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A meta-analysis of mobile commerce adoption and the moderating effect of culture

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ABSTRACT

This research aims to discover the general factors that influence mobile commerce adoption. A meta-analysis of previous empirical studies on individuals' mobile commerce adoption behavior was conducted and the proposed mobile commerce adoption model was tested using structural equation modeling. Furthermore, moderator analysis was carried out using partition tests by dividing context into subgroups of eastern and western culture, to investigate the moderating effect of culture. Results confirm the proposed model, and moderator analysis indicates that culture does have specific moderating effects on mobile commerce adoption. The findings of this paper will yield theoretical and managerial implications for the future.

1. Introduction

Mobile commerce, also known as M-Commerce, or mCommerce, refers to the business activities conducted via wireless telecommunication networks. As a new stage of electronic commerce, mobile commerce has plenty of unique advantages over electronic commerce, such as instantaneity, ubiquity, localization, personalization and identification. With a wide popularity of mobile devices, such as smart phones, laptops, net books, and tablet computers, as well as increasingly powerful mobile technologies like 3G and the Internet of Things, mobile commerce has emerged as a new business phenomenon and has become a market with great potential. Mobile commerce now provides ever-widening content and services (Lee, 2008), including mobile ticketing, mobile banking, mobile marketing and other location-based services. Many researchers have made the effort to investigate those popular mobile commerce services, like mobile financial services (Hsu & Wang, 2011; Kleijnen, Wetzels, & Ruyter, 2003), mobile banking (Kleijnen et al., 2003), mobile transaction (Khalifa & Shen, 2008), and ubiquitous commerce (Zhang & Liu, 2011).

However, mobile commerce is still in its early stage. Numerous studies show that mobile services so far have failed to attract the hearts and minds of potential consumers (AlHinai, Kurnia, & Smith, 2010). Moreover, the development of mobile commerce in different countries is significantly different. The mobile commerce markets in Korea, Japan, Taiwan and Singapore appear to be more mature than those of many other countries. These phenomena in mobile commerce development are critically significant to the study of factors that influence mobile commerce adoption. Scholars have already investigated this issue, based on some popular adoption theories. Yang (2005), Cheong and Park (2005) and Wu and Wang (2005) conducted their studies using the Technology Acceptance Model (TAM). Hung, Ku, and Chang (2003) and Mallat and Rossi (2009) enriched their studies with the Innovation Diffusion Theory (IDT). The Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB) also played a part in many studies.

Meta-analysis is "the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings" (Glass, 1976). Although meta-analysis still encounters problems, like "oranges and apples", ample research proves it is rigorous and robust. King and He (2005) compared it with other three methods of reviewing a body of literature, and confirmed it as objective and effective. In addition, they found meta-analysis underutilized in IS research. Many scholars have conducted meta-analysis in TAM research. Ma and Liu (2004), Yousafzai, Foxall, and Pallister (2007a, 2007b), and other researchers conducted meta-analytic reviews of TAM studies, aiming at integrating the conflicting and somewhat confusing previous findings with mixed statistical significance, direction, and magnitude. They all brought profound implications for TAM research.

Since there is a good deal of quantitative research available on mobile commerce adoption, this research conducted a meta-analysis. Several studies have made meta-analyses of mobile commerce adoption research in the past, but they all have drawbacks. Min and Ji (2008) conducted a meta-analysis of mobile commerce research in China, but it was entirely qualitative and was confined to one country. AlHinai, Kurnia, and Johnston (2007) made a meta-analysis about the adoption of mobile commerce services by individuals, but it was a qualitative one that analyzed the literature according to Pedersen's triangulation framework of mobile commerce users' roles. They continued their research (AlHinai et al., 2010), analyzing and synthesizing the existing

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literature, but they focused on the classification of various factors that impact the adoption of mobile commerce. In contrast to their research, this paper makes an in-depth meta-analysis of mobile commerce adoption. The main work is as follows.

First, the mobile commerce adoption models proposed by extant research cover limited constructs. Most have only tested perceived usefulness, perceived ease of use, and essential technological elements from established models like TAM, TPB and IDT. Pedersson and Heinonen (2002) proposed that mobile commerce users have three roles: technology users, network members, and consumers. This may remind us not to discuss the adoption of mobile commerce from a solely technological perspective, just as with traditional IT adoption issues. More constructs that are critical to customers (e.g., perceived cost, perceived risk and perceived enjoyment) have to be considered in the adoption of mobile commerce. Therefore, this research proposed a conceptual model that extended TAM with additional constructs, based on abundant previous mobile commerce adoption studies. The conceptual model was tested using structural equation modeling.

Second, there are some contradictory empirical findings from past research. This may due to the divergence of sample sizes, sample characteristics, or investigation contexts. For instance, perceived usefulness and behavioral intention was tested to have a very large correlation in many studies (e.g., Kim, Park, & Morrison, 2008; Lu, Yao, & Yu, 2005; Turel, Serenk, & Bontis, 2007; Wei, Marthandan, Chong, Ooi, & Arumugam, 2009), while some found the relationship non-significant (e.g., Cho, Kwon, & Lee, 2007; Kurnia, Smith, & Lee, 2007; Mallat & Rossi, 2009). Therefore, meta-analysis of that reported divergence will lead to a more comprehensive result.

