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Abstract

This study explores factors significantly impact the acceptance of Wireless Internet via Mobile Technology (WIMT) in China. The results indicate that the acceptance of WIMT is related with factors of: perceived usefulness, perceived ease of use, social influences, wireless trust environment, and facilitating conditions. Factors of perceived usefulness and ease of use are directed by system complexity. This study provides diagnostic insight into how different factors influence user intention to accept WIMT and thus helps business build solid strategy to prompt WIMT and m-commerce in China.

Keywords: Wireless Internet, mobile technology, m-commerce, e-commerce, technology adoption, TAM

Introduction

Mobile Commerce represents the convergence of two technologies – the web and wireless technology. While the former has radically changed the way business is conducted, the later has added a mobile dimension to e-commerce and mobile computing through mobile devices such as cell phone, PDA, or pager (Coyle 2001). Mobile Commerce is a subset of electronic commerce (e-commerce), which is forecasted to continue to grow and have a profound impact on the global business environment, despite recent worldwide slowdown in the Internet sector (Piven 2002). It seems that, mobile commerce, based on wireless Internet via mobile technology (WIMT), which delivers e-commerce capabilities directly into the consumer's hand via wireless technology, can be a force with strong potential to expedite business transactions and significantly change how businesses serve customers in the global market (Kutler 2000).

While enjoying recent high economic achievement, China is rapidly heading towards having the largest mobile communications network and business in the world for both cellular and paging operations. As a direct reflection of China's population of 1.3 billion people and huge demand driven by the major cities and economic zones, the McKinsey Research predicted that China will overtake the U.S. as the world's largest mobile phone market with more than 300 million mobile subscribers in 2005 (Kenyon and Perkins 2000). According to this study, there are two main factors driving the growth of WIMT in China: A mobile infrastructure that is more developed than its fixed-line counterpart and the greater affordability of mobile telephones as compared with personal computers. In addition, the active involvement of a few world leading telecommunications suppliers such as Ericsson, Motorola, Nokia, and Siemens in China's telecom industry, especially in cellular supply and service business also contribute a great deal to this phenomenon (Zhang 2001).

Unlike the United States and Europe, e-commerce practices in China can hardly reach the low-income earners that constitute the majority of the population because of the limited household possession of wired personal computers (Hu 2000). On the other hand, many of the existing mobile users have an already established comfort level with mobile devices' interface and functionality, which may well alleviate reluctance to conduct mobile commerce activities. However, the substantial volume of using WIMT should not be seen as a natural consequence of high penetration of mobile phones, PDAs, or pagers. WIMT goes far beyond

mobile devices in terms of Internet usage and system functionality. Literature reveals very limited studies on WIMT and its acceptance, not to mention the situation in China. Therefore, the major objective of this study is to explore factors associated with acceptance of WIMT in China. The following question makes up this work:

What factors significantly impact acceptance of wireless Internet via mobile technologies in China?

Background

The International Data Corporation (IDC 2001) reports that almost all handsets manufactured in 2001 were equipped with wireless application protocol (WAP). In addition, most of this wireless equipment will have a functionality of global positioning system (GPS) in the newer models, which will enable the system to locate almost any store in customers' current geographical location (Ostermiller 2001).

Although much has been accomplished toward the goal of conducting business activities anywhere and anytime in mobile devices, some researchers believe that this concept is too broad and misleading (Saia 2002). People want more specific information when they are mobile. Therefore, the business content and service people request to access from a WIMT enabled system may be quite different from those when they are in a fixed location. The ultimate value of using WIMT is to provide people with required content services through the portability and accessibility (Goldman 2000).

Like in many other countries, mobile devices in China, especially cell phones, have experienced three generations of development so far. The first generation provided the ability of mobile communications. The second generation improved reception and enabled a range of sophisticated services to be offered by using the global system for mobile communications (GSM). The third generation, which is offered in many Chinese cities, has the ability to conduct wireless Internet access by using GPRS (general packet radio service), a technology based on packet switching as used in current data transmission over the Internet. With the GPRS, data transmission speeds will expand from 9.6 or 14.4 kbps in the GSM system to the current 115 kbps (Kenyon and Perkins 2000). It can support a wide range of services for mobile users, including unified messaging, e-shopping, location-based, and time critical services (Darrow and Harding 2000). With the huge mobile subscriber base in China and the long habit of using mobile phones in various business activities, the potential for m-commerce in China is tremendous.

