중국 모바일 인스턴트 메시징 서비스의 지속사용 의도에 관한 실증연구

An Empirical Study on User's Continuance Intention Towards Mobile IM Service in China

라 위 의 (Weiyi Luo)　　　　동국대학교 일반대학원 국제비즈니스협동과정 박사과정, 제1저자
소　　정 (Jing Shao)　　　　동국대학교 일반대학원 국제비즈니스협동과정 박사과정, 공동저자
이 영 찬 (Young-Chan Lee)　동국대학교 경주캠퍼스 경영학부 부교수, 교신저자

─── 요　약 ───

　최근 카카오톡, 라인, 위챗 등과 같은 모바일 인스턴트 메시징(IM) 서비스는 낮은 전환비용으로 인해 치열한 경쟁을 펼치고 있다. 따라서 서비스 업체 입장에서는 모바일 IM 서비스 이용자의 지속적인 사용의도에 영향을 미치는 요인들을 파악하는 것이 무엇보다도 중요하다고 할 수 있다. 이를 위해 본 연구에서는 네트워크 효과(network externalities)와 인지된 서비스 품질을 모바일 IM 서비스의 지속적인 사용의도의 외생변수로 고려하였다. 여기서 네트워크 효과는 직접 효과(네트워크 크기)와 간접 효과(보완적 서비스)를 모두 포함한다. 중국 모바일 서비스 사용자를 대상으로 실증분석을 수행한 결과 '네트워크 크기'는 '인지된 유용성'에, '보완적 서비스'는 '인지된 즐거움'에 유의한 영향을 미치는 것으로 나타났다. 또한 '인지된 서비스 품질'은 예상대로 '고객만족' 뿐만 아니라 '인지된 유용성'과 '인지된 즐거움' 모두에 유의한 영향을 미치는 것으로 나타났다. 한편, 인지된 유용성 및 인지된 즐거움은 '고객만족'을 통한 간접적인 영향 이외에도 '지속적인 사용의도'에 직접적으로도 유의미한 영향을 미치는 것으로 나타났다.

키워드 : 스마트폰, 모바일 인스턴트 메시징 서비스, 인지된 서비스 품질, 인지된 보완적 서비스, 네트워크 크기, 인지된 유용성, 인지된 즐거움, 고객만족, 지속적인 사용의도

Ⅰ. Introduction

The application of third generation of mobile communication technologies has triggered the rapid development of mobile commerce. Based on CNNIC (China Internet Network Information Center)'s report in 2012, the number of mobile Internet users in China has reached 388 million which account for 72% of the whole Internet population (538 million) in China. As the rapid development of mobile commerce and huge user base in China, variety of mobile value-added services have been provided by mobile service providers, such as mobile payment service, mobile online game service and mobile instant messaging service. Among these services, mobile instant messaging service (mobile IM service) is the

most popular service in China which has been used by 82.8% of mobile Internet users in China. There are lots of mobile IM products have been provided in China market, such as Weixin, mobile QQ, Line, Kakao Talk. Even all of these IM products provide some similar functions, such as text chat, voice message and facial emotion icons; but there still exist some unique functions for each mobile IM product. For instance, Weixin integrated the video chatting function and LBS (location based service) function which allows their users to make more friends based on their present location into their product; Line integrated the free call function which allows their users to make free call to each other into their product; mobile QQ integrated SNS platform which is called as Weibo into their product to enhance customer's usage experience into their product and Kakao Talk integrated mobile game service and gift shop service into their product. The only reason for these mobile IM service providers to differentiate their products is to increase the switching cost when users switch from a mobile IM platform to another. Under the intense competition environment, identifying the factors which will affect customer's continuance intention towards using mobile IM product is very important for the mobile IM service providers to keep their market share.

There are lots of previous studies have proved that network externalities can significantly affect user's adoption of communication technologies (Strader *et al.*, 2007; Wang *et al.*, 2004; Lu *et al.*, 2010). Based on their findings, a user can communicate with more peers when the number of mobile IM users increases. Meanwhile with the wide adoption of mobile IM service, users have the access to more abundant value-added services which have been integrated into their original service. Thus network externalities can be also considered as a significant de-

terminant to affect user's continuance intention towards mobile IM service. On the other hand, as lots of previous studies have mentioned that service quality can be considered as a critical determinant on user's behavior in the field of mobile services (Chae *et al.*, 2002; Kuo *et al.*, 2009), we also decided to adopt perceived service quality in this study. So in this study, network externalities has been used to represent the differences between customer's expectation and their perceived performance in the perspective of mobile IM service's network size; perceived service quality has been used to represent the differences between customer's expectation and their perceived performance in the perspective of mobile IM service's fundamental characteristics.

The purpose of this study is to theoretically propose and empirically validate a research model to identify the effects of both network externalities and perceived service quality on customer's continuance intention towards mobile IM service. We involve perceived usefulness, perceived enjoyment and satisfaction as mediators based on the previous studies of motivation theory and expectation-confirmation model.

Ⅱ. Literature Review

2.1 Literature Review of Network Externalities

In Katz and Shapiro's study (1985), they defined the network externalities as "the value or effect that users can obtain from a product or service will bring about more values to customers with the increase of users, complementary product, or service." In other words, once the user scale reaches a critical number, external benefits will be creased and emerged in which will attract more users to adopt a specific product or service. Many previous studies (Katz and

Shapiro, 1985; Gupta and Mela, 2008; Lin and Lu, 2011; Zhou and Lu, 2011) have pointed out there exists two categories of network externalities: direct network externalities and indirect network externalities. Based on Katz and Shapiro's study (1985), direct network externalities derive from the increase in users of a particular product or service, where user's benefits increase. For instance, the more users buy and sell products via e-commerce platform, such as C2C, the more probabilities for buyers to choose the products which match their needs most and also the higher the transaction value could be for the sellers. On the other hand, indirect network externalities display an increased sense of user value from using a product or service, as the effect the users obtains from such product or service increases with the increase of related complementary products. For instance, when the number of users who use Android phone reaches a critical mass, it generates relative benefit and provides subsequent users with more correspondents, as well as attracting third-party software developers to make more and more useful software for this mobile platform. In contrast, due to its limited users of Windows phone, the number of valuable software for this mobile platform is also limited. Considering there are lots of previous studies have proved the accuracy of using network externalities to evaluate customer's behavior in the field of social network environment (Lin and Lu, 2011; Zhou and Lu, 2011), so we decided to adopt network externalities as independent variable in this study.

