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Factors affecting consumers' mobile payment behavior: a meta-analysis

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Abstract

Mobile payment is quickly changing consumers' spending patterns and payment habits. Many empirical studies have been conducted globally in the last decade about consumers' mobile payment behavior. To analyze and synthesize the findings, a meta-analysis is conducted to build consensus about what factors significantly affect consumers' mobile payment behavior. Overall, it is found that there is a high level of consensus among researchers that these factors, including perceived usefulness, perceived risk, social influence, trust and perceived ease of use, have significant impact over consumers' intention to use mobile payment. While our meta-analysis supports most findings revealed in previous studies, there are also findings that cannot be supported. In addition, the place where consumers live is identified as a new factor that could potentially affect consumers mobile payment behavior. The practical significance of the current study is that consumers' spending habit is difficult to change but can be adapted through careful design and awareness training around these significant factors. To encourage consumers' adoption of mobile payment, especially in Western countries like US, the factors such as perceived usefulness, perceived risk, social influence, trust and perceived ease of use must be carefully considered and incorporated into mobile payment products and marketing campaigns.

Keywords Mobile payment · Consumer mobile payment behavior · Intention to use · Meta-analysis · Network graph of relationships · Place factor

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1 Introduction

As a new form of making payments digitally, mobile payment is disrupting consumers' spending patterns and payment habits. It enables consumers make payments anytime and anywhere using their smart phones or mobile devices via wireless technologies such as Wi-Fi, 4G LTE, Near Field Communication (NFC), Bluetooth or Radio Frequency Identification (RFID) [1]. A mobile payment app or platform, installed on a mobile device (a smart phone or tablet), is used to initiate, authorize and confirm a payment to complete a commercial transaction [2–5], such as transferring funds from a payer to a payee or to a merchant over the Internet. These mobile apps may include mobile wallets such as Apple Wallet, mobile payments apps such as PayPal Mobile Cash, Alipay or Venmo, and social media platforms with Wallet or payment functions such as WeChat.

In comparison, mobile banking refers to consumers using a bank's mobile apps installed on their smart phones to handle traditional banking services, such as making a deposit, paying recurrent utility bills, transferring funds between different accounts or validating payment transactions.

Both mobile payment and mobile banking allow payments to be made digitally over the Internet, but there is a fundamental difference between them. Mobile payment technology is typically provided by non-traditional financial companies, i.e. third-party payment providers or Fintech startups such as Alipay or Venmo, while mobile banking is typically offered by traditional banks or financial institutions by expanding traditional services to the Internet. In other words, mobile payment is largely made possible by new generations of IT companies aiming to provide innovative financial services solutions to millions of customers. This study will focus on consumer use behavior related to only mobile payment.

Many empirical studies have been conducted on factors affecting consumers' mobile payment behavior in different places—countries or regions in last ten or so years. Among these prior studies, a lot of variables (or factors) were selected to study and different research models were applied.

The problem is that findings from these studies are often inconsistent or inconclusive. In some studies the perceived usefulness significantly affect consumers' intention to use mobile payments which in turn affects the actual use behavior [2, 6]. However, a few other studies indicated that the perceived ease of use may not significantly affect consumers' use behavior and further verification may be needed [3, 7].

There are also a lot of noises in which relationships are significant. Among 284 pairs of relationships identified in this study, only 34 pairs of valid relationships are left, after deleting invalid or insignificant relationships. As many as 250 disqualified relationships are eliminated.

Consensus building is necessary. This paper attempts to use the meta-analysis method to comprehensively analyze and identify the variances in existing empirical studies on consumer mobile payment behavior. Meta-analysis is effective in re-analysis of individual research results and integrating the differences between individual studies. It is a way to evaluate the overall results synthetically.

In the following sections, major theories and technology adoption models will be discussed. Previous studies will be reviewed, and potential factors and major findings will be explained. The research methodology and data collection will be described, and meta-analysis results will be discussed. The valid relationships among variables in the selected papers will be analyzed and integrated to help build consensus among research findings. The factors that significantly affect consumers' mobile payment behavior are identified, and improvement suggestions are provided for subsequent studies.

2 Literature review

2.1 Key theory descriptions

Mobile payment is an application of new information technologies to the financial sector. Mobile payment behavior refers to consumers' behavior of adoption and use of mobile payment instead of traditional means of payments like credit cards or cash. Consumers' mobile payment behavior is essentially information technology adoption behavior. Thus, to understand and analyze the behavior of consumer mobile payment, a review of key theories and models about information technology adoption is necessary. In this section, three key theoretical models and associated influencing factors are reviewed and discussed. The influencing factors that are associated with these models are summarized in Table 1.

The technology acceptance model (TAM) is proposed based on the information systems success model (ISSM) and the theory of reasoned action (TRA) model [8]. ISSM argues that the system quality and information quality will affect consumers' intention to use and their use satisfaction with a system [9]. TRA is based on the premise that consumer behavior must be rational and voluntary, which can be impracticable. According to the TAM model, perceived usefulness and perceived ease of use are believed to directly affect consumers' attitudes toward use. Meanwhile perceived ease of use affects perceived usefulness, and perceived usefulness affects intention to use. Intention to use directly determines the actual system use behavior. The disadvantage of the TAM model is that it does not consider the influence of other social factors on consumers' attitudes toward use. Venkatesh and Davis [10] propose an extended technology acceptance model (TAM2) based on TAM by adding five social factors (i.e. subjective norms, image, job relevance, output quality and result demonstrability) to emphasize the influence of social factors on perceived usefulness which then affects consumers' intention to use and usage behavior. Venkatesh and Bala [11] integrated multiple factors, which affect consumers' perceived ease of use, into the TAM2 model to create a more comprehensive TAM3 model. These factors include computer self-efficacy, perceptions of external control, computer anxiety and playfulness, perceived enjoyment and objective usability.

