THE EFFECTS OF NETWORK EXTERNALITIES AND HERDING ON USER SATISFACTION WITH MOBILE SOCIAL APPS

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ABSTRACT

Due to the rapid development of social media and mobile technologies, more and more users access social media via mobile devices. Existing research focuses on user satisfaction with either social networking services or mobile applications. Perceived benefits, such as perceived usefulness and perceived enjoyment, are important antecedents of user satisfaction with mobile applications in general. Mobile social apps are different from general mobile apps in the sense that the intensive social connections and influence among users may affect user satisfaction with the product. Very few studies have examined the factors influencing user satisfaction with mobile social apps. In this study, we built an integral research model on user satisfaction with mobile social apps by drawing on the theories of network externalities and herd behavior. By conducting a survey with the users of a popular mobile social app, WeChat, we empirically show that network externalities and herd behavior have significant influence over users' perceived benefits toward the mobile social app. We also find the significant mediating effects of perceived benefits on the relationship between network externalities and user satisfaction and the relationship between herd behavior and user satisfaction. Our findings provide useful insights to mobile social app developers and marketers as well as mobile social app users.

Keywords: Mobile social apps; Social networking; User satisfaction; Network externalities; Herd behavior

1. Introduction

Mobile users are reaching a mass audience due to the fast development of Internet and mobile technologies. Mobile applications, commonly referred to as mobile apps, are programs that run on mobile devices and perform functions ranging from web browsing to social networking [Taylor & Strutton 2010]. Compared to traditional Internet services, mobile apps have many advantages such as ubiquity, convenience and immediacy, which enable users to interact with their friends anytime and anywhere [Wei & Lu 2014]. Mobile social apps, designed to support social networking, have experienced a rapid expansion in terms of number of users among all types of mobile apps [Wei 2008]. Social networking services provide information sharing and networking opportunities as well as a new way for acquiring news [Newman, 2016]. The number of social networking users is expected to reach 2.5 billion, a third of earth's entire population, in 2018 [1]. Among all social networking platforms, Facebook is the undeniable leader in terms of number of monthly active users (1.6 billion around the world), followed by WeChat (excluding instant messenger apps such as WhatsApp and QQ) [2]. As of January 2016, about 52 percent of users in North

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America accessed social networking services via mobile apps, while the global social app user percentage was 27 percent. Those numbers are expected to continue to increase in the coming years.

As social networking services and mobile devices have become increasingly popular, there is a strong research need to understand user satisfaction with mobile social apps and user retention against competitor apps. Compared to traditional products or services, mobile apps have a low switching cost because a user can easily switch from one mobile app to another with just a few touches. For mobile social apps, the consequence of user dissatisfaction and losing a user is critical. Satisfied users are more likely to continue using the product or service and distribute positive word-of-mouth [Kondo et al. 2012]. Existing studies focus on either social networking services, such as Facebook [Lin et al. 2014; Banerjee & Dey 2013], Twitter [Johnson & Yang 2009], mobile technologies [Kim et al. 2013], and Microblog [Zhao & Lu 2012], or mobile applications in general (e.g., Nayebi et al. 2012). Mobile social apps, which combine both a social network platform and mobile experience, become increasingly popular due to the wide adoption of mobile devices. However, very few studies have examined the factors influencing user satisfaction with mobile social apps. Chang [2015] empirically shows that perceived value, such as emotional, social, price, and performance/quality value, has a positive effect on user satisfaction and loyalty with mobile apps. The antecedent measures a user's perceived value without considering the influence of others, which is highly likely in mobile social apps. Hsiao et al. [2016] find that social ties, along with utilitarian and hedonic factors, have strong influence over users' satisfaction with mobile social apps. However, it fails to explain why social ties can influence user satisfaction. Those studies find the antecedents of user satisfaction with mobile apps, but fail to recognize the peer influence in the social networking context. In this study, we aim to examine the impact of social influence on user satisfaction with mobile social apps. Network externalities and herd behavior are considered as the two major social factors that may affect user satisfaction. We build an integral research model by drawing on the theories of network externalities and herd behavior, which explain the extrinsic factors influencing mobile social app users' satisfaction.

The rest of this paper is structured as follows. In the next section, we describe existing work related to our research. In Section 3, we present our research model and develop research hypotheses. In Section 4, we introduce the methodology and operationalization of our empirical study, followed by a discussion of the empirical results. In the final section, we conclude the paper with further discussions of the findings, theoretical and practical contributions, limitations, and suggestions for future research.