Theoretical Framework and Research Hypotheses

The theoretical framework, presented in Figure 1, was constructed in a conceptual research effort based on Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB). TRA was developed for understanding human behavior of interest. Assuming that human beings are rational decision makers, this theory views a person's action as determined by intention to perform. Intention is a function of personal attitude toward the behavior and subjective norms of behavior, which can be traced back to a person's behavioral beliefs (an individual's positive or negative evaluation of performing a certain behavior) and the normative beliefs (a person's perception of the social pressures to perform or not perform the behavior in question). The relative weights of these two types of beliefs may vary from person to person (Ajzen and Fishbein 1980). TRA provides a model for exploring the opportunities for influencing or manipulating the determinants of intention to bring about the desired behavior.

Based on TRA, TPB was developed to predict behaviors in which individuals have incomplete volitional control. The major difference between TRA and TPB is the addition of a third determinant of behavioral intention, perceived behavioral control. This construct refers to the degree to which an individual feels that performance of the behavior in question is under his or her volitional control. Control factors include both internal and external factors. Internal factors are such things as skills, abilities, information, emotions such as stress, etc. External factors include such things as situation or environmental factors (Ajzen 1985).

Over the years, TRA and TPB have been tested in various disciplines and in different settings. These two theories are regarded as most applicable in understanding behavioral intentions. Influenced by TRA and TPB, theories such as technology acceptance model (TAM) by Davis (1989), decomposed TPB by Taylor and Todd (1995) and some extended or revised models were developed to guide IS/IT acceptance research and practices. A commonality among all those theories supported by substantial volume of empirical studies is the direct association between changes in beliefs and changes in outcome expectancies and intentions. However, none is existent for explaining and predicting WIMT acceptance behavior.

