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Investigating the Components of Perceived Risk Factors Affecting Mobile Payment Adoption

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Abstract: As smartphone ownership rapidly expands, mobile payment options are gaining popularity due to the portability and convenience they offer. This study examines attitudes towards adopting mobile payment, focusing on the component risk, which consists of multiple dimensions including performance, financial, time, psychological, and social risks. The study uses a quantitative approach, collecting data through a survey distributed to mobile payment users, with 361 respondents in the United States. The survey instrument includes measures of performance and psychological risk, as well as attitudes towards mobile payment acceptance. Data analysis using SPSS 25.0 and AMOS 24.0 reveals that both performance and psychological risk significantly negatively impact attitudes towards mobile payment acceptance, underscoring the importance of mobile payment service providers implementing effective risk management policies to improve users' positive attitudes towards their platforms.

Keywords: mobile payment; performance risk; financial risk; time risk; psychological risk; social risk; attitude

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1. Introduction

Modern life has embraced mobile/smartphones as an indispensable means of communication in various activities, whether in corporate offices or at home (Hijazi et al. 2023). The integration of new utilities into mobile phones, facilitated by advances in information and telecommunications technologies and wireless Internet, has created favorable conditions for them to drive the growth and development of mobile commerce (Moghavvemi et al. 2021). Mobile commerce encompasses various forms such as mobile payment, mobile office, mobile entertainment, mobile gaming, mobile advertising, and mobile education (Mobarak et al. 2024), with mobile payment being a catalyst for other applications (Hazarika et al. 2023).

The banking landscape has been transformed by digitalization, driven by advancements in mobile technology (Sebayang et al. 2024). The payment industry is experiencing a significant transformation as consumers increasingly favor mobile payment over traditional methods like cash (Nguyen et al. 2023). Sharma and Sharma (2023, p. 3) offer a comprehensive definition by describing mobile payment "as a contemporary system that leverages on mobile devices (e.g., smartphone, tablet) and wireless technologies (e.g., QR code, Internet) to facilitate electronic monetary transactions (e.g., payment, top-up) among users (e.g., buyers and sellers of goods and services), thereby providing an alternative to traditional, non-mobile payment systems". Mobile devices are used to initiate, authenticate, and confirm transactions involving payment for goods and services in a convenient, efficient, effective, and simple manner (Al-Qudah et al. 2024). This payment channel is

increasingly popular as a replacement for other forms of payment, such as cash, checks, debit cards, and credit cards (Rahardja et al. 2023).

Mobile payment offers benefits to both individuals and businesses (Singh et al. 2023). For consumers, the ability to purchase goods and services anytime and anywhere is a significant advantage. Additionally, the costs associated with using a mobile payment service are much lower than with other forms of payment. Moreover, mobile payment is simple and convenient, requiring only a mobile device and a wireless Internet connection. For businesses, the first benefit is that using mobile payment does not require a large investment relative to other forms of payment. The second benefit is that mobile payment can help businesses increase their customer base, creating favorable conditions for higher sales and profits, because the expanded customer base is not limited by space and time. The third benefit is that it is faster to collect money from customers and that money is turned around for other profitable purposes within the firm (Sayed et al. 2020).

Governments worldwide, alongside consumers and businesses, are reaping the benefits of mobile payment technologies (Dong et al. 2023). Mobile payment serves as a catalyst for governments aiming to advance digital transformation and establish smart governments, cities, and citizens (Pham et al. 2023). By enhancing transaction transparency, mobile payment systems play a crucial role in areas with limited access to traditional banking services (Tang and Tsai 2024).

In a study reviewing 455 articles focusing on mobile payment, Sharma and Sharma (2023) reported an increasing number of articles in this area over the past five years. Despite this growth, the field is considered "nascent," primarily driven by a few researchers, and remains open to new perspectives on attitudes and the acceptance of mobile payment. Commonly employed theories include the diffusion of innovation, theory of reasoned action, theory of planned behavior, technology acceptance model, and institutional theory. The antecedents of mobile payment investigated include the perceived ease of use, perceived usefulness, perceived risk, trust, perceived security, privacy, relative advantage, performance expectancy, effort expectancy, and social influence, among others (e.g., Agárdi and Alt 2022; George and Sunny 2023; Kaur et al. 2020; Ly et al. 2022; Mombeuil 2020; Schmidthuber et al. 2020; Singh and Sinha 2020; Singh et al. 2020; Yang et al. 2021).

Another study by Sahi et al. (2022) reviewed 591 studies examining mobile payment and security or privacy risk. They noted a scarcity of studies investigating the antecedents of risk in mobile payments, highlighting a gap in the literature that this study aims to address. Several studies have examined the antecedents of perceived risk in the contexts of online shopping, e-service adoption, retailing, mobile banking, and FinTech (e.g., Forsythe and Shi 2003; Park et al. 2004; Featherman and Pavlou 2003; Vincent-Wayne and Harris 2005; Damghanian et al. 2016; Luo et al. 2010; Meyliana et al. 2019). Agárdi and Alt (2022) assessed the impact of financial risk and privacy risk on mobile payment use intention, finding no significant impact. Yang et al. (2015) separated risk into financial, privacy, performance, psychological, and time risks, reporting that financial, performance, and privacy risks significantly influenced mobile payment intention. Pal et al. (2021) examined the relationship between the intention to use and financial, privacy, security, and performance risks, mediated by perceived risk, finding all four risk subdimensions significantly mediated the intention to use.

