The Acceptance and Adoption of Smartphone Use among Chinese College Students

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Abstract. This study aims to develop a questionnaire to investigate the acceptance and adoption of smartphone among college students in China, and to find factors affecting the acceptance and adoption. A total of 402 valid questionnaires were received from Chinese college students. The internal reliability of the questionnaire was pretty high and acceptable (cronbach's α= 0.939). Extended Technology Acceptance Model (TAM) is attempted to be utilized to explain users' Behavior Intention (BI) to smartphone use. Structural Equation Model was used to test the extended TAM, and the results demonstrated majority relationships of the extended TAM. The study also found that social influence, entertainment utility and compatibility of smartphone impact Chinese college students' perceived usefulness and attitude to use. That is very valuable implication for manufacturers to improve smartphone's interactive interface to win bigger market share.

Keywords: Smartphone, extended TAM, Social influence, Entertainment utility, Compatibility, Structural equation model.

1 Introduction

In the past decade, mobile phone experienced a tremendous growth. With the development and innovation of technology, smartphone arises at the historic moment. It was invented by Lee, Han, and Hwang in 2007 [10]. Its core functions are not only phone calls and text massages, but also include camera, wireless communication, and multimedia messaging and so on. It integrates mobile phone and many other technologies into one single device, which can be regarded as a handheld computer, like the Apple, Nokia N-series, Samsung, Motorola, HTC, MI, etc.

According to the investigation on 30,000 mobile phone users in Unite State by the market research institute comScore [14], the market share of smartphone in USA has been 51.9% by October 2012, which is higher 6% than that in July 2012. In China, smartphone has spread from high-end consumer group to mid- and low-end consumer groups. Young college student is main force of the mid-/low-end consumer groups. The population of college students has reached more than 20 million in 2010 [5]. They are young adults pursuing fashion and new technology products. That presents a sizeable market opportunity for smartphone, as well as a challenge to provide

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appropriate smartphone products for this group. Therefore, understanding the fundamentals of what determines smartphone use among this group is worth being studied. It can lead to more effective and meaningful strategies for smartphone manufacturers and thus, allows them to remain competitive. However, few literatures about such studies have been found. Therefore, the purpose of this study is to investigate the acceptance and adoption of smartphones among Chinese college students and the factors affecting such acceptance behaviors, and to explore the critical external variables affecting users' attitude to use and perceived usefulness of smartphone.

2 Background Literature

The technology acceptance model (TAM) was proposed by Davis [6]. It was originated from the theory of reasoned action (TRA) which is used for explaining and predicting people's behavior. TAM was widely used to explain and analyze information technology usage behavior. Previous research has proven that it is a useful theoretical model in helping to understand and explain users' behavior in information system implementation [11].

Basic TAM has five components: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude (AT), Behavior Intention (BI), and actual use. In the context of smartphone acceptance, mobile services can be available at any time and any place. PU is defined here as "the degree to which a user believes using a smartphone would enhance his or her life quality and could integrate into their daily activities" [9] and recognized as the most important variable to predict technology acceptance in several studies [1, 8]. However, if a product is too hard to use, even if potential users believe that it is useful, the acceptance could also be influenced. Thus, PEOU is also considered as an important variable to influence usage. PEOU here refers to the degree to which a user believes that using a smartphone would be free of effort.

Based on the structure of the model, five relationships are suggested among the five components: (1) PEOU affects PU; (2) PEOU affects AT; (3) PU affects AT; (4) AT affects BI; and (5) PU affects BI. Finally, the actual use is influenced by behavior intention (BI). Venkatesh et al. [17] and Wu et al. [20] suggested that PEOU and PU are the two most important factors in explaining technology use. Studies had empirically proved the relationships between factors in TAM based on smartphone use in healthcare [15] and delivery service [2, 3]. When PEOU increases, users' PU of a smartphone will also increase and this will influence their behavioral intentions to use. Both PU and PEOU would have a positive effect on users' attitude and this would influence their behavioral intentions to use.

