

Understanding the Mobile Internet Use

*Eun-Hee Jeon, *Tae-Wan Kim, *Doo-Hwan Bae, *Jae-In Oh

Abstract

The purpose of this study is to demonstrate individual's mobile Internet acceptance by extending the technology acceptance model (TAM) to the field of the mobile Internet. This research utilized the structural equation model to examine the research model on the mobile Internet use. System quality and information quality as external variables were examined, and playfulness as an intrinsic factor was tested. The research model was successfully validated in the environment of extension model for the mobile Internet.

Keywords: Technology acceptance model; Structural equation model; Mobile Internet; System quality; Information quality; Intrinsic motivation; Social influence

* : Dept of MIS, Dankook University
TEL: +82 2-709-2514 FAX : +82 2-709-2855
e-mail : jeonehh@korea.com

1. Introduction

Today, most countries in the world are rapidly embracing the mobile Internet and mobile technology. In Europe, for example, it was expected to be the highest concentration of mobile Internet users by 2005, being 194 million people going online with mobile devices, up from 7 million in 2000 (Intermarket group, 2001). In Japan, as of April 31, 2002, there were surprisingly about 32 millions of i-mode subscribers using NTT DoCoMo's mobile Internet services, just after the initial service launching of i-mode in February 1999. In the North America, mobile Internet services are less developed than other areas, such as Europe and Japan. But the number of mobile Internet users in North America was expected to increase from 2 million in 2000 to 89 million in 2005 (Intermarket group, 2001).

As the field of the mobile Internet has been getting popular, there has been an abundance of research on the prediction in the mobile market and related demographic statistics. However, there is a lack of study on why people use the mobile Internet and which factors influence mobile Internet users' behavior.

The purpose of this study is to demonstrate individual's mobile Internet acceptance by extending the technology acceptance model (TAM) to the field of the mobile Internet. Chapter 2 describes prior research on TAM. Based on the review of this prior research, Chapter 3 proposes the research model on the application of TAM to the mobile Internet. Chapter 4 explains a research methodology and proposes an adjusted research model and hypotheses by conducting the factor analysis. Chapter 5 examines the fitness of the adjusted research model and the hypotheses. Chapter 6 describes research findings from the analysis of the model and hypotheses. Chapter 7 concludes with the contributions and limitations of this research and proposes directions in the future research.

2. Prior Research

In this chapter, based on the literature on the TAM, this research classified the field of TAM into orgianl TAM, external variables, intrinsic motivation, and social influence. <Table 1> shows previous TAM studies.

<Table 1> Previous Studies on TAM

Extension to TAM	Literature	Applications	Findings
TAM	Davis 1989	PROF, XEDIT, chart-Master, Pendraw	U→Usage EOU→Usage
	Davis et al. 1992	WriteOne	EOU→U, U→A, EOU→A, A→BI U→BI, BI→Usage
	Adams et al. 1992	E-mail, V-mail, Wordperfect, Harvard Graphics	EOU→Usage, U→Usage, EOU↔U
	Szajna 1996	E-mail	EOU→U, U→BI, BI→Usage
External Variables	Igbaria et al. 1995a	Micorcomputer	IC→EOU, IC→EOU, SC→EOU, IC→U, OC→U, SC→U
	Straub et al. 1995	V-mail	U→Usage, EOU→Usage, SPIR→U SPIR(Social presence/information richness)
	Venkatesh & Davis 1996	personal computer	SE, OU→EOU
	Igbaria et al. 1997	Personal Computing	IF, EF→EOU, IF, EF→U, EOU→U, EOU, U→Usage
	Gefen and Straub 1997	E-mail	Gender→SPIR, Gender→U, Gender→EOU, SPIR→U, U→Usage
	Agarwal & Prasad 1999	Personal computer	ID→EOU, ID→U, EOU→U, U→A, U→A, U→BI, A→BI
	Leder et al. 2000	Web	IQ→U Understanding, Finding→EOU, EOU→Usage, U→Usage
	Luscas & Spilter 2000	Workstation	ID→EOU, ID→U,
	Hong et al 2002	ID, SC	ID→EOU, SC→EOU, SC→U, EOU→U, U→BI, EOU→BI