2. Theoretical Background

2.1. User Satisfaction with Mobile Apps

User satisfaction is defined as users' overall evaluation and affective response to a product or service, or to the experience after they use a product or service [Oliver 1997; Song et al. 2014]. Online user satisfaction has been extensively studied in the context of e-business [Hung et al. 2014]. Extant research has shown that user satisfaction has a positive impact on customer loyalty [Zhou & Lu 2011; Chang 2015], continuance using intention [Zhao & Lu 2012; Lin et al. 2014], and willingness to pay [Zhao et al. 2016]. Different studies have proposed different antecedents of perceived user satisfaction. Zhao et al. (2016) show empirical evidence that perceived usefulness and perceived ease of use have positive impact on user satisfaction in the context of social media. In the context of mobile apps, Chang [2015] empirically shows that perceived value, such as emotional, social, price, and performance/quality value, has a positive effect on user satisfaction and loyalty. Hsiao et al. [2016] find that social ties, along with utilitarian and hedonic factors, have strong influence driving user satisfaction with mobile social apps. However, it fails to explain why social ties can influence user satisfaction. In this study, we consider network externalities and herd behavior as the social factors driving user satisfaction. In the remainder of this section, we review literature related to network externality and herd behavior.

2.2. Network Externality

Network externality is defined as "the utility that a user derives from consumption of good increases with the number of other agents consuming the good" [Katz & Shapiro 1985]. Network externalities occur when a person's participation in a network creates benefits for others in the network. Thus, the value of the network increases as the number of network participants increases [Economides 1996]. Katz and Shapiro [1985] identify two types of network externalities: direct and indirect externalities [Katz & Shapiro 1985]. Direct network externalities derive value from the size of the user network of a product or service. For example, a telephone has virtually no value if only one user exists. However, it becomes extremely valuable if billions of individuals have access to the telephone system [Clements 2004]. Indirect network externalities, on the other hand, increase value when there are more complementary or compatible products and services becoming available [Katz & Shapiro 1986]. The increase in the usage of one product also boosts the value of a complementary product, which in turn inflates the value of the original product. For example, a DVD player becomes more valuable as the variety of available DVD productions increases. The variety of DVDs also increases as the total number of DVD users grows [Clements 2004]. Network

externalities also exist in the user networks of mobile social apps. The more users spend their time with a particular mobile social app, the larger their social networks are, which in turn creates more value for the users [Katz & Shapiro 1985]. Therefore, we argue that the added value due to network externalities can positively influence user satisfaction with mobile social apps.

2.3.   Herd Behavior

Herd behavior refers to the phenomenon that "everyone does what everyone else is doing, even when their private information suggests doing something quite different" [Banerjee 1992]. Herding is likely to occur if people have incomplete information or face uncertain circumstances [Fiol & O'Connor 2003; Walden & Browne 2009]. Prior research has shown that herd behavior occurs in a wide range of circumstances, including imitating other's behavior in financial investment [Hirshleifer et al. 1994; Welch 1992], increasing software product downloads [Duan et al. 2009] and information system adoption [Sun 2013]. Herding exhibits two types of actions: imitating others' behavior and discounting own information [Sun 2013]. When imitating others, a person observes others' behavior or actions and makes the same decision by following the majority. When discounting one's own information, an individual is less responsive to his/her own information and favors a predecessor's action, believing that the predecessor is better informed. In the context of mobile social apps, some users are uncertain about which mobile social app to adopt. We argue that, by imitating others' adoption decisions and discounting own information, those uncertain users will be more satisfied with their adoption decisions as well as their experience with the product.

3. Research Model and Hypotheses

In this study, we consider both network externalities and herding in the research model in order to understand the effect of social influence on user satisfaction with mobile social apps. In this section, we present our research model (Figure 1) and hypotheses that explain how the two factors influence user satisfaction.
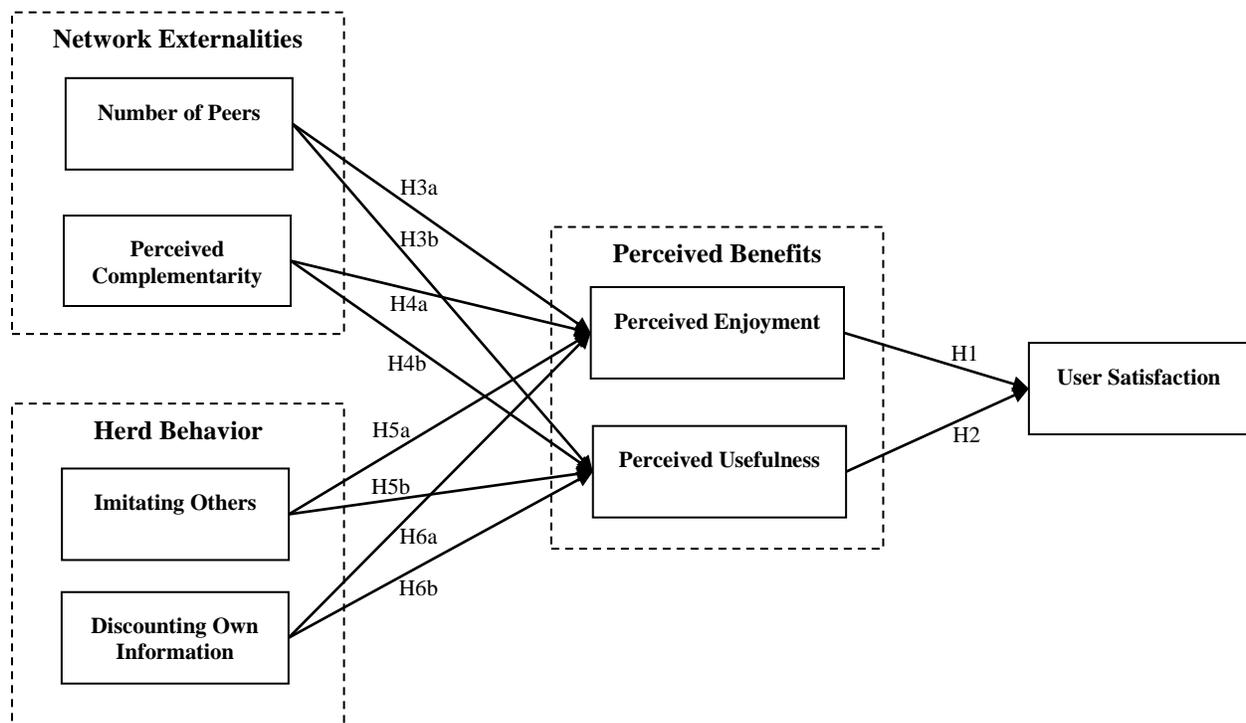