Additionally, several researchers proposed that self-efficacy also influences users' acceptance of technology. Self-efficacy was defined as users' perception of their ability to use a product to accomplish a task [4]. Self-efficacy measures user's perception on how he/she is able to complete a task. Without skill, performance is not possible; without self-efficacy, performance may not be attempted. Users' self-efficacy and perceptions contribute to the causal relationship between acceptance of technology and user's cognitive factors [15]. Literature empirically proved that users' self-efficacy affected perceived ease of use (PEOU) and behavior intention to use [2, 3, 7, 15, 16]. From this literature, it is postulated that confident users in learning to use a

smartphone are likely to perceive it as easier to use while those who are not confident in learning the smartphone use perceive it as harder to use. Therefore, self-efficacy was included in the extended TAM and the extended TAM is attempted to be utilized to explain users' behavior to smartphone use in this study.

Finally, which external variables contributing to the acceptance of smartphone is another important purpose of this study. Like the diffusion of innovation theory, persuasive social information such as peer influence, advertisement may increase people's perceived usefulness of a service or technology [16]. Social influence here was defined as "the degree to which individual has the impression that others believe they should use advanced mobile services" [18]. Social influences have been demonstrated to have an indirect impact, via PU, on people's behavior intention. Lu et al. [13] proved that social influences can affect a person's perceived usefulness of advanced wireless Internet. Therefore, social influence is considered as one of the main external variables.

3 Research Framework and Hypotheses

The purpose of this study was to examine the acceptance level of the smartphone technology and the factors that affect such an acceptance, and to explore the critical external variables affecting users' attitude to use and perceived usefulness of smartphone. Based on the discussion in the previous chapter, the conceptual model of research framework is proposed as shown in **Fig. 1**. It showed factors derived from extended TAM and external variables from literature and pilot study which may affect smartphone use. According to the research framework and the research purpose, hypotheses are proposed.

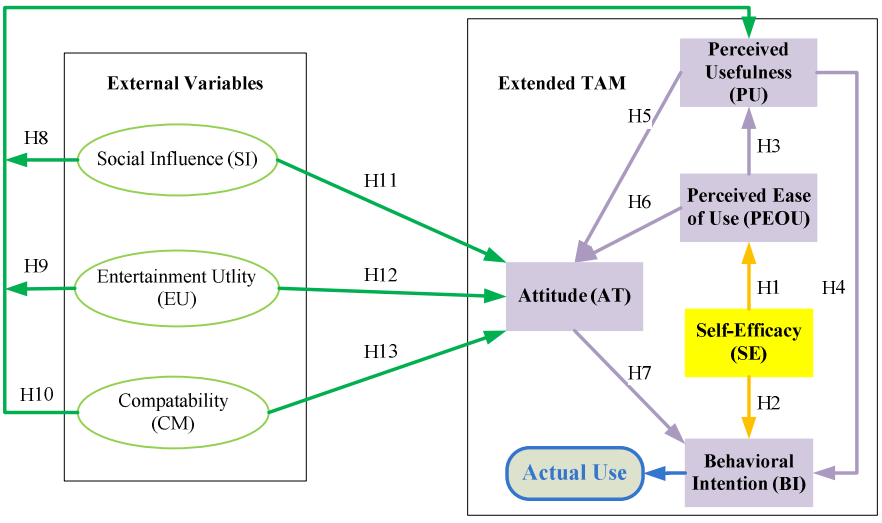

Fig. 1. Research Framework

H1: Users' self-efficacy to smartphone positively influences perceived ease of use.
H2: Users' self-efficacy to smartphone positively influences behavioral intention.
H3: Perceived smartphone ease of use positively affects perceived usefulness.
H4: Perceived smartphone usefulness positively affects behavioral intention.
H5: Perceived smartphone usefulness positively affects attitude.
H6: Perceived smartphone ease of use positively affects attitude.
H7: Users' attitude to use smartphone positively affects behavioral intention.
H8-H10: External variables significantly influence users' perceived usefulness of smartphone.
H11-H13: External variables significantly influence users' attitude to use smartphone.