Based on lots of previous studies, there are two kinds of method to measure network externalities. In Lin and Lu's study (2011), they adopted number of members, number of peers and perceived complementarity as sub-dimensions to measure network externalities and found out, compared with the other two sub-dimensions, number of members has relatively weak influence to generate customer's perceived benefit, which in turn generates customer's continuance intention. There are lots of previous studies found out that using two sub-dimensions (referent network size and perceived complementarity) to measure network externalities can obtain more accurate and efficient results (Lin and Bhattacherjee, 2008; Zhou and Lu, 2011). So we decided to adopt two sub-dimensions (referent network size and perceived complementary) to measure network externalities based on Zhou and Lu's study. In this study, referent network size, which represents direct network externalities, refers to the extent to which the number of people in a user's social circle adopts a mobile IM platform as well as perceived complementarity, which represents indirect network externalities, refers to the extent to which complementary functions and additional services, which will bring more additional values to their customers, can be acquired by their users as user base expands.

2.2 Literature of Perceived Service Quality

In Parasuraman *et al.*'s study (1988), they conceived that service quality is the difference between customers' expectation and their perceived performance of a service. Based on this concept, they developed the SERVQUAL model (tangible, responsiveness, reliability, assurance and empathy) to measure service quality. This model has drawn attention from the academic and the practical circles. There are a lot of previous studies that have proved the accuracy of SERVQUAL model to evaluate service quality in the domain of information technology (DeLone and McLean, 2003; Luis *et al.*, 2009). As the importance of SERVQUL, there is no doubt the providers of mobile value-added service also need an efficient

SERVQUL-based measurement to evaluate their service quality in order to assess their service quality and the key drivers for service quality improvements (Turel and Serenko, 2006). As there are lots of previous studies have verified that service quality is a critical factor to impact on customer's adoption of a specific service (DeLone and McLean, 2003; Luis *et al.*, 2009; Ahn *et al.*, 2007; Jang and Noh, 2011), we decided to adopt service quality as independent variable in this study from customer's perception perspective.

The differences of characteristics among each mobile value-added service will result in the modification of measurement suited to a specific service. In the research domain of mobile value- added services, mobile setting has several particularities that influence service quality. There is, at least, a need for proper interpretation of the quality dimensions identified in the context of mobile value-added services. In Kuo *et al.*'s study (2009), they categorized service quality into four dimensions (content quality, navigation and visual design, management and customer service, system reliability and connection quality). According to the results of their study, service quality had been categorized into four new dimensions (content quality, navigation and visual design, customer service and system reliability and connection speed) in the context of mobile value-added service. There is no doubt mobile IM service can be included inside mobile value-added services, so the measurement method verified in Kuo *et al.*'s study also can be adopted in this study. Considering about the fundamental characteristics of mobile IM service, we tried to measure service quality via response speed, system stability and UI design in this study and defined perceived service quality of mobile IM service refers to the extent to which customer's perceive the difference between their expectation and their perceived performance of mobile IM service mainly based on

the fundamental characteristics.

2.3 Literature Review of Motivation Theory and Expectation-Confirmation Model

Previous studies have widely adopted motivation theory to explain individual's behavior of accepting information technology systems. Based on Deci's study (1975), individual's motivation has been divided into extrinsic motivation and intrinsic motivation; extrinsic motivation refers to committing and action because of its perceived helpfulness in achieving value while intrinsic motivation refers to committing an action because of interest in the action itself. In Davis *et al.*'s study (1992), they adopted usefulness and enjoyment represented extrinsic and intrinsic factors respectively and found out both usefulness and enjoyment could affect individual's motivation to use information technology systems. There are lots of previous researches have confirmed the accuracy of using perceived usefulness to represent extrinsic motivation while using perceived enjoyment to represent intrinsic motivation and found that both perceived usefulness and perceived enjoyment could significantly affect individual's intention to use information technology systems (Kim *et al.*, 2007; Lin and Bhattacherjee, 2008). In this study, the definition of perceived usefulness was adopted from Davis's study (1989) and defined as the degree to which a person believes that using mobile IM service would enhance his or her job performance; and the definition of perceived enjoyment was adopted from Moon and Kim's study (2001) and defined as the degree to which a person feels pleasure objectively when using mobile IM service.

Since the early 1970s, much effort has been made in consumer behavior research to investigate con-

sumer's post-purchase behavior processes. Among the research frameworks used in this effort, expectation confirmation theory is popularly used to explain consumer's satisfaction and re-purchase intention in wide domains. Based on expectation-confirmation theory (ECT), Bhattacherjee (2001) developed and empirically tested an expectation-confirmation model (ECM) to evaluate the substantial differences between initial adoption and continuance usage behavior in the context of information technology. According to his study, customer's continuance intention was determined by both perceived usefulness and customer's satisfaction. Moreover, perceived usefulness also had a significantly positive influence on customer's satisfaction in the context of information system. Based on his study, satisfaction refers to the extent to which customers perceive a positive affective state resulting from an overall evaluation of performance based on past usage experience of mobile IM service as well as continuance intention refers to the extent to which consumers will continuously use mobile IM service and deliver their usage experiences to friends and relatives. There are lots of previous studies have proved the feasibility to integrate motivation theory into original ECM. In Lin *et al.*'s study (2005), they integrated

perceived playfulness, which had a similar definition with perceived enjoyment, into original ECM in the context of web portal and found out that, besides confirmation and perceived usefulness, perceived playfulness also had significant influence on satisfaction and customer's continuance intention. In addition, Sun *et al.* (2011) also found out the consistent results compared with Lin *et al.*'s study (2005). Based on these studies, we decided to combine perceived enjoyment into ECM as mediators in this study.

Ⅲ. Research Model and Hypotheses

3.1 Research Model

The approach for our research model is mainly constructed by the effects of network externalities (referent network size and perceived complementary) and perceived service quality on customer's continuance intention towards mobile IM service and perceived usefulness, perceived enjoyment and satisfaction were involved as mediators based on lots of previous studies related to motivation theory and ECM. <Figure 1> presents the research model as follows.
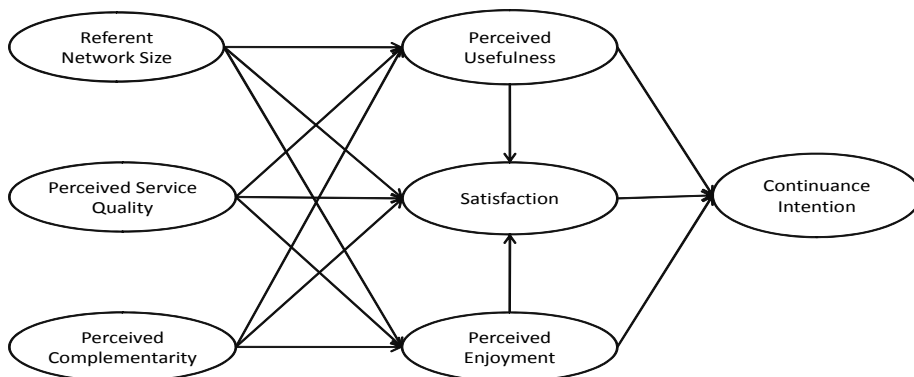
〈Figure 1〉 Research Model