This research extends the studies by Pal et al. (2021) and Yang et al. (2015) by including social risk alongside performance, financial, time, and psychological risks to assess their collective impact on consumers' attitudes towards adopting mobile payment solutions. The central research question investigates the influence of these diverse risk types on consumer attitudes towards mobile payment adoption.

This study endeavors to bridge the identified gap by exploring the array of risks that affect attitudes towards mobile payment adoption. By broadening the scope of the existing literature, this research aims to pinpoint specific risk factors that influence consumer attitudes towards mobile payment. Specifically, the main research question in this study is as follows: what are component risks in the mobile banking environment, and which

have a negative and statistically significant influence on the attitude towards mobile payment adoption?

The manuscript is organized as follows: An initial section will elaborate on mobile payment concepts, perceived risk, and review pertinent research. This will be followed by the detailed expositions of the research model, the methodology employed, and the findings. The discussion will then synthesize these results, focusing on both their theoretical and practical implications. Finally, future research directions will be outlined.

2. Literature Review

Mobile payment refers to a transactional method wherein a mobile device is utilized to initiate, authenticate, and finalize a financial transaction involving the purchase or exchange of goods and services (Zhang et al. 2023). It stands as a prominent component of mobile commerce (Chen et al. 2023) and represents the natural progression of online payment systems (Alrawad et al. 2023). Operating through mobile networks, this payment method leverages wireless Internet technology to process financial transactions, and devices such as smartphones, personal digital assistants, or tablets are commonly used for mobile payment transactions (Tang and Tsai 2024).

The two primary forms of mobile payment are remote mobile payment and proximity mobile payment. Remote mobile payment entails transactions between customers and businesses' point-of-sale systems without direct physical contact (Behera et al. 2023). Conversely, proximity mobile payment, commonly referred to as contactless payment, requires direct physical interactions between customers and point-of-sale systems, typically using near-field communication (NFC) technology (Zhong and Chen 2023).

Mobile payment can be further classified into four groups: carrier billing, NFC, applications, and card readers (Moghavvemi et al. 2021). Carrier billing allows customers to charge purchases to their mobile phone bills, commonly used for buying digital content like apps from platforms such as Apple Store or Google Play. NFC, on the other hand, enables contactless payments using mobile devices, reducing transaction times and enabling quick payments by scanning barcodes. Mobile payment via applications is a widely adopted method, with banks and companies offering mobile banking services through dedicated apps, including e-wallets and mobile wallets. Lastly, card readers, a newer form of mobile payment, involve the use of handheld card readers inserted into mobile devices to initiate and complete transactions conveniently, supported by major mobile payment companies like PayPal or MasterCard (Dash et al. 2023).

2.1. Prior Studies on Mobile Payment

Recent advancements in mobile payment research reflect ongoing innovations and developments within the field. This research progresses in parallel with technological advances, focusing primarily on established technology acceptance models (Chaw et al. 2024; Sharma and Sharma 2023). These studies typically aim to assess the factors influencing the acceptance of mobile payment, drawing on theoretical frameworks rooted in the models of behavioral intention (Anwar et al. 2024).

A frequently employed theoretical framework is the theory of reasoned action (TRA) by Fishbein and Ajzen (1975), which highlights behavioral variables such as attitudes towards behavior and subjective norms to elucidate individual behavior. The theory of planned behavior (TPB) by Ajzen (1991) expands upon TRA by including beliefs that affect attitudes, normative beliefs that shape subjective norms, and control beliefs that impact behavioral control.

The technology acceptance model (TAM), formulated by Davis et al. (1989), serves as another prominent framework frequently applied in mobile payment research. TAM emphasizes two critical variables—the perceived ease of use and perceived usefulness—which significantly influence the intention to adopt information technology.

Researchers often rely on one or a combination of these models to explain mobile payment acceptance, often augmenting them with additional variables to enhance the base acceptance model.

Factors such as convenience, speed, security, privacy, and compatibility are among the additional variables included in various studies (e.g., Lin et al. 2022; Wang 2022; Yi et al. 2024). Compatibility, personal mobility, and subjective norms have been identified as the key influencers of the intention to use mobile payment (Alkhalifah 2022; Ku 2021), while factors like behavioral beliefs, social influences, and personal characteristics also play significant roles in acceptance and use (Ghosh 2024; Hameed et al. 2024; Lin and Hsieh 2023). Perceived risk, cost, compatibility, and comparative advantage are other critical factors affecting the intention to use mobile payment (Kim et al. 2023; Lisana 2024; Mobarak et al. 2024). Additionally, outcome expectations and social influences serve as driving forces for mobile payment use, whereas perceived costs and risks function as deterrents (Zhang et al. 2023).