Figure 1: Research Model

3.1.   The Effect of Perceived Benefits on User Satisfaction

Customers are rarely motivated by the features of a service or product, but by the perceived benefits those features bring to them [Liang & Wang 2004]. Kim et al. [2007] argue that perceived benefits affect an individual's use of information technology, therefore it is important to investigate the influence of perceived benefits on consumers. Perceived benefits refer not only to the economic value [Brynjolfsson & Kemerer 1996], but also to one's affective and cognitive belief toward a product or service [Lin & Bhattacherjee 2008; Van Slyke et al. 2007].

Park et al. [2011] use utilitarian and hedonic values to measure perceived benefits. More specially, utilitarian value is measured by goal-directed performance such as perceived usefulness while hedonic value is measured by pleasantness such as perceived enjoyment. Consistent with existing literature, we argue that the perceived enjoyment and perceived usefulness can affect user satisfaction toward mobile social apps.

(1) The Effect of Perceived Enjoyment on User Satisfaction

Moon and Kim [2001] define perceived enjoyment as "the pleasure individuals perceive objectively when committing a particular behavior or carrying out a particular activity". Prior research has shown that perceived enjoyment has positive influence on user satisfaction in various research contexts. Kamis et al. [2010] find the positive relationship between enjoyment and satisfaction in the context of electronic commerce. Zhou and Lu [2011] confirm the positive relationship between perceived enjoyment and user satisfaction in the context of mobile instant messaging service. Maier et al. [2013] also find that perceived enjoyment positively influences user satisfaction among Facebook users. In the context of mobile apps, studies have shown that the fun and entertainment effects of mobile applications can raise user satisfaction [Hsiao et al. 2016] and thus increase their intention to purchase [Hsu and Lin 2015]. In line with these arguments, we propose the following hypothesis:

H1: Perceived enjoyment is positively associated with user satisfaction with mobile social apps.

(2) The Effect of Perceived Usefulness on User Satisfaction

Perceived usefulness, which is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" [Davis 1989], is a major component in the well-known Technology Acceptance Model (TAM). According to the Expectation Confirmation Theory (ECT) [Oliver 1980], perceived usefulness, regarded as post-adoption expectation, has significantly positive influence on user satisfaction [Bhattacherjee 2001]. Extant research has confirmed the significant influence of perceived usefulness on user satisfaction in the context of mobile instant messaging applications [Zhou & Lu 2011], social networking services [Maier et al. 2013], and social media (e.g., LINE) [Zhao et al. 2016]. In those studies, perceived usefulness reflects the improvement of users' living and working efficiency after using the app or service [Zhou & Lu 2011]. Mobile social apps integrate the functions of mobile instant messaging, social networking, and social media into a single product. Therefore, we expect perceive usefulness to positively influence user satisfaction with mobile social apps. We put forward the following hypothesis:

H2: Perceived usefulness is positively associated with user satisfaction with mobile social apps.

3.2.   The Effect of Network Externalities on Perceived Benefits

Both direct and indirect network externalities may have effects on perceived benefits. We, therefore, discuss their effects separately in this section.

(1) Direct Network Externalities: Referent Network Size

Mobile social apps are designed for the purpose of letting the acquainted keep in touch and share information at anytime from anywhere [Pfeil et al. 2009; Powell 2009; Tapscott 2008]. Most users normally do not aim to make new friends on mobile social apps. Instead, they bring their real-life social networks online in order to make more frequent contacts [Boyd & Ellison 2007]. Thus, when we consider direct network externalities, we are concerned with each individual's referent network rather than the entire social network that has all users on the same mobile social app. A referent network consists of people in a user's immediate social circle who has adopted the same mobile social app [Lin & Bhattacherjee 2008]. The perceived number of peers can be used to assess the referent network size [Lou et al. 2000], which reflects the perceived value of direct network externalities. When a referent network is large, the increased social interactions and sharing among its members create a greater sense of usefulness and pleasure [Powell 2009; Tapscott 2008]. In contrast, when a user's referent network is small, the user may perceive low utility and enjoyment before finally giving up on using the mobile social app. Previous research has evidenced the positive relationship between number of peers and perceived enjoyment and usefulness in the context of social networking sites [Lin & Lu 2011]. Zhou and Lu [2011] also find a positive association between the referent network size and the perceived usefulness of mobile instant messaging apps. Consequently, we hypothesize that:

H3a: Number of peers in a user's referent network is positively associated with the user's perceived enjoyment with a mobile social app.