3.2 Research Hypotheses

3.2.1 Network Externalities (Referent Network Size and Perceived Complementarity)

Research has considered that network externalities is an important factor directly affecting customer's behavior of using information technology (Kim and Lee, 2007; Yang and Mai, 2010). Previous studies have suggested, when referent network size is large, users can communicate with more peers in which may improve their perceived usefulness and perceived enjoyment (Lin and Bhattacherjee, 2008; Zhou and Lu, 2011). In contrast, when referent network size is small, users may perceive low utility and give up using a social network service. The effect of perceived complementarity on perceived usefulness and perceived enjoyment has been supported by lots of previous studies (Zhou and Lu, 2011; Lin and Lu, 2011). For instance, as there is a huge user base to use Kakao Talk, which is one of the most popular mobile IM platforms in the world; the users of Kakao Talk can receive more comprehensive services embedded inside, such as games, gift shop and coupons which could bring their users additional value to enhance their usage experience. Meanwhile, these ancillary services will also advance users' satisfaction as they can access various services via a single platform (Zhou and Lu, 2011). So based on these findings, we made the hypotheses as follows:

H1a: Referent network size of mobile IM service positively impact on perceived usefulness.

H1b: Referent network size of mobile IM service positively impact on satisfaction.

H1c: Referent network size of mobile IM service positively impact on perceived enjoyment.

H2a: Perceived complementarity of mobile IM service positively impact on perceived usefulness.

H2b: Perceived complementarity of mobile IM service positively impact on satisfaction.

H2c: Perceived complementarity of mobile IM service positively impact on perceived enjoyment.

3.2.2 Perceived Service Quality

There are lots of previous studies have proved the accuracy of SERVQUAL model to evaluate service quality and found out service quality was one of the most important factors to affect customer's intention in the domain of information technology and online service (DeLone and McLean, 2003; Luis et al., 2009). Based on Ahn et al.'s study (2007), they divided web quality into system quality, information quality and service quality and found out service quality had positive influences on both playfulness and perceived usefulness in the context of online retailing. Furthermore, in Jang and Noh's study (2011), they adopted and integrated IPTV service quality, which was the only independent variable in their research model, into the extension of TAM and found out IPTV service quality also had positive influences on both perceived enjoyment and perceived usefulness. So based on these findings, we made the hypotheses as follows:

H3a: Perceived service quality of mobile IM service positively impact on perceived usefulness.

H3b: Perceived service quality of mobile IM service positively impact on perceived enjoyment.

There are lots of scholars have verified that service quality also had a positive influence on satisfaction in different domains. In Chae et al.'s study (2002), they introduced service quality for mobile

Internet services which included four dimensions and pointed out service quality had a positive influence on user's satisfaction. In order to verify the relationships among perceived value, satisfaction and post-purchase intention in the perspective of technologic characteristics of mobile value-added services, Kuo *et al.* (2009) made a comprehensive dimensions of service quality to evaluate mobile value-added services which included content quality, navigation and visual design, management and customer service and system reliability and connection quality, and found out that service quality also had a positive influence on customer's satisfaction. So based on these findings, we made the hypotheses as follows:

> *H3c: Perceived service quality of mobile IM service positively impact on satisfaction.*

3.2.3 Perceived Enjoyment and ECM

Prior studies pointed out that satisfaction has potential effect to customer behavior intention (Cronin *et al.*, 2000). Furthermore, Based on Bhattacherjee's study (2001), he introduced expectation‐confirmation model and pointed out Satisfaction was the key determinant of IS continuance intention as well as perceived usefulness. According to lots of ECM‐related studies, if customers could perceive more usefulness towards a product/service, they will feel more satisfaction with a product/service by which they will repurchase or have no reason to refuse continued using the product/ service (Hong *et al.*, 2006; Al-Shafi *et al.*, 2009; Stuart and Martin, 2011). In Lin *et al.*'s study (2005), they integrated perceived playfulness into original ECM in the context of web portal and found out that, perceived playfulness also had positive influences on satisfaction and customer's continuance intention. Mean-

while, Sun *et al.* (2011) also found out the consistent results with Lin *et al.*'s study (2005) in the context of online social networks. So based on these studies, we made the hypotheses as follows:

> *H4a: Perceived usefulness towards mobile IM service positively impact on satisfaction.*
> *H4b: Perceived usefulness towards mobile IM service positively impact on customer's continuance intention.*
> *H5a: Perceived enjoyment towards mobile IM service positively impact on satisfaction.*
> *H5b: Perceived enjoyment towards mobile IM service positively impact on customer's continuance intention.*
> *H6: Satisfaction towards mobile IM service positively impact on customer's continuance intention.*

Ⅳ. Research Design

4.1 Data

The population of interest in this study is the individuals who are using mobile instant messaging service. For the convenience of doing survey, we tried to collect data from university students in China. The most important reason for us to do this is most of university students have Smartphone and also are familiar to the usage of mobile instant messaging service. In total, 240 respondents were answered and 17 respondents were discarded due to insincere responses. Finally, 223 respondents were used to analysis for this study. This study used SPSS18.0 for reliability and validity analysis of the data we collected, AMOS18.0 for the structural equation modeling program and hypothesis testing.

4.2 Measurement

In our study, we built a research model included seven constructs which were measured by 22 multiple items with a five-point Likert-type scale ranging from "Strongly disagree" to "Strongly agree." All the items used in this study were developed from suggested and validated measures based on previous studies. And all these items were carefully revised to truly reflect the features of mobile IM service. <Table 1> shows the details of each item with previous studies.