2.2. Perceived Risk

E-commerce represents an evolution from traditional commerce (Mai and Nguyen 2024). In traditional commerce, transactions occur through direct, physical interactions between customers and company employees (Nguyen et al. 2020). Conversely, in e-commerce, transactions take place through interactions between customers and companies' websites (Dang et al. 2023). Electronic payment is a core aspect of e-commerce, and with the evolution of mobile commerce, mobile payment has emerged as a prominent feature (Laksamana et al. 2022). Mobile payment enables the seamless transactions of goods and services without the constraints of physical space and time, highlighting the importance of considering perceived risk in this context.

Perceived risk refers to the extent to which the unfavorable outcomes of an economic event might occur, impacting various entities such as individuals, businesses, organizations, or governments. It has been a key focus in empirical studies to better understand consumer behaviors, particularly in marketing. The concept of perceived risk finds its roots in the foundational works of Cunningham (1967) and Kaplan et al. (1974), who delineated the different component risks that collectively form perceived risk. This multi-faceted nature of perceived risk has been underscored by Luo et al. (2010) and Featherman and Pavlou (2003) in their investigations of online services and mobile banking. Depending on the research context, perceived risk can encompass various component risks, including performance risk, financial risk, privacy risk, security risk, psychological risk, time risk, and social risk, among others.

In the realm of mobile payment, perceived risk arises from various sources, including banks, applications, and wireless Internet service providers. Risks associated with banks and applications include concerns about unreliable technology leading to unsatisfactory transactions or the misuse of personal and financial information. Risks related to wireless Internet service providers include potential interruptions or slow speeds, resulting in increased transaction times and opportunity costs for customers.

3. Theoretical Background

Perceived risk plays an important role in the studies of the acceptance of new technology or innovation. It is composed of component risks, which are considered in different research settings, including e-commerce, mobile commerce, online banking, or mobile banking. The theoretical framework for these studies includes the seminal work of Bauer (1960), Cunningham (1967), Kaplan et al. (1974), Meyliana et al. (2019), and Pal et al. (2021), which distinguished different risk groups (Featherman and Pavlou 2003).

Perceived risk also plays a significant role in shaping consumer trust within the mobile payment landscape (Alrawad et al. 2023; Van et al. 2020), subsequently influencing the intention to use mobile payment services. It should not be treated as a single factor in a research model. Perceived risk is a multifaceted construct composed of various types of

risk. Hence, the theoretical foundation for this study is the perceived risk theory, which states that consumers must deal with uncertainty when making purchase decisions (Wei et al. 2018).

According to Featherman and Pavlou (2003), perceived risk can be separated into multiple subdimensions. This study will examine the direct impact that the risk facets of performance risk, financial risk, time risk, psychological risk, and social risk have on consumers' attitudes towards mobile payment adoption. It is possible that not all components that compose perceived risk play a significant role in forming a consumer's attitude towards mobile payment. Without an understanding of the underlying components of perceived risk, the risk factors that impact consumers' decisions the most may go unaddressed. This may result in customers being unlikely to proceed with completing their purchases using mobile payment methods.

This study aims to explore how these component risks, including performance, financial, time, psychological, and social risks, influence attitudes towards mobile payment adoption. The proposed research model, depicted in Figure 1, will provide insights into the complex interplay of these risks and their impact on consumer behavior.

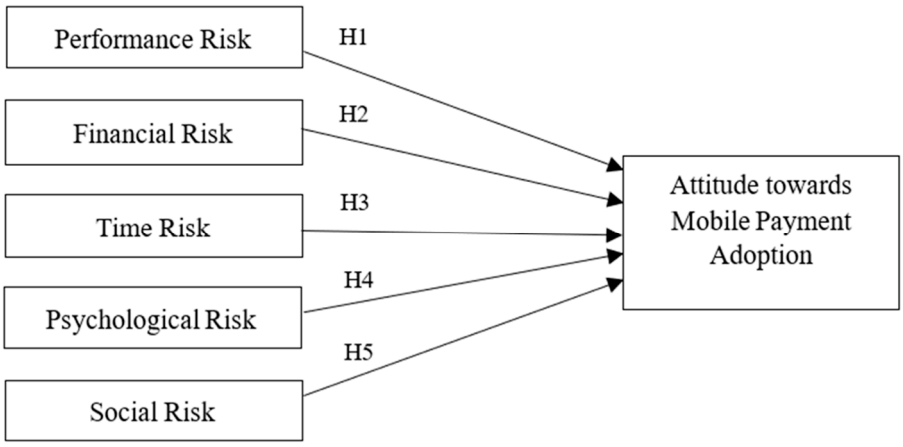

Figure 1. Research models and hypotheses.

Perceived risk is a significant factor influencing consumer behavior (Nguyen et al. 2020; Widyanto et al. 2022) and comprises component risks such as performance, financial, time, psychological, and social risks. The impact of these component risks on consumer behavior varies depending on the nature of the goods and services involved in the transaction (Salameh et al. 2024).