Third, previous research concentrates on mobile commerce adoption in single country. Yang (2005) explored this issue in Singapore, a country famous for its pro-technology policy and superior telecommunications infrastructure, while Wei, Marthandan, Chong, Ooi, and Arumugam (2009) tested the Malaysian context. Chew (2006) investigated the case of the United States in his honors thesis, and Kleijnen et al. (2003) are among many researchers who conducted their studies in the Netherlands. Kurnia et al. (2007) tested the situation in Australia. Through these investigations, mobile commerce adoption research has been conducted in more than 20 countries. There are several more studies taken across nations. Dai and Palvia (2008) undertook their research in China and the United States, Frank (2001) conducted his in Finland, Germany and Greece. But these studies still cannot draw comprehensive conclusions. The current situation shows that unlike electronic commerce, the development of mobile commerce in eastern countries (especially Korea, Japan, Singapore, etc.) is equal with western countries, or even faster. To discuss this phenomenon, this research categorized studies into western and eastern culture, and carried out a moderator analysis to investigate the moderating effect of culture on mobile commerce adoption.

The paper is organized as follows. Section 2 describes the research model and its key constructs. Section 3 discusses the methodology, including data collection, coding and analysis processes. Section 4 presents the analytical results of this research. Implications are showed in Section 5. Finally, the conclusion is stated in Section 6.

2. Research model

2.1. Technology acceptance model

Fishbein and Ajzen (1975) proposed the theory of reasoned action (TRA) in the social psychological setting. The theory became well established and has been broadly used to predict and explain human behavior in various domains ever since (Wu & Wang, 2005). Originally developed from TRA, Davis (1989) proposed the Technology Acceptance Model (TAM) to provide a basis for tracing the impact of external factors on internal beliefs, attitudes, and intentions. The main constructs of TAM include actual use (U), behavioral intention (BI), attitude toward using (AT), perceived use (PU), and perceived ease of use (PEOU).

Behavioral intention (BI) is defined as "the strength of one's intention to perform a specific behavior" (Chew, 2006. According to TAM, BI is the most important determinant of one's actual behavior. BI is determined by AT, which is described as "an individual's positive or negative feelings (evaluative effect) about performing the target behavior" (Fishbein & Ajzen, 1975). PU and PEOU, the two most critical internal beliefs in the technology acceptance model, both influence AT.

Perceived use (PU) is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). Perceived ease of use (PEOU) is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). According to TAM, PU and PEOU measure users' internal perception of accepting a particular behavior. They impact AT together, and PEOU has an impact on PU.

Since Davis (1989) developed TAM, substantial theoretical and empirical support has accumulated in favor of TAM. Numerous studies have found that TAM consistently explains a substantial proportion of the variance in usage intentions and behavior. TAM has become well-established as a robust and powerful model for predicting user acceptance.

However, many researchers (Hung, Ku, & Chang, 2003; Wei, Marthandan, Chong, Ooi, & Arumugam, 2009; Wu & Wang, 2005) suggested that TAM needed to be extended with additional constructs, so it could provide better explanations and predictions of users' acceptance behavior.

2.2. Theory of planned behavior

Ajzen (1991) revised and extended TRA into the theory of planned behavior (TPB) in 1991. According to TPB, behavioral intention (BI) is jointly determined by attitude (AT), subjective norm (SN), and perceived behavior control (PBC). The biggest difference of TPB and TAM is that TPB pays attention to external factors while TAM only concentrates on users' internal perceptions.

Subjective norm (SN) is defined as "a person's perception that most people who are important to him think he should or should not perform the behavior". There are many factors that influence SN, such as significant others (Fishbein & Ajzen, 1975), normative belief (Taylor & Todd, 1995) and informational influence (Karahanna, Straub, & Chervany, 1999). The role of SN in technology acceptance is intricate and inconclusive (Schepers & Wetzels, 2007); it was not included in TAM because Davis (Davis, 1989) found that the correlation between SN and BI was not significant. However, as many studies found the influence of SN considerable, Venkatesh and Davis (2000) reconsidered its role in TAM in 2000. This time, they proved that SN directly influences both BI and PU, indirectly influencing actual use. Furthermore, they also pointed out that experience and voluntariness can impact SN.

Perceived behavioral control (PBC) refers to "people's perception of the ease or difficulty of performing the behavior of interest". Ajzen (1991) believed the resources and opportunities available to a person are of great importance to his/her behavioral intention. Bandura (1977) concept of perceived self-efficacy is compatible with PBC, which "is concerned with judgments of how well one can execute courses of action required to deal with prospective situations". His investigation showed that people's behavior is strongly influenced by their confidence in their ability to perform it.

Although in comparison to TAM, TPB does not show better empirical performance in most cases. SN and PBC, the two

constructs that did not appear in TAM, made TPB more reasonable in some circumstances.

2.3. Innovation diffusion theory

TAM and TPB focus on people's internal and external perceptions. But in the early stage of new information technology (e.g., mobile commerce), people have little knowledge from internal perception and external environment. And in this circumstance, innovativeness is the factor that had to be considered.

Rogers (1995) put forward the well-known innovation diffusion theory (IDT) in 1995. IDT believes that innovation characteristics are the main determinant of innovation diffusion. Rogers (1995) pointed out five innovation characteristics: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage is the "degree to which an innovation is perceived as being better than the idea it supersedes". Compatibility is defined as "the degree to which an innovation is perceived as consistent with past values, past experience, and the needs of the potential adopters". The complexity of an innovation is "whether the innovation is perceived as relatively difficult to use and understand". Trialability refers to whether an innovation may be "experimented with on a limited basis". Lastly, observability is "whether the results of an innovation are visible to others". Nevertheless, according to previous research, among the five characteristics, only relative advantage, compatibility, and complexity are consistently related to innovation adoption.