〈Table 1〉 Questionnaire Development

Construct	Questionnaire	Literature
Referent Network Size (RNS)	I think many friends around me use mobile IM service.	Lin and Bhattacherjee (2008) Zhou and Lu (2011)
	I think most of my friends are using mobile IM service.	
	I anticipate more friends will use mobile IM service in the future.	
Perceived Service Quality (PSQ)	Mobile IM service is quickly to respond my needs and requests (such as sending and receiving messages without delay).	Parasuraman *et al.* (2008) Chae *et al.* (2002) Kuo *et al.* (2009)
	I believe Mobile IM service is very stable.	
	I believe Mobile IM service provides me efficient UI design (such as navigation and display).	
Perceived Complementarity (PC)	A wide range of value-added service (such as games) is available on mobile IM service.	Lin and Bhattacherjee (2008) Zhou and Lu (2011) Lin and Lu (2011)
	A wide range of images, skins and emotional icons is available on mobile IM.	
	A wide range of support tools (such as video chat and free call) is available on mobile IM.	
Perceived Usefulness (PU)	Using Mobile IM service can improve my living and working quality.	Zhou and Lu (2011) Lin and Lu (2011)
	Using Mobile IM service can improve my living and working efficiency.	
	Overall, Mobile IM service is useful to my living and working.	
Satisfaction (SN)	Using Mobile IM service makes me feel very satisfied.	Bhattacherjee (2001) Shafi *et al.* (2009) Stuart and Marin (2011)
	Using Mobile IM service makes me feel very pleased.	
	Overall, I am satisfied with Mobile IM service.	
Perceived Enjoyment (PE)	I feel that using Mobile IM service is fun.	Zhou and Lu (2011) Lin and Lu (2011)
	I feel that using Mobile IM service is exciting.	
	I feel that using Mobile IM service is interesting.	
Continuance Intention (CI)	I would recommend anyone to use Mobile IM service.	Bhattacherjee (2001) Shafi *et al.* (2009) Kuo *et al.* (2009)
	I intend to continue to use Mobile IM service in the future.	
	I intend to use Mobile IM service as much as possible.	
	I would encourage those who are important to me to use Mobile IM service.	

Ⅴ. Data Analysis

5.1 Validity and Reliability Analysis of Research Model

In order to identify the validity and reliability of the measurement of research model, we adopted confirmatory factor analysis and reliability test, convergent validity test and discrimination validity test. As shown in <Table 2>, all the values of Cronbach's α for each construct ranged from 0.835 to 0.894 were larger than 0.60, all the squared multiple correlations (SMC) of the measured items ranged from 0.536 to 0.760 were larger than 0.50 and the composite reliability (CR) of all the measured items ranged from 0.813 to 0.876 were higher than the lowest acceptance level of 0.60 indicating that the measurement of research model had a good reliability (Bagozzi and Yi, 1988; Hair *et al.*, 1998). Meanwhile, all the values of completely standardized factor loading ranged from 0.696 to 0.857 reached the significant level compared with the lowest acceptance level of 0.50. Meanwhile, each measured constructs had an average variance extracted (AVE) above 0.50 also indicated that a good convergent validity could be obtained (Fornell and Larcker, 1981).

〈Table 2〉 Confirmatory Factor Analysis and Reliability Test and Convergent Validity Test

Construct	Item	Standardized Item Loading	Cronbach's α	SMC	CR	AVE
Referent Network Size	RNS 1	0.835		0.722		
	RNS 2	0.838	0.839	0.647	0.870	0.690
	RNS 3	0.819		0.549		
Perceived Service Quality	PSQ 1	0.840		0.701		
	PSQ 2	0.857	0.838	0.568	0.876	0.703
	PSQ 3	0.817		0.613		
Perceived complementarity	PC 1	0.809		0.717		
	PC 2	0.839	0.865	0.578	0.869	0.688
	PC 3	0.840		0.760		
Perceived Usefulness	PU 1	0.834		0.703		
	PU 2	0.743	0.842	0.594	0.826	0.614
	PU 3	0.770		0.634		
Satisfaction	SN 1	0.748		0.711		
	SN 2	0.783	0.852	0.628	0.813	0.592
	SN 3	0.776		0.639		
Perceived Enjoyment	PE 1	0.766		0.749		
	PE 2	0.834	0.835	0.536	0.829	0.617
	PE 3	0.755		0.597		
Continuance Intention	CI 1	0.743		0.711		
	CI 2	0.738	0.894	0.621	0.837	0.563
	CI 3	0.818		0.605		
	CI 4	0.696		0.772		

〈Table 3〉 Discrimination Validity Test of Research Model

	RNS	PSQ	PC	PU	SN	PE	CI
RNS	0.831						
PSQ	0.098	0.838					
PC	0.229[**]	0.077	0.829				
PU	0.477[**]	0.341[**]	0.253[**]	0.784			
SN	0.403[**]	0.351[**]	0.438[**]	0.501[**]	0.769		
PE	0.176[**]	0.251[**]	0.520[**]	0.291[**]	0.451[**]	0.785	
CI	0.351[**]	0.384[**]	0.460[**]	0.543[**]	0.591[**]	0.549[**]	0.750

Moreover, in order to test discriminant validity, we checked whether the square root of AVE for each construct exceeded the bivariate correlations between the construct and all other constructs (Fornell and Larcker, 1981). The square roots of AVE are indicated along the principal diagonal of the correlation matrix in <Table 3>. The lowest of these values among all constructs was 0.750 for the omnipresence scale, which was larger than the highest bivariate correlation values between each pair of constructs in this study. So the discrimination validity was also adequate for the measurement of research model (Fornell and Larcker, 1981). Based on these test results of validity and reliability, the measurement of our research model can be accepted.

5.2 Model Fit Analysis of Research Model

<Table 4> showed the results of Goodness Fit Index for measurement model and structural model of this study. From the fit indices, we can know that the research model suggested in this study is appropriate to estimate the relationships among all these constructs, as the results with satisfactory levels including Chi-square/degrees of freedom (X^2/DF), root mean square residual (RMR), goodness-of-fit (GFI), adjusted goodness-of-fit (AGFI), parsimony goodness

of fit (PGFI), normalized fit index (NFI), root mean square error of approximation (RMSEA) and comparative fit index (CFI). Comparison of all fit indices with their corresponding recommended values (Hair *et al.*, 1998), the evidence of a good model fit was revealed.

〈Table 4〉 Measurement Model Fit Analysis of Research Model

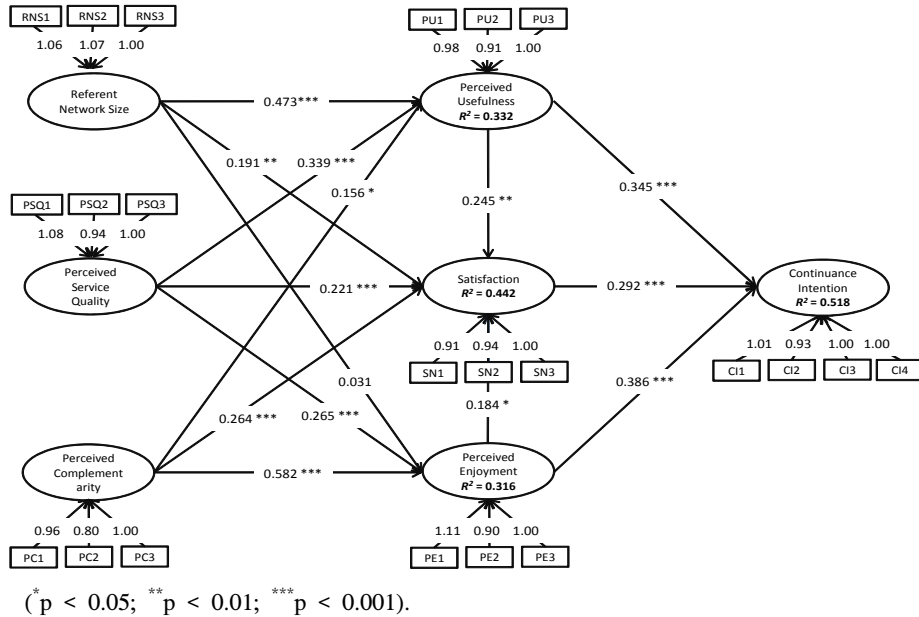| Fit Indices		Measurement Indices	Structural Indices	Recom-mended
Absolute Fit Indices	X^2/DF	1.322	1.333	< 3.000
	GFI	0.924	0.921	> 0.900
	AGFI	0.898	0.896	> 0.800
	NFI	0.928	0.926	> 0.900
	CFI	0.981	0.980	> 0.900
	PGFI	0.687	0.699	> 0.600
	RMR	0.038	0.039	< 0.080
	RMSEA	0.035	0.036	< 0.080

