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A use-diffusion model of 3G services in China

Yong-Sheng Jin[1] and Zhao-Hui Li[1,2]*

[1]School of Economics and Management, Beijing University of Posts and Telecommunications, XituChenglu, No. 10, Beijing 100876, China.
[2]Department of Economics and Management, De Zhou University, China.

Since use-diffusion (UD) theory is firstly presented in 2004, few studies about UD theory have been investigated to date. In order to enrich UD theoretical results and test the feasibility of this theory applied in different research fields, we study use-diffusion of 3G services in China. This paper modifies UD determinants and established 3G services use-diffusion model. A web-based survey was used in collecting data to test UD model in explaining the usage degree of consumer. The results show that: (1) Perceived usefulness, subjective norm, innovativeness and perceived cost are the determinants of significantly affecting the variety of use, rate of use is significantly affected by perceived usefulness, perceived ease of use, perceived cost and perceived mobility; (2) Perception of UD determinants among four types of users is different; (3) There are significant differences among four typological users about satisfaction of 3G services and interest in future 3G services. Based on these findings, the study proposes some managerial implications and suggestions.

Key words: Use-diffusion, variety of use, rate of use.

INTRODUCTION

In the innovation diffusion research, diffusion has traditionally focused on the adoption perspective (Rogers, 1995; Shih and Venkatesh, 2004). Adoption-diffusion (AD) paradigm examines the process by which an innovative product reaches a critical mass of adopters, the diffusion is accelerated and the innovative product is considered successful (Rogers 1995). Recently, researchers have pointed out the limitations of the AD model, stating that diffusion processes cannot be understood if only discuss accepting/rejecting the innovative product. So, we should prolong the diffusion process to the usage stage (Golder and Tellis, 1998; Lewis and Seibold, 1993). Roberston and Gatignon (1986) emphasized that the adoption of innovative product is not the only object of the diffusion research, used degree of innovative product can be considered as an important variable of innovation diffusion degree. Shih and Venkatesh (2004) proposed the theory of use-diffusion and constructed a use-diffusion model which is

evolving UD determinants, UD patterns and UD outcomes.

Use-diffusion is a new academic term and belongs to a new field of study which mainly studied some factors affected variety of use and rate of use. However, in my knowledge scope, there is little research investigating use-diffusion of innovative product to date. We find that 3G service is a good case of studying the use-diffusion. There are two reasons for this. On one hand, there are various 3G services released, such as mobile internet access, customized infotainment, multimedia message service (MMS), location-based service and so on. On the other hand, the success of 3G services is not only depending on the adoption decision and the number of people that actually join in 3G networks, but relies at least as much on its actual usage. Profits of the operator is more when consumers use more variety and rate of mobile services. That is, only adoption of 3G network does not produce much profit, profit of telecom operator is increased with the improving of used rate and variety. Nevertheless, variety and rate of using 3G services in China are not high. So, understanding consumer's usage degree of 3G services has become a key issue. We want to know, what are the factors affecting variety and rate of

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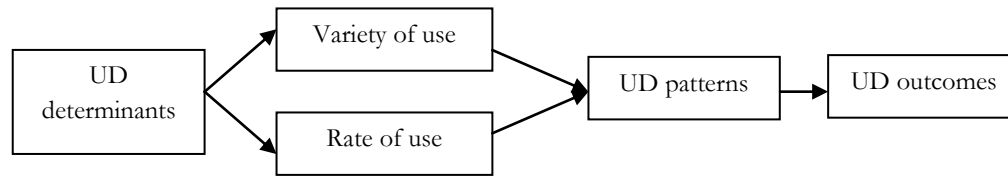*Corresponding author. E-mail: dzulzh@163.com. Tel: 15201646641.

Figure 1. Basic structure of UD model.

using 3G services? How do telecom operators increase profit by improving variety and rate of using 3G services? Studying use-diffusion of 3G services can answer these questions. So it is significant for us to study the use-diffusion of 3G services both from theoretical and practical perspectives.