4 Experiment

4.1 Pilot Study

Research Instrument. The research instrument was a questionnaire which contained two sections. The first section contained questions relating to demographic information (i.e., gender, age and education level). Using experience with smartphone, the manufacturer and model of user's current smartphone, the most commonly used functions, and suggestion for function improvement are also included.

The second section contained items used to measure factors from extended TAM and the external variable *social influence* (SI), which are mainly from the study of Park et al. [15], Liu et al. [12], Zhang et al. [22] and Wang et al. [19]. Multi-items were used to measure each. A five-point Likert-type scale was used in constructing the questionnaire. The scale ranged from 1 (strongly disagree) to 5 (strongly agree).

The questionnaire was constructed in English and was translated into Chinese by using the method of back-translation to make sure the translated Chinese does not violate the original meanings of the English questionnaire items. After back-translation, the questionnaire was reviewed by three classmates to ensure clarity and face validity.

Sample. A total of 188 valid questionnaires (130 males and 58 females) were received. Respondents averaged 23.4 years of age (SD=1.25 years). All respondents were Chinese college students which consisted of 170 graduate students (90.4%) and 18 undergraduate students (9.6%).

Reliability. As shown in **Table 1**, the cronbach's α of all variables were higher than 0.7 and the cronbach's α of the whole scale was 0.922, which mean the internal reliability of the questionnaire was pretty high and acceptable.

Table 1. Cronbach's α in pilot study

Variable	Cronbach's α	Variable	Cronbach's α
Self-efficacy (SE)	0.79	Behavioral intention (BI)	0.87
Perceived ease of use (PEOU)	0.80	Attitude (AT)	0.86
Perceived usefulness (PU)	0.86	Social influence (SI)	0.77
Whole Scale	**0.922**		

Results. The investigation also found that except making phones, the top three of the most commonly used function were internet (66.2%), chat tools (43.8%) and mobile games (32.1%). The improvement suggestions from respondents mainly focused on smartphones' entertainment functions, compatibility and battery endurance ability.

Based on these results, the questionnaire was revised. Except social influence, entertainment utility and compatibility were also considered as important external variables that contributing to smartphone acceptance. Items of *entertainment utility* (EU) and *compatibility* (CM) in the revised questionnaire were created based on the results of pilot study.

4.2 Final Study

Research Instrument. The first section of the questionnaire was the same as that in pilot study. The second section of the revised questionnaire contained 40 items about factors from extended TAM (i.e., SE, PEOU, PU, AT & BI) and external variables (SI, EU & CM).

Sample. A total of 402 valid questionnaires (244 males and 158 females) remained for further analysis. Respondents averaged 21.4 years of age (SD=2.96 years). All respondents were Chinese college students which consisted of 138 graduate students (34.3%) and 264 undergraduate students (65.7%).

Reliability. See **Table 2** for cronbach's α in final experiment. Cronbach's α of the whole scale was 0.939, and except compatibility (cronbach's α= 0.637), cronbach's α for other variables were higher than 0.70. Thus, it could be concluded that the internal reliability of the questionnaire was acceptable.

Table 2. Cronbach's α in final study

Variable	Cronbach's α	Variable	Cronbach's α
Self-efficacy (SE)	0.789	Attitude to use (AT)	0.860
Perceived ease of use (PEOU)	0.868	Social influence (SI)	0.706
Perceived usefulness (PU)	0.863	Entertainment utility (EU)	0.810
Behavioral intention (BI)	0.830	Compatibility (CM)	0.637
Whole Scale	**0.939**		

Descriptive Statistics. There were 20 manufacturers represented in final study, and the six most popular manufacturers accounted for more than 80% of the samples: Apple (22.9%), Nokia (19.7%), Samsung (14.7%), HTC (12.2%), Motorola (5.5%), Huawei (4.5%) and Mi (2.7%).