5.3 Hypothesis Test

In order to test the significance of each hypothesis path in this research model, we use SPSS 18.0 to generate structural equation model (SEM) and indicate standardized estimates for all specified paths, as well as significant level for each path. Meanwhile, as R-square is considered as the most powerful indicator for variance explanation, we also indicate the

R-Square of perceived usefulness, perceived enjoyment, satisfaction and continuance intention in this study. The result is shown in <Figure 2>. Except the effect of referent network size on perceived enjoyment, the rest of paths we made in this study are significant. Variances in perceived usefulness, per-ceived enjoyment and satisfaction are 33.2%, 31.6% and 44.2%, respectively. Variance in continuance in-tention is 51.8%.

The results of path coefficient, standard error and test statistics for each path has arranged in <Table 5>.

(*p < 0.05; **p < 0.01; ***p < 0.001).

〈Figure 2〉 Results of the Structural Model Analysis

〈Table 5〉 Results of Hypothesis Test

Hypothesis	Path	Path Coefficient	S.E.	T-Value	Hypothesis Test
H1a	RNS → PU	0.473***	0.072	6.595	Accepted
H1b	RNS → SN	0.191**	0.070	2.646	Accepted
H1c	RNS → PE	0.031	0.061	0.495	Rejected
H2a	PC → PU	0.156*	0.054	2.513	Accepted
H2b	PC → SN	0.264***	0.066	3.358	Accepted
H2c	PC → PE	0.582***	0.061	8.168	Accepted
H3a	PSQ → PU	0.339***	0.070	5.242	Accepted
H3b	PSQ → PE	0.265***	0.067	4.207	Accepted
H3c	PSQ → SN	0.221***	0.072	3.201	Accepted
H4a	PU → SN	0.245**	0.079	2.976	Accepted
H4b	PU → CI	0.345***	0.069	5.296	Accepted
H5a	PE → SN	0.184*	0.080	2.262	Accepted
H5b	PE → CI	0.386***	0.069	6.104	Accepted
H6	SN → CI	0.292***	0.082	3.915	Accepted

(*p < 0.05; **p < 0.01; ***p < 0.001).

Ⅵ. Discussion

(1) Influences of referent network size on perceived usefulness, perceived enjoyment and satisfaction

Referent network size had significantly positive influences on perceived usefulness (γ = 0.473; ***) and satisfaction (γ = 0.191; **), but didn't have a significant influence on perceived enjoyment (γ = 0.031; 0.621), so hypothesis H1a and H1b can be accepted but hypothesis H1c have to be rejected. The hypothesis testing results of H1a, H1b and H1c are consistent with the results of previous studies on mobile IM service (Zhou and Lu, 2011) and SNS (Lin and Lu, 2011). As referent network size reflects the number of people in a user's social circle who are using the same mobile IM service, when referent network size is large, users can communicate with more peers by using this mobile IM service to improve their working and living efficiency and effectiveness which, in turn, will enhance their perceived usefulness and satisfaction towards this mobile IM service. In contrast, when referent network size is small, users may perceive low utility and even give up using this mobile IM service. Notably, referent network size has no significant influence on the generation of perceived enjoyment in this study. As there exist a huge user base of mobile IM service in China (0.3 billion), users' attention are no longer focus on how many friends they can communicate with via this mobile IM service; instead they have turned their attention to how this mobile IM service could deliveries them more comprehensive usage experience. In other words, simple Communication with friends represents a greater extent of user's utilitarian purposes, such as share information, keep relationship with each other, kill time and so on; but users prefer to achieve their hedonic purposes via the abundant entertainment-oriented services embedded into original mobile IM service. Thus the influence from referent network size on perceived enjoyment has been decreased compared with before.

(2) Influences of perceived complementarity on perceived usefulness, perceived enjoyment and satisfaction

Lots of previous studies have confirmed that perceived complementarity had significantly positive influences on perceived usefulness, satisfaction and perceived enjoyment (Wang *et al*., 2004; Strader *et al*., 2007; Lin and Bhattacherjee, 2008; Lu *et al*., 2010; Zhou and Lu, 2011; Lin and Lu, 2011). As we expected, user's perceived usefulness (γ = 0.156; *), satisfaction (γ = 0.264; ***) and perceived enjoyment (γ = 0.582; ***) are significantly influenced by perceived complementarity, so hypotheses H2a, H2b and H2c can be accepted. In this study, perceived complementarity refers to the extent to which complementary functions and additional services, which will bring more additional values to their customers, can be acquired by their users as user base expands. In fact, complementary functions can be considered as the extended functions which will help users to communicate with each other via a more efficient way, such as free call, PTT (push to talk) or video chat functions. Through these complementary functions, user's perceived usefulness and satisfaction towards mobile IM service while be enhanced; on the other hand, as more and more additional services have been integrated into original mobile IM service, particularly entertainment-oriented services, it will be helpful to provide a better usage experience to their users which, in turn, will enhance user's perceived enjoy-

ment and satisfaction towards mobile IM service. Meanwhile, no matter which complementarity that we mentioned above is provided, as more additional values will be perceived by their users, their satisfaction will be enhanced. Notably, compared with providing brand-new and unique complementarity functions, it will be much easier for mobile IM practitioners to integrate existing additional services into their mobile IM services, thus compared with the influence from perceived complementarity to perceived usefulness (γ = 0.156; [*]), the influence from perceived complementarity to perceived enjoyment (γ = 0.582; [***]) is significantly stronger.