In this paper, we conduct an empirical research with the data collected in China and investigate the actual feeling of 3G services users. The study organizes the rest of the paper as follows. First, it reviews the use-diffusion theory, raise hypotheses and establish the 3G service concept model. Next, the study introduces research method and data used in the study. Then we present our empirical findings and discuss the results. Finally, the study concludes by discussing theoretical contribution, research limitations and prospects of future research in future.

THEORETICAL BACKGROUND, HYPOTHESES AND CONCEPTUAL MODEL

Use-diffusion theory

The limitation of the adoption diffusion theory makes researchers pay attention to the use diffusion of innovation products. Early researches on product use which apply variety or rate to measure degree of usage, while with the technological advancement and enhancement of product's functions, we cannot measure the degree of usage completely only by one variable. Shih and Venkatesh (2004) propose that we should use two distinct dimensions (variety of use and rate of use) to measure degree of using the new product. Variety of use refers to the different ways the product is used. Rate of use refers to the time a person spends using the product during a designated period (Shih and Venkatesh, 2004). The model of UD has three key components: (1) UD determinants, (2) UD patterns and (3) UD outcomes. Basic structure of UD model is shown in Figure 1. Factors which affect variety of use and rate of use make up UD determinants. The combination of variety (low/high) and rate (low/high) yields a fourfold typology of use or users (intense users, specialized users, non-specialized users and limited users) which is named UD patterns. Intense users refer to the people who use an innovative product to a significant degree in terms of both variety of use and

rate of use. With specialized users, the focus shifts to increasing rate of use. Such usage behavior essentially treats the innovation as a specialized tool (Tinnell, 1985). Non-specialized users refer to the people who use many functions of the product but take short time in use. Finally, limited users refer to the people who use an innovative product to a lower degree in terms of both variety of use and rate of use. Different type of user has different experience to UD outcome, for example, degree of satisfaction, interest in future features of the product, etc. This paper establishes 3G services use-diffusion model based on this framework.

Hypotheses

Variety of use and rate of use

The results of the relationship between variety of use and rate of use are inconsistent. Some researchers find that variety of use positively affect rate of use, because more time may be needed to perform more uses (Shih and Venkatesh, 2004). It is not confirmed whether rate of use affects variety of use. Rate of use perhaps affects variety of use, because the more time in using new product, the more possibility of using variety functions. However, Ridgeway and Price (1994) have found that users have higher rate of use under the circumstance of no higher variety of use, perhaps users have necessity demand for the product. In order to investigate the relationship between variety and rate of use in circumstance of 3G services, we hypothesize as follows:

H1a: Variety of use perhaps positively affects rate of using 3G services.
H1b: Rate of use perhaps positively affects variety of using 3G services.

Perceived usefulness (PU)

According to Davis (1993), perceived usefulness refers to the individual's perception that using the new technology will enhance or improve her/his performance. Kim et al. (2010) and Hong et al. (2006) found that perceived usefulness has a significant impact on use willingness. Tan and Teo (2000) suggest that the perceived

usefulness is an important factor in determining the adoption of innovations. The mobile itself is a kind of helpful tool to life and work, so, the functions of mobile network provided are more useful, and consumers are more willing to use or take longer time to use. That is, if 3G services can help users in work and life circumstance, users will improve variety and rate of using 3G services. So we hypothesize as follows:

H2a: Perceived usefulness perhaps positively affects variety of using 3G services.
H2b: Perceived usefulness perhaps positively affects rate of using 3G services.

Perceived ease of use (PEU)

Perceived ease of use refers to the degree of difficulty or ease in using the new product (Davis, 1989). In this study, we define perceived ease of use as users paid less time and energy for using 3G service. Past researchers have found that users will get engaged in using technology product, if it takes less time and energy (Davis, 1993; Moon and Kim, 2001; Vander Heijden, 2003). Yan (2003) researches mobile users in China and find that ease of using new product positively affects use attitude. Venkatesh (2000) once proclaimed that for any emerging IT/IS, perceived ease of use is an important determinant of users' intention of acceptance and usage behavior. When users feel that 3G services are complicated, they have no willingness to use a variety of 3G services. In other words, if 3G services are operated simply and users pay less time and energy for using 3G services, they will improve their variety and rate of using 3G services. So we hypothesize as follows:

H3a: Perceived ease of use perhaps positively affects variety of using 3G services.
H3b: Perceived ease of use perhaps positively affects rate of using 3G services.