Since proposed, IDT has been widely used in research of new information technology adoption behavior combined with other theories like TAM. Agarwal and Prasad (1998) initially considered innovativeness as a determinant of information technology acceptance. Innovativeness (INNO) is "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system". Rogers proposed five adopter categories: innovators, early adopters, early majority, late majority and laggards according to the tendency of new technology adoption.

IDT seems similar to TAM to some extent. For example, relative advantage is similar to PU, whereas complexity is similar to PEOU (Wu & Wang, 2005). IDT and TAM can supplement each other well. Once integrated, they provide a better explanation and prediction of information technology acceptance behavior.

2.4. Conceptual model

The above models have been consistently proved valid in information technology field and in extended electronic commerce research. As mobile commerce is highly related to IT and EC, it is appropriate to further apply those models to study mobile commerce. The three models vary on their emphases: TAM focuses on internal perceptions, TPB concentrates on external influences, and IDT emphasizes innovation characteristics. This research integrated them for a comprehensive study on mobile commerce.

Considering the validity of TAM in explaining and predicting users' acceptance behavior and its popularity in mobile commerce adoption researches, this research adopts the entire technology acceptance model, and extends it with SN and PBC from TPB, and INNO and COMPA from IDT as the supplement.

Besides constructs from those established models, other constructs that were expected to influence mobile commerce adoption, and were tested by many researchers were also considered. After reviewing abundant prior researches, perceived cost (PC), perceived risk (PR), trust (T) and perceived enjoyment (PE) were chosen.

Perceived cost (PC) is "the extent to which individual perceive that using m-commerce is costly". Cost in mobile commerce mainly covers initial fees, subscription fees, and communication fees. Wei, Marthandan, Chong, Ooi, and Arumugam (2009) investigated mobile commerce adoption in Malaysia and empirically proved PC has a negative effect on mobile commerce adoption. Bouwman and Carlsson (2007) found out that the impact of cost on mobile commerce adoption is much bigger than privacy and security issues in Finland.

Perceived risk (PR) is defined as "the certain types of financial, social, psychological, physical, or time risks when consumers make transactions online". Many researches (e.g., Liu & Chen, 2009; Mallat & Rossi, 2009; Wu & Wang, 2005) pointed out the negative role of PR on mobile commerce adoption. Wu and Wang (2005) listed many possible risks that users may be anxious about, such as fraud, product quality, unjustifiable delay in product delivery, and other, more illegal activities.

Trust (T) is "the extent to which an individual believes that using m-commerce is secure and has no privacy threats". Cho et al. (2007) indicated that the issue of trust is much more complicated in mobile commerce than in traditional commerce. Wang, Lin, and Luarn (2006) and Wei, Marthandan, Chong, Ooi, and Arumugam (2009) and many other researchers have reported significant correlations between trust and behavioral intention, and they all regarded T as a non-ignorable factor in mobile commerce adoption.

Perceived enjoyment (PE) is "the intrinsic reward derived through the use of the technology or service studied". Kargin and Basoglu (2006) believed that many mobile services are entertainment services first. Therefore, the stronger entertainment the mobile service can bring, the stronger adoption intention customers will have. More and more researchers put PE in their mobile commerce adoption models in recent years. Studies like work done by Cheong and Park (2005) proved strong correlation between PE and BI.

Many other constructs, like mobility, personalization, and visibility were excluded from the conceptual model. The main reasons are because their roles in mobile commerce adoption remained unclear through previous research, and they are not appropriate to be included in the meta-analysis since they were only investigated in a few studies.

Fig. 1 and Table 1 shows the conceptual model and the description of those constructs.

3. Methodologies

Meta-analysis is the process of summarizing, evaluating and analyzing quantitative research findings (Kirca & Yaprak, 2010). To fulfill it, we conducted an overall search of the literature, identified a common metric: the Pearson product-moment correlation coefficient r as the effect size to carry out a series of data analysis, and we tested the proposed model using structural equation modeling.

3.1. Data collection

In order to guarantee the quality of the meta-analysis, the authors carried out a wide scan of literature, including published journals, book chapters, dissertations and conference proceedings. The first step of the search included all available databases: ACM, EBSCO, CiteseerX, ScienceDirect, JSTOR, Proquest Direct, Emerald, ISI-Web of Knowledge, IEEE Xplore, SpringerLink, and Google Scholar, specifically concentrating on journals relevant to mobile commerce, like the International Journal of Mobile Communications (IJMC). Dissertations and conference proceedings were also carefully searched and were largely included in the meta-analysis, aiming at finding more unpublished studies, thus solving the file drawer problem in which journals are more likely to publish significant results. For conference proceedings, we focused on