(3) Influences of perceived service quality on perceived usefulness, perceived enjoyment and satisfaction

Lots of previous studies have confirmed that perceived service quality had significantly positive influences on satisfaction (Kim *et al.*, 2004; Kuo *et al.*, 2009), perceived usefulness and perceived enjoyment (Ahn *et al.*, 2007) in the context of online services. In this study, as we expected, user's perceived usefulness (γ = 0.339; [***]), satisfaction (γ = 0.221; [***]) and perceived enjoyment (γ = 0.265; [***]) are significantly influenced by perceived service quality, so hypotheses H3a, H3b and H3c can be accepted. In this study, we used perceived service quality to measure the extent of the differences between users' expectation and their perceived performance based on the fundamental characteristics of mobile IM service. There is no doubt the more stable network communication, the faster response speed and the better UI design provided by mobile IM service, the higher their perceived usefulness, perceived enjoyment and satisfaction towards mobile IM service will be. Meanwhile, compared with the

influences from perceived service quality to satisfaction (γ = 0.221; [***]) and perceived enjoyment (γ = 0.265; [***]), as the fundamental characteristics usually can be considered as the basic standard for users to evaluate the utility of a specific service, the influence from perceived service quality to perceived usefulness (γ = 0.339; [***]) is relatively stronger. For instance, as a mobile instant messaging service, if the application always crash or there exists a long delay for users to receive messages, users may think this mobile IM service is useless and then don't want to use it anymore.

(4) Influences of perceived usefulness on satisfaction and continuance intention

Based on lots of previous studies related to expectation-confirmation model, they found out that perceived usefulness had significantly positive influences on both customer's satisfaction and continuance intention (Bhattacherjee, 2001; Kim, 2010; Kim, 2012; Kang *et al.*, 2013). In this study, user's perceived usefulness had significantly positive influences on both satisfaction (γ = 0.245; [**]) and continuance intention (γ = 0.345; [***]), so hypothesis H4a and H4b can be accepted. In other words, the higher the user's perceived usefulness towards mobile IM service, the higher his/ her satisfaction and continuance intention will be. Meanwhile, compared with the influence from perceived usefulness to satisfaction (γ = 0.245; [**]), perceived usefulness (γ = 0.345; [***]) has a relatively stronger influence on user's continuance intention. This shows users are utilitarian; they are always concerned about whether using the mobile IM service can enhance their working and living effectiveness and efficiency. Moreover, for utilitarian-oriented users, if the mobile IM service can fully achieve users' utilitarian purposes,

they may decide to continuous use it without the consideration of other factors.

(5) Influences of perceived enjoyment on satisfaction and continuance intention

As motivation theory mentioned both usefulness and enjoyment could affect customer's motivation to use information technology systems (Davis *et al.*, 1992; Kim *et al.*, 2007; Lin and Bhattacherjee, 2008), lots of previous studies proposed and verified the feasibility to integrate perceived enjoyment to expectation-confirmation model and found out that perceived enjoyment had significantly positive influence on both customer's satisfaction and continuance intention (Lin *et al.*, 2005; Kim, 2010; Kang *et al.*, 2013). The results of this study are consistent with these previous studies, as the influences from perceived enjoyment to user's satisfaction (0.184, [*]) and continuance intention (0.386, [***]) are significant, so hypotheses H5a and H5b can be accepted. In other words, the higher the user's perceived enjoyment towards IM service, the higher his/her satisfaction and continuance intention will be. Meanwhile compared with the influence from perceived enjoyment to satisfaction (0.184, [*]), perceived enjoyment (0.386, [***]) has a significantly stronger influence on user's continuance intention. This shows users are also hedonic; accompanying with their utilitarian purposes, they are also concerned about whether using the mobile IM service can bring them pleasure during the process of interacting with mobile IM service. If the mobile IM service can achieve their hedonic purposes, no matter how they perceive from the utilitarian perspective, they may also decide to continuous use the mobile IM service as there exists an extremely strong influence from perceived enjoyment to user's continuance intention.

(6) Influence of satisfaction on continuance intention

Lots of previous studies have confirmed that satisfaction had a significantly influence on continuance intention (Bhattacherjee, 2001; Kin *et al.*, 2007; Kuo *et al.*, 2009; Kim, 2012; Kang *et al.*, 2013). The results found out in this study are consistent with these studies, as the influence from user's satisfaction to continuance intention (0.292, [***]) is significant, so hypotheses H6 can be accepted. In other words, the higher the user's satisfaction towards mobile IM service, the stronger the user's continuance intention will be.

Ⅶ. Implications

7.1 Implications for Academic Researchers

For academic researchers, this study contributes to a theoretical understanding of the factors which can be used to promote user's continuance intention towards mobile IM service. As the main purpose of adopting utilitarian innovations is to improve productivity to fulfill one's task more efficiently as well as adopting hedonic innovations is to bring them pleasure, when users have multiple purposes towards a behavior such like the continuance use of mobile IM service, considering both intrinsic motivation (i.e., perceived enjoyment) and extrinsic motivation (i.e., perceived usefulness) should be a more efficient way to explain and predict user's behavior. Meanwhile, the accuracy of ECM and the feasibility of integrating perceived enjoyment into original ECM to evaluate user's continuance intention also can be confirmed by this study. Furthermore, based on the analysis results of this study, as both perceived service quality and network externalities,

〈Table 6〉 Standardized Effects on Continuance Intention to Use Mobile IM Service

Construct	Direct Effects	Indirect Effects	Total Effects
Referent Network Size	/	0.266	0.266
Perceived Service Quality	/	0.322	0.322
Perceived Complementarity	/	0.398	0.398
Perceived Usefulness	0.345	0.071	0.417
Satisfaction	0.292	/	0.292
Perceived Enjoyment	0.386	0.054	0.440

including referent network size and perceived complementarity, can affect user's continuance intention through perceived usefulness, satisfaction and perceived enjoyment, thus it is reasonable to suggest both perceived service quality and network externalities can be considered as useful drivers to explain and predict user's continuance intention under the environment of mobile network-based services.

7.2 Implications for Mobile IM Practitioners

As shown in <Table 6>, both perceived usefulness (0.417) and perceived enjoyment (0.440) have significantly strong effects on the generation of user's continuance intention towards mobile IM service. With the help of user's strong appeal for entertainment, how to integrate more attractive or even exclusive entertainment-oriented services into mobile IM service-based platform will be the biggest opportunities for Chinese mobile IM practitioners. Among the characteristics of mobile IM service we adopted in this study, perceived complementarity (0.398) has the strongest indirect effect on the generation of user's continuance intention towards mobile IM service, followed by perceived service quality (0.322) and referent network size (0.266). In terms of network externalities, even it is difficult for mobile IM practitioners to control referent network size, but they can affect perceived complementarity by providing

more complementary functions and additional services to users which, in turn, can affect their perceived enjoyment and perceived usefulness towards mobile IM service. Considering both complementary functions and additional services will enhance user's perceived complementarity towards mobile IM service, besides the integration of entertainment-oriented services, it's necessary for mobile IM practitioners to think about establishing cooperative relationships with Chinese mobile operators to provide more attractive customized services for their common users through the experience enhancement from the perspective of complementary functions. For instance, if mobile operators can provide a better network bandwidth with less cost to support some complementary functions of mobile IM service, such as free call or group video chat, users can perceive more usefulness and enjoyment during the process of communicating with each other and also prefer to use this mobile IM service as much as possible. Meanwhile, perceived service quality also has a strong influence on user's continuance intention through perceived usefulness, satisfaction and perceived enjoyment. Considering the limitations of mobile smart devices and network environment, such as network delay, network instability and relative small screen, mobile IM practitioners need to continuously improve their UI design and deliver more reliable and convenient service to their users.