3.1. Performance Risk

Performance risk pertains to factors that can affect the efficiency of mobile payment from the users' perspective (Kamboj et al. 2024; Van et al. 2021). It typically includes situations such as the following: (1) system failures due to slow wireless Internet speeds, server downtime, or maintenance phases; (2) failure to meet customers' expectations and requirements regarding the functionality and convenience of mobile payment; and (3) discrepancies between mobile payment service providers' advertising claims and users' actual experiences (Ha et al. 2024). Users often may encounter malfunctioning or defective mobile payment applications. Addressing performance risk is vital for enhancing consumers' attitudes towards mobile payment. Therefore, in the mobile payment environment, the following hypothesis is proposed:

H1. *There is a negative relationship between performance risk and attitude towards mobile payment adoption.*

3.2. Financial Risk

Financial risk pertains to consumers' apprehensions regarding potential financial losses when using mobile payment (Widyanto et al. 2022). This risk manifests in several scenarios, including the following: (1) errors in mobile payment transactions leading to incorrect account debits or amounts; (2) financial losses not compensated by mobile payment service providers; and (3) the loss of control over one's account for unknown reasons (Van et al. 2020). The penalty for loss could be significant when using mobile payment apps that manage financial transactions and are directly connected to bank accounts, especially when compared to offline payment methods like cash (Zhou 2013). With the increasing banking malware attacks, this makes the financial risk one of the most important types of perceived risk (Pal et al. 2021). Therefore, in the context of mobile payment, the following hypothesis is proposed:

H2. *There is a negative relationship between financial risk and attitude towards mobile payment adoption.*

3.3. Time Risk

Time risk in mobile payment systems is a significant factor that influences consumer behavior, referring to the concerns related to the temporal aspects of mobile payment use (Kamboj et al. 2024). These concerns encompass several dimensions: (1) the duration required to acquire proficiency in using mobile payment technologies; (2) the time spent addressing complications such as transaction errors; and (3) the latency involved in initiating and completing transactions (Wang et al. 2024). Time risk is indicative of the potential delays and inefficiencies inherent in the adoption and operation of mobile payment systems due to user uncertainty, the learning curve associated with new applications, and the possibility of transaction failures (Featherman and Pavlou 2003). Furthermore, extended transaction times can result in consumer inconvenience, emphasizing the necessity for developers to enhance system usability and efficiency (Choi and Choi 2017). Therefore, in the context of mobile payment, the following hypothesis is proposed:

H3. *There is a negative relationship between time risk and attitude towards mobile payment adoption.*

3.4. Psychological Risk

Psychological risk in mobile payment systems encompasses not only a perceived lack of trust and inherent insecurity among consumers but is also closely linked to the feelings of unfamiliarity, unreliability, and fear (Ghosh 2024; Trachuk and Linder 2017). These apprehensions arise from consumers' uncertainty about engaging with mobile payment technologies and a general mental unpreparedness for adopting such systems. The hesitation frequently arises from a lack of technological readiness or a more generalized apprehension towards adopting new financial technologies. To effectively overcome these obstacles, it is imperative for technology developers and financial institutions to invest in educational programs and enhancements in user-friendly design that enhance familiarity and reliability. Thoroughly addressing these psychological barriers is vital for increasing consumer acceptance and encouraging the widespread adoption of mobile payment technologies. Consequently, the following hypothesis is proposed in the context of mobile payment:

H4. *There is a negative relationship between psychological risk and attitude towards mobile payment adoption.*

3.5. Social Risk

Social risks associated with mobile payment could significantly influence consumer behavior and the attitude towards such technologies. These risks encompass several key concerns: (1) the potential lack of support or endorsement from family, friends, and

colleagues; (2) the risk of diminished social status following errors or transaction failures; and (3) the reduced personal contact that mobile payments entail (Nguyen et al. 2020). Furthermore, the integration of mobile devices into daily life has heightened the impact of social influences on consumer choices.

Katz and Sugiyama (2006) noted that cellphones not only serve functional purposes but also reflect individual self-image and status within social groups, with different devices signifying varying social symbols. The importance of social context, as identified by Featherman and Pavlou (2003), underscores that consumers perceive significant social risks when mobile payment methods are not recognized or validated within their social circles, potentially leading to a loss of identity or status.

These findings highlight the necessity for technology developers and marketers to consider the social dimensions of mobile payment adoption. Enhancing the social acceptability and perceived social benefits of mobile payment can mitigate these risks and foster greater consumer acceptance and satisfaction. Therefore, in the mobile payment environment, the following hypothesis is proposed:

H5. *There is a negative relationship between social risk and attitude towards mobile payment adoption.*

4. Research Methodology

Measurement Development

The survey instrument for this study was developed by adapting the survey items for performance risk and financial risk from a study by Featherman et al. (2010). The survey items for time risk were adapted from a study by Ling et al. (2011). The survey items for psychological risk were adapted from the studies by Ling et al. (2011) and Venkatesh et al. (2012). The survey items for social risk were adapted from a study by Yang et al. (2016). The survey items for the attitude towards mobile payment adoption were adapted from a study by Davis et al. (1989).

The questionnaire consists of thirty-four (34) questions. Utilizing a 5-point Likert scale, participants were prompted to respond to thirty (30) questions concerning their perceptions of risk. The remaining four questions gathered demographic information from the respondents. To ensure the clarity of these questions, three professors and three researchers reviewed and provided feedback on the survey questions. Based on this feedback, revisions were made to the survey.