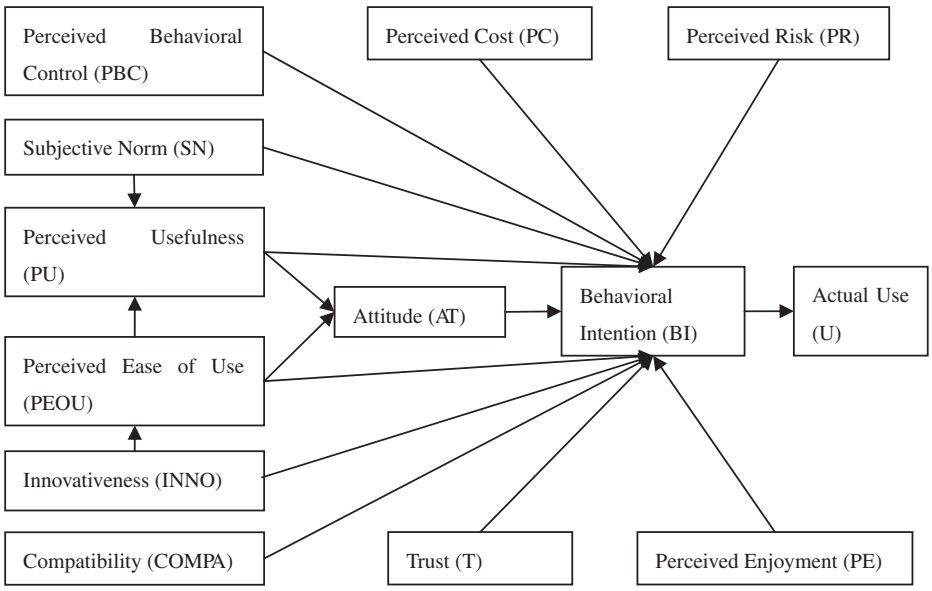

Fig. 1. Conceptual model.

Table 1
Main constructs in the proposed model.

Construct	Definition	Source
Perceived Usefulness (PU)	The degree to which a person believes that using a particular system would enhance his or her job performance	Davis (1989)
Perceived Ease of Use (PEOU)	The degree to which a person believes that using a particular system would be free of effort	Davis (1989)
Subjective Norm (SN)	A person's perception that most people who are important to him think he should or should not perform the behavior	Fishbein and Ajzen (1975)
Perceived Behavioral Control (PBC)	A person's perception of the ease or difficulty of performing the behavior of interest	Ajzen (1991)
Compatibility (COMPA)	The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters	Rogers (1995)
Innovativeness (INNO)	The degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system	Rogers (1995)
Perceived Cost (PC)	The extent to which an individual perceive that using m-commerce is costly	Wei, Marthandan, Chong, Ooi, and Arumugam (2009)
Perceived Risk (PR)	Certain types of financial, product performance, social, psychological, physical, or time risks when consumers make transactions online	Wu and Wang (2005)
Trust (T)	The extent to which an individual believes that using m-commerce is secure and has no privacy threats	Wei, Marthandan, Chong, Ooi, and Arumugam (2009)
Perceived Enjoyment (PE)	The intrinsic reward derived through the use of the technology or service studied	Igbaria, Parasuraman, and Baroudi (1996)

established IS conferences, such as the International Conference on Information Systems (ICISs), Pacific Asia Conference on Information Systems (PACISs), Hawaii International Conference on Systems Sciences (HICSSs) and the International conference on Mobile Business (ICMB).

"Mobile commerce", "m-commerce", "mobile service", "adoption", "acceptance", etc. were used as the primary, but not limited keywords in the literature search. Besides keywords searches, the authors also reviewed references of each article in order to get more relevant papers not involved in the search.

The initial search found 212 papers. Each of them was reviewed carefully to judge if they met the criteria to be included in this meta-analysis. The criteria included:

- The research must be carried out on individual's volunteer mobile commerce adoption;
- The research must be empirically investigating mobile commerce adoption;
- The research must have reported correlation coefficients, or other values that could be converted to correlation coefficients.

Besides those screening criteria, studies that were carried out by the same authors and based on the same samples were eliminated to insure the independence of selected articles. Four articles included two or three countries as the research objects; their sample sizes and effect sizes were reported separately, so we regarded them as different studies. Two articles were excluded for the lack of sample size.

Finally, a total of 53 articles with 58 studies were selected for the meta-analysis. Among the 53 articles, 39 are journal articles, 11 are published in conference proceedings, two are honors theses and one is a program report. The total sample size is 19, 334 and the median sample size is 266. All the articles are listed in Table 2. (Articles that have been selected as samples of the meta-analysis are labeled with * in the reference.)

3.2. Coding procedure

In the coding procedure, each article was read through for information needed in the meta-analysis. Items were collected from them, including basic information (author, year, publication, etc.),

sample size, investigated country, research model, key constructs and all reported effect sizes. Since there were masses of various constructs investigated in those selected articles, some constructs with different names may stand for similar meanings. Therefore, for the effectiveness of the study, they were merged to be consistent with constructs of the proposed model, which were the most commonly used in the majority of papers. Self-efficacy and facilitating conditions were closely related with perceived behavioral control, thus in some articles, the investigation of these two constructs were viewed as perceived behavioral control. Perceived cost, price, fees, and financial resources were all talking about the expected cost, so they were regarded as the same construct, perceived cost. The situation regarding perceived enjoyment, playfulness and entertainment was handled in a similar matter.

To conduct the moderator analysis of culture, all the articles were categorized into two subgroups in this study: eastern culture and western culture. Although this method of defining culture may be crude, this is still the most suitable method in the early stage of researching culture's moderating effects. According to history, people in eastern and western culture are significantly different when it comes to human behavior. Investigating the differences of mobile commerce adoption in eastern culture and western culture will lead to a brief conclusion of culture's moderating effects. Many researches (e.g., Schepers & Wetzels, 2007) have

Table 2
Articles involved in the meta-analysis.