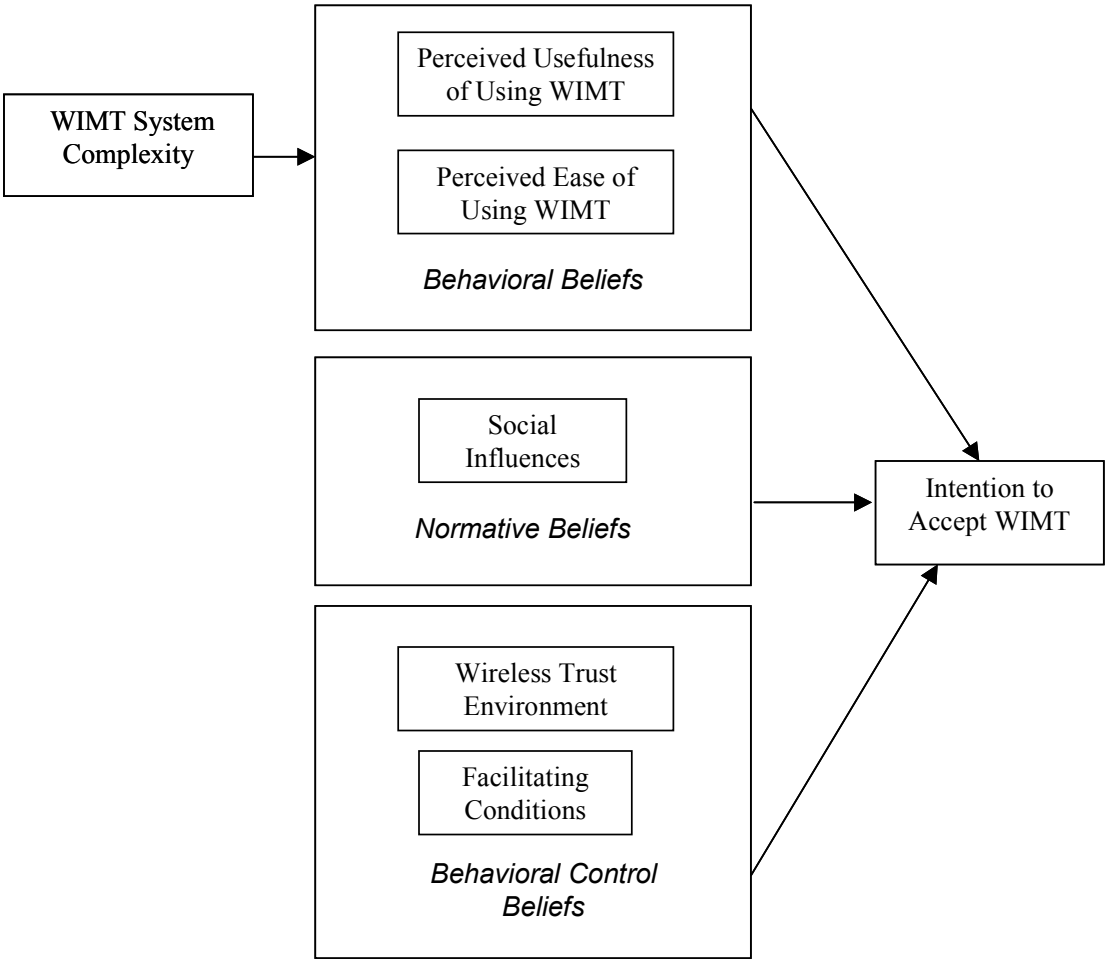

Figure 1. Wireless Internet via Mobile Technology Acceptance Behavior Model

The proposed model in this study regards the intentions to accept WIMT as a combined effect of three beliefs: individual perceived usefulness and ease of use of the technology, perceived social norm influences, perceived facilitating conditions and wireless trust environment. The perceived usefulness and ease of use are the behavioral beliefs strongly influenced by system complexity of WIMT as an external factor. The emphasis of this model is on explaining the antecedent beliefs of the behavioral intentions. Therefore, the linear relationships between beliefs and attitude and between attitude and intention are not included in the model. The following paragraphs will explain each construct and the relevant relationship in detail.

Perceived Usefulness of Using WIMT

Prior research indicates that perceived usefulness is an important indicator for technology acceptance (Taylor and Todd 1995; Chau 1996; Jiang et al. 2000). Perceived usefulness originally refers to job related productivity, performance, and effectiveness (Davis, 1989). This is an important belief identified as providing diagnostic insight into how user attitude toward using and intention to use are influenced – perceived usefulness has a direct effect on intentions to use over and above its influence via attitude (Davis et al. 1989; Davis 1993; Taylor and Todd 1995). Incorporating concepts used in expectancy theory, Triandis (1980) proposed that an important factor influencing behavior is the expected consequences of the behavior. Individuals evaluate the consequences of their behavior in terms of perceived usefulness and base their choice of behavior on the desirability of the perceived usefulness. If WIMT does not provide for wireless access of information and conducting business transactions, it is not likely to be perceived favorably despite the fact that the wireless mobile devices have a high penetration rate in China.

Some recent research explored user acceptance of the Internet. The research by Jiang et al (2000) proposed that user perceived usefulness comprises near-term and long-term usefulness. TAM's perceived usefulness complies with Triandis' explanation for near-term consequence: improvement in productivity, effectiveness, job performance or satisfaction. There is also a long-term usefulness which refers to consequential result in one's career prospects or social status. Their research findings revealed that the acceptance of Internet technology is positively related to perceived near-term and long-term usefulness. However, their study investigated only the use of wired Internet. It will be interesting to see if their findings can be confirmed in use of WIMT. This study is intended to investigate if the perceived usefulness of using WIMT is related to users' intention to accept WIMT. Thus, we propose:

H1: Perceived usefulness of using WIMT is directly related to intention to accept WIMT.

Perceived Ease of Using WIMT

The degree of easiness felt by the customers using WIMT is also important. Perceived ease of use is an important determinant of user satisfaction (Baroudi et al. 1986). This internal belief ties to an individual's assessment of the mental effort involved in using a system (Davis 1989).

Quite a few empirical studies confirmed the effect of ease of use on attitude toward using and intention to use (Lu and Gustafsen 1994; Venkatesh and Davis 1996). Venkatesh (2000) believes that for any emerging IT/IS, perceived ease of use is an important determinant of users' intention of acceptance and usage behavior. Even though Chau (1996) excluded the original construct of perceived ease of use in his Modified TAM model, he also admitted that in the exploratory state of technology use, ease of use plays an important role. This point was again supported by a recent survey done in Europe. A mail survey by Embedded Solutions among 800 professionals in England in 1999 found ease of use among the top five factors in order of significance for determining use of wireless handheld devices (Clarke 2000). Therefore, another hypothesis is generated:

H2: Perceived ease of using WIMT is directly related to intention to accept WIMT.