The unified theory of acceptance and use of technology (UTAUT) is derived from the integration of eight individual acceptance models [12]. It is used to evaluate users' intention to use technology or information systems. The model has four main components: performance expectation, effort expectancy, social influence, and

Table 1 Summary of factors used in different models

Author/reference number	Year	Theory	Main impact factor
Bauer [80]	1960	PR	Perceived time-loss risk, Perceived performance risk, Perceived personal risk, Perceived financial risk, Perceived social risk
Fishbein and Ajzen [81]	1975	TRA	Attitude Toward Behavior (AT), Subjective Norm (SN) Behavioral Intention (BI), Actual Behavior
Rogers [14]	1983	IDT	Ease of Use (EOU), Personal Innovativeness (PI) Relative Advantage (RA), Compatibility (Com)
Ajzen [82]	1985	TPB	Attitude Toward Behavior (AT), Subjective Norm (SN) Perceived Behavioral Control (PBC) Behavioral Intention (BI), Actual Behavior
Delone and Mclean [9]	1992	ISSM	System Quality, Information Quality Information Use, User Satisfaction (US)
Davis et al. [8]	1989	TAM	Perceived Usefulness (PU), Perceived Ease of Use (PEOU) Attitude Toward Using (AT) Behavioral Intention to Use (BI), Actual System Use External Variables (Social Influence (SI), Facilitating Conditions (FC) etc.)
Venkatesh and Davis [10]	2000	TAM2	Perceived Usefulness (PU), Perceived Ease of Use (PEOU) Subjective Norm (SN), Image etc.
Venkatesh and Bala [11]	2008	TAM3	TAM and TAM2 Anchor (Computed Self-efficacy, Perceptions of External Control etc.) Adjustment (Perceived Enjoyment etc.)

Table 1 (continued)

Author/reference number	Year	Theory	Main impact factor
Venkatesh et al. [12]	2003	UTAUT	Performance Expectancy (PE), Effort Expectancy (EE) Attitude toward using technology (AT) Social Influence (SI), Facilitating Conditions(FC) Self-efficacy, Anxiety Behavioral Intention to use the system (IU), Use Behavior (UB)
Venkatesh et al. [13]	2012	UTAUT2	Hedonic Motivation, Price Value, Habit Individual differences (age, gender, experience etc.)

facilitating conditions. The first three directly affect consumers' behavioral intention to use. Then, behavioral intention, together with facilitating conditions, affects the use behavior. The facilitating conditions consists of four variables, including gender, age, experience and voluntariness. Venkatesh et al. [13] proposes three new measurement variables, i.e., hedonic motivation, price and habit, to be integrated into the UTAUT model to arrive at the UTAUT2 model.

The innovation diffusion theory (IDT), also known as "diffusion of innovations (DOI)", was first discussed in 1962 in the book entitled *Diffusion of Innovation* and is more widely accepted after 1983 [14]. It is often used to predict and explain the adoption and diffusion behavior of innovation technology, with the main influencing factors including relative advantage, personal innovativeness and compatibility.

2.2 Potential factors

Many factors or variables have been studied before. Table 2 has listed major factors and their definitions from related literatures. Inconsistencies exist across studies in terms of which factors are statistically significant, as will be discussed below.

Some studies have shown that perceived usefulness significantly affect consumers' intention to use mobile payments [2, 6], and consumer's intention to use mobile payment determines the actual use behavior. There is a positive relationship between perceived usefulness and use behavior. However, other studies indicate that the perceived ease of use doesn't significantly affect consumers' behavior and further verification may be needed [3, 7]. However, it is also shown that perceived usefulness is affected by perceived ease of use, compatibility, consumers' needs and attitudes [15].

Factors that have a significantly positive impact on perceived ease of use and perceived usefulness could also have a significant negative impact on perceived risk [5, 16]. Perceived risk does not directly affect the mobile payment use behavior, but it indirectly reduces the effect of perceived usefulness on consumers' use behavior [7]. It is shown that consumers' attitudes and intention to use are affected by perceived risk and trust [17, 18]. A study conducted in China indicates that trust reduces perceived risk [19]. However, perceived security and perceived ease of use have a significantly positive impact on initial trust, and initial trust in turn determines perceived usefulness and use behavior [20]. This conforms to the finding that initial trust directly or indirectly affects consumers' intention to use [21].

The factors that affect consumers' intention to use mobile payments also include social influence and personal innovativeness [5, 22]. Social influence, personal innovativeness, compatibility and relative advantage have a significantly positive influence on consumers' mobile payment [5, 7]. However, when analyzing how consumers use smart phones to transfer money, the impact of personal innovativeness over mobile payment behavior is not significant as revealed in [6].

As discussed above, there exist multiple factors affecting consumers' use of mobile payment. These factors include perceived usefulness, performance expectation, perceived ease of use, effort expectancy, compatibility, personal innovativeness, and social influence. However, whether these factors have direct or indirect,

Table 2 Definitions of main factors

Major factors	Definitions
Attitude toward behavior	"An individual's positive or negative feelings about performing the target behavior." [81]
Compatibility	"The degree to which an innovation is perceived as being consistent with existing values, needs and experiences of potential adopters." [83]
Effort expectancy	"The degree of ease associated with the use of the system." [12]
Facility condition	"The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system." [84]
Individual mobility	"The degree to which an individual pursues a mobile lifestyle." [45]
Intention to use	"Individual's subjective probability that he or she will perform a specified behavior." [81]
Perceived convenience	"Consumers' perceived expenditures of time and effort to affect transaction." [85]
Perceived cost	"Transferring from wired Internet payment services to ubiquitous mobile payment options involves incurring additional expenses, both monetary and non-monetary." [21]
Perceived ease of use	"The degree to which a person believes that using a system would be free of effort." [86]
Perceived risk	Bauer (1960) argues that consumer purchasing decisions imply uncertainty about the outcome. [80]
Perceived security	"The degree to which a customer believes that using a particular mobile payment procedure will be secure." [18]
Perceived usefulness	"The degree to which a person believes that using a particular system his or her job performance." [86]
Performance expectancy	"The degree to which an individual believes that using the system will help him or her to attain gains in job performance." [12]
Personal innovativeness	"The willingness of an individual to try out any new information technology." [87]
Relative advantage	"The degree to which using an innovation is perceived as being better than using its precursor." [83]
Social influence	"The degree to which an individual perceives that important others believe he or she should use the new system." [12]
Subjective norm	"The person's perception that most people who are important to him think should or should not perform the behavior question." [81]
Initial trust	"The willingness of an individual to take risks in order to fulfill his or her needs." [21]
Trust	"The belief that vendors will perform some activity in accordance with customers' expectations." [18]
Usage	"An individual's actual direct usage of the given system in the context of his or her job." [86]
User satisfaction	"The recipient response to the use of the output of an information system." [9]

positive or negative, significant or insignificant effects, the findings in these previous studies are often inconsistent. The purpose of this study is to integrate these findings and analyze the influence of various factors on consumers' behavior in adopting mobile payments. Stata version 14.2 is used in this study to conduct a meta-analysis.