Author	Sample size	Country/area	Culture
Wu and Wang (2005)	310	Taiwan	Eastern
Pedersson and Heinonen (2002)	232	Norway	Western
Yang (2005)	866	Singapore	Eastern
Hung, Ku, and Chang (2003)	267	Taiwan	Eastern
Wei, Marthandan, Chong, Ooi, and Arumugam (2009)	222	Malaysia	Eastern
Liu and Chen (2009)	196	China	Eastern
Li and Zhang (2010)	132	China	Eastern
Kim, Chan, and Gupta (2005)	161	Singapore	Eastern
Kargin and Basoglu (2006)	40	Turkey	Western
Chew (2006)	205	United States	Western
Sun, Wang, and Cao (2009)	228	China	Eastern
Khalifa and Cheng (2002)	202	Hong Kong	Eastern
Cheong and Park (2005)	1279	Korea	Eastern
Lu, Liu, Yu, and Yao (2003)	128	China	Eastern
Wang et al. (2006)	258	Taiwan	Eastern
Lopez-Nicolas, Molina-Castillo, and Bouwman (2008)	542	The Netherlands	Western
Theodora and Vaggelis (2010)	392	Greece	Western
Bigne, Ruiz, and Sanz (2007)	606	Spain	Western
Yen and Wu (2010)	231	Taiwan	Eastern
Pavlou, Lie, and Dimoka (2007)	300	United States	Western
Lee and Jun (2007)	249	Korea	Eastern
Bruner and Kumar (2005)	212	United States	Western
Min, Li, and Ji (2009)	837	China	Eastern
Khalifa and Shen (2008)	202	Hong Kong	Eastern
Dai and Palvia (2008)	106	China	Eastern
	84	United States	Western
Lee (2005)	384	Korea	Eastern
Mallat and Rossi (2009)	360	Finland	Western
Turel et al. (2007)	222	Canada	Western
Kim and Mirusmonov (2010)	269	Korea	Eastern
Bouwman and Carlsson (2007)	484	Finland	Western
Hung, Chou, Chung, and Dong (2010)	265	Taiwan	Eastern
	214	Malaysia	Eastern
Cho et al. (2007)	209	Korea	Eastern
Lin, 2010	177	Taiwan	Eastern
Kim (2008)	283	United States	Western
Ko, Kim, and Lee (2009)	511	Korea	Eastern
Lee (2008)	613	United States	Western
	539	Korea	Eastern
	309	China	Eastern
Kim et al. (2008)	286	Korea	Eastern
Chang and Tung (2008)	212	Taiwan	Eastern
Cho (2011)	280	United States	Western
	290	Korea	Eastern
Li, Fu, and Li (2007)	140	China	Eastern
Shin (2009)	296	Korea	Eastern
Lu et al. (2005)	388	United States	Western
Porter and Donthu (2006)	539	United States	Western
Islam, Ahmad, Khan, and Ali (2010)	100	Bangladesh	Eastern
Akturan and Tezcan (2010)	311	Turkey	Western
Kurnia et al. (2007)	192	Australia	Western
Bauer, Barnes, Reichardt, and Neumann (2005)	1028	Germany	Western
Jayasingh and Eze, 2010	781	Malaysia	Eastern
Amin (2008)	108	Malaysia	Eastern
Liao, Thou, and Huang (2007)	532	Taiwan	Eastern
Dickinger and Kleijnen (2008)	370	Austria	Western
Kleijnen et al. (2003)	105	The Netherlands	Western
Constantiou, Papazafeiropoulou, and Vendelø (2009)	50	Denmark	Western

adopted this method and have yielded reliable results. After coding the culture, the homogeneity analysis Q test and partition test will be carried out in the following moderator analysis.

If there were any divergences in the coding process, coders would discuss until finally reaching a consensus. This minimized ambiguity from the coding process.

Reliability was also collected in the coding procedure. According to the results, the Cronbach's alpha coefficients of the constructs range from 0.803 to 0.907, all exceeding the recommended value 0.8.

Another important work was the conversion of effect size. Since the correlation coefficient was selected as the effect size in our meta-analysis, other effect sizes like the regression coefficient β, χ^2, and F were converted into correlation coefficient r, according to the formulas presented by Wolf (1986), Hunter and Schmidt (1990), Rosenthal (1991) and Wu and Lederer (2009), Gelbrich and Roschk (2011).

The research examined 17 pairs of relationships according to the proposed model. Among all the 58 studies, PU–BI was tested 38 times, the most in all the 17 pairs. This was followed by PEOU–BI 30 times and PEOU–PU 25 times. Only 6 studies investigated the relationships of INNO–PU; PR–BI and SN–PU are also less reviewed. Most of the correlation coefficients of these pairwise relationships are significant among all the studies. PC–BI has the lowest ratio of significance at 76.9%. The average sample size of each relationship seems quite comparable, mainly around 350. The detailed descriptive statistics are shown in Table 3.

3.3. Data analysis

To address the critical problems of measurement error and sampling error, the first step of our data analysis was to correct the correlation coefficients of those pairwise relationships. For each relationship, a simple mean of the effect size was calculated first. Then we calculated the reliability-adjusted mean to meet the belief that a correlation generated from more reliable data sources can produce a mean correlation closer to the population mean. The method was based on Lipsey and Wilson's (2001) work, dividing the correlation by the square root of the reliability of two constructs. For studies that haven't reported the reliabilities, the average reliability of that construct was used as an approximation (Kirca, Satish, & William, 2005). After that, those reliability-adjusted correlations were weighted by sample size to make an adjustment for sampling error.

A series of univariate statistics were conducted subsequently, mainly including the 95% confidence intervals, the Fail-safe N statistics, the homogeneity analysis Q test, and the partition test for moderator effects.

The confidence interval was used to interpret the significance of mean effect size. In this paper, a 95% confidence interval was calculated. If it excludes 0, the mean effect size is statistically significant at a .05 level.