Subjective norms (SN)

When assessing the variety of use of the technological product, the social context of the decision maker should not be neglected. If the social context is in favor of using a technology, this plays an important role in the decision process (Webster and Trevino, 1995). We incorporate the social context in our research model by including the factor of subjective norm. Fishbein and Ajzen (1975) describe subjective norms as "the degree to which an individual believes the people who are important to him/her and expect him/her to perform the behavior in question". Theory of reasoned action and theory of planned behavior all mention that subjective norms have a positive and direct impact on behavior intention

(Fishbein and Ajzen, 1975; Ajzen, 1989). Nysveen et al. (2005) show that people use mobile services in a public social context in which they observe others' activities and in which they must adapt to others' interactions, because Chinese traditional culture is a kind of typical collectivism culture, consumer is influenced by others to a large extent before adoption of new technology product or new service. Therefore, subjective norms perhaps affect variety of using 3G service. So we hypothesize as follows:

H4: Subjective norms perhaps positively affect variety of using 3G service.

Perceived cost (PC)

In the researches of information technology acceptance model, many researchers have considered cost as an important factor affecting user to accept some new information technology (Hung et al., 2003; Luarn and Lin, 2005; Wu and Wang, 2005). Hong et al. (2006) find that cost of mobile services remarkably affects the use intention. In this study, perceived cost is defined as all kinds of expense which users should pay for using 3G services. This cost mainly includes terminal equipment cost and 3G services charge. Because terminal equipment cost is fixed, perceived cost mainly refers to telecommunication fee. Internet consumer research center (2010) investigate 3G use cases of China's IT citizens, the results show that 41.4% of responders think that high cost is the most important factor impeding them from using 3G services. If consumers perceived that the cost of telecommunication outweighs their expectation, they will reduce variety and rate of using 3G services. Thus, perceived cost is proposed to have a negative effect on usage behavior. We hypothesize as follows:

H5a: Perceived cost perhaps negatively affects variety of using 3G services.
H5b: Perceived cost perhaps negatively affects rate of using 3G services.

Innovativeness of user (IU)

Personal differences perhaps influence usage degree of technological product. Chen and Chen (2009) propose that the personalities of customers should be discussed in order to precisely predict the perception and behavior of customers. Innovativeness of user refers to the user's willingness of trying a new technology (Agarwaland and Prasad, 1998).Hirschman (1980) proposes inherent novelty seeking as an antecedent of use variety. Ram and Jung (1990) suggest that involvement and innovativeness have a positive relationship with usage variety, though the effect of involvement was lower in

comparison. Price and Ridgeway (1983) consider that consumers must have the ability (creativity) and the incentive (curiosity), for them to use existing products in multiple novel ways. Based on previous theory and empirical work, we hypothesize as follows:

H6: Innovativeness of user perhaps positively affects variety of using 3G services.

Perceived mobility (PM)

The key feature and major advantage of mobile services is their ubiquity. Mobile services can be used anytime and virtually anywhere (Dahlberg et al., 2003). Amberg et al. (2004) defines perceived mobility as 'users can access mobile service anytime and anywhere'.Zmjewska (2005) and Tang (2008) find that perceived mobility positively affects use intention. If consumers are not limited by time and space in using 3G network, they will use 3G services anytime and anywhere, for example, they can use 3G services on the way when going to work and getting off work. So perceived mobility can increase the use time of 3G services.

H7:Perceived mobility perhaps positively affects rate of using 3G services.