3 Research methodology

Meta-analysis method is used to find the factors or variables that affect consumers' mobile payment behavior as well as the correlations among variables. It was derived from Fisher z-transformation and was named by psychologist Glass [23]. According to Glass, meta-analysis is used to conduct statistics, mergers and re-analysis of individual research results with the purpose of integrating them to analyze the differences between individual studies and to evaluate the overall results synthetically.

Compared with the traditional descriptive statistics, meta-analysis is reasonable in design, can objectively evaluate the evidence, can evaluate the effect indicators more accurately and objectively, and can explain the heterogeneity between different research results. The reason why the meta-analysis method was chosen in this study is, first, there are many completed quantitative studies on consumers' mobile payment behavior which meets the inventory requirements for meta-analysis. Second, in the present empirical research, different research models lead to different research conclusions; thus, the statistical results obtained by meta-analysis synthesizing of individual studies are more universal. Third, in different studies, there are variables with similar measurement dimensions, but the results of the effects in different studies are inconsistent, which, to some extent, can be reasonably explained by meta-analysis through comprehensive statistical analysis.

The research procedure goes as follows: We begin by selecting and downloading the literature. With screening and filtering, the data is extracted and collected. Then, we convert the correlation coefficient into Fisher's Z value which is the effect size. We also calculate the weighted-average value of β associated with each group of relationship. The effect size is used to reflect the intensity value of the relationship between two variables and is commonly used in meta-analysis. We then use the meta-analysis application software Stata macro program for data processing. The results are analyzed and interpreted to arrive at the research conclusions.

3.1 Data collection

In this study, literature screening is conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). As shown in Fig. 1.

Literature screening was done through an advanced search function of the web of science database using keywords which include mobile payment, m-payment, mobile wallet, online payment, electronic payment, e-payment, cashless payment, smartphone payment, mobile credit card, adoption, intention, acceptance, perception, and continuance usage. The core collection citation index selected by the journal is Science citation index expanded (SCI-Expanded) and Social sciences citation index (SSCI).

The time span of our selected literature is from 2008 to 2017, mainly based on the availability of literatures. From the world payment report WPR, global payment growth is mainly from Asia, and China accounts for 39% of the mobile payment market. In China, the milestone for mobile payment is that Alipay officially launched

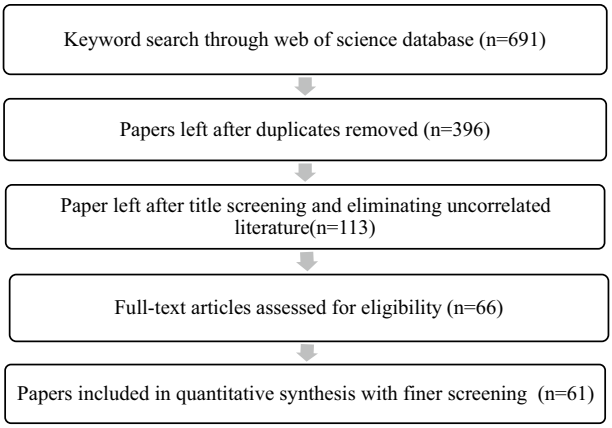

Fig. 1 PRISMA flow diagram

its mobile payment service in 2008. In addition, a lot of payment data wasn't publicly made available until recently. For example, data from 27 main countries has been published on the website of BIS (Bank for International Settlements) since 2012, and the world payment report also published payment data started in 2012.

By searching with keywords, 691 papers were returned. All the retrieved papers were added to EndNote. After removing duplications, 396 papers are left. Among them, 113 papers that meet the content relevant requirements are selected through title and full-text browsing. Further screening with full text assessment eliminated 46 papers that didn't have high impact factors, 4 papers that used data sets that were used before, and another 2 papers that didn't provide a standardized coefficients beta value. Finally, a total of 61 papers were left and included in the current study (see Fig. 1 and Appendix 1).

3.2 Calculating the effect size

Meta data about each paper, such as the author name, year of publication, topic, journal name, the model used, sample size, place where sample is from, the relationship among the variables, the path coefficient, standardized beta coefficient and T value of each relationship, are extracted from EndNote and entered to an Excel file. If β value is missing in a study, then the weighted-average value of β of the path coefficient of the relationship is calculated by formula (1). In our study, standardized beta coefficient (β)is used to directly substitute for correlation coefficients (*r),* based on suggestions made in previous studies [24, 25]. While some authors thought using the Fisher's Z transformation may reduce the bias, Hunter and Schmidt [26] found that using Fisher's Z can enlarge the bias. We use standardized beta coefficient in Fisher's Z transformation (2) to calculate effect size.

$$\beta = \frac{\beta_1 * N_1 + \beta_2 * N_2 + \ldots \beta_n * N_n}{N_1 + N_2 + \ldots N_n} \tag{1}$$

where N represents sample size, and β represents standardized beta coefficient of individual study.

$$Z = 0.5 * \ln\left(\frac{1+r}{1-r}\right) \tag{2}$$

where Z represents the unit of the Fisher z-transformation (different from z-value in the statistical test); *r* represents standardized beta coefficient for the sample.