To further test the significance of those pairwise relationships, fail-safe N was adopted. Rosenthal's (1979) fail-safe N was an ingenious response to the so-called "file drawer problem" in research integration (Orwin, 1983). It would provide the number of studies that reported non-significant results, which would have to be included in the sample to reverse the conclusion that a significant relationship existed. Fisher r to Z transformation was conducted Following Wolf's (1986)) formula $Z = 0.5 * \ln\left(\frac{1+r}{1-r}\right)$, and then the fail-safe N for $p = 0.05$ was calculated using the formula $N_{fs.05} = \left(\frac{\sum Z}{1002E645}\right)^2 - N$, where $\sum Z$ is the sum of individual Z scores and N is the number of tests.

Q statistics was then made to test the homogeneity of the distribution of effect sizes. Q was calculated by the formula recommended by Hedges and Olkin (1985): $Q = \sum(n_i - 3)(z_i - \bar{z})^2$, where n_i was the sample size in study i, and $\bar{z} = \sum n_i z_i / \sum n_i$. The Q value was then compared to the chi-square of $(k - 1)$ degrees of freedom, where k was the number of studies included. If the results of Q statistics show heterogeneity varying more than would be expected by sampling error, the existence of moderator will be confirmed. And moderator analysis will be subsequently conducted.

As culture is a categorical moderator factor, the partition test (Hunter & Schmidt, 1990) was adopted as the method of moderator analysis in this research. The partition test divides sampled effect sizes into subgroups by moderator factors and compares subgroup means and variance, to assess if the means are significantly different.

Lastly, the paper used LISREL 8.80 for structural equation modeling, testing whether our proposed model of the mobile commerce adoption is fit. The correlation coefficient matrix and the median sample size were used as input. Path coefficients and goodness of fit statistics were analyzed.

4. Results

4.1. Correlation analysis

Table 4 shows the simple mean of correlation r, the sample size weighted reliability-adjusted correlation r_c, standard deviation SD,

Table 3
Descriptive statistics.

Pairwise relationship	No. of studies	Range of correlations		Correlations			Range of sample sizes		Cumulative sample Size	Average sample Size
		Lower	Upper	Significant	Non-significant	Significant (%)	Lower	Upper		
BI–U	11	0.201	0.854	11	0	100	192	613	3658	333
AT–BI	19	0.196	0.880	19	0	100	105	1279	7583	399
PU–BI	38	0.100	0.780	34	4	89.5	50	1279	11,388	300
PEOU–BI	30	0.007	0.651	26	4	86.7	84	1279	9056	302
PU–AT	20	0.124	0.871	20	0	100	40	1279	8036	402
PEOU–AT	16	−0.036	0.700	13	3	81.3	40	1279	6264	392
PEOU–PU	25	0.089	0.907	22	3	88	40	1279	8932	357
SN–BI	21	0.110	0.679	20	1	95.2	84	1028	6992	333
SN–PU	9	0.340	0.580	9	0	100	40	837	3328	370
PBC–BI	12	0.150	0.649	10	2	83.3	128	370	2891	241
COMPA–BI	19	−0.610	0.680	18	1	94.7	84	1279	7181	378
INNO–BI	13	0.010	0.392	11	2	84.6	84	1028	5382	414
INNO–PEOU	6	0.092	0.809	5	1	83.3	40	866	2523	421
PC–BI	13	−0.394	−0.035	10	3	76.9	50	1279	3397	261
T–BI	14	0.056	0.530	12	2	85.7	84	781	3419	244
PR–BI	8	−0.370	−0.080	7	1	87.5	196	1028	3464	433
PE–BI	12	0.027	0.670	11	1	91.7	84	1279	5025	419

Table 4
Correlation analysis.

Pairwise relationship	r	r_c	SD	95% CI	$N_{fs.05}$
BI–U	0.423	0.477	0.177	0.372 | 0.582	4.243
AT–BI	0.502	0.632	0.238	0.525 | 0.739	59.953
PU–BI	0.428	0.490	0.175	0.434 | 0.546	126.659
PEOU–BI	0.386	0.483	0.187	0.416 | 0.550	56.105
PU–AT	0.448	0.527	0.184	0.446 | 0.608	32.711
PEOU–AT	0.270	0.274	0.212	0.170 | 0.378	−6.214
PEOU–PU	0.477	0.544	0.209	0.462 | 0.626	79.949
SN–BI	0.385	0.492	0.187	0.412 | 0.572	18.338
SN–PU	0.442	0.513	0.079	0.462 | 0.564	0.513
PBC–BI	0.376	0.391	0.200	0.278 | 0.504	0.143
COMPA–BI	0.246	0.277	0.291	0.146 | 0.408	−5.992
INNO–BI	0.172	0.195	0.140	0.119 | 0.271	−10.079
INNO–PEOU	0.269	0.419	0.281	0.194 | 0.644	−2.566
PC–BI	−0.180	−0.193	0.110	−0.253| −0.133	−10.215
T–BI	0.277	0.325	0.152	0.245 | 0.405	−4.836
PR–BI	−0.180	−0.180	0.105	−0.253| −0.107	−6.851
PE–BI	0.354	0.486	0.229	0.357 | 0.615	1.014

95% confidence interval CI and the fail-safe N of each pair of relationship.

The attitude–behavioral intention (AT–BI) relationship shows the largest correlation 0.632; the correlations of perceived usefulness–attitude (PU–AT) and perceived ease of use–perceived usefulness (PEOU–PU) also exceed 0.5, presenting a strong correlation, which is in accordance of most of the extant studies of TAM. Except attitude, among all the other constructs that are correlated with behavioral intention, perceived usefulness, perceived ease of use, subjective norm and perceived enjoyment also show large correlations. Perceived cost–behavioral intention (PC–BI) and perceived risk–behavioral intention (PR–BI) are negatively correlated. None 95% confidence intervals of all the relationships contain zero state clearly that all these correlations are significant. Seven pairs of relationships have not passed the fail-safe N test.