The surveys were administered to students affiliated with a university in the southwestern portion of the United States. The students were selected as the sample group to participate in this study because they represent the major demographic group that extensively uses mobile technology. Four hundred and thirty (430) subjects participated in this study. However, only 361 responses were returned completed. The participants' demographics are shown in Table 1 below.

Table 1. Subjects' demographics (n = 361).

Gender						
Male		Female				No Answer
146 (40.44%)		209 (57.89%)				6 (1.66%)
Highest Education						
High School	Associate	Bachelor	Master	Doctoral		No Answer
74 (20.50%)	26 (7.20%)	190 (52.63%)	55 (15.24%)	9 (2.49%)		7 (1.94%)
Age (in years)						
18–25	26–35	36–45	46–55	56–65	Above 65	No Answer
144 (39.89%)	96 (26.59%)	80 (22.16%)	28 (7.76%)	6 (1.66%)	1 (0.28%)	6 (1.66%)
Employment						
Full-Time		Part-Time	Not Employed			No Answer
28 (27.15%)		270 (74.79%)	54 (14.96%)			9 (2.49%)

5. Data Analysis and Discussion

SPSS 25.0 and AMOS 24.0 were used to analyze the data. This section describes the data analysis.

5.1. Reliability Test

A reliability test was performed to assess the internal consistency of the survey instrument constructs. The reliability was calculated for each of the constructs in the research model. The results of the reliability test are listed in Table 2. The results of the reliability tests were all above the recommended value of 0.70 (Nunnally 1978). Thus, the internal consistency of the constructs is acceptable.

Table 2. Reliability test.

Constructs	Measurement Items	Cronbach's α
Performance Risk	PR1, PR3, PR4, and PR5	0.915
Financial Risk	FR1, FR2, FR3, and FR5	0.897
Time Risk	TR1, TR3, TR4, and TR5	0.946
Psychological Risk	PSR2, PSR3, PSR4, and PSR5	0.977
Social Risk	SR1, SR2, SR4, and SR5	0.982
Attitude towards Mobile Payment Adoption	ATT1, ATT2, ATT3, ATT4, and ATT5	0.941

5.2. KMO and Bartlett's Test

The KMO and Bartlett's tests were performed to evaluate the degree of unidimensionality of the scales (see Table 3). The sphericity test showed a *p*-value of 0.000. The sampling adequacy was also supported with a value of 0.878.

Table 3. KMO and Bartlett's test.

KMO and Bartlett's Test		
KMO Sampling Adequacy Measurement.		**0.878**
Sphericity Test	Approx. Chi-Square	9382.695
	Degree of Freedom	528
	Significance	0.000

5.3. Common Method Bias

Harman's single-factor test is a technique used to assess common method bias, which can occur when a single method of data collection influences respondents' answers across all variables. In our study, we used SPSS to conduct this test, which involved performing an un-rotated, single-factor constraint factor analysis. This analysis aims to identify if a single factor explains the majority of the variance in the data, which would suggest the presence of common method bias.

The result of the analysis, as shown in Table 4, indicated that the highest variance explained by one factor was 47.460%. This result suggests that there is no significant problem with common method bias in our study. When a single factor does not explain a large proportion of the variance, it indicates that the variance in the data is likely due to the different constructs being measured rather than a methodological bias.

Table 4. Total variance explained.

Total Variance Explained						
Components	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**Variance %**	**Cumulative %**	**Total**	**Variance %**	**Cumulative %**
1	11.865	47.460	47.460	11.865	47.460	47.460
2	3.765	15.058	62.518	3.765	15.058	62.518
3	2.723	10.891	73.410	2.723	10.891	73.410
4	1.340	5.360	78.770	1.340	5.360	78.770
5	1.034	4.135	82.905	1.034	4.135	82.905
6	0.821	3.282	86.187	0.821	3.282	86.187
7	0.401	1.604	87.791			
8	0.380	1.521	89.312			
9	0.314	1.254	90.566			
10	0.283	1.132	91.698			
11	0.273	1.092	92.790			
12	0.246	0.985	93.775			
13	0.220	0.880	94.654			
14	0.210	0.841	95.495			
15	0.199	0.796	96.290			
16	0.159	0.638	96.928			
17	0.154	0.616	97.544			
18	0.135	0.539	98.083			
19	0.105	0.420	98.503			
20	0.089	0.357	98.860			
21	0.085	0.341	99.201			
22	0.074	0.295	99.496			
23	0.050	0.198	99.694			
24	0.042	0.169	99.863			
25	0.034	0.137	100.000			

5.4. Factor Loadings

To evaluate the convergent validity of the factors in our study, we employed a factor analysis using the principal component analysis (PCA) extraction method and varimax rotation with Kaiser normalization.

The PCA extraction method was chosen to identify the underlying structure of the data by extracting the linear combinations of the original variables (survey items) that account for the maximum amount of variance in the data. This method is useful for reducing the dimensionality of the data and identifying the most important factors that explain the variation in the observed variables.