Meta-analysis is conducted in this paper with a single group rather than the classical binary classification, due to the lack of a control group. The same method is used as Hunter and Schmidt [26] to convert the beta coefficient into effect size through Fisher Z-transformation. The selection of the relationship among variables in this study is based on three criteria: the beta coefficient is revealed by at least three papers, the same direction (either positive or negative) beta coefficient must be reported by more than 3 datasets, and finally, the value of effect sizes needs to be at least three to be valid. Only the relationship with the above three conditions simultaneously satisfied can be selected for meta-analysis [27].

Meta data values such as sample size and the effect sizes are entered to the Stata input editor. The equation *sqrt* (Z*$(1-Z)/n$) is used to calculate the SE value before the meta-analysis results are generated.

3.3 The effect model selection

The effect models of meta-analysis include fixed effect models and random effects models. Before using STATA software for meta-analysis, the type of effect model must be determined according to the heterogeneity between studies. The degree of heterogeneity is determined by qualitative Q Test and quantitative I^2 test. The values of P and I^2 measure the degree of heterogeneity. In the Q test, the P value is less than 0.1 will be considered as heterogeneity; in the I^2 test, the I^2 value is greater than 40% will be considered as heterogeneity. For meta-analysis, when the values of $P > 0.1$ and $I^2 \leq 40\%$ are satisfied at the same time, the homogeneity among the studies is better and the fixed effect model is adopted; otherwise the random effect model [28] should be adopted when there is a large heterogeneity among the studies. Taking the relationship between perceived usefulness and intention to use as an example, the results of the meta-analysis show $P < 0.001$ and $I^2 = 99.1\%$. Therefore, the random effect model is chosen for the study. All P values for heterogeneity testing in this study are 0.000, except that the correlation between perceived intention to use and usage is 0.011. All I^2 values are greater than 73%.

4 Data analysis and results

4.1 Descriptive statistics

Of the 61 papers eventually selected, they represent 22 countries that cover 5 continents (except Antarctica and Africa). They were published in 33 journals, with

sample sizes ranging from 82 to 2520, and used at least 15 major research models. A total of 66 datasets were collected, of which 5 papers used two sets of samples.

The year of publication for the selected papers peaked around 2016 (Table 3). This is consistent to China's practice in mobile payment and e-commerce development which boomed around the same time. In China, the rapid development of Internet finance wasn't regulated by the government until 2016. Especially under the strict supervision of the People's Bank of China, the issuance of new third-party payment license has stopped. As a result, the mobile payment market is characterized by a high degree of concentration or monopoly. In 2017, 90% of the payment market share was split between Alipay and WeChat payment. It is also a result of the rapid development of e-commerce in China which calls for faster payment methods for consumers. The advance in mobile Internet technology such as 4G LTE and other wireless technologies has made mobile payment grow very rapidly in China. And the widespread adoption of mobile payments in turn has made the use of traditional credit cards or check payment not necessary, unlike the practice in Europe and United States. Other countries or regions in Asia such as Malaysia and Taiwan experienced a similar growth period of growth.

4.2 Network graph of relationships

There are 284 relationships included in the meta-analysis. After deleting insignificant relationships and applying three criteria as described in Sect. 3.2, as many as 250 disqualified relationships are eliminated. Only 34 pairs of valid relationships are left. A network graph is created using Stata to illustrate these relationships (see Fig. 2). The link thickness in the graph represents the total number of studies involved, while node size representing the number of studies combined from all relationships the node is involved. It is easy to see that the links among perceived usefulness, perceived risk, social influence, trust, perceived ease of use and intention to use are relatively thick, indicating that the relationship between these factors and consumers' intention to use are strong and evidenced in many studies.

4.3 Results analysis

The total number of studies, sample size, weighted-average value of β, and meta-analysis results (P value, I^2 value, Z-value and 95% confidence interval of the combined effects) of the 34 relationships are summarized in Table 4. As can be seen, of the 34 relationships, 32 are significantly correlated ($P < 0.05$), with the maximum Z-value of 20.64 and the minimum Z-value of 1.68.

Regarding the 18 factors that affect the intention to use, 2 factors perceived risk (PR) and cost are negatively correlated to the intention to use. The remaining factors are all significantly positively correlated. The results of quantitative heterogeneity test with random model reveal that the I^2 value of the relationship is over 90%, indicating that there is a high heterogeneity between these influencing factors and the intention to use. The 95% confidence interval results show that attitude toward use (AT-IU, 95% CI = 0.132–0.718), trust (TR-IU, 95%

Table 3 Article by journal and year of publication

Journal	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
African Journal of Business Management				1							1
Behaviour & Information Technology							1			1	2
China Communications				1	1						2
Computers in Human Behavior		1	1		1			1	1	1	6
Decision Support Systems						1					1
Economic Research—Ekonomska Istrazivanja										1	1
Electronic Commerce Research and Applications			2						2		4
Electronic Markets					1						1
Expert Systems with Applications						1			1		2
Industrial Management & Data Systems							1	2		1	4
Information & Management				1							1
Information Development				1							1
Information Systems and E-Business Management									1	1	2
Information Systems Frontiers								1	1	1	3
Information Technology for Development									1		1
International Journal of Contemporary Hospitality Management									1	1	2
International Journal of Hospitality Management									1		1
International Journal of Human–Computer Interaction			1								1
International Journal of Human-Computer Studies										1	1
International Journal of Information Management							1				1
International Journal of Information Technology & Decision Making								1			1
International Journal of Mobile Communications				1				2		1	4
Internet Research						1	1		1		3
Journal of Computer Information Systems								1		1	2

Table 3 (continued)

Journal	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Journal of Organizational Computing and Electronic Commerce								1			1
Psychology & Marketing								1			1
Review of Business Management										1	1
Service Industries Journal					1	1		1			3
Sustainability									1	1	2
Technology Analysis & Strategic Management								1			1
Telematics and Informatics							1				1
Transportation Research Part C-Emerging Technologies						1		1			2
Wireless Personal Communications							1				1
Total	1	1	4	6	4	5	6	13	11	12	61

