	Source(s)	Items	Mean
Security Concerns	Luarn & Lin (2005); Wang et al. (2006); Chen (2008)	SECC01; SECC02; SECC03	3.43
Privacy Concerns	Luarn & Lin (2005); Wang et al. (2006); Chen (2008)	PRIV04; PRIV05; PRIV06	3.34
Trust Concerns	Kaasinen (2005)	TRUC07; TRUC08; TRUC09	3.34
Perceived Risk	Chen (2008)	PRSK10; PRSK11; PRSK12	3.26
Social Influence	Gupta et al. (2008); Tan et al. (2011)	SINF13; SINF14; SINF15	3.18
Perceived Value	Davis (1989); Kaasinen (2005); Luarn & Lin (2005); Wang et al. (2006); Chen (2008); Tan et al. (2011)	PVAL16; PVAL17; PVAL18	3.61
Perceived Ease of Use	Davis (1989); Kaasinen (2005); Luarn & Lin (2005); Wang et al. (2006); Chen (2008); Gupta et al. (2008); Tan et al. (2011)	PEOU19; PEOU20; PEOU21	3.94
Perceived Financial Resources	Luarn & Lin (2005); Wang et al. (2006)	PFIN22; PFIN23; PFIN24	3.88

Table 3: Consistency Matrix

4. Analysis and Results

The PLS approach to structural equation modeling (SEM) was used to test the hypotheses. PLS-SEM is "an ordinary least squares (OLS) regression-based method… [which] uses available data to estimate the path relationships in the model" (Hair, Hult, Ringle, & Sarstedt, 2014, p. 14). For the data analysis a popular implementation of PLS, SmartPLS 3 (Ringle, Wende, & Becker, 2015), was used.

An assessment of the reflective measurement model included examining composite reliability (CR) to evaluate internal consistency, individual indicator reliability, and average variance extracted (AVE) to evaluate convergent validity. To assess discriminant validity we first used the Fornell-Larcker criterion (the results are indicated in Table 4). This is a more conservative approach (to cross loadings) and was considered appropriate since all constructs are reflective (Hair et al., 2014). Next we followed the recommendation of Henseler, Ringle and Sarstedt (2015) and examined the heterotrait-monotrait (HTMT) ratio of correlations. All values were below the conservative 0.85 threshold level (Kline, 2011), thus confirming that discriminant

validity had been established. The initial path modeling procedure was performed using the default settings in SmartPLS 3.

Indicator reliability was assessed by examining the outer loadings. All but three indicators were above the 0.70 threshold and the impact of deleting the three indicators was examined. One indicator was removed (outer loading < 0.40) but the others were kept as no significant increase in CR or AVE was achieved (Hair et al., 2014). Table 4 presents a summary of the assessment results, showing CR in column 2, AVE in column 3, and Fornell-Larcker results in columns 4-12.

	CR	AVE	INT	PEOU	PFR	PR	PV	PC	SC	SI	TC
Intention to Adopt (INT)	1.000	1.000	1.000								
Perc. Ease of Use (PEOU)	0.908	0.767	0.114	0.876							
Perc. Fin. Resources (PFR)	0.700	0.559	0.139	0.074	0.748						
Perc. Risk (PR)	0.835	0.629	-0.101	-0.222	-0.074	0.793					
Perc. Value (PV)	0.796	0.579	0.177	0.397	0.256	-0.268	0.761				
Privacy Concerns (PC)	0.855	0.666	0.117	0.158	0.162	-0.338	0.267	0.816			
Security Concerns (SC)	0.855	0.665	0.066	0.228	0.217	-0.418	0.341	0.67	0.815		
Social Influence (SI)	0.888	0.726	0.146	0.391	0.264	-0.265	0.581	0.249	0.304	0.852	
Trust Concerns (TC)	0.846	0.649	0.127	0.327	0.195	-0.442	0.458	0.525	0.559	0.416	0.805

Table 4: Assessment of Reflective Measurement Model

In order to maximize the explained variance the effect of removing constructs and relationships were examined. It was found that removing the PFR construct and SI -> INT and PEOU -> INT relationships improved the model. Findings from the PLS analysis of the structural model are shown in Figure 2. The values 0.238, 0.372 and 0.034 present the coefficient of determination (R^2) for the PR, PV and INT constructs respectively. Path coefficients are shown on relationships. To determine the statistical significance of structural paths bootstrapping using 5,000 samples (and the default settings in SmartPLS 3) was used, which is sufficient for assessing significance (Hair et al., 2014).