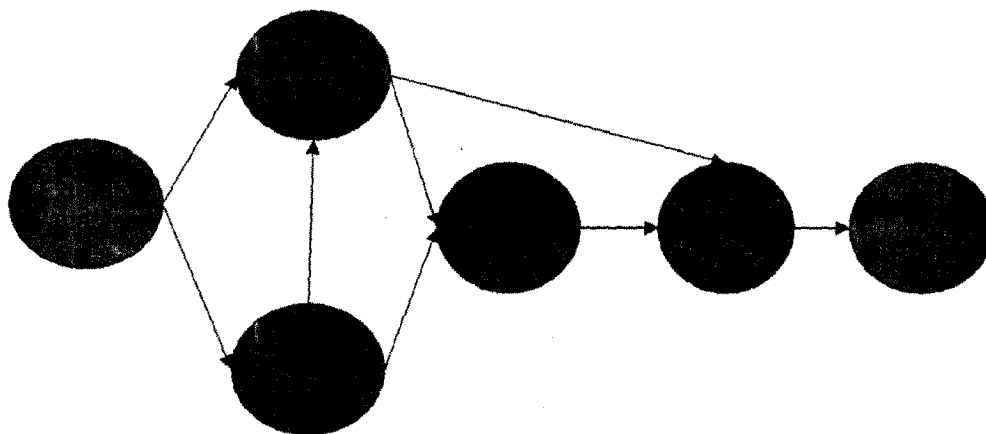
<Table 1> continued

Extension to TAM	Literature	Applications	Findings
Intrinsic Motivation	Igbaria et al. 1995b	Computer	EOU→U, EOU→Usage, EOU→PE, U→Usage, PE→Usage(non-sig.)
	Teo et al.1999	Internet	EOU→U, EOU→Usage, EOU→PE, U→Usage, PE→Usage
	Moon and Kim 2001	WWW	EOU→U, EOU→Usage, EOU→PP, U→Usage, PP→Usage
Social Influence	Taylor & Todd 1995	Computer	SN→BI
	Lucas & Spittler 1999; 2000	Workstation	SN→Usage
	Venkatesh & Morris 2001	New technology	SN→BI
	Chau & Hu 2002	Telemedicine technology	SN→BI(non-Sig.)

Legend: A, attitude; BI, behavior intention; EOU, ease of use; U, usefulness; PE, perceived enjoyment; PP, perceived playfulness; SN, subjective norms; IC, individual characteristics; ID, individual difference; IF, interorganizational factor; IQ, information quality; EF, extraorganizational factor; OU, objective usability; SC, system characteristics; SE, self-efficacy

2.1. Technology Acceptance Model

This section describes TAM that was first proposed by Davis(1989). TAM has been applied in a variety of studies in the area of IS. <Figure 1> shows TAM.



<Figure 1> Technology Acceptance Model(Davis et al, 1989)

Davis et al. (1989) proposed the technology acceptance model (TAM) for implementation research, based on the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975). Davis's model includes two perceptions, perceived ease of use and perceived usefulness. These perceptions predict attitudes toward using a system. Attitudes predict intentions to use, and intentions predict actual usage.

TAM has seen many applications and extensions in the IS field. Many studies have supported to TAM. Some applications have tested the correlation between new technology usage as predicted by TAM and actual usage behavior (Szanjina, 1996) and self-reports of intended IS usage to actual usage (Straub et al., 1997). TAM has been used to examine adoption differences between genders (Gefen and Straub, 1997), and across diverse cultures (Straub et al., 1997). Other works have sought to extend TAM either by adding additional constructs to the core model (Jackson et al., 1997; Taylor and Todd, 1995) or by pursuing a deeper understanding of the two antecedent constructs that predict behavioral intention (Venkatesh and Davis, 1996). Recently, TAM has been used to assess the individual's behavioral intention to the Internet use (Moon and Kim, 2001; Teo et al., 1999).