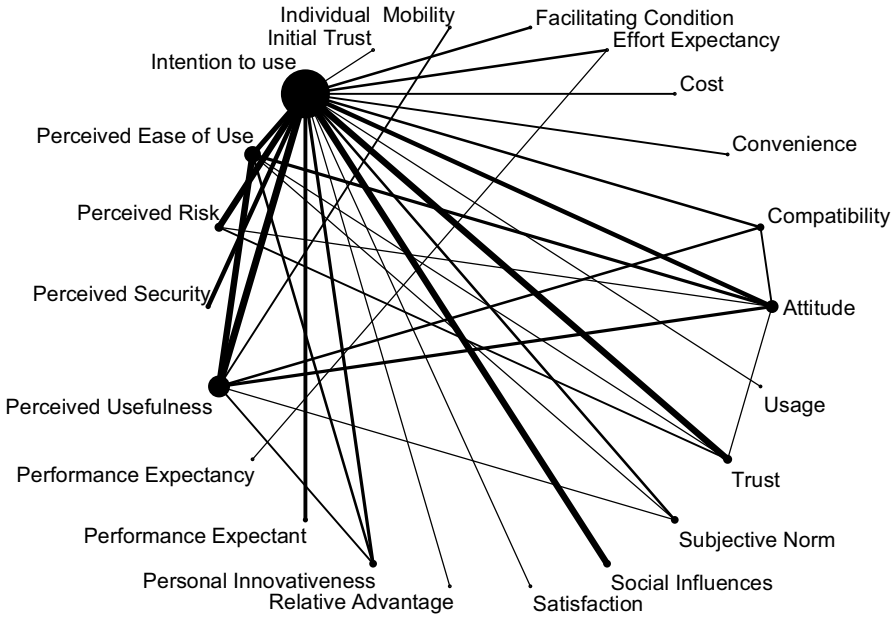

Fig. 2 Network graph of paired relationships. Note: Link thickness representing the total number of studies involved, while node size representing the number of studies combined from all relationships the node is involved

CI = 0.192–0.589) and compatibility (COM-IU, 95% CI = 0.159–0.548) have wider confidence intervals than the others, indicating the relationships are not very strong. In addition, more than 20 papers analyzed consumers' intention to use through perceived usefulness, perceived risk and social influence. This indicates that researchers have reached a level of consensus that these factors are the main variables to analyze consumers' intention to use mobile payments.

Regarding the factors affecting consumers' mobile payment attitude, main factors include perceived usefulness, perceived ease of use, perceived risk, trust and compatibility. Among them, perceived risk is significantly and negatively correlated to consumers' mobile payment attitude; compatibility is insignificantly correlated ($P = 0.094 > 0.05$), and the 95% confidence interval between compatibility and attitude to use (PC-AT, 95% CI = − 0.044–0.561) is relatively wide to indicate a weaker relationship. Perceived usefulness, perceived ease of use and trust are significantly positively correlated to attitude, which means consumers' attitudes towards mobile payments are largely affected by these three factors.

Among all the factors affecting perceived usefulness, the perceived ease of use is the major factor that has more consensus that other factors. As shown in Table 4, there are 19 papers that found significantly positive correlations between perceived usefulness and perceived ease of use. Meanwhile, subjective norm is weakly correlated with perceived usefulness, with a wider confidence interval (SN-PU, 95% CI = − 0.01 to 0.854), indicating a lower credibility.

Table 4 Summary of the meta-analysis of each relationship

Relationship	No. of studies	No. of sig. studies	Total size	Average β	I^2 (%)	Estimated P	Fisher's Z-value	95% CI (low–high)	
PU-IU	21	20	10,606	0.283	99.1	0.000	7.55	0.217	0.369
PR-IU	20	15	11,237	− 0.115	98.2	0.000	7.45	0.136	0.233
SI-IU	20	17	11,341	0.307	98.3	0.000	7.32	0.153	0.265
AT-IU	13	13	11,502	0.295	100.0	0.004	2.85	0.132	0.718
TR-IU	19	16	8007	0.432	99.9	0.000	3.85	0.192	0.589
PEOU-IU	15	12	4096	0.209	92.7	0.000	9.43	0.167	0.255
PS-IU	13	11	7048	0.390	99.7	0.003	2.94	0.08	0.399
SN-IU	7	9	4682	0.376	99.1	0.000	5.18	0.226	0.501
PI-IU	10	10	3264	0.219	96.7	0.000	5.79	0.144	0.292
PE-IU	11	9	3314	0.299	97.3	0.000	6.92	0.239	0.428
COM-IU	8	9	4733	0.402	99.5	0.000	3.56	0.159	0.548
EE-IU	8	3	2690	0.145	97.5	0.000	4.5	0.094	0.239
FC-IU	7	5	2581	0.103	96.1	0.000	4.45	0.081	0.209
PC-IU	5	3	2360	0.245	99.5	0.022	2.29	0.035	0.453
COST-IU	5	3	2036	− 0.110	98.2	0.013	2.48	0.045	0.381
IT-IU	4	4	2318	0.326	98.5	0.000	4.15	0.183	0.511
RA-IU	3	4	1923	0.246	90.0	0.000	7.95	0.206	0.34
US-IU	3	3	718	0.357	96.0	0.000	4.33	0.209	0.556
PU-AT	9	11	10,360	0.427	99.6	0.000	6.88	0.371	0.666
PEOU-AT	9	7	10,360	0.214	99.5	0.000	4.02	0.089	0.257
PR-AT	3	3	4740	− 0.130	98.0	0.000	4.06	0.073	0.21
TR-AT	3	2	4024	0.1573	91.4	0.000	6.62	0.097	0.179
COM-AT	5	4	2476	0.4226	99.7	0.094	1.68	− 0.044	0.561

Table 4 (continued)