Satisfaction of user

Customer satisfaction is customer's cumulative impression of a firm's service performance (Johnson and Fornell, 1991). In this study, user's satisfaction is defined as the total consumption perception of consumers after using mobile 3G services. It has been suggested that a person's ability to use a product successfully results in higher satisfaction (Anderson and Ortinau, 1988; Downing, 1999; Kekre et al., 1995). Bolton and Lemon (1999) find that customer satisfaction and service usage are highly correlated. Nijssen and Lieshout (1995) consider that consumers will continue to use the technology product when they perceived being content with the product. According to Oliver (1980, 1985), customers tend to compare the actual usage and expectations, when actual usage outweighs the expectations, satisfaction increases. So if usage behavior approaches intense use, actual usage is likely to outweigh prior expectations and leads to higher product satisfaction. Thus, we think that degree of satisfaction among four categorical users are different, the intense users should be more satisfied with the new technology product than others. Shih and Venkatesh (2004) find satisfaction of intense, specialized, non-specialized and limited users remarkably different. Based on previous theory and empirical work, we hypothesize as follows:

H8: Satisfaction of different types of users in using 3G

service is different.

Interest in future 3G services

After adoption of new product, consumer's experience of using the product can affect future consumptive behavior. Users who have successfully integrated the technology into their lives should be least resistant to acquiring similar technologies, because past successful experiences reduce the level of perceived risk involved and heighten the possible benefits that can be realized (Venkatesh et al., 2003). Intense users have the highest variety and rate of use, so the usage degree of intense users is the highest. They perhaps have higher interest in future 3G services. Shih and Venkatesh (2004) found that highest interest in future technology acquisition is in the intense use category, followed by the non-specialized use, specialized and limited use. Based on previous theory and empirical work, we hypothesize as follows:

H9: Interest in future 3G service of different types of users is different.

Conceptual model

Based on what is stated earlier, we propose our conceptual model of this research as shown in Figure 2.

RESEARCH METHODOLOGY

Questionnaire design

The questionnaire consists of three segments. To begin with, the first, which is used to measure the variety and the rate of use has two questions, which are "which services do you often use (multiple-choice question)" and "how many hours do you use 3G services on average every day". In this study, we identified 22 different functions for 3G service.

The second segment consists of 19 items used to measure six UD determinants. Drawing from prior research, we use existing scales. Each of the determinants shown in Figure 2 is described subsequently. All these items adopt Likert 5-point scale (extent of agreement or disagreement with a statement, namely, 1 means "Disagree extremely", 2 "Disagree", 3 "Neither disagree nor agree", 4 "agree" and 5 "agree completely"). It should be emphasized that this study wants to investigate the actual feeling which is different from adoption and use willingness research, so the items apply past tenses.

The third seqment consists of 5 questions to measure the satisfaction and future interest with 3G services. All these items adopt Likert 5-point scale.

Data collection

Data for this study is collected from people who have used 3G network. The study adopts online surveys and selects non-probability sampling method. First, we adopt snowball sampling method to select respondents. We look for friends, classmates and
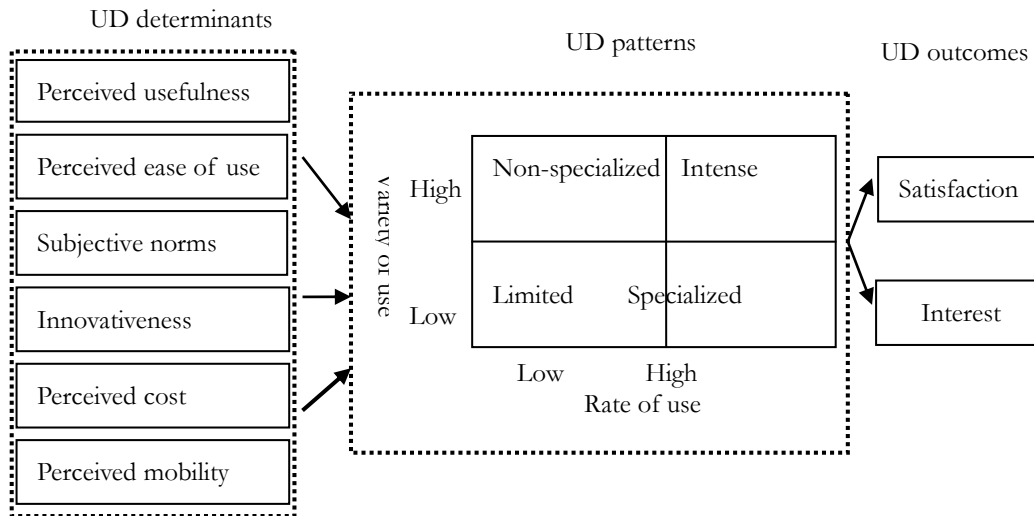
Figure 2. UD model of 3G services.