System Complexity

Literature has already revealed that characteristics of wireless mobile systems link directly to issues concerning user demand (Beaulieu 2002). To study the impact of the typical wireless mobile technology on user intentions to accept WIMT, we propose a conceptual construct, System Complexity. The impact of system characteristics has been widely recognized in system and technology user acceptance research. Davis et al. (1989), for example, proposed that system characteristics exhibit indirect effects on usage intentions or behaviors through their relationships with perceived usefulness and perceived ease of use.

WIMT has its own complexity that is different from what has been discussed in the technology user acceptance research. WIMT system complexity can be defined as the degree of integration between wireless Internet and mobile technologies supporting various communications and services.

Operationally, it could be examined in four facets: efficiency of data transfer, system functionality, interface design, and mobile device capacity. Effectiveness of WIMT largely depends on efficiency of data transfer on the wireless system (Varshney and Vetter 2001). Besides, WIMT has some unique functions that provide special Internet services of its own, in addition to supporting a variety of information services and business applications (Weisman 2000). Currently, the mobile devices for accessing wireless Internet all provide small screens. The smaller the screen, the less information is displayed at any one time. The user interface, therefore, becomes central in application delivery (Regis 2001). Mobile devices currently serve as entry points into the wireless Web, carrying with them their own capabilities and limitations (Beaulieu 2002). Each aspect serves as an indispensable part of the entire WIMT system complexity. Any aspect may have some impact on users' satisfaction of performance and mental effort, which in the long run would shape their overall impression of usefulness and importance of WIMT. Significant as they are, we view these four facets as critical system determinants of both perceived usefulness and perceived ease of using WIMT. Based on this identification, we propose:

H3a: System complexity is directly related to perceived usefulness of using WIMT.
H3b: System complexity is directly related to perceived ease of using WIMT.

Social Influences

Social Influences construct is derived from subjective norm in TRA and is defined as family members' and friends' opinions, important people's influence, and peer influence. Empirical support for the relationship between social norms and IT/IS acceptance can be found in many studies (Venkatesh and Davis 2000). Davis and his colleagues (1989) believed that in some cases people might use a system to comply with others' mandates rather than their own feelings and beliefs. Venkatesh and Davis (2000) later expanded social influences to include subjective norm and image as well. Image is derived from the research on diffusion of innovations. Moore and Benbasat (1991) defined it as the extent to which use of an innovation is perceived as enhancement of one's status in a social system.

Mobile users are usually in social situations. To comply with social influences is a common phenomenon, especially when wireless mobile devices are still considered a sort of fashion. In front of another person, sense of social image is rendered as critical for many. In China, 73 percent of the executive class in big cities owned mobile phones as early as in 1998, not only for its convenience but also as a symbol for social status (Samson and Hornby 1998). In addition, young people treat smart-phones as new fashion items to show off in the public. Thus, we propose:

H4: Social influences are directly related to the intention to accept WIMT.

Wireless Trust Environment

Wireless trust is an important environmental control over intention to adopt WIMT. As business marketers place greater emphasis on building long-term relationships with their customers, trust has assumed a central role (Viega et al. 2001). All business transactions require an element of trust, especially those conducted in the uncertain environment of mobile commerce (Lee 1998). There are two key ingredients of a wireless trust environment: security and privacy. Wireless security must be seen in the broader context of Internet-based e-commerce systems to include confidentiality, authentication, and message integrity (Coyle 2001). Different from e-commerce which relies on wired Internet, m-commerce is on wireless Internet and is exposed to greater danger of insecurity, since hackers may intercept anywhere in the free air.

To build consumer's trust in the safety of using wireless devices for transaction, wireless transport layer security (WTLS), public-key infrastructure (PKI), certificate authority (CA), Wired Equivalent Privacy (WEP), device independent smart card, and wireless biometric services have emerged as common solutions (Kay 2002). WTLS offers security feature for wireless application protocol (WAP) to deliver communications by using wireless devices. WEP allowed the encryption of wireless traffic. Smart card and/or wireless biometric services provide a core authorization infrastructure to verify that only the authorized user is making the transaction. However, many current applications for wireless have a very low requirement for security. Many organizations and individuals using wireless networks are still not fully aware of the importance of wireless security in nurturing a virtual trust environment (Louw and Yarberry 2002).