Relationship	No. of studies	No. of sig. studies	Total size	Average β	I^2 (%)	Estimated P	Fisher's Z-value	95% CI (low–high)	
PEOU-PU	19	19	11,586	0.324	99.4	0.000	8.31	0.367	0.594
SN-PU	4	5	3700	0.540	99.9	0.050	1.96	− 0.001	0.854
COM-PU	7	6	3396	0.379	99.5	0.000	3.56	0.159	0.548
IM-PU	6	5	3222	0.170	99.0	0.003	2.98	0.076	0.368
PI-PU	6	3	1388	0.083	96.4	0.001	3.32	0.091	0.352
PI-PEOU	8	7	1853	0.291	98.3	0.000	4.15	0.15	0.419
SN-PEOU	3	4	3306	0.220	98.6	0.000	4.16	0.164	0.457
TR-PEOU	3	3	4286	0.387	99.1	0.000	3.7	0.138	0.449
EE-PE	4	3	964	0.408	96.1	0.000	4.37	0.21	0.551
PR-TR	5	4	5656	− 0.236	98.2	0.000	5.27	0.138	0.303
IU-UB	4	4	3569	0.3975	73.0	0.000	20.64	0.381	0.461

PU perceived usefulness, *PR* perceived risk, *SI* social/external influences, *AT* attitude, *TR* trust, *PEOU* perceived ease of use, *PS* perceived security, *SN* subjective norm, *PI* perceived innovativeness, *PE* performance expectant, *COM* compatibility, *EE* effort expectancy, *FC* facilitating condition, *PC* perceived convenience, *COST* cost, *IT* initial trust, *RA* relative advantage, *US* use satisfaction, *IM* individual mobility, *IU* intention to use, *UB* use behavior

The main factors affecting perceived ease of use are personal innovativeness, subjective norm and trust. I^2 is greater than 40% and the 95% confidence interval is narrow, indicating that there is a high heterogeneity between these factors and perceived ease of use. All three factors significantly and positively affect perceived ease of use. However, the personal innovativeness factor is more often used to analyze perceived ease of use, while other influencing factors are not often used by researchers.

Table 4 shows that the main factor that affect performance expectation is effort expectation ($P = 0.000 < 0.05$), but the factor influencing consumers' trust is significantly and negatively correlated with perceived risk. The P values is 0.000 which is less than 0.05, and the I^2 greater than 40%. The study also finds that intention to use is significantly correlated with consumers' use behavior, the 95% confidence interval between the two (IU-UB, 95% CI = 0.381–0.461) is narrow, indicating a higher level of credibility.

Specifically, our study confirmed the following major findings about relationships among key factors:

- Perceived usefulness, trust, compatibility and perceived ease of use have a significantly positive influence on consumers' attitude toward mobile payment. This meta-analysis result is consistent to most researchers' findings, while invalidated the findings presented by Liébana-Cabanillas [29] about compatibility not being a significant factor affecting consumer's attitude.
- Personal innovativeness and trust significantly affect the perceived ease of use.
- There is a significantly positive correlation between the perceived usefulness and use behavior. The meta-analysis in our study supports the findings reached in many previous studies, while effectively invalidated some studies where the same conclusions cannot be drawn [4, 30].
- The perceived usefulness of mobile payment was significantly affected by perceived ease of use, compatibility, and personal innovativeness.
- The perceived usefulness of mobile payment was not significantly affected by subjective norm factor. This is confirmed in our meta-analysis and consistent to the findings in this study [31], but disqualifying the findings in previous studies [32]. This literally means that how a consumer views the usefulness of mobile payment may not be significantly affected by external influences such as their closest friends.
- Perceived risk has a direct and indirect significant influence on intention to use. Perceived risk establishes a negative relationship with trust and attitude. Both trust and attitude had a significantly positive effect on intention to use. These meta-analysis results confirmed the findings in the studies by Yang et al. [19] and Lim [33]. Perceived risks about a mobile payment platform will reduce consumers' trust and affect their attitude [19], therefore reducing their intention to use mobile payment systems [34].

To help illustrate the relationships among these factors as discussed above, a relationship diagram is created (see Fig. 3). In this diagram, the number on each link is the value of β which measures the relationship between two factors.

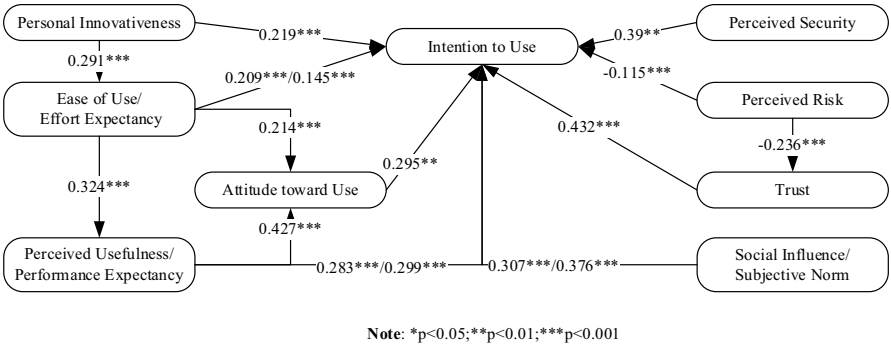

Fig. 3 Relationships among the key factors

4.4 The place factor

In this section, the place as a meta factor is discussed. This is an advantage of meta-analysis, and a unique contribution of the current study to the field of mobile payment behavior research.

The place—a country or region, where the consumers live and different regulations or economic stages exist, is also an important factor in understanding consumers' behavior in mobile payment adoption. For example, mobile payment is adopted more rapidly in developing countries than developed countries while credit card payment is still pervasive. Consumers in developing countries have cash-centric payment culture, while consumers in the developed countries like Europe countries and the United States have developed the habit of paying by checking or credit cards. Facts have shown that the habit of paying by checking or credit cards in developed countries is difficult to change in a short amount of time.

A place includes the physical and human aspects of a location, such as culture and regulations. Mobile payment, as a financial service, is regulated in different places. Mobile payment operators or third parties need to be licensed to offer services to retailers and consumers, and mobile payment activities may be monitored and controlled by government agencies. On the other hand, Hofstede's theory about dimensions of national culture is widely used in cross-cultural research although its stereotypes have been the subject of considerable criticism. All five of Hofstede's cultural values may play a role, for example, in affecting the relationship between perceived usefulness of mobile social apps (i.e. WeChat) and the intention to use the mobile payment [35, 36].