2.2. External Factors

This section describes the external factors.

Based on TAM, Davis et al. (1989) proposed that an external factor has an impact on beliefs construct which consist of perceived usefulness and perceived ease of use. TAM proposes that external factors, such as individual, system, and organizational characteristics, will affect behavior (usage) through their effects on the beliefs. Many studies have tested the external variables of TAM (e.g., Agarwal and Prasad, 1999; Hong et al., 2002; Igbaria et al., 1995a; Igbaria et al., 1997; Leder et al., 2000; Lucas and Spittler, 2000; 1999; Venkatesh and Davis, 1996). These studies have supported the effects of the external variables, such as individual characteristics, organizational characteristics, and system characteristics, in order to predict technology acceptance.

2.3. Intrinsic Motivation

This section describes the new factor of the beliefs, which is called perceived playfulness.

Recently, motivation theories have been used to understand individual's IT acceptance behaviors (e.g., Davis et al., 1992; Igbaria et al., 1995b; Moon and Kim, 2001; Teo et al., 2001). Motivation is divided into extrinsic motivation and intrinsic motivation on individual behavior (Deci and Ryan, 1985, Disaw and Strong, 1999).

Intrinsic motivation is defined as a behavior performed for itself, in order to experience pleasure and satisfaction inherent in activity (Deci and Ryan, 1985; Vallerand, 1997). In contrast to extrinsic motivation that is typically associated with the expectation of greater rewards or other instrumental outcomes, intrinsic motivators result in activities becoming autotelic or "an end in themselves" (Csikszentmihalyi, 1990).

Davis et al. (1992) distinguished between perceived usefulness which is an extrinsic motivator and perceived enjoyment which they characterized as intrinsic motivator. Davis et al. (1992) proposed that people expend effort to study included both extrinsic and intrinsic motivation.

Studies of the domain of the Internet show strong relationship between intrinsic motivation (enjoyment/playfulness) and behavioral intention to use (Teo et al., 1999; Moon and Kim, 2001). Igbaria et al. (1995b) found the significant relationship between intrinsic motivation and perceived ease of use, but don't found the significant relationship between intrinsic motivation and behavioral intention in study to computer usage in workplace.

2.4. Social Influence

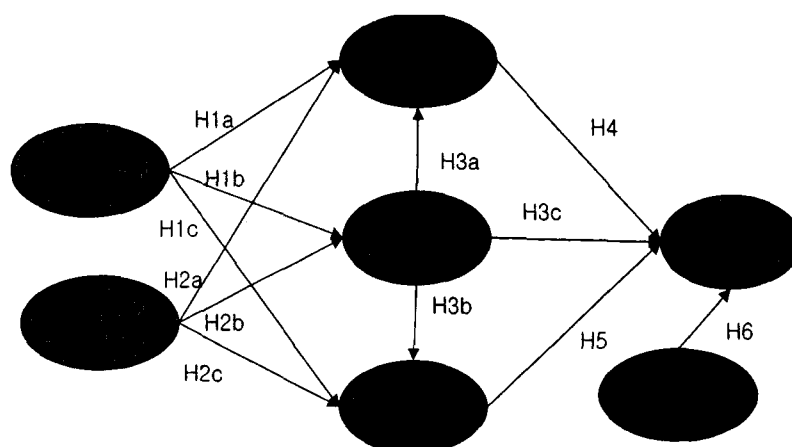
This section describes the social influence related to behavioral intention to IS use.

TAM's referent theory (TRA) includes social influence via a construct called subjective norms.

But TAM excluded this construct due to the theoretical and measurement problems (Davis et al., 1989). Past research in psychology found subjective norms to be an important determinant of intention and/or behavior (Ajzen, 1991). However, although subjective norms can be expected to be important in determining technology acceptance and usage based on TRA and the Theory of Planned Behavior (TPB) (Ajzen, 1985; 1991), empirical evidence supporting the role of this construct has been somewhat unclear. Some researchers have excluded the subjective norms construct (e.g., Adams et al., 1992; Szajna, 1996). Others have found the construct to be non-significant (e.g., Chau and Hu, 2002; Hartwick and Barki, 1994; Mathieson, 1991). Still others have found the construct to be significant (e.g., Lucas and Spittler, 1999; 2000; Parthasarathy and Bhattacharjee, 1998; Taylor and Todd, 1995; Venkatesh and Morris, 2001).