Varimax rotation with Kaiser normalization was used to rotate the factors to achieve a simpler and more interpretable factor structure. This rotation method aims to maximize the variance of the squared loadings within each factor, leading to more distinct and easily interpretable factors. Kaiser normalization is a method used to standardize the factor loadings to have a mean of zero and a variance of one, which facilitates the interpretation of the loadings.

We examined the factor loadings of each survey item to ensure that they were sufficiently high and statistically significant. Factor loadings indicate the strength and direction of the relationship between each item and its underlying factor. According to Hair et al. (2009), factor loadings above 0.5 are considered acceptable.

As shown in Table 5, our analysis revealed that all twenty-five survey items loaded onto their respective factors with loadings above the threshold of 0.5, indicating that each item effectively measured the intended construct. The total variance explained by these factors was 86.187%, suggesting that the factors collectively accounted for a substantial portion of the variability in the data. This high level of explained variance indicates that the factors are distinct and contribute uniquely to the measurement model.

Table 5. Factor analysis.

Rotated Component Matrix						
	Component					
	1	**2**	**3**	**4**	**5**	**6**
Performance Risk 1	−0.079	0.120	0.154	0.133	**0.781**	0.266
Performance Risk 3	−0.184	0.142	0.139	0.230	**0.721**	0.375
Performance Risk 4	−0.195	0.098	0.176	0.302	**0.766**	0.309
Performance Risk 5	−0.108	0.145	0.079	0.225	**0.817**	0.304
Financial Risk 1	−0.077	0.194	0.174	0.286	0.349	**0.700**
Financial Risk 2	−0.126	0.055	0.039	0.066	0.248	**0.839**
Financial Risk 3	−0.073	0.206	0.203	0.197	0.352	**0.735**
Financial Risk 5	−0.171	0.141	0.186	0.203	0.324	**0.739**
Time Risk 1	−0.090	0.227	0.193	**0.797**	0.216	0.225
Time Risk 3	−0.116	0.225	0.270	**0.796**	0.222	0.266
Time Risk 4	−0.120	0.267	0.287	**0.810**	0.232	0.168
Time Risk 5	−0.122	0.293	0.269	**0.780**	0.250	0.078
Psychological Risk 2	−0.122	0.410	**0.789**	0.275	0.170	0.135
Psychological Risk 3	−0.125	0.353	**0.801**	0.302	0.170	0.165
Psychological Risk 4	−0.105	0.366	**0.836**	0.257	0.153	0.153
Psychological Risk 5	−0.119	0.357	**0.837**	0.246	0.135	0.167
Social Risk 1	−0.050	**0.879**	0.289	0.199	0.118	0.125
Social Risk 2	−0.048	**0.892**	0.287	0.212	0.120	0.136
Social Risk 4	−0.040	**0.882**	0.304	0.230	0.132	0.131
Social Risk 5	−0.053	**0.882**	0.281	0.238	0.127	0.133
Attitude towards Mobile Payment Adoption 1	**0.894**	−0.027	−0.130	−0.104	−0.154	−0.059
Attitude towards Mobile Payment Adoption 2	**0.891**	−0.083	−0.114	−0.109	−0.056	0.006
Attitude towards Mobile Payment Adoption 3	**0.899**	−0.050	−0.062	−0.113	−0.051	−0.010
Attitude towards Mobile Payment Adoption 4	**0.873**	−0.011	0.021	0.028	−0.071	−0.194
Attitude towards Mobile Payment Adoption 5	**0.886**	−0.028	−0.075	−0.072	−0.129	−0.162
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.						

Items with factor loadings below 0.5 were removed from the analysis to ensure that only items strongly related to their factors were retained. This process enhances the reliability and validity of the measurement model by eliminating items that do not effectively measure the intended constructs.

Overall, our analysis provides evidence for the convergent validity of the factors in our study, demonstrating that they accurately measure the underlying constructs of interest.

5.5. Structural Equation Model (SEM) and Hypothesis Testing

SPSS AMOS 24.0 was used to examine the research model. Figure 2 below shows the properties of the causal paths including standardized path coefficients. Table 6 presents the results of the hypothesis tests.

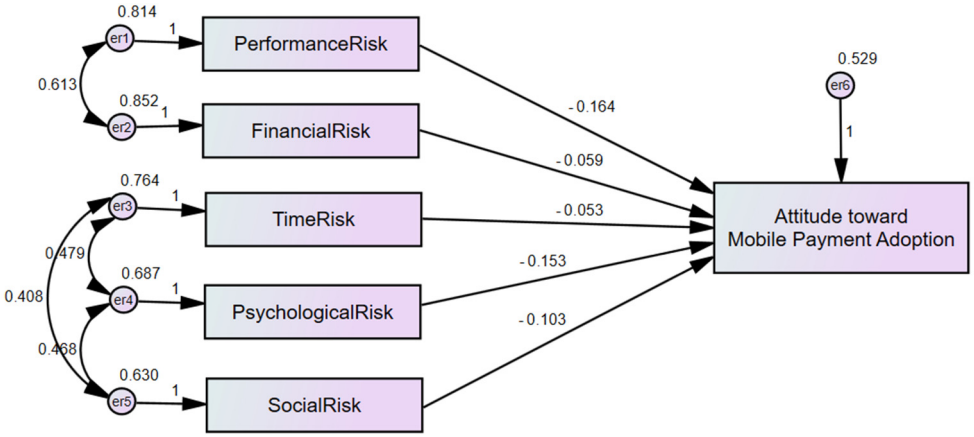

Figure 2. Path analysis of structural equation model.