4.2. Moderator analysis

The homogeneity analysis Q test was conducted on each pair of the relationship and the results denote that all of them are significant, with the Q value far exceeding the critical value. This forcefully proves the presence of a moderator. The research then continued to test the impact of culture on each correlation using a partition test. Table 5 shows the mean correlation of each relationship in the subgroups of eastern culture and western culture, and their Z-score ($a = 0.05$) to see if the variance was significant.

Table 5
Moderator analysis.

Pairwise relationship	Q-value	Critical value	Eastern	Western	Z-score
BI–U	440.07	18.31	0.539	0.399	**1.983**
AT–BI	2094.57	28.87	0.602	0.671	0.607
PU–BI	1082.38	53.38	0.494	0.478	0.234
PEOU–BI	557.09	42.56	0.519	0.309	**2.534**
PU–AT	1187.52	30.14	0.466	0.606	**2.092**
PEOU–AT	399.88	25.00	0.247	0.363	1.046
PEOU–PU	2384.19	36.42	0.613	0.337	**3.096**
SN–BI	630.03	32.67	0.490	0.493	0.029
SN–PU	50.97	15.51	0.571	0.432	**3.732**
PBC–BI	310.79	19.68	0.403	0.364	0.275
COMPA–BI	652.68	28.87	0.250	0.307	0.354
INNO–BI	166.95	21.03	0.178	0.203	0.284
INNO–PEOU	2136.87	11.07	0.523	0.118	**2.107**
PC–BI	601.57	21.02	−0.200	−0.096	**2.231**
T–BI	160.01	22.36	0.339	0.280	0.811
PR–BI	34.91	14.07	−0.261	−0.116	**3.240**
PE–BI	561.50	19.68	0.561	0.206	**2.899**

Results show that effect size differences caused by culture are significant in nine pairs of relationships, while other eight fail to show significance. The general impact of culture on mobile commerce adoption seems hard to descript. But it is clear that the perceived ease of use greatly influences behavioral intention and perceived usefulness in eastern culture, while at the same time, perceived usefulness is more important in western culture. Additionally, perceived cost, perceived risk and perceived enjoyment all denote a larger influence on behavioral intention in eastern culture than western one.

4.3. Structural equation modeling

Fig. 2 shows the estimation of path coefficients according to the structural equation modeling using LISREL. Of the 17 pairs of relationships in our proposed model, 14 pairs are significant at the .05 level.

From the goodness of fit indexes, the proposed model shows an excellent fit with previous meta-analysis statistics. $\chi^2(61) = 11.87$, $p > 0.05$; AGFI = 0.99, CFI = 0.99, SRMR = 0.020.

5. Discussions

5.1. Theoretical implications

The conceptual model of mobile commerce adoption in this paper integrated TAM, TPB, IDT and additional constructs, and TAM is the core of this model. As stated in Section 2, for more than two decades, TAM has been tested by plenty of researchers to be supportable and robust. Results of this paper once again demonstrate it. According to our meta-analysis, TAM is valid in mobile commerce adoption research. From the descriptive statistics, researchers investigating mobile commerce adoption issue have used TAM most frequently. From the correlation analysis, all the seven pairs of TAM relationships show significance. Perceived ease of use and attitude (PEOU–AT) have not passed the fail-safe N. This may because the correlation coefficient of this relationship is relatively small in many researches. It may also be due to the belief that any correlation between perceived ease of use and attitude is indirect. Its path coefficient is also non-significant according to SEM, which can be explained by the same reasoning. The path coefficient of perceived usefulness and behavioral intention (PU–BI) is also non-significant in the path estimation, which may seem unexpected. This may be caused by the divergence of previous findings. From the moderator analysis, perceived usefulness is more important in western culture and perceived ease of use is more critical in eastern culture. This result is consistent with previous analyses of culture's moderating effect (e.g., Schepers & Wetzels, 2007).

Besides TAM, subjective norm, perceived behavioral control, innovativeness and compatibility are critical components of TPB and IDT, demonstrating their importance in mobile commerce adoption. Among these four constructs, subjective norm shows the greatest significance. From the descriptive statistics, the relationship between subjective norm and behavioral intention (SN–BI) was investigated in nearly half of the studies. This amount was equal to, or even more than some relationships of TAM. This clearly shows subjective norm's importance and popularity in mobile commerce adoption research. As for its effect on behavioral intention and perceived usefulness, although Fishbein and Ajzen (1975) reported them non-significant and omitted subjective norm from the original TAM, they did acknowledge the need for additional research on that issue. Venkatesh and Davis (2000) reconsidered TAM in 2000 and they proved the relationship of subjective norm and perceived usefulness (SN–PU) significant. They further pointed out that subjective norm had a direct effect on behavioral