workmates who have used 3G services and then let them look for more friends to fill in the questionnaire. Then we send questionnaire to some electronic product BBS (http://bbs.weiphone.com, http://www.jd-bbs.com, http://www.hi-pda.com/forum) to look for users. The respondents in China provide the data by means of an online questionnaire in March 2011. A total of 345 questionnaires are obtained and 326 usable responses are acquired after removing incomplete samples, yielding a response rate of 95%.

Statistical method

SPSS15.0 is used to analyze the data. First, the study examines the validity and reliability of the questionnaire. Next the study analyzes the relevance between the UD determinants and variety and rate of using 3G value-added services. The study believes that variety and rate of use are simultaneous, that is, increase in variety of use often result in increase in rate of use because more time may be needed to perform more uses. Meanwhile less variety of use can lead to lower rate of use because users simply have less to do. In addition, the study believes that variety and rate of use depend on the exogenous variables described in the preceding hypotheses. Thus, the study specifies a two-equation model of variety and rate of use and estimate it with two-stage least squares (2SLS). Then a multinomial logistic (MNL) method is used to analyze the influences of the four diffusion patterns on UD determinates. Finally the One-Way ANOVA method is used to analyze whether the feelings of the four categories of users in satisfaction and future interest in 3G services are different.

Data analysis

Validity analysis and reliability analysis

This study mainly uses factor analysis to examine construct validity of the questionnaire. KMO is 0.857, Bartlett's test of sphericity is 4295.603 and the corresponding probability is close to zero, so the study suits to do factor analysis.

The factor analysis result is shown in Table 1. After excluding an item, all the standardized factor loadings of items exceed the 0.50 norm and total cumulative variance is 75.161%, indicating a

satisfactory estimation.

To assess the reliability of the constructs, the coefficient of internal consistency (Cronbach's α) is ascertained. As shown in Table 1, we can see that the Cronbach's α of each factors is above the critical value of 0.70 (Devellis, 1991; Nunnally, 1978), indicating that the measurement of each variable has a high reliability.

Therefore, the hypothesized measurement model is reliable and meaningful to test the structural relationships among the constructs.

Two-stage least squares (2SLS) analysis

Results for the 2SLS analysis of use-diffusion are shown in Table 2. We find that the total explanatory power of which the determinant variables significantly affect variety of use was $R^2=0.156$ and four hypothesis are supported; the total explanatory power of which the determinant variables significantly affect rate of use was $R^2=0.194$ and four hypothesis are supported. We elaborate them, respectively as in follows.

We find variety of use, significantly affects rate of use and H1a is supported. That is, variety of use is more and rate of use is higher. This result is consistent with this research (Shih and Venkatesh, 2004). We also find that rate of use positively affects variety of use and H1b is supported. This result is not in agreement with opinion of this study (Shih and Venkatesh, 2004). Perhaps because object of study is different, users take longer time in using 3G services, and they will use more types of 3G services.

Perceived usefulness is positively related to variety of use (β=0.258, p<0.01) and rate of use (β=0.196, p<0.01), H2a and H2b are supported. If users perceive usefulness in process of using 3G services, they will improve variety of use and rate of use. Perceived ease of use is positively related to rate of use (β=0.131, p<0.01), H3b is supported, but H3a is not supported.