H3b: Number of peers in a user's referent network is positively associated with the user's perceived usefulness with a mobile social app.

(2) Indirect Network Externalities: Perceived Complementarity

Perceived complementarity represents indirect network externalities [Lin & Bhattacherjee 2008]. When the user base of a product or service expands, users can achieve higher perceived complementarity because they can acquire many complementary functions and services [Strader et al. 2007] and create additional benefits and more demand [Lin & Bhattacherjee 2008]. In a mobile social app, complementary functionalities, such as social games,

photo and video sharing, and friend searching, can help users present themselves and interact with their friends, giving users more pleasure [Powell 2009; Tapscott 2008]. Existing research has confirmed the positive influence of perceived complementarity on users' perceived enjoyment [Lin & Lu 2011; Zhou & Lu 2011]. Those applications and services help increase the actual availability of complementary products perceived by users and further enhance users' perceived usefulness [Lin & Lu 2011]. Zhou and Lu [2011] confirm that perceived complementarity affects perceived usefulness in the context of mobile instant messaging. In line with extant research, we hypothesize that:

H4a: *Perceived complementarity is positively associated with perceived enjoyment of a mobile social app.*

H4b: *Perceived complementarity is positively associated with perceived usefulness of a mobile social app.*

3.3.   The Effect of Herd Behavior on Perceived Benefits

In this study, we define herd behavior as the extent to which a user is influenced by others who use the same mobile social app. Following Sun [2013], we consider both the action of imitating others and that of discounting own information as herd behavior. Imitating others means that an individual follows others' decisions or behavior, while discounting his or her own information or beliefs in decision making. According to the Stimulus-Organism-Response (S-O-R) framework, environmental or situational stimuli affect internal organism (e.g., cognition and emotion) [Mehrabian and Russell, 1974]. Stimuli may manifest in different representations. In our research context, a user's perceived enjoyment and usefulness (i.e., emotional organism) can be affected by other users' perception (e.g., mood-related cues) toward a mobile social app. Parboteeah et al. [2009] use the S-O-R framework to show that both task-related and mood-related cues (stimuli) have significantly positive effects on organism such as perceived usefulness and perceived enjoyment. Similarly, Floh & Madlberger [2013] find that atmospheric cues in e-stores are positively related to consumers' shopping enjoyment. Many have witnessed and participated in technology adoption decisions where adopters are strongly influenced by the herd behavior of previous adopters [Duan et al. 2009; Walden & Browne 2009] because herding can overcome uncertainty and save the cost of information search [Darban & Amirkhiz 2015]. Uncertainty and easy access to predecessors' decisions are the reasons why individuals are prone to be influenced by others and to discount own information [Sun 2013]. Therefore, it is reasonable to argue that herd behavior has a positive impact on perceived benefits. We put forward the following hypotheses:

H5a: *Imitating others is positively associated with perceived enjoyment with a mobile social app.*

H5b: *Imitating others is positively associated with perceived usefulness with a mobile social app.*

H6a: *Discounting own information is positively associated with perceived enjoyment with a mobile social app.*

H6b: *Discounting own information is positively associated with perceived usefulness with a mobile social app.*

4.   Research Methodology

4.1.   Operationalization

We tested our research model using one of the popular mobile social apps, WeChat. As of December 2015, WeChat has over a billion created accounts and about 700 million active users globally [eMarketer 2016]. We chose WeChat over more popular mobile social network platforms such as Facebook for the following reasons. First, most WeChat users access the social networking service through the mobile app rather than the web or client application because the web/client interface provides very limited functionalities. Facebook, on the other hand, only has 50% of its users access its service through the mobile app [3]. With WeChat, we can avoid the interference of user satisfaction with the web application. Second, WeChat's mobile app is arguably one of the best mobile social apps [4]. It has far more features than the Facebook app, integrating functions such as instant messaging, moment sharing, payment and money transfer, gaming, shopping, city services, and third-party services. WeChat users have more interactions than users of traditional mobile social network platforms. Therefore, we expect that the effects of network externalities and herding on user satisfaction are stronger with the WeChat mobile app than the Facebook app.