Privacy concerns often arise when new information technologies such as the Web enabled mobile technology that support enhanced capabilities for collection, storage, use, and communication of personal information (Webster 1998). Reports of concerns about privacy on wireless Internet are recently on the rise (Phillips 2002). It is impossible to translate the potential business applications of the wireless technology into viable business ventures without first setting up trustworthy online environment. This leads to the following hypothesis:

H5: Wireless trust environment is directly related to intention to accept WIMT.

Facilitating Conditions

Facilitating conditions can be viewed as another external aspect of behavioral control relating to environment (Triandis 1980). Behavior could not occur if objective conditions in the environment prevent it, or if the facilitating conditions make the behavior difficult (Thompson et al. 1994). Facilitating conditions originally provide two dimensions: resource factors (such as time and money needed) and technology factors regarding compatibility issues that may constrain usage. The argument is that when all other things are equal, behavioral intention and IT usage would be expected to be less likely as less time and money are available and as technical compatibility decreases (Taylor and Todd 1995). This variable was tested in a number of technology acceptance

researches, and empirical supports were found on the proposed effect on the technology acceptance (Taylor and Todd 1995; Jiang et al. 2000).

In terms of technology, it has been argued that the facilitating conditions for WIMT is much better than for the PC based Internet access (Anchar and D'lncau 2002) due to the lower hardware investments and the proficiency with mobile devices. Therefore, the high cell phone penetration in China helps provide favorable facilitating conditions for the acceptance of WIMT. However, the compatibility and interoperability issues caused by existence of different wireless protocols and varying networks still linger.

Further, policies, regulations, and legal environment are also conditions critical to technology acceptance. Both businesses and consumers who engage in m-commerce activities need the same level of legal protections as they are conducting traditional business transactions. However, there are few laws or regulations in China guiding online business activities. But the powerful influences of legal environment, government policies and regulations in China can never be neglected in considering whether environmental conditions encourage intention to accept WIMT. Therefore, another hypothesis is:

H6: Facilitating conditions is directly related to the intention to accept WIMT.

Research Methodology

A survey approach was used in this study. The survey was conducted in May 2002. Research subjects were MBA students enrolled in a required graduate e-commerce course at a large university in Beijing, China. Over 160 students participated in the survey, 128 of which were usable data points.

Measurement of Variables

Some measurement variables were adopted from previous studies related to TAM. Others were generated from literature review on mobile commerce and key word searches of mobile device, m-commerce security, privacy, system design, technology acceptance, and China in ABI/INFORM, an online database marketed by University of Microfilms (UMI). Search results were scanned by reading titles and abstracts. All variables in the survey were measured on a seven-point Likert scale from (1) completely disagree to (7) completely agree. Table 1 shows the research constructs, the relevant measurement variables, and the internal reliability assessment results.

Reliability and Validity of the Measure

Reliability assessment was carried out using Cronbach's alpha. A low value of Cronbach's alpha (i.e. close to 0) implies that the variables are not internally related in the manner expected (Churchill 1979). As can be seen in Table 1, the alpha values for all the research constructs under study are equal to or well above 0.70, the level commonly regarded for good reliability. Therefore, it is assumed that internal consistency for the proposed constructs exists in this study (Nunnally 1978).

In addition, a thorough examination was made of the relevant literature. To further reduce the possibility of non-random errors, a pilot was conducted to examine the questionnaire for content validity (measuring what is intended), completeness (including all relevant variable items), and understandability.

Data Analysis and Results

Mean values and a matrix of intercorrelations among the research constructs were calculated. The average response of user intention to use WIMT is predetermined as the indicator of intention to accept WIMT. If the mean rating on intention to accept WIMT correlates significantly with any of the five research constructs, and the system complexity correlates with perceived usefulness and ease of using WIMT, then the six hypotheses could be supported. The means, standard deviations, and matrix of intercorrelations among the six research constructs are presented in Table 2.

As the results in Table 2 suggest, a strong relationship exists for H1, H2, H3a, H3b, H4, and H5. The last hypothesis (H6) suggests that facilitating conditions are directly related to intention to accept WIMT. The correlation coefficient is 0.15, with a p value greater than 0.05, but less than 0.1. Therefore, there is a weak support for this hypothesis.