That is, if users perceive higher degree of usability, they will take longer time in using 3G services. Subjective norms is positively related to variety of use (β=0.109, p<0.5) and H4 is supported, this indicates users use many functions of 3G services which is affected by important people, such as friends, classmates, workmates, etc. Perceived cost is negatively related to variety of use (β=-0.132, p<0.5) and rate of use (β=-0.108, p<0.5) and H5a and H5b are supported. That is, if users perceived higher cost in using 3G services, they will use limited types of 3G services or reduce

Table 1. Deduction analysis and reliability results.

Variables	Items	Factor loadings	Cronbach's-α
Perceived usefulness	PU1	0.738	0.853
	PU2	0.741	
	PU3	0.564	
	PU4	0.736	
Perceived ease of use	PEU1	0.828	0.898
	PEU2	0.882	
	PEU3	0.827	
Subjective norm	SN1	0.636	0.783
	SN3	0.826	
	SN4	0.709	
Perceived cost	PC1	0.931	0.900
	PC2	0.928	
Innovativeness of user	IU1	0.809	0.842
	IU2	0.762	
	IU3	0.863	
Perceived mobility	PM1	0.816	0.855
	PM2	0.872	
	PM3	0.776	

using time. Innovativeness of user is positively related to variety of use (β=0.238, p<0.5) and H6 is supported, this result is in agreement with the result that Ridgeway and Price (1994) and Ram and Jung (1990) reported.

That is, user has higher innovative quality and he will use more type of 3G services. Perceived mobility is positively related to rate of use (β=0.115, p<0.5) and H7 is supported. That is, if users can use 3G services anywhere and anytime, the time of using 3G services is longer.

Multinomial logistic (MNL) analysis

We measured variety of use with numbers of using 3G services and dichotomized variety of use from its mean. The mean number is 6.03. So, using 7 or more 3G services is high variety of use and using 6 or less 3G services is low variety of use.

We measured rate of use as the hours of using 3G service per day. We dichotomized rate of use from the mean high and low rate-of-use behavior. The mean of using time is 1.36 h per day. So using 1.36 h or more hours is high rate of use and using 1.36 h or less hours is low rate of use.

Together, variety of use and rate of use form the 2×2 matrix of UD patterns. Table 3 gives the percentage of each use pattern in our sample.

We performed an MNL analysis on the four UD patterns: intense, specialized, non-specialized and limited use. Limited use was the control category. Results of the MNL analysis are reported in Table 4. The model -2LL is 710.288 with model χ^2 = 110.295 (p<0.001)and Pearson χ^2=955.879 (p<0.001). All independent variables are significant in predicting UD patterns.

Perceived usefulness is significantly related to intense users (β= 1.370, p<0.001), non-specialized users (β=1.582, p<0.001) and specialized users (β=1.041, p<0.01). This finding suggests that users who perceive usefulness of 3G services tend to develop broader variety of use and higher rate of use than users with limited usage behavior. Perceived ease of use and perceived mobility all were significant in predicting intense users (β=0.854, p<0.01; β=0.644, p<0.01) and specialized users (β=0.496, p<0.01; β= 0.733, p<0.01), which means the degree of perceived usability and mobility is different among users who take longer time to use 3G services. Subjective norms and innovativeness all are significantly related to intense users (β=0.453, p<0.01; β= 0.386, p<0.05) and non-specialized users (β=0.693, p<0.01; β = 0.155, p<0.5), which means users who have higher innovation and subjective norm use more types of 3G services.

One-way ANOVA analysis

We used one-way ANOVA method to analyze whether UD outcomes was notably different with different types of users. The result is shown in Table 5. We found that hypothesis 8 and 9 were proved.

The means of each outcome variables investigated are reported in Table 5. Consistent with the hypothesis, intense users rated satisfaction highest and users who experienced a limited UD pattern rated lowest (3.37 versus 3.01, p< 0.05). The remaining two groups, in the categories of specialized and non-specialized users, were not significantly different from each other (3.16 versus 3.15, p> 0.05), but both were significantly lower than intense users and significantly higher than limited users.

We also found intense users ranks the highest with regard to

Table 2. 2SLS analysis of use-diffusion.