We used a survey as our primary research methodology for this study. We adopted multi-item scales to measure the constructs in our research model. All items were adapted from prior literature with minor modifications in order to fit our research context. As the survey was conducted in China, we used back-translation to ensure translation validity. In order to enhance the validity of the measurement items, we conducted a pilot study in which thirty questionnaires were distributed before the formal survey. After making some revisions on the wording based on the comments and suggestions received from the pilot survey, the questionnaire items and their sources are shown in Table 1. All items were measured using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

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[3] http://venturebeat.com/2015/07/29/nearly-half-of-facebooks-users-only-access-the-service-on-mobile/

[4] http://www.pdfdevices.com/wechat-the-best-android-and-windows-phone-messaging-app-vs-whatsapp/

Table 1: Constructs and Measurement Items

Construct (Abb.)	Measurement Item	Reference
Perceived Usefulness(USE)	USE1: Using WeChat enables me to acquire more information or know more people. USE2: Using WeChat improves my efficiency in sharing information and connecting with others. USE3: WeChat is a useful service for interaction between members.	Davis [1989], Kwon and Wen [2010]
Number of Peers (NP)	NP1: I think many friends around me use WeChat. NP2: I think most of my friends are using WeChat. NP3: I anticipate many friends will use WeChat in the future.	Lou et al. [2000]
Perceived Complementarity (PC)	PC1: A wide range of applications is available on WeChat. PC2: A wide range of supporting tools is available on WeChat (e.g., photo sharing, message sharing, video sharing). PC3: A wide range of social activities on WeChat can be joined (e.g., fan pages). PC4: A wide range of friend-finding tools is available on WeChat.	Lin and Bhattacherjee [2008]
Imitating Others (IMI)	IMI1: It seems that WeChat is the dominant mobile social app; therefore, I would like to use it as well. IMI2: I follow others in accepting WeChat. IMI3: I would choose to accept WeChat because many other people are already using it.	Sun [2013]
Discounting Own Information(DOI)	DOI1: My acceptance of WeChat would not reflect my own preferences for mobile social apps. DOI2: If I were to use WeChat as a mobile social app, I wouldn't be making the decision based on my own research and information. DOI3: If I did not know that a lot of people have already accepted WeChat, I might choose another mobile social app.	Sun [2013]
Perceived Enjoyment (ENJ)	ENJ1: Using WeChat provides me with a lot of enjoyment. ENJ2: I have fun using WeChat.	Agarwal and Karahanna [2000], Kim et al. [2007]
User Satisfaction (SAT)	SAT1: I feel satisfied with using WeChat. SAT2: I feel contented with using WeChat. SAT3: I feel pleased with using WeChat.	Bhattacherjee [2001]

4.2.   Data Collection

    We distributed questionnaires to students in two Chinese public universities (i.e., Xiamen University and Qilu Normal University) located in two different Chinese provinces in August, 2014. The questionnaires were distributed to those who had prior experience of using WeChat. The respondents were told that the questionnaire was used for academic research and their anonymity would be assured. Using college students as research subjects might limit the generalizability of our results. However, we believe that this should not be a major concern because students represent the largest user group (24.9%) of mobile internet [CNNIC 2014]. Mobile social apps as an emerging service are popular among young individuals, especially college students.

    We distributed 247 questionnaires and received 225 valid responses, which corresponds to a valid response rate of 91.1%. Table 2 summarizes the demographic statistics of the final sample. There are slightly more female respondents (56.9%) than male respondents. The majority of the respondents age between 18 and 24 years old (58.7%). Furthermore, most respondents start to use WeChat in 2013. Most of them have experiences of using other mobile social apps. 80% of the respondents either frequently (i.e., using the app any time anywhere and the app always stays logged in) or often (i.e., using the app at least once a day) use the app. "Sometimes use" is defined as using the app at least once a week, while "seldom use" is defined as using the app less than once a week.

Table 2: The Demographics of Respondents (N=225)

Profiles	Options	Frequency	Percentage
Gender	Male	97	43.1
	Female	128	56.9
Age	18 or Younger	2	0.9
	18-24	132	58.7
	25-30	71	31.5
	31 or older	20	8.9
Year started to use WeChat	2011	31	13.8
	2012	73	32.4
	2013	94	41.8
	2014	27	12
Frequency of using WeChat	Frequently Use	71	31.5
	Often Use	108	48
	Sometimes Use	35	15.6
	Seldom Use	11	4.9
Experience of using another mobile social app	Yes	121	53.8
	No	101	44.9
	Incomplete	3	1.3

5. Data Analysis

Structural Equation Model (SEM) has become a quasi-standard in marketing and management research when analyzing the cause-effect relations between latent variables [Hair et al. 2011]. We chose to use the Partial Least Squares Structural Equation Model (PLS-SEM) rather than the Covariance-based Structural Equation Model (CB-SEM) to analyze the relationships defined in our research model because PLS-SEM has less stringent requirements on the distributions of variables and error terms with a relatively small sample size [Chin et al. 2003]. We applied Kolmogorov-Smirnov's test to our data set and found that none of the variables is normally distributed (P<0.001). Therefore, it is appropriate to use PLS-SEM because it is robust when dealing with non-normal data. The sample size (225) is relatively small in order to satisfy the research sample size requirement for SB-SEM. It is suggested that the sample size should be 10 to 20 times the number of parameters to be estimated (a factor loading for each of the 21 measured items and corresponding error variances) in CB-SEM [Jackson 2003]. In addition, our research model is considered as a complex model with 7 constructs and 21 items. PLS-SEM is recommended to deal with complex models [Hair et al. 2011]. Therefore, we adopted the two-step analytical procedure with PLS-SEM [Hair et al. 2006] to test our research model: the first step is to analyze the measurement model while the second step is to test the structural model.