However, due to that previous studies haven't explicitly studied the culture and regulation factors, in this meta-analysis study, we didn't explicitly make culture or regulations as independent factors on their own. As a result, we view the culture and regulation factors as sub-factors implicitly contained in the place factor.

Among the total of 61 studies, 37 of them were from Asia, 14 were from Europe, 7 were from North America, 2 were from Oceania, and 1 was from South America. Compare to other countries, China's Internet + national strategy and relatively

regulatory environment has created adequate conditions for Chinese mobile payment industry to take off rapidly in the last decade [37]. Consequently, we see consumers' mobile payment behavior is being studied in many places in Asia, with China being the most active, followed by Europe, and North America (see Table 5 and Appendix 1). On the other hand, studies from Africa have been lacking. This may be related to stronger government regulations, or lack of enough Internet infrastructures. However, Africa is arising in mobile payment. For example, M-Pesa is popular in Kenya

Table 5 Factors studied by place (no. of studies)

Relationship	America	Asia	Europe	Oceania	Total
PU-IU	2	13	9		24
PR-IU	3	14	6		23
SI-IU	3	14	5		22
TR-IU	2	12	4	1	19
PEOU-IU	1	11	4		16
AT-IU	2	4	9		15
PS-IU	2	6	6		14
PE-IU	1	8	2		11
PI-IU		5	6		11
COM-IU	1	5	3		9
SN-IU		3	6		9
EE-IU	1	5	2		8
FC-IU	2	4	1		7
COST-IU		5			5
PC-IU	1	2		1	4
IT-IU		3		1	4
RA-IU		4			4
US-IU		3			3
PEOU-PU	2	9	11		22
COM-PU		2	5		7
SN-PU	1	1	4		6
PI-PU		2	4		6
IM-PU		2	4		6
PI-PEOU		4	4		8
SN-PEOU			4		4
TR-PEOU		1	3		4
PU-AT		2	9		11
PEOU-AT		2	9		11
COM-AT		1	4		5
PR-AT		1	3		4
TR-AT			3		3
PR-TR	1	2	3		6
IU-UB	1	1	2		4
EE-PE		4			4

with nearly 50% of people are served by mobile wallets, while Safaricom launches mobile banking business to allow convenient payments.

About the type of factors selected to study, in Asia countries, it seems that all studies concentrated on factors such as perceived usefulness, perceived risk, perceived ease of use, trust, social influence. In Western countries, not only perceived innovativeness, attitude and subject norm were discussed, but also perceived usefulness, attitude to use and perceived ease of use, and attitude, perceived innovativeness and subject norm are more preferred (see Table 5).

An analysis is also conducted to compare the differences between Eastern and Western countries about the relationships among factors. Each pair of relationship is divided into Eastern (Asia & Oceania) and Western (America & Europe), and there are 12 sets of relationships that satisfy the conditions for meta-analysis (see Table 6). It can be observed that no matter which pair of relationship is concerned, they all are significant no matter whether Eastern or Western is considered. This indicates that both Eastern and Western countries appear to have consensus about

Table 6 summary of east–west comparison results

Relationship		No. of studies	Total size	Average β	I^2 (%)	Estimated P	Z-value	95% CI (low–high)	
PU/PE-IU	Western	12	7793	0.3012	99.4	0	5.26	0.188	0.412
	Eastern	21	6127	0.2691	97.7	0	8.76	0.24	0.378
PEOU/EE-IU	Western	8	2706	0.1465	95.3	0	5.54	0.113	0.237
	Eastern	15	4080	0.1889	96.4	0	7.23	0.151	0.263
AT-IU	Western	9	7830	0.2185	100.0	0.039	2.07	0.019	0.723
	Eastern	4	3672	0.4567	99.5	0	4.57	0.346	0.864
COM-IU	Western	4	2351	0.5503	99.4	0.001	3.47	0.212	0.763
	Eastern	5	2382	0.2558	86.1	0	10.1	0.204	0.302
PI-IU	Western	6	1433	0.2717	98.1	0.002	3.1	0.084	0.372
	Eastern	4	1831	0.1771	85.5	0	7.76	0.151	0.253
PR-IU	Western	8	5820	−0.1658	98.8	0	5.15	0.163	0.364
	Eastern	12	5417	−0.0601	90.7	0	7.19	0.079	0.138
PS-IU	Western	7	3431	0.2660	98.4	0	3.51	0.073	0.259
	Eastern	6	3617	0.5078	99.7	0.033	2.13	0.026	0.624
SI-IU	Western	7	4397	0.4960	95.5	0	4.62	0.088	0.218
	Eastern	13	6944	0.1872	98.7	0	5.56	0.152	0.318
SN-IU	Western	5	3665	0.3334	99.1	0.001	3.36	0.11	0.418
	Eastern	2	1017	0.5300	83.5	0	13.4	0.484	0.649
TR-IU	Western	6	1696	0.3349	99.7	0	4.12	0.217	0.611
	Eastern	13	6311	0.4586	99.7	0	3.79	0.183	0.573
PEOU-PU/EE-PE	Western	11	8386	0.3631	97.1	0	13	0.353	0.478
	Eastern	13	4164	0.2647	99.4	0	5.49	0.343	0.724
PI-PEOU	Western	4	864	0.3718	96.7	0	3.96	0.179	0.528
	Eastern	4	989	0.2213	98.1	0.007	2.72	0.06	0.372

the key factors affecting mobile payment behavior. In addition, a t-test is conducted on total sample size and β value respectively. However, no significance is found between Eastern and Western countries along these two dimensions. This indicates that the counterparts in Eastern or Western countries conducted their studies following similar statistical analysis practices.

5 Conclusions and future research directions

Overall, it is found in this meta-analysis study that there is a high level of consensus among researchers in the past decade about the key factors affecting consumers' mobile payment behavior. These key factors, including perceived usefulness, perceived risk, social influence, trust and perceived ease of use, have significant impact over consumers' intention to use mobile payment. In other words, these factors positively affect consumers' spending patterns and consumption habits. While our meta-analysis supports most findings revealed in previous studies, there are also occasions where previous findings cannot be supported. For example, our meta-analysis result does not suggest a consensus that compatibility has a significantly positive influence on consumers' attitude toward mobile payment; our meta-analysis result also does not suggest a consensus that the perceived usefulness of mobile payment was significantly affected by the subjective norm factor.