Variable	Variety of use			Rate of use		
	Coefficients	β	Standard error	Coefficients	β	Standard error
α	0.891***	-	0.232	1.515***	-	0.497
PU	0.182**	0.258	0.052	0.301**	0.196	0.115
PEU	0.070	0.088	0.051	0.225*	0.131	0.110
SN	0.069*	0.109	0.035	-	-	-
IU	0.113*	0.238	0.045	-	-	-
PC	-0.077*	-0.132	0.032	-0.139*	-0.108	0.070
PM	-	-	-	0.164*	0.144	0.075
Variety	-	-	-	0.045*	0.115	0.022
Rate	0.056*	0.123	0.026	-	-	-
R^2	0.156			0.194		
Adjusted R^2	0.135			0.174		
F	7.333***			7.537***		

*$p<0.05$;**$p<0.01$;***$p<0.001$

Table 3. Use-diffusion patterns.

UD	Rate of use	Variety of use	Number	Percentage
Intense user	High	High	65	19.9
Specialized user	High	Low	86	26.4
Non-specialized user	Low	High	39	12.0
Limited user	Low	Low	136	41.7

interest in acquiring futuristic 3G services and this interest is the weakest in limited users (3.98 versus 3.28, p< 0.001), the limited users is significantly different from other three type. Specialized and non-specialized users are not significantly different from each other (3.73 versus 3.88, p>0.05). The total results illustrate different UD patterns result in differential levels of satisfaction and interest in future 3G services acquisition and intense users' exhibit highest level of satisfaction and interest than the others.

RESULTS AND DISCUSSION

UD determinants

In our research results, perceived usefulness, subjective norm, innovativeness and perceived cost are the determinants of significant affecting the variety of use. Rate of use are significantly affected by perceived usefulness, perceived ease of use, perceived cost and perceived mobility. So the perceived usefulness and perceived cost are the most important factors. The results indicate the marketing suggestion as follows:

1. The usefulness of 3G service is the main driving forces to enhance performance expectations of the consumers. If different types of 3G service can satisfy the different requirements of consumers and help consumers solve the problems timely, consumers perceived usefulness will increase. So developing and designing new 3G services should meet the real needs of users, especially new 3G service can increase work efficiency in life and working environment which can increase variety and rate of using 3G services.

2. Many researchers have shown that perceived cost is an important factor which impedes consumer adopting of 3G services, and this research found that perceived cost is also an important factor which hinders consumers from using more various types of 3G services and taking longer time to use 3G services. Telecom services have the scale economic effect, that is the more services people use, the lower the cost, so operators must attract more people to use 3G networks by taking many marketing strategies and improving the ratio of quality and price by constantly enriching pricing models to reduce perceived cost.

3. Operators should attach importance to the word-of-mouth effect. We find subjective norm to significantly affect variety of using 3G services. This result indicates that consumer can be affected in selecting some new 3G services by suggestions of colleagues, friends and family. Therefore, operators can encourage and reward existing users and make them spread the source of new 3G services which can form the snowball effect and attract

Table 4. MNL analysis of use-diffusion.

Variable	Intense user	Standard error	Non-specialized	Standard error	Specialized	Standard error
α	-6.273***	1.475	-5.864**	1.801	-3.644**	1.346
PU	1.370***	0.358	1.582***	0.404	1.041**	0.325
PEU	0.854**	0.328	0.288	0.404	0.496**	0.300
SN	0.453**	0.232	0.693**	0.226	0.765	0.221
IU	0.386*	0.298	0.155*	0.339	-0.224	0.256
PC	-0.417**	0.215	-0.341**	0.244	-0.544**	0.192
PM	0.644**	0.240	0.078	0.251	0.733**	0.218
-2LL	710.288					
modelχ^2	110.295***					
Pearsonχ^2	955.879***					

* p<0.05;**p<0.01;***p<0.001

Table 5. Analysis of outcomes of use-diffusion.