5.1. Validity and Reliability

We tested the item reliability, convergent validity, and discriminant validity of our operationalized measures [Chin 1998]. A general criterion for item reliability is that all item loadings are above 0.6 or, ideally, 0.7 [Chin 1998; Barclay et al. 1995]. The measurement items in this study loaded heavily on their respective constructs (as shown in Table 3), with all loadings above 0.7, thus demonstrating adequate item reliability.

Table 3: Loadings and Cross-loadings of Measures

Items	DOI	ENJ	IMI	NP	PC	SAT	USE
DOI1	**0.848**	0.307	0.211	0.292	0.133	0.354	0.326
DOI2	**0.802**	0.219	0.271	0.184	0.185	0.231	0.244
DOI3	**0.743**	0.185	0.247	0.186	0.136	0.239	0.145
ENJ1	0.280	**0.944**	0.166	0.378	0.361	0.661	0.626
ENJ2	0.304	**0.944**	0.199	0.388	0.439	0.615	0.617
IMI1	0.039	0.100	**0.737**	0.151	0.300	0.217	0.205
IMI2	0.359	0.230	**0.883**	0.362	0.261	0.321	0.346
IMI3	0.214	0.055	**0.728**	0.293	0.246	0.172	0.168
NP1	0.198	0.352	0.250	**0.856**	0.295	0.397	0.455
NP2	0.254	0.339	0.351	**0.814**	0.326	0.385	0.368
NP3	0.250	0.286	0.267	**0.743**	0.385	0.364	0.356
PC1	0.061	0.256	0.252	0.325	**0.721**	0.247	0.293
PC2	0.130	0.298	0.187	0.351	**0.746**	0.288	0.277
PC3	0.170	0.391	0.286	0.279	**0.815**	0.262	0.298
PC4	0.192	0.306	0.269	0.284	**0.701**	0.244	0.196
SAT1	0.267	0.538	0.271	0.457	0.389	**0.809**	0.534
SAT2	0.295	0.584	0.184	0.299	0.285	**0.829**	0.499
SAT3	0.320	0.561	0.340	0.422	0.200	**0.850**	0.619
USE1	0.215	0.502	0.206	0.296	0.369	0.487	**0.764**
USE2	0.222	0.448	0.251	0.401	0.257	0.520	**0.847**
USE3	0.328	0.645	0.342	0.487	0.269	0.615	**0.842**

Notes: NP= Number of Peers, PC= Perceived Complementarity, IMI= Imitating Others, DOI= Discounting Own Information, ENJ= Perceived Enjoyment, USE= Perceived Usefulness, SAT=User Satisfaction

Convergent validity measures the degree to which the items of a given construct are measuring the same underlying latent variable [Kim et al. 2004]. We assessed convergent validity based on three criteria. First, standardized path loadings must be greater than 0.7 and statistically significant [Gefen 2000]. Second, composite reliability and Cronbach's alphas must be greater than 0.7 [Nunally & Bernstein 1978]. Third, the average variance extracted (AVE) for each factor must exceed 0.5 [Fornell & Larcker 1981]. Data shown in Table 4 satisfy all the requirements. Hence, convergent validity is established.

Table 4: Results of Convergent Validity and Reliability Tests

Construct	Item	Loading	t-statistic	Composite reliability	AVE	Cronbach's alpha
DOI	DOI1	0.848	17.770	0.841	0.638	0.730
	DOI2	0.802	12.124			
	DOI3	0.743	10.184			
ENJ	ENJ1	0.944	90.658	0.943	0.891	0.878
	ENJ2	0.944	95.148			
IMI	IMI1	0.737	7.117	0.828	0.618	0.720
	IMI2	0.883	14.848			
	IMI3	0.728	6.553			
NP	NP1	0.856	30.841	0.847	0.649	0.729
	NP2	0.814	22.479			
	NP3	0.743	13.762			
PC	PC1	0.721	14.321	0.834	0.558	0.736
	PC2	0.746	12.597			
	PC3	0.815	26.911			
	PC4	0.701	10.490			
SAT	SAT1	0.801	19.335	0.869	0.688	0.773
	SAT2	0.829	32.878			
	SAT3	0.850	31.470			
USE	USE1	0.746	16.498	0.859	0.670	0.755
	USE2	0.847	29.529			
	USE3	0.842	36.583			

Discriminant validity is the degree to which the measures of two constructs are empirically distinct [Kim et al. 2004]. It is established if the square root of a construct's AVE is larger than its correlation with any other constructs [Nunally & Bernstein 1978]. Table 5 shows that the square root of AVE for each construct exceeds the correlation between that construct and other constructs. Thus, discriminant validity is established.