Ⅷ. Conclusion

This study aimed to find out the factors which affect user's continuance intention towards mobile IM service. Our study has the following contributions. First, based on the analysis results of this study, the integration of motivation theory and expectation-confirmation model can be used to explain and predict user's continuance intention in the context of mobile IM service. Second, based on the definition of mobile IM service, we adopt network externalities (include referent network size and perceived complementary) and perceived service quality to represent the differences between users' expectation and their perceived performance in the perspective of network characteristics and fundamental characteristics, respectively. As we expected, network referent size has a critical influence on perceived usefulness while perceived complementarity has a critical influence on perceived enjoyment. Meanwhile, perceived usefulness, perceived enjoyment and satisfaction can be affected by perceived service quality. Third, besides testing the structural equation modeling of the proposed model, we give insights into the results of hypothesis test, which provides useful information for mobile IM practitioners.

Even though the study succeeds in validating the research model made in this study, but there are still some limitations of our study that we point out the following issues. One of the reasons is that the measurement scale of perceived service quality in mobile IM service is designed according to the related literatures including in the context of mobile Internet services (such as mobile Web portals and mobile Website services) and traditional mobile value-added services (mobile music download service), but the attributes of mobile IM service are still different from these services we mentioned above. This situation in-dicated that the measurement scale of perceived service quality in this study may result in bias. Second, in order to simplify the process of obtaining data, all the data we collected for this study only came from university students which would result in the lack of credibility of this study. Third, we included perceived usefulness, satisfaction and perceived enjoyment as the mediators between network externalities, perceived service quality and user's continuance intention. There still exist other possible mediators which also should be considered, such as perceived value. Future study is needed to solve these problems mentioned above.

References

Ahn, T., S. Ryu, and I. Han, "The impact of web quality and playfulness on user acceptance of online retailing", *Information and Management*, Vol.44, No.3, 2007, pp. 263-275.

Amin, A., R. K. Abdollah, and S. F. Seyed, "Evaluation of Service Quality, Value and Customer Satisfaction on Consumer Buying Behavior", *American Journal of Scientific Research*, Vol.39, No.1, 2011, pp. 78-90.

Al-Shafi, Shafi and Weerakkody, Vishanth, "Modelling use continuance in virtual worlds: The case of second life", *ECIS 2009 Proceedings,* Paper 101.

Bhattacherjee, A., "An empirical analysis of the antecedents of electronic commerce service continuance", *Decision Support Systems*, Vol.32, No.2, 2001, pp. 201-214.

Bhattacherjee, A., "Understanding information systems continuance: An expectation confirmation model", *MIS Quarterly*, Vol.25, No.3, 2001, pp. 351-362.

Bagozzi, R. P. and Y. Yi, "On the evaluation of structural equation models", *Journal of the Academy of Marketing Science*, Vol.16, No.1,

1988, pp. 74–94.

Cronin, J. J. and S. A. Taylor, "Measuring service quality: A reexamination and extension", *Journal of Marketing*, Vol.56, No.3, 1992, pp. 55–68.

Chae, M., J. Kim, H. Kim, and H. Ryu, "Information quality for mobile internet services: A theoretical model with empirical validation", *Electronic Markets*, Vol.12, No.1, 2002, pp. 38–46.

Cao, S. and H. Yin, "Trust and habit in e-Service continuance: An integrated model", *Journal of Computational Information Systems*, Vol.6, No.11, 2010, pp. 3595-3604.

Cronin, Jr. J. J., M. K. Bady, and G. T. M. Hult, "Assessing the effects of quality, value and customer satisfaction on consumer behavioral intentions in service environments", *Journal of Retailing*, Vol.76, No.2, 2000, pp. 193-218.

Davis, F. D., "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, Vol.13, 1989, pp. 319–340.

Davis, F. D., R. P. Bagozzi, and P. R. Warshaw, "Extrinsic and intrinsic motivation to use computers in the workplace", *Journal of Applied Social Psychology*, Vol.22, 1992, pp. 1111–1132.

DeLone, W. and E. McLean, "Information systems success: the quest for the dependent variable", *Information Systems Research*, Vol.3, No.1, 1992, pp. 60-95.

DeLone, W. and E. McLean, "The D&M model of information system success: A ten-year update", *Information System Research*, Vol.19, No.4, 2003, pp. 9-30.

Deci, E. L., "Intrinsic motivation", *New York: Plenum Press*, 1975.

Fornell, C. and D. F. Larcker, "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol.18, No.1, 1981, pp. 39–50.

Gupta, S. and C. F. Mela, "What is a free customer worth", *Harvard Business Review*, Vol.86, 2008, pp. 102–109.

Hong, W., Y. L. James, L. C. Thong, and Gurpreet, D., "User acceptance of agile information systems: A model and empirical test", *Journal of Management Information Systems*, Vol.28, No.1, 2011, pp. 235-272.

Hair, J. F. Jr., R. E. Anderson, R. Tatham, and W. C. Black, Multivariate Data Analysis, 5th edition, *Prentice-Hall, Englewood Cliffs, NJ*, 1998.

Jang, H. Y. and M. J. Noh, "Customer acceptance of IPTV service quality", *International Journal of Information Management*, Vol. 31, 2011, pp. 582-592.

Kang, Y. S., J. Min, J. Kim, and H. Lee, "Roles of alternative and self-oriented perspectives in the context of the continued use of social network sites", *International Journal of Information Management*, Vol.33, No.3, 2013, pp. 496-511.

Katz, M. L. and C. Shapiro, "Network externalities, competition, and compatibility", *American Economic Review*, Vol.75, No.3, 1985, pp. 424–440.

Kim, M. K., M. C. Park, and D. H. Jeong, "The effects of customer satisfaction and switching barrier on customer loyalty in Korean mobile telecommunication services", *Telecommunications Policy*, Vol.28, No.2, 2004, pp. 145–159.