3. Research Model

In the context of the mobile Internet, this research proposes the extension model to TAM, which is consisted of seven constructs: system quality, information quality, perceived playfulness, perceived ease of use, perceived usefulness, social influence, and behavioral intention to use. The follow <figure 2> shows the research model.



<Figure 2> Research Model

3.1. System Quality and Information Quality

System quality is measured by information processing system itself and Information Quality is measured of information output (Delone and Mclean, 1992).

Prior studies have supported that system quality and information quality play a dominant role as IS success (Delone and Mclean, 1992; Doll et al., 1994; Leder et al., 2000; Li, 1997; Liu and Arnett, 2000; Rai et al., 2002; Seddon, 1997; Shok et al., 2000; Teo and Choo, 2001; Zhang and Dran, 2001-2002). Some supported that system quality and information quality are positively related to perceived ease of use and perceived usefulness (Agarwal and Prasad, 1999; Doll et al., 1994; Igbaria et al., 1995a; Rai et al., 2002; Igbaria et al., 1997; Lucas and Spittler, 2000; 1999; Seddon, 1997; Venkatesh and Davis, 1996). Others examined the relationship between information and system quality and beliefs construct in the context of the Internet (Hong et al., 2002, Lederer et al., 2000). System quality and information quality are expected to be the antecedent variables of the beliefs in the context of the mobile Internet.

3.2. Perceived Easy of Use

Perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort." This follows from the definition of "easy": "freedom from difficulty or great effort" (Davis, 1989). Prior studies have supported perceived ease of use is directly or indirectly related to behavioral intention (Davis, 1989; Adams et al., 1992; Venkatesh and Morris, 2000). In the context of the Internet, some researchers also found positive relationship between perceived ease of use and perceived usefulness, perceived playfulness/enjoyment, and usage (Moon and Kim, 2001; Teo et al., 1999). Perceived ease of use is expected to have a positive effect on perceived playfulness, perceived usefulness, and behavioral intention in the context of the mobile Internet.

3.3. Perceived Playfulness

Perceived playfulness is defined as intrinsic belief or motive, which is shaped from the individual's experiences with the environment (Moon and Kim, 2001). Individuals may engage in a particular behavior if it yields fun and enjoyment. This implies that individuals may adopt technology because its use is enjoyable. Recent studies have found that intrinsic motivation is positively related to behavioral intention to WWW (Liu and Arnett, 2000; Moon and Kim, 2001; Teo et al., 1999). Perceived playfulness is also expected to be positively associated with behavioral intention in the context of the mobile Internet.

3.4. Perceived Usefulness

Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). Previous studies find that perceived usefulness strongly influence behavior intention and IT use. Perceived usefulness is also expected to be associated with behavioral intention in Mobile Internet. Perceived usefulness is expected to have a positive effect on behavioral intention in the context of the mobile Internet.

3.5 Social influence

Social influence is the extent to which members of a social network influence on another's behavior (Rice et al., 1990). Many studies have tested the effect of the social influence on the behavioral intention. However, most of them only examined the interpersonal influence, for example, peer, senior, friends, and family. This research includes external influence which is identified as the *secondary sources of information* such as TV and newspaper (Roggers, 1995).

Recent research examined social influence, which consists of interpersonal and external influence (i.e., Parthasarathy and Battacherjee, 1998; Venkatesh and Morris, 2002). These studies show that social influence positively affects behavioral intention. Social influence will also affect behavioral intention in the context of the mobile Internet.

4. Research Methodology

In order to support research model, the survey instrument was developed, based on the prior study on IS. Exploratory factor analysis and Cronbach's alpha test were performed. Then the adjusted research model was proposed by analyzing the results.