Table 5: Discriminant Validity Test

No.	Constructs	Mean(Std.Dev)	1	2	3	4	5	6	7	VIF
1	SAT	3.816(0.599)	0.830 [a]							
2	ENJ	3.622(0.764)	0.676**	0.944						1.914
3	DOI	3.375(0.750)	0.344**	0.296**	0.799					1.176
4	IMI	3.404(0.771)	0.287**	0.158*	0.257**	0.786				1.265
5	PC	3.724(0.607)	0.344**	0.420**	0.186**	0.339**	0.747			1.416
6	NP	3.973(0.600)	0.465**	0.404**	0.282**	0.338**	0.422**	0.806		1.495
7	USE	3.824(0.660)	0.652**	0.643**	0.285**	0.289**	0.363**	0.471**	0.819	1.939

Notes: [a] Diagonal elements represent the square root of AVE for that construct; *: $p<0.05$, **: $p<0.01$.

We also tested multi-collinearity among all constructs using the variance inflation factor (VIF). As shown in Table 5, the VIFs of all constructs range from 1.176 to 1.939, far below the suggested threshold value 5 [Hair et al. 2006]. Therefore, multi-collinearity is not a threat to our study.

5.2.   The Structural Model

The relationships between the variables proposed in the research model were examined by formulating the structural model using SmartPLS 3.0.

Table 6 presents our hypotheses testing results. All hypotheses are supported, with the exception of H4b and H5a. Indicated by the R^2 value, the combination of variables for network externalities and herd behavior (except for imitating others) explained 27.9% of the variance in perceived enjoyment. Similarly, those variables (except for perceived complementarity) explained 31.1% of the variance in perceived usefulness. In addition, perceived enjoyment and perceived usefulness combined explained 54.3% of the variance in user satisfaction with WeChat. Figure 2 shows the standardized path coefficients as well as their respective significance levels and variance explained.

Table 6: Hypotheses Testing Results

Hypothesis	Relationships	Beta	t-Statistic	Results
H1	ENJ—>SAT	0.419	7.18	Supported
H2	USE—>SAT	0.390	5.86	Supported
H3a	NP—>ENJ	0.243	2.65	Supported
H3b	NP—>USE	0.344	4.16	Supported
H4a	PC—>ENJ	0.304	3.54	Supported
H4b	PC—>USE	0.151	1.95	Not supported
H5a	IMI—>ENJ	-0.053	0.80	Not supported
H5b	IMI—>USE	0.113	1.96	Supported
H6a	DOI—>ENJ	0.199	3.25	Supported
H6b	DOI—>USE	0.158	2.98	Supported

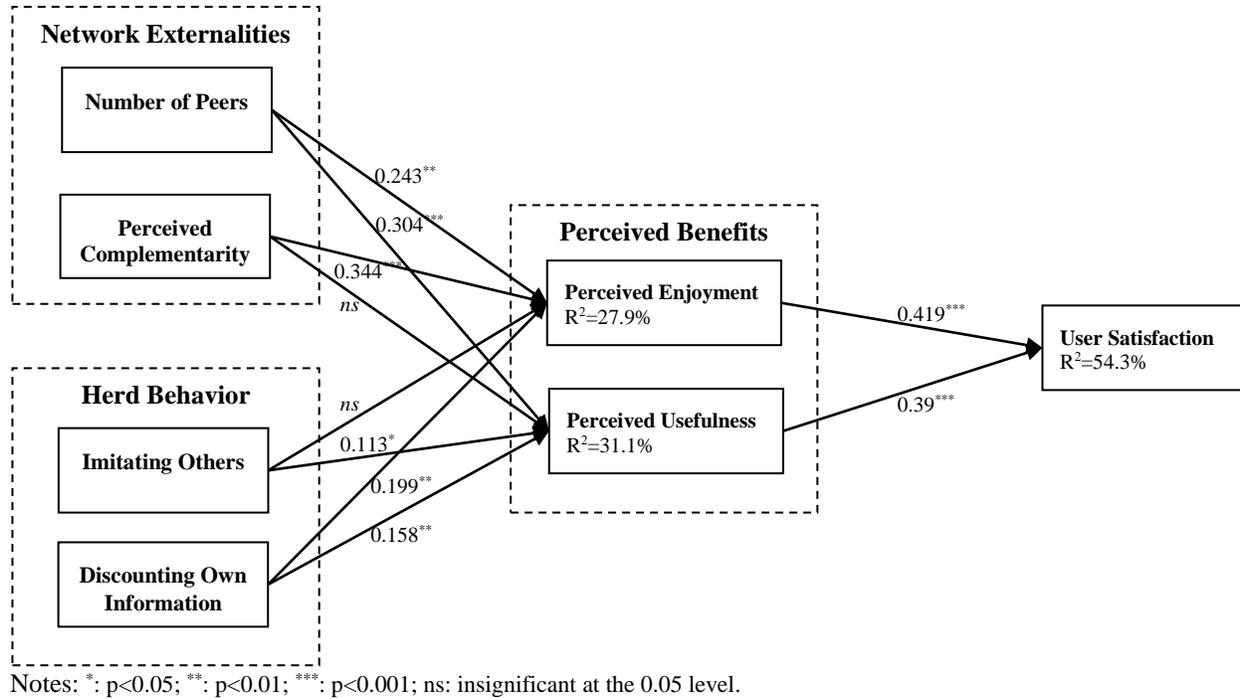Notes: *: p<0.05; **: p<0.01; ***: p<0.001; ns: insignificant at the 0.05 level.