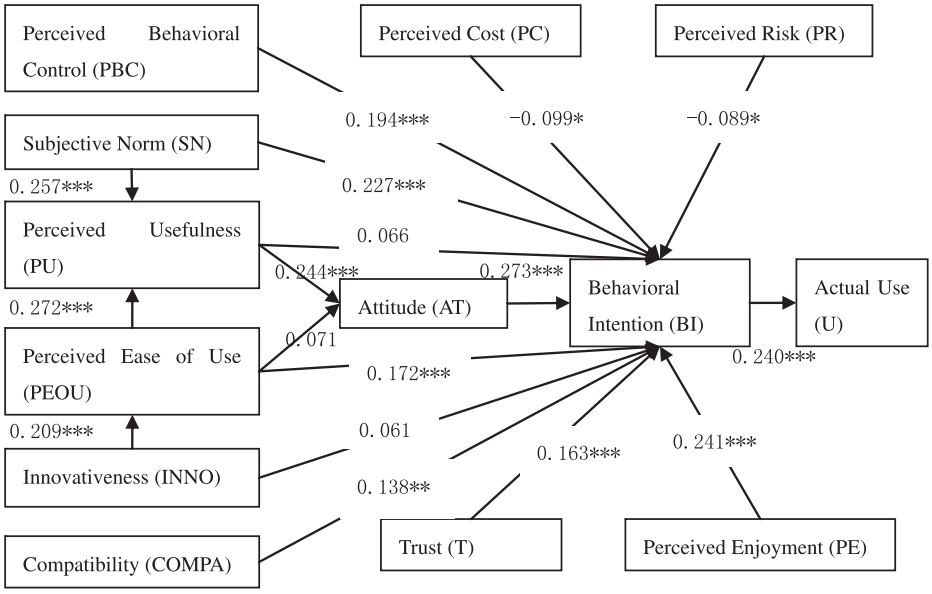

Fig. 2. Structural equation modeling estimation.

intention for mandatory, not voluntary usage contexts, which may explain previous research that found it non-significant (Fishbein & Ajzen, 1975). However, results in this meta-analysis indicate subjective norm significantly influences behavioral intention and perceived usefulness both in correlation analysis and path estimation, proving subjective norm's significant role in a voluntary use context. From the moderator analysis, the correlation of subjective norm and behavioral intention (SN–BI) shows no significant divergence. But the effect of culture on the relationship of subjective norm and perceived usefulness (SN–PU) is significant. It can be concluded that subjective norm influences people's perception of mobile commerce's usefulness much stronger in eastern culture than in western culture.

Perceived cost, perceived risk, trust and perceived enjoyment are also important constructs in mobile commerce adoption. Different from researches of early IT technology adoption and electronic commerce adoption, the impact of these factors on mobile commerce appears to be much more important, concerning more and more researchers. Although, aside from perceived enjoyment–behavioral intention (PE–BI), the other three haven't passed the fail-safe *N* test; despite this, they are all significant in the path estimation. Through the correlation analysis and path estimation, perceived enjoyment is found to have a much larger effect than other three elements. Its importance in mobile commerce adoption is therefore confirmed. From the moderator analysis, culture does have a moderating role on the relationships of perceived cost, perceived risk and perceived enjoyment. And the effect size of eastern culture is bigger in all these three pairs of relationships. Individuals seem to consider more factors in eastern culture when they consider adopting mobile commerce.

This paper also contributes to meta-analysis research in the academic field. Scholars called for meta-analysis researches in IS fields because they believed the methodology of meta-analysis was underutilized in this field (King & He, 2005; Ma & Liu, 2004). They pointed out that the inevitable problem of inconsistent empirical findings on essentially the same question need to be integrated and presented as a general conclusion. This paper is an attempt to conduct meta-analysis on mobile commerce. Results of this research will enrich the academic findings in this field.

What is more, by taking a meta-analysis, the publication practice of the mobile commerce adoption field may also be improved considering the inclusion of unpublished papers and the effort to resolve the file-drawer problem in the meta-analysis.

5.2. Managerial implications

Mobile commerce has become a new and inevitable trend for the future. The research has also brought some implications for mobile commerce providers and operators who aim at promoting individuals' adoption of mobile commerce.

First of all, managers should pay more attention to factors from the users' angle instead of focusing solely on technology-related issues. High technology will not be the only secret weapon to achieve a competitive advantage. In order to attract more users, companies and managers need to carefully consider elements like subjective norm, cost, risk, and enjoyment that relate more to individuals' roles from both social and consumer perspectives.

As different factors have different effects in different cultures, companies from various countries should have different managing strategies, especially for those international companies. For example, importance should be placed on perceived usefulness in western cultures to bring more adoption, and perceived ease of use is definitely vital in eastern countries. Managers should pay more attention to the price, risk and entertainment of their services in eastern countries than western ones. What is more, in contrast with western culture, eastern culture appears to be more collectivistic, which means the significance of subjective norm.

6. Conclusions

Based on previous mobile commerce adoption studies, this research conducted a meta-analysis, tested a model that extended TAM with additional constructs, and analyzed the moderating effect of culture. According to the results of the meta-analysis, there are convergences and divergences among previous findings. Meta-analysis in this research not only integrates previous mobile commerce adoption studies, but also enriches the method of meta-analysis in the field of mobile commerce. The extended TAM model fits very well in the mobile commerce circumstance. Except perceived usefulness, perceived ease of use, subjective norm and those constructs that play critical roles in traditional information technology acceptance, such as perceived cost, perceived risk, trust

and perceived enjoyment all take important roles in mobile commerce adoption. Culture does have specific effects on mobile commerce adoption, which explains current developmental discrepancies and indicates future evolutionary directions. The moderating effect of culture will definitely be helpful for companies in mobile commerce industry to develop international strategies.

Certainly, this study still has limitations. Firstly, regardless of all the efforts the authors have made to search comprehensive studies for samples used in the meta-analysis, some may have failed to be included. Secondly, the categorization of eastern and western culture may be too crude to obtain an exact conclusion of moderating effect. Confined by limited studies, this research chose this solution, but more studies about the influence of culture on mobile commerce adoption should be made.

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