Kim, E. and B. Lee, "An economic analysis of customer selection and leveraging strategies in a market where network externalities exist", *Decision Support Systems*, Vol.44, 2007, pp. 124–134.

Kim, B., "An empirical investigation of mobile data service continuance: Incorporating the theory of planned behavior into the expectation-confirmation model", *Expert Systems with Applications*, Vol.37, No.10, 2010, pp. 7033-7039.

Kim, B., "The diffusion of mobile data services and applications: Exploring the role of habit and its antecedents", *Telecommunications Policy*, Vol.

36, No.1, 2012, pp. 69-81.

Kuo, Y. F., C. M. Wu, and W. J. Deng, "The relationships among service quality, perceived value, customer satisfaction, and post-purchase intention in mobile value-added services", *Computers in Human Behavior*, Vol.25, No.4, 2009, pp. 887-896.

Lee, Y. and O. Kwon, "Intimacy, familiarity and continuance intention: An extended expectation-confirmation model in web-based services", *Electronic Commerce Research and Applications*, Vol.10, No.3, 2011, pp. 342-357.

Lin, C. S., S. Wu, and R. J. Tsai, "Integrating perceived playfulness into expectation-confirmation model for web portal context", *Information and Management*, Vol.42, 2005, p. 683.

Lin, C.-P. and A. Bhattacherjee, "Elucidating individual intention to use interactive information technologies: The role of network externalities", *International Journal of Electronic Commerce*, Vol.13, No.1, 2008, pp. 85-108.

Lin, K, Y. and H, P. Lu, "Why people use social networking sites: An empirical study integrating network externalities and motivation theory", *Computers in Human Behavior*, Vol.27, 2011, pp. 1152-1161.

Lu, Y., Z. Deng, and B. Wang, "Exploring factors affecting Chinese consumers' usage of short message service for personal communication", *Information Systems Journal*, Vol.20, No.2, 2010, pp. 183-208.

Luis. K. R., H. Norberto, and L. H. Jorge, "Management of perceptions of information technology service quality", *Journal of Business Research*, Vol.62, 2009, pp. 876-882.

Moon, J. W. and Y. G. Kim, "Extending the TAM for a World-Wide-Web context", *Information and Management*, Vol.38, 2001, pp. 217-230.

Parasuraman, A., V. A. Zeithaml, and L. L. Berry, "SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality", *Journal of Retailing*, Vol.64, No.1, 1988, pp. 12-40.

Strader, T. J., S. N. Ramaswami, and Houle, P. A., "Perceived network externalities and communication technology acceptance", *European Journal of Information Systems*, Vol.16, No.1, 2007, pp. 54-65.

Stuart J. B. and B. Martin, "Modeling USE CONTINUANCE behavior IN Microblogging Services: THE CASE OF TWITTER", *Journal of Computer Information Systems*, summer, 2011.

Sun, Y., Y. L. Zhu, X. M. Peng, and B. Klaus, "Understanding users' continuance intention in online social networks", *E-Business and E-Government*, 2011, pp. 1-4.

Turel, O. and A. Serenko, "Satisfaction with mobile services in Canada: An empirical investigation", *Telecommunications Policy*, Vol.30, No.5/6, 2006, pp. 314-331.

Wang, C. C., Y. Hsu, and W. Fang, "Acceptance of technology with network externalities: An empirical study of Internet instant messaging services", *Journal of Information Technology Theory and Application*, Vol. 6, No. 4, 2004, pp. 15-28.

Yang, J. and E. Mai, "Experiential goods with network externalities effects: An empirical study of online rating system", *Journal of Business Research*, Vol.63, 2010, pp. 1050-1057.

Zeithaml, V. A., L. L. Berry, and A. Parasuraman, "The behavioral consequences of service quality", *Journal of Marketing*, Vol.60, No.2, 1996, pp. 31-46.

Zhou, T. and Y. Lu, "Examining mobile instant messaging user loyalty from the perspectives of network externalities and flow experience", *Computers in Human Behavior*, Vol.27, 2011, pp. 883-889.

An Empirical Study on User's Continuance Intention Towards Mobile IM Service in China

Weiyi Luo[*]·Jing Shao[**]·Young-Chan Lee[***]

Abstract

Due to the intense competition and low switching cost, to find out which factors will significantly impact on user's continuance intention is very important for mobile instant messaging (IM) practitioners. In this study, we adopted network externalities and perceived service quality as independent variables based on the definition of mobile IM service. Network externalities also include direct externalities (referent network size) and indirect externalities (perceived complementarity). The result of this study shows that referent network size has a critical influence on perceived usefulness and perceived complementarity has a critical influence on perceived enjoyment; perceived service quality, as we expected, has significantly impact on not only customer's satisfaction but also perceived usefulness and perceived enjoyment. Meanwhile, both perceived usefulness and perceived enjoyment have directly critical influences on customer's continuance intention.

Keywords: *Smartphone, Mobile Instant Messaging Service, perceived Service Quality, Perceived Complementarity, Referent Network Size, Perceived Usefulness, Perceived Enjoyment, Satisfaction, User's Continuance Intention*

* International Business Cooperative Program, Graduate School, Dongguk University
** International Business Cooperative Program, Graduate School, Dongguk University
*** College of Management and Tourism, Dongguk University

◐ 저 자 소 개 ◑

라 위 의 (luoweiyi1984@gmail.com)

동국대학교 일반대학원 경영학 석사학위를 취득하고 현재 동 대학원 국제비즈니스 협동과정 박사과정에 재학 중이다. 한국IT서비스학회지, 지식경영연구 등 학술지 및 학회에 논문을 발표하였다. 주요 관심분야는 스마트 폰, 모바일 서비스, 소셜네트워크, 클라우드 컴퓨팅 등이다.

소　정 (shaojing2208@hotmail.com)

동국대학교 일반대학원 경영학 석사학위를 취득하고 현재 동 대학원 국제비즈니스 협동과정 박사과정에 재학 중이다. 주요 관심분야는 국제투자전략, 다국적 기업관리, 기업의 사회적 책임 등이다.

이 영 찬 (chanlee@dongguk.ac.kr)

서강대학교 경영학사, 동 대학원에서 경영학 석사 및 박사학위를 취득하였다. 현재 동국대학교 경주캠퍼스 경상학부 교수로 재직하고 있으며, Annals of Management Science, The Open Operational Research Journal의 Editorial Board, 한국정보시스템학회 편집위원장으로 활동 중이다. Expert Systems with Applications, Knowledge-Based Systems, Human Factors and Ergonomics in Manufacturing, Technological and Economic Development of Economy, Information Systems Management 등에 논문을 게재하였으며, 주요 관심 분야는 지식경영, 기업성과측정, 데이터마이닝, 복잡계 이론, 다기준의사결정 등이다.