Figure 2: The Structural Model Testing Results

We also tested the mediation effect of perceived benefits using the bootstrapping method [Preacher & Hayes 2008; Hayes 2013]. The results are shown in Table 7. We find that the indirect effects of IVs (i.e., independent variables) on user satisfaction are consistent, indicating the mediating role of perceived benefits on the relationship between network externalities or herd behavior and user satisfaction.

Table 7: Mediating Testing of Perceived benefits

IV	M	DV	Indirect effect of IV on DV	Bootstrap SE	Bootstrap confidence interval	Mediating Effect
NP	ENJ	SAT	0.236	0.050	[0.141, 0.337]	**Significant**
PC	ENJ	SAT	0.268	0.061	[0.158, 0.398]	**Significant**
IMI	ENJ	SAT	0.080	0.042	[0.069, 0.218]	**Significant**
DOI	ENJ	SAT	0.149	0.041	[0.076, 0.241]	**Significant**
NP	USE	SAT	0.262	0.056	[0.157, 0.380]	**Significant**
PC	USE	SAT	0.217	0.062	[0.108, 0.352]	**Significant**
IMI	USE	SAT	0.139	0.046	[0.063, 0.247]	**Significant**
DOI	USE	SAT	0.137	0.044	[0.063, 0.236]	**Significant**

Notes: IV: Independent Variable, M: Mediating Variable, DV: Dependent Variable; Indirect effects are significant if bootstrap confidence intervals do not include zero, insignificant otherwise; Bootstrap number is 5000; Confidence level is 95%.

6. Conclusions and Discussions

Existing research focuses on user satisfaction with either social networking services or mobile apps. Perceived benefits, such as perceived usefulness and perceived enjoyment, are important antecedents of user satisfaction with mobile apps in general. Mobile social apps are different from general mobile apps in the sense that the intensive social connections and influence among users may affect user satisfaction with the product. Very few studies have examined the factors influencing user satisfaction with mobile social apps. In this study, we built an integral research model on user satisfaction with mobile social apps by drawing on the theories of network externalities and herd behavior. By conducting a survey with the users of a popular mobile social app, WeChat, our empirical study shows that network externalities and herding constructs have significant influence over users' perceived benefits toward the mobile social app. Specifically, number of peers, perceived complementarity, discounting own information are positively associated with users' perceived enjoyment. Number of peers, imitating others, and discounting own information have significantly positive effects on perceived usefulness. Consistent with previous studies, perceived benefits, namely perceived enjoyment and perceive usefulness, are found to have a significantly

positive relationship with user satisfaction. We also discovered significant mediating effects of perceived benefits in all of the relationships between network externalities or herding constructs and user satisfaction.

6.1.   Theoretical and Practical Contributions

This study has both theoretical and practical implications for mobile social apps in terms of building users' satisfaction. From a theoretical perspective, this study enhances current understanding of user satisfaction by focusing on the peer influence among mobile social app users. More specifically, this study shows how network externalities (i.e., referent network size and perceived complementarity) and herd behavior (i.e., imitating others and discounting own information) enhance mobile social app users' perceived benefits (i.e., perceived enjoyment and perceived usefulness), which further influence their satisfaction. Our findings not only provide empirical evidence on the effect of social influence on user satisfaction with mobile social apps, but also explain how it affects user satisfaction. From a practical perspective, this research helps mobile social app practitioners retain users and gain competitive advantages against competing social apps. Our research results show that both network externalities and herd behavior are important for improving user satisfaction. Developers should focus on expanding existing users' friend circles in order to increase direct network externalities. Indirect network externalities can be improved by bringing more complementary products and services to the mobile social app. Moreover, it is a good strategy for mobile social app providers to encourage imitating behavior among users because it can increase user satisfaction.

6.2.   Limitations and Future Directions

This study has several inherent limitations due to the sampling methods and measurements used. First, a convenience sampling method was used to select the sample. The subjects used in the survey were drawn from college students. There is no evidence that the sample is representative of the whole population of WeChat users. Future studies should investigate and compare different samples to increase external validity. Second, our sample size is limited. In order to gain better external validity of our findings, further research can validate the model by using a larger sample as well as diversifying respondents. Third, the findings may not be generalized to all mobile social apps without further testing. This survey was conducted with Chinese mobile social app users. Cultural differences between countries may affect the external validity of our research.

Several future directions can be pursued following this study. First, we can replicate this study among mobile social apps in different countries to examine whether the social influence antecedents affecting the perceived benefits and user satisfaction differently. Second, the study can be extended to other contexts involving social interactions such as crowdsourcing, crowdfunding, and online question and answering forums. Lastly, it is interesting to explore the determinants of herding behavior. Mobile social app practitioners can therefore take strategic initiative to encourage herding behavior and further increase user satisfaction.

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