4.1. Instrument Development

The survey instrument for this research was developed in two steps. First developed the measurement from prior studies. Second examined pilot test of measurement to university students. Respondents could choose from a 1-to-7 Likert-type scale to indicate the importance of each of the measurement instrument. The instrument also had demographic questions about the subjects.

Based on Lucas and Spilter (2000) and Moon and Kim (2001), the operationalization of the constructs in this model was applied to the specific context of the mobile Internet utilization. <Table 2> shows the items of this study.

<Table 2> Operational Definition of Variables

Constructs	Definitions	Items		References
System Quality	The degree to mobile internet processing system itself	sq_a	Accessibility	Bailey & Pearson 1983, Delone & Mclean 1992
		sq_r	Reliability	
		sq_l/r	Loading/Response Time	
		sq_s	Security	
		sq_i	Interface	
		sq_n	Navigation	
Information Quality	The degree to the output of mobile internet contents	iq_a	Accuracy	Baily&Pearson 1983, Delone&Mclean1992, Doll & Torkzadeh 1998, Doll et al. 1994, Seddon 1997, Lederer et al. 2000, Liu & Atnett2000, Teo & Choo 2001, Rai et al. 2002
		iq_r	Relevance	
		iq_t	Timeliness	
		iq_v	Variety	
Perceived Usefulness	The degree to which a person believes that using the mobile internet would enhance his or her job performance	pu_q	Work more Quickly	Davis et al. 1992
		pu_p	Job Performance	
		pu_e	Make job easier	
		pu_u	Usefulness	
Perceived Ease of Use	the degree to which a person believes that using the mobile internet would be free of effort	peou_el	Easy to learn	Davis et al. 1992
		peou_c	Controllable	
		peou_s	Become Skillful	
		peou_eu	Easy of Use	
Perceived Playfulness	The degree to intrinsic belief or motive	pp_con	Concentration	Moon & Kim 2000
		pp_e	Enjoyment	
		pp_curi	Curiosity	
Social Influence	the degree to which members of a social network influence one another's behavior	si_i	Interpersonal Influence	Barthasaraty & Bhattacharjee 1998, Venkatech & Brown 2002
		si_e	external Influence	

4.2. Subjects

The purpose of this study is to demonstrate individual's mobile Internet acceptance by extending the technology acceptance model (TAM) to the field of the mobile. Therefore,

Individuals chosen were those who have used the mobile Internet. And internet survey method was employed for the survey. A total of 1082 data were respond to the survey a period of one week and the effective data of 953 were selected. <Table 3> summarizes the demographic characteristics of the respondents.

<Table 3> Demographic Characteristics

Category		Frequency	Percent(%)
Sex	Male	497	52.2
	Female	456	47.8
Year	Below 20	46	4.8
	20-24	261	27.4
	25-29	310	32.5
	30-34	208	21.8
	35-39	71	7.5
	above 40	57	6.0
Level of Education	In middle/high school	39	4.1
	High school	89	9.3
	University	724	76.0
	Graduate	101	10.6
Occupation	Middle/high school student	39	4.1
	University/graduate student	254	26.7
	Salesman	348	36.5
	Special	109	11.4
	A self-employed person	40	4.2
	Others	163	17.1
Total		953	100

4.3. Validity and Reliability

In order to support the validity of scale, a factor analysis with Varimax rotation was performed. The results extracted six constructs, which were consisted of system quality, information quality, perceived ease of use, perceived usefulness, perceived playfulness, and behavioral intention, but excluded the social influence construct. Items of factor loadings below 0.5 were also omitted. <Table 4> shows the results of the factor analysis.

<Table 4> Results of Factor Analysis

Constructs		Factors					
		1	2	3	4	5	6
System Quality	sq_i	0.786					
	sq_n	0.727					
	sq_lr	0.635					
	sq_s	0.515					
	sq_r	0.501					
	si_r	-					
Information Quality	iq_t		0.661				
	iq_a		0.619				
	iq_r		0.588				
	iq_v		0.577				
	sq_a		-				
Perceived Usefulness	