UD outcomes	UD patterns	means	F	Sig	Scheffe
Satisfaction	Intense 1	3.37	-	-	-
	Non-specialized 2	3.15	2.920	-	-
	Specialized3	3.16	*	0.034	4<1
	Limited 4	3.01	-		-
Future interest	Intense 1	3.98	-	-	4<3
	Non-specialized 2	3.88	21.848	-	4<2
	Specialized 3	3.73	**	0.000	4<1
	Limited 4	3.28	-	-	-

*p<0.05; **p<0.01; ***p<0.001

users to use more type of 3G services.
4. Many researchers have shown that innovativeness of consumer significantly affect adoption of new technological products and we find that innovativeness of user positively affects variety of using 3G services in this research.

This result indicates user of higher innovativeness tends to use more types of 3G services. So operators can use data mining technology to find characteristics of innovators. Operators should first promote the new 3G service to innovative users when they have developed a new service.
5. Perceived ease of use is positively related to rate of use. Ease of using 3G services mainly embodies in usability of 3G terminal equipment. Terminal equipment is operated more simple and more rapid, expectations of consumer is lower and perceived performance is higher, consumer is more likely to produce use behavior.
6. This research proves that perceived mobility of users positively affects rate of using 3G service which indicates the service quality of 3G net is an important factor to influence rate of use. So operators should improve

service quality of 3G network and make users use 3G services anytime anywhere.

UD patterns

In our research, we divided users into four categories (intense, specialized, non-specialized and limited users) on the basis of variety of use (high, low) and rate of use (high, low). Limited users account for a large proportion of the total, about 41.7%, followed by specialized (26.4%) and intense users (19.9%) and the percentage of non-specialized users is only 12.0%, which means most users have lower variety of use and rate of use, and they use 3G network as 2G network and use 3G mobile as 2G mobile. Internet consumer research center (2010) investigates 3G use cases of China's IT citizens, the results show that 33% of 3G mobile phone users do not use 3G services. The development of 3G network in China is not mature. So operators should take active measures to improve the usage degree of consumers.

Intense users may be considered use innovators par

excellence in the UD context, because they score high on both variety and rate. Operators should keep intense user, and transform specialized users and non-specialized users into intense users by improving the variety of use in specialized users and rate of use in non-specialized users. Limited users can be looked as good candidates for upgrading to a higher level of use if the reasons for their limited use are known in advance.

UD outcomes

We found significant differences among diffusion categories on satisfaction of 3G services and interest in future 3G services. The means of UD outcomes of intense users is highest, and next is specialized and non-specialized users, while the lowest is limited users. The results indicate that users with higher UD levels are not only are more satisfied with the current innovation but also are more interested in adopting future innovations.

Satisfaction of users will be improved if operators can successfully strengthen the level of use. This higher satisfaction will result in higher reuse intent and makes users influence others usage degree by word-of-mouth effect, which will accelerate the speed of the use of diffusion. Operators should introduce new 3G service to intense and non-specialized users; because they score higher on interest in future 3G services.

Conclusions

Previous researches about the diffusion process are studied on the adoption diffusion viewpoint, while Shih and Venkatesh (2004) propose use-diffusion theory which studies use degree of adopters. Use-diffusion theory provides us with a new perspective of studying the diffusion process. Reviewed UD researches, a few related researches are studied. This paper modified UD determinants and established 3G services use-diffusion model based on UD model (Shih and Venkatesh, 2004). We validated the feasibility of UD model in 3G service by empirical method, further laid a theoretical basis for application in other areas of use-diffusion model. However, the study has some limitations that can be addressed in future studies. First, in respect of UD determinants, we selected six factors to study, in fact, there are more factors influencing variety and rate of using 3G services and we can extend more influence factors in future. Second, in respect of sample selection, we used online survey method to collect data. Although, this method is simple and highly efficient, perhaps it can cause certain errors in study, so we should select more samples by more different methods and make study more accurate. Third, demographics of users perhaps affect variety and rate of use and different categories of users have different demographics. So, we can study whether demographics of users is related with variety and rate of use and find demographics of four categories of users, and provide different marketing strategies to them.

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