Table 6. Hypothesis testing.

H#	Hypothesis			Standardized Estimate (β)	Critical Ratio	*p*-Value
1	Performance Risk	→	Attitude towards Mobile Payment Adoption	−0.164	−2.601	0.009
2	Financial Risk	→	Attitude towards Mobile Payment Adoption	−0.059	−0.952	0.341
3	Time Risk	→	Attitude towards Mobile Payment Adoption	−0.053	−0.880	0.379
4	Psychological Risk	→	Attitude towards Mobile Payment Adoption	−0.153	−2.092	0.036
5	Social Risk	→	Attitude towards Mobile Payment Adoption	0.103	0.147	0.147

6. Result and Discussion

This study delves into the intricate relationship between various types of risk and the attitude towards mobile payment adoption. It examines how performance risk, which relates to concerns about the efficiency and functionality of mobile payment systems, affects individuals' attitudes towards adopting this payment method. Financial risk, another key aspect, pertains to the fear of financial loss or errors in transactions. Time risk considers the perceived time investment required to learn and use mobile payment, as well as the potential delays or inefficiencies in transactions. Psychological risk encompasses the emotional and cognitive dimensions of risk perception, including the feelings of insecurity or mistrust related to mobile payments. Additionally, social risk considers how factors like the influence of family, friends, and colleagues, as well as concerns over social status, affect individuals' attitudes towards adopting mobile payments. This study focuses on these distinct types of risk to offer a thorough understanding of the factors that influence consumers' attitudes towards the acceptance of mobile payment.

Hypothesis 1 investigated the impact of performance risk on attitudes towards adopting mobile payment systems. Performance risk encompasses concerns about the efficiency, reliability, and effectiveness of these systems. The analysis indicated a significant negative relationship between performance risk and adoption attitudes, with a coefficient of −0.164 (t = −2.601, $p < 0.01$). These findings align with Onurlubas and Gumus (2023), who observed a similar significant impact of performance risk on purchase intentions for refurbished products. Additionally, consistent results were noted in the studies by Yang et al. (2015) on mobile payment intention, Damghanian et al. (2016) on online banking, and Almousa (2011) on online shopping intentions, all reporting significant negative impacts. Conversely, Piarna et al. (2020) and Elasaria (2024) found that performance risk could positively influence intentions, mediated by perceived risk. In contrast, Zhu et al. (2022)

reported no significant relationship among Thai consumers. This pattern suggests that higher perceived performance risks may lead to less favorable attitudes towards mobile payment adoption, underscoring the need for reliable and effective systems to boost user acceptance.

Hypothesis 2 examined the impact of financial risk—concerns related to potential financial loss or transaction errors—on attitudes towards mobile payment adoption. The analysis revealed no significant relationship between financial risk and adoption attitudes, with a coefficient of −0.059 (t = −0.952, $p = 0.341$). This suggests that financial risk may not substantially influence these attitudes, a finding supported by research from multiple studies. Agárdi and Alt (2022) observed no significant impact of financial risk on NFC mobile payment intentions among Generation Z. Similarly, Zhu et al. (2022), Munikrishnan et al. (2023), Nguyen et al. (2021), and Salameh et al. (2024) all reported no significant relationship between financial risk and various types of online payment intentions. Contrarily, Masoud (2013) found a significant negative relationship between financial risk and online shopping intention, indicating that the influence of financial risk might vary across different contexts and payment technologies. These findings collectively imply that factors other than financial risk may be more influential in shaping the adoption of mobile payment.

Hypothesis 3 assessed the impact of time risk on attitudes towards mobile payment adoption, finding no significant relationship; the path coefficient was −0.053 (t = −0.880, $p = 0.379$). This indicates that time risk, concerning potential delays and the time investment required for transaction processing, does not significantly affect adoption attitudes. These findings align with those of Yang et al. (2015) and Masoud (2013), who observed no significant impact of time risk on the intentions to use mobile payments and online shopping, respectively. Similarly, Salameh et al. (2024) found no significant relationship between time risk and the intention to use e-money services. However, this study's results contrast with those of Almousa (2011), Zhu et al. (2022), and Munikrishnan et al. (2023), who identified a significant influence of time risk on online shopping and mobile payment attitudes. Additionally, findings from Onurlubas and Gumus (2023) and Nguyen et al. (2021) indicate varying impacts of time risk on purchase intentions. Collectively, these mixed results suggest that time risk may influence payment adoption differently across contexts, and other factors might be more crucial in shaping user attitudes towards mobile payment.