The practical implications of the above conclusions are that, to encourage consumers' adoption of mobile payment, especially in Western countries like US, the factors such as perceived usefulness, perceived risk, social influence, trust and perceived ease of use must be carefully designed and incorporated into mobile payment products and marketing campaigns. Spending habit is challenging to change. But through careful designs and awareness training, spending pattern can be adapted.

This study has some limitations that future studies should address. The literature selected in this study did not include dissertations, or conference papers, only papers published in referred academic journals included. Based on the sample we collected in this study, some factors or relationships were eliminated during the statistical process. Future studies may find some of these factors or relationships worthy studying when more new samples become available. In addition, there was no control group used. The current study is a meta-analysis with a single-group. Different opinions exist about the proper meta-analytic technique to use for single group meta-analysis research.

Besides the limitations discussed above, given that consumer's intentions and behaviors can also be affected by culture or regulations, future research may consider including culture and regulatory environment as separate factors to study. Hofstede's dimensions of national culture, including individualism/collectivism, masculinity/femininity, uncertainty avoidance, power distance, and long-term orientation, can be a good starting point to identify the relevant cultural factors to study.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Appendix 1

Summary of selected studies

Country/region	Authors and reference number	Published year	Sample size	Theoretical model
North America				
Canada	Cocosila and Trabelsi [38]	2016	289	ISSM
USA	Shin [39]	2010	294	TAM, UTAUT
USA	Morosan and DeFranco [40]	2016	794	UTAUT
USA	Ozturk [16]	2016	305	TAM
USA	Khalilzadeh et al. [17]	2017	412	UTAUT, TAM
USA	Ozturk et al. [41]	2017	412	VT[a]
USA and China	Zhang et al. [42]	2012	394	TAM
Europe				
Ireland	O'Reilly et al. [43]	2012	82	Push and Pull based SMMS
Ireland	Duane et al. [44]	2014	82	TAM
German	Schierz et al. [45]	2010	1447	TAM
France	Koenig-Lewis et al. [46]	2015	316	TAM, UTAUT
Finland	Kujala et al. [47]	2017	239	TAM
Portugal	Oliveira et al. [48]	2016	301	UTAUT2, DOI
Spain	Liébana-Cabanillas et al. [4]	2014	2012	TAM, UTAUT
Spain	Francisco et al. [49]	2015	2012	TAM
Spain	Liébana-Cabanillas et al. [30]	2015	201	TAM
Spain	Liébana-Cabanillas et al. [29]	2015	168	TAM
Spain	Ramos-de-Luna et al. [50]	2016	191	TAM
Spain	Liébana-Cabanillas et al. [32]	2017	871	TPB, TAM
Italy	Di Pietro et al. [15]	2015	439	TAM, DOI, UTAUT
UK	Slade et al. [51]	2015	268	UTAUT
Asia				
Korea	Shin [18]	2009	2520	UTAUT
Korea	Kim et al. [2]	2010	269	TAM
Korea	Kim et al. [52]	2010	219	ISSM
Qatar	Musa et al. [53]	2015	169	UTAUT
Kuwait	Rouibah et al. [54]	2016	350	TAM, TPB
Malaysia	Leong et al. [1]	2013	262	TAM
Malaysia	Ming-Yen Teoh et al. [55]	2013	183	Important Factors
Malaysia	Tan et al. [22]	2014	156	TAM
Malaysia	Teo et al. [56]	2015	194	UTAUT
Malaysia	Teo et al. [57]	2015	319	UTAUT

Country/region	Authors and reference number	Published year	Sample size	Theoretical model
Malaysia	Ooi and Tan [3]	2016	459	TAM
Thailand	Bhuasiri et al. [58]	2016	372	UTAUT
Iran	Keramati et al. [59]	2012	623	TAM
Iran	Barkhordari et al. [60]	2017	246	TAM3
India	Thakur and Srivastava [61]	2014	774	TAM, UTAUT
India	Kapoor et al. [62]	2015	323	DOI
India	Upadhyay and Jahanyan [6]	2016	196	TAM, IDT
Jordan	Qasim and Abu-Shanab [63]	2016	253	UTAUT
China	Liu and Zhang [64]	2011	370	TAM
China	Liu et al. [65]	2011	202	HCI[b]
China	Lu et al. [21]	2011	961	IDT
China	Zhou [20]	2011	277	TAM, IDT
China	Yang et al. [5]	2012	639	TAM, TAM2
China	Zhou [66]	2013	195	ISSM
China	Zhou [67]	2011	229	TAM, IDT
China	Zhou [68]	2014	226	TAM, IDT
China	Yang et al. [19]	2015	870	TRA, TPB,TAM,DTPB
China	Yang et al. [69]	2015	310	PR
China	Choi and Sun [70]	2016	280	Service Quality
China	Chen and Li [71]	2016	243	ITC[c]
China	Lou et al. [72]	2017	247	IDT
China	Lu et al. [73]	2016	724	TAM
China	Wu et al. [74]	2017	484	TAM
China	Yang et al. [75]	2016	317	TAM
China/Taiwan	Tu et al. [76]	2011	716	TAM,IDT
China/Taiwan	Chen and Chang [77]	2013	189	TAM
China/Taiwan	Cheng and Huang [7]	2013	262	UTAUT,TAM
Oceania				
Australia	Gao and Waechter [78]	2017	851	ISSM
New Zealand	Xin et al. [79]	2015	302	ISSM
South America				
Brazil	Luna et al. [31]	2017	423	TAM

[a]VT is an abbreviation for valence theory, which refers to the association of negative (e.g. perceived risk) and positive (e.g. beneficial) characteristics of a product or service

[b]Human–computer interaction (HCI), which research group emphasizes ease of use in design

[c]ITC is the abbreviation of IT continuance Theory, IT continuity theory

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