The results of hypothesis testing is summarized in Table 5. Of the ten hypotheses, five were supported. As indicated in Table 5 and Figure 2, the model explains approximately 24 percent, 37 percent, and 3 percent of the variance. The highest explanatory power of 37 percent is the path for social influence and perceived ease of use leading to perceived value. Consistent with H3, perceived value has a significant positive effect on intention to adopt NFC mobile payments. Although security and trust concerns have a significant effect on perceived risk, the subsequent effect on intention to adopt is not significant. The results of the structural model testing indicates support for a model that contextualizes perceived value in relation to the intention to adopt NFC mobile payments.

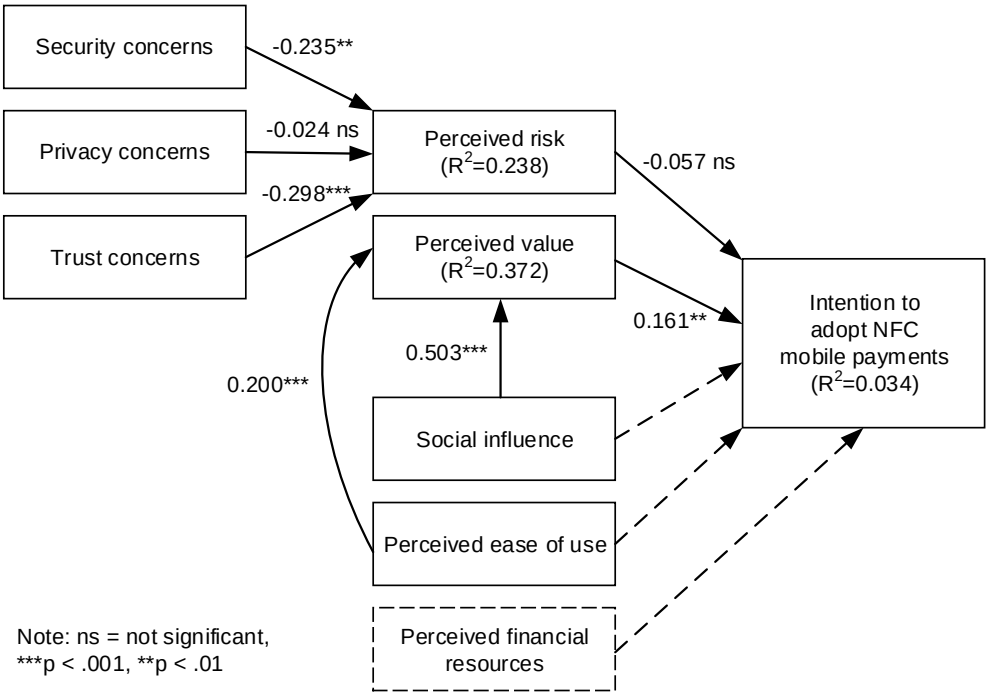

Figure 2: Results of PLS Structural Model Analysis

Hypothesis	Path Coefficient	T-Value	P-Value	Supported?
H1a: SC -> PR	-0.235	3.042	p < .01	Supported
H1b: PC -> PR	-0.024	0.350	p > .10	Not supported
H1c: TC -> PR	-0.298	4.798	p < .001	Supported
H2: PR -> PV	-0.057	0.937	p > .10	Not supported
H3: PV -> INT	0.161	2.765	p < .01	Supported
H4: SI -> PV	0.503	10.672	p < .001	Supported
H5: SI -> INT (removed)	-	-	-	Not supported
H6: PEOU -> PV	0.200	4.062	p < .001	Supported
H7: PEOU -> INT (removed)	-	-	-	Not supported
H8: PFR -> INT (removed)	-	-	-	Not supported