Of respondents, as shown in **Fig. 2** for using experience, 5.0 percent indicated that total using experience of smartphone was 4 years and above; 7.2 percent between 3 years to 4 years; 17.2 percent between 2 years to 3 years; 25.4 percent between 1 year to 2 years; 21.9 percent between 0.5 year to 1 year; and 23.4 percent less than 0.5 year. From these results, we can draw that smartphone is more and more popular among Chinese college students.

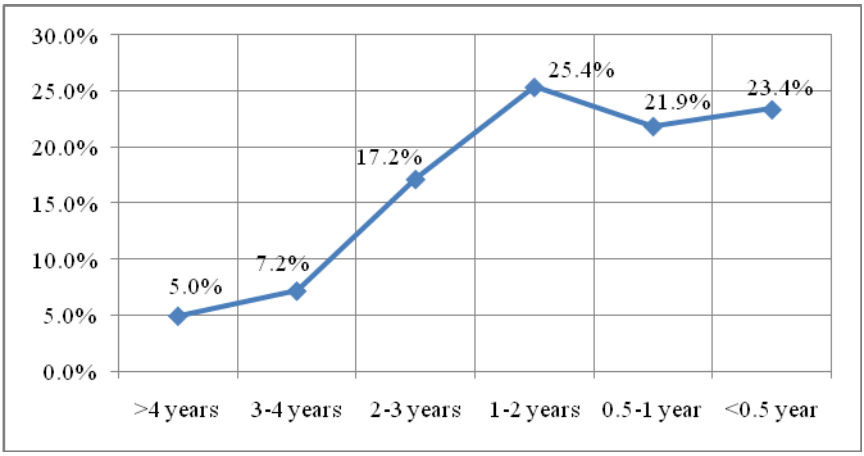

Fig. 2. Respondents' using experience of smartphone

Hypotheses Testing.

Extended TAM. The extended TAM including self-efficacy (H1-H7) is analyzed through structural equation modeling using AMOS. The results were provided in **Fig. 3** and **Table 3**.

H1-H7 tested the causal relationships demonstrated in extended TAM. As shown in **Table 3**, except AGFI, other adapter indexes all met the adapter criteria, which mean that using the extended TAM to explain the acceptance of smartphone among Chinese college students was pretty well. From the results in **Fig. 3**, this study confirmed the majority relationships of the extended TAM.

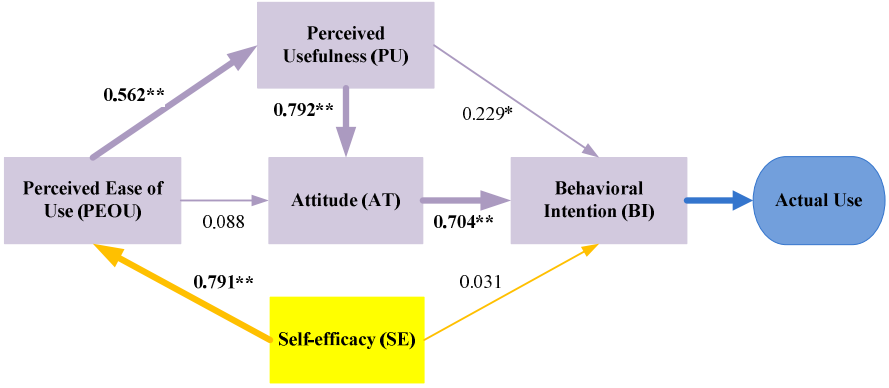

Fig. 3. Test results of extended TAM (*p<0.01, **p<0.001)