Data analysis for this research has not been completed up to this date. More will be conducted in the months to come. Currently, the authors are using structural equation modeling technique to further test the proposed model. Full results will be available when present at this conference.

Conclusions

Apparently, acceptance of WIMT is related with factors of: perceived usefulness, perceived ease of use, social influences, wireless trust environment, and facilitating conditions. Factors of perceived usefulness and ease of use are directed by wireless system complexity. Business organizations that launch wireless applications in China should be more aware of these factors. Based on the results, several recommendations can be advanced.

First, businesses should actively seek ways to improve wireless trust environment to bring security and privacy concerns in their applications. Without security and privacy protections, customers will shy away from your wireless services.

Second, businesses should add more values for the wireless applications and services. In addition, wireless application designer should focus on the way in which customers use the wireless devices for Internet access. The results indicated the importance, in general, of intention to accept perceived usefulness and perceived ease of use.

Third, this study has yielded some findings on system complexity for WIMT. Results of the measurement procedures reveal that each of the four sub-constructs – data transfer efficiency, interface design, mobile device capacity, and functionality – are correlated to measure the construct of System Complexity. This means that these four conceptual sub-factors are indispensable parts of WIMT technology complexity. From a theoretical perspective, the findings of this study add value to m-commerce and technology acceptance literature by providing a current profile of what needs to be considered in terms of technology when assessing the acceptance of m-commerce.

Fourth, the results corroborated the hypothesized direct relationship between facilitating conditions with the acceptance of WIMT. Surprisingly, this hypothesis only received a weak support from this study. More studies are needed here for further exploration.

Finally, businesses should actively seek ways to use social influences factor to increase the acceptance of WIMT. Fashion and social images seemed critical in this study for the acceptance of WIMT.

Table 1. Research Constructs, Measurements, and Reliability Assessment

Hypothesis No.	Research Construct	Measurement Variables	α
H1	Perceived Usefulness	• decreased the time needed for work/study/life • increase quality or output for life • increase the effectiveness of life • improve opportunities • increase varietes • increase flexibilityes • gain job/life security	0.88
H2	Perceived Ease of Use	• clear and understandable • doesn't require a lot of mental effort • easy to use • easy to do what I want it to do	0.71

Hypothesis No.	Research Construct	Measurement Variables	α
H3(a,b)	System Complexity	• screen design • input feature • response time • roaming capabilities • data transmission rate • data throughput in uplinks and downlinks • bandwith • memnory storage • battery power • screen size • e-mail and messaging services • time and location based services • personalization • long time wireless access	0.75
H4	Social Influences	• more prestige • high profile • status symbol • other people's influences	0.75
H5	Wireless Trust Environment	• notice • choice • access • managerial security protection • security technique protection	0.70
H6	Facilitating Conditions	• help/instruction availability • training • resource • knowledge • wireless access • availability • legal protection • government policies/regulations	0.71

Table 2. Matrix of Intercorrelations Among Study Constructs (N=139)

Construct	Mean	St.D.	1	2	3	4	5	6	7
1. Intention to accept WIMT	5.53	1.46	1.00 (0.0)						
2. Perceived Usefulness	4.80	0.96	0.36 (0.0001)	1.00 (0.0)					
3. Perceived Ease of Use	4.65	1.16	0.32 (0.0001)	0.36 (0.0001)	1.00 (0.0)				
4. System Complexity	4.77	0.61	0.39 (0.0001)	0.33 (0.0001)	0.29 (0.0004)	1.00 (0.0)			
5. Social Influences	4.04	1.05	0.17 (0.0441)	0.49 (0.0001)	0.31 (0.0003)	0.28 (0.0009)	1.00 (0.0)		
6.Wireless Trust Environment	5.23	0.83	0.21 (0.0112)	0.32 (0.0002)	0.27 (0.0014)	0.35 (0.0001)	0.33 (0.0001)	1.00 (0l0)	
7. Facilitating Conditions	4.44	0.80	0.15 (0.08)	0.40 (0.0001)	0.36 (0.0001)	0.36 (0.0001)	0.47 (0.0001)	0.43 (0.0001)	1.00 (0.0)

*Note: (1) p values are in the ( ).
(2) The measurement scale of mean values is from 1 (strongly disagree) to 7 (strongly agree).

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