Table 5: Overview of Findings

5. Discussion

Previous studies have conceptualized social influence and perceived ease of use as direct antecedents of intention to adopt. However, our results do not support this relationship, instead pointing to perceived value as a mediating construct. Perceived value is a well-established construct in marketing, but perhaps underutilized in information systems. Thus this presents an opportunity for further theoretical investigation. From a practical perspective the significance of this relationship implies that consumers' base their adoption decision on an assessment of the benefits and costs involved (at least in our sample). This reinforces the importance of values in this environment (e.g. Kaasinen, 2005); a combined perspective of value is more important than individual usage factors.

Interestingly social influence had the most significant influence on perceived value. Social influence has been shown to affect mobile payment system adoption (Gupta et al., 2008; Tan et al., 2011). In the context of our sample, students undoubtedly experience significant social influence and it could be argued that this points to a limitation of the current study. Within the context of mobile payment social influence is a little-explored construct which, our results indicate, deserves further investigation. Practitioners responsible for marketing of NFC mobile payments should note the positive effect of social influence as an important part of gaining user acceptance.

Interestingly, perceived financial resources did not play a role in our results – within a developing country context this is surprising. This could be explained by the characteristics of the sample since most students at this particular institution have financial freedom. The fact that 55 percent of the sample are contract (post-paid) mobile subscribers further supports this perspective. However, a multi-group analysis of our data revealed no significant difference between subscriber types in relation to perceived financial resources. The importance of this construct this deserves further attention.

Our research supports prior findings that a user's security and privacy concerns have a significant influence on perceived risk. Chen (2008) reported that perceived risk negatively affects user intention to adopt mobile payments, as the reliance on unfamiliar technology produces uncertainty. If a consumers don't think that sufficient security and privacy measures are in place for consumer protection their intention to adopt the system could be lower. Previously Chen (2008) found that 49.5 percent of respondents were concerned about data collection, 27.7 percent of respondents were concerned about the secondary use of their personal information, while 52.7 percent of respondents did not think mobile payment was secure. While we did not find a significant relationship between perceived risk and intention to adopt we investigated this further using a multi-group analysis of gender. We found that women exhibit a significant relationship ($p < .05$) between perceived risk and intention to adopt. In addition, women are significantly ($p < .05$) more concerned about trust, while men are more concerned about security.

According to our results, trust has the biggest influence on perceived risk. This supports Kaasinen (2005) who claimed that trust is becoming increasingly important. This is due to mobile services getting more involved in the personal life of people, as services increasingly collect, analyze and store personal data. It should be ensured that the user feels (and really is) in control. Thus practitioners will have to make sure security controls, privacy protection, and sufficient control is available to reduce user uncertainty and increase acceptance.

6. Conclusion

As an emerging technology NFC is received theoretical and practical attention. This study contributes to the literature on mobile payments by exploring the factors influencing the intention to adopt NFC mobile payments. We contribute a theoretical model, based on previous literature related to mobile payments, and test our model using empirical data. The results of our analysis show the significance of perceived value as a cost-benefit assessment leading to adoption. Our findings demonstrate that perceived value is a multi-dimensional construct,

affected by social influence and perceived ease of use. While security and trust concerns are important they do not have a significant effect on the perception of risk and subsequent adoption.

Our study is limited by the sample and context. Our sample is predominantly young South African users, and the data should be interpreted in this context. This points to further research opportunities, broadening the data collection to other groups and areas. The importance of perceived value as an antecedent to mobile payment adoption should also be investigated further, through the testing of other related constructs and identifying the influence of adoption phases.

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