Hypothesis 4 assessed the influence of psychological risk on attitudes towards mobile payment adoption, identifying a significant negative relationship; the path coefficient was −0.153 (t = −2.092, $p < 0.05$). This suggests that psychological concerns, such as insecurity or mistrust regarding mobile payments, significantly deter adoption. Supporting this, Munikrishnan et al. (2023) noted a similar negative impact on online food purchase intentions, and Onurlubas and Gumus (2023) observed a significant effect on purchase intentions for refurbished products. Öztürk (2022) also reported a significant relationship between psychological risk and attitudes towards halal products. However, these findings contrast with those by Salameh et al. (2024) and Zhu et al. (2022), who found no significant relationship between psychological risk and the intentions to use e-money services and mobile payments, respectively, among Thai consumers. These mixed results underscore the importance of addressing psychological barriers to enhance the acceptance of mobile payment systems.

Hypothesis 5 investigated the impact of social risk on attitudes towards mobile payment adoption, revealing no significant influence; the coefficient was 0.103 (t = 0.147, $p = 0.147$). This indicates that concerns about social factors, such as peer influence and social status, may not significantly affect attitudes towards mobile payment adoption. Supporting this finding, Masoud (2013) also observed no significant impact of social risk on online shopping intentions. However, contrasting results were noted in the studies by Onurlubas and Gumus (2023), Savas-Hall et al. (2022), and Xiao et al. (2021), which identified a significant relationship between social risk and various purchase intentions. Similarly, Koay et al. (2023) found that social risk significantly influenced the purchase

intentions of current second-hand clothing customers, but not among non-customers. These mixed findings suggest that the effect of social risk on payment adoption decisions may vary across different contexts and consumer groups.

7. Study Implications

7.1. Theoretical Implications

This study enriches the academic dialogue on mobile payment by extending the conceptualization of perceived risk. It integrates established risk dimensions—financial and performance risks—and explores under-researched dimensions, such as time, psychological, and social risks. This holistic approach not only corroborates but also broadens the perceived risk theory, delineating the specific impacts of diverse risk dimensions on consumer attitudes towards mobile payment.

The findings of this research enhance the integration of the technology acceptance model (TAM) and the theory of planned behavior (TPB), emphasizing the critical role of perceived risk factors in shaping behavioral intentions. Proposing the incorporation of an extended spectrum of risk factors, this study suggests that such comprehensive integration could markedly improve the predictive capabilities of these models regarding user acceptance and active participation with emerging technologies.

This investigation offers a detailed examination of the variability in risk perceptions across different contextual settings. It reveals that while some risks are consistently recognized as barriers, others are perceived variably depending on the context. This insight calls for a more adaptive and nuanced application of predictive models to better cater to consumers.

7.2. Practical Implications

For developers and marketers within the technology sphere, recognizing the differential impact of various risk types on consumer attitudes is essential. Such insights can direct the development of tailored marketing strategies that specifically address individual consumer concerns, thereby enhancing trust and security perceptions related to mobile payment platforms.

These findings offer valuable insights for policymakers and regulators, enabling the formulation of comprehensive guidelines that address the spectrum of risks associated with mobile payments, with particular attention to the often-neglected social and psychological aspects. Effective policy measures could significantly bolster consumer confidence and adoption rates.

Given the pronounced effects of psychological risks, there is a compelling need for targeted educational programs. By informing consumers about the robust security protocols of mobile payment systems and their acceptance within social frameworks, it is possible to alleviate apprehensions and foster a more favorable disposition towards the adoption of such technologies.

Understanding that risk perceptions vary can help practitioners cater to specific consumer concerns that could enhance overall user satisfaction and encourage a broader adoption of mobile payment.

8. Conclusions, Limitations, and Future Research Directions

Smartphones and similar technologies have become increasingly prevalent in modern society, suggesting a growing acceptance of smart payment options that leverage this technology. However, the consumer adoption of mobile payments may be impeded by perceived risks. This study investigates how five such risks influence consumer adoption of mobile payments. Drawing on a sample of 361 survey participants from a US university, the study explores the impact of performance risk, financial risk, time risk, psychological risk, and social risk on attitudes towards mobile payment adoption. The results support hypotheses 1 and 4, indicating significant negative relationships between performance risk

and attitude towards mobile payment, as well as between psychological risk and attitude towards mobile payment adoption.

While this study makes significant contributions to the field, there are still some limitations. First, it focuses solely on negative factors, namely the component risks. Future research could expand this scope to include other negative factors to gain a more comprehensive understanding of their effects on mobile payment acceptance. Second, the research model does not integrate positive factors. Subsequent studies could integrate both negative and positive factors to create a more robust research model. Additionally, the study's sample is limited in terms of age, education, race, and ethnicity, which may impact the generalizability of the findings. Future research should consider using a larger and more diverse sample to enhance the external validity of the results.

One interesting finding is the positive coefficient of the path between social risk and attitude towards mobile payment adoption, contrary to the hypothesized negative relationship. This unexpected result suggests that given the COVID-19 pandemic, the lack of person-to-person contact associated with mobile payments might be viewed positively. Future research could further investigate the variables related to social risk to determine which aspects are fostering the consumer acceptance of mobile payment and which are hindering it. Finally, the study did not examine the interplay of component risks. Future research should explore these interactions to gain a more nuanced understanding of the dynamics influencing mobile payment adoption.

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