Table 3. Adapter index of extended TAM

Absolute adapter index	Adapter criteria[21]	Value-added adapter index	Adapter criteria	Contracted adapter index	Adapter criteria
GFI: 0.914	>0.90	NFI: 0.92	>0.90	PGFI: 0.697	>0.50
AGFI: 0.887	>0.90	RFI: 0.903	>0.90	PNFI: 0.76	>0.50
RMR: 0.034	<0.05	IFI: 0.96	>0.90	CN: 401.94	>200
RMSEA: 0.048	<0.05	TLI: 0.951	>0.90	NC: 1.938	1<NC<3
		CFI: 0.959	>0.90		

Supporting H1, Self-efficacy was found to have a significant effect on PEOU (β=0.791, $p<0.001$). This implied that if college students felt confident about using smartphone they generally demonstrated a higher perceived ease of use. Supporting H3, PEOU had a significant positive impact on PU (β=0.562; $p<0.001$). Supporting H5 and H6, PU positively determined attitude to use smartphone (β=0.792; $p<0.001$) and had a positive impact on behavioral intention to use (β=0.229; $p<0.01$). Supporting H7, Chinese college students' behavioral intention to use was largely influenced attitude to use (β=0.704, $p<0.001$).

These results indicated that the attempt of extended TAM into the investigation of college students' behavioral intention to use smartphone was successfully demonstrated in this study.

External variables. H8-H13 examined the relationship between external variables and factors of extended TAM, especially, the influence of external variables on users' perceived usefulness of smartphone and attitude to use smartphone. Regression analysis was used to test this relationship. The results (see **Table 4**) indicated that social influence, entertainment utility, compatibility all had a significant positive impact on user's perceived usefulness of smartphone (β=0.398, β=0.410, β=0.580; $p<0.0001$) and user's attitude to use smartphone (β=0.406, β=0.395, β=0.617; $p<0.0001$).

These results were easy to understand. On one hand, mobile games are very popular among young people in nowadays, so the entertainment utility of smartphone is important to them. On the other hand, the initial purpose of smartphone invention was to give users a single solution for all personal communication needs and to make users life more convenient. However, if the smartphone is not compatible with other devices like laptop, it will make the life more complex than before, which is against its initial purpose. In addition, China is collectivism culture and Chinese behavior was easily affected by external factors. Especially, for Chinese college students, they are just free from high school and without parents' control. Their behaviors were quite easy to be affected by peer and society. Thus, social influence to their behaviors was understandable.

Table 4. Regression analysis for external variables

Hypotheses	Relationship	R^2	Standardized coefficients	Results
H8	SI→PU	0.159	0.398	Supported (p<0.0001)
H9	EU→PU	0.168	0.410	Supported (p<0.0001)
H10	CM→PU	0.337	0.580	Supported (p<0.0001)
H11	SI→AT	0.165	0.406	Supported (p<0.0001)
H12	EU→AT	0.156	0.395	Supported (p<0.0001)
H13	CM→AT	0.381	0.617	Supported (p<0.0001)

Notes: PU – Perceived usefulness; AT – Attitude to use; SI – Social influence; EU – Entertainment utility; CM – Compatibility.

5 Conclusion

User's perceived acceptance under TAM and external attributes have been previously explored, this study extended prior research by providing research constructs for Chinese college students, especially found the external variables which affect acceptance of smartphone. Our findings confirmed the majority relationships of the extended TAM (SE→PEOU→PU→AT→BI→actual use). The results also showed that attitude to smartphone use among college students was found to be affected significantly not only by PEOU and PU, but also by social influence, entertainment utility and compatibility among college students.

These findings imply that the smartphone manufacture should pay attention to the entertainment utility when designing smartphone for college students. Meanwhile, compatibility of smartphone should be taken into serious consideration during designing the man-machine interactive interface for young people, especially college students. Besides, according to suggestions from respondents, the battery endurance ability, which was an essential problem for smartphone and hadn't been studied in this study, would be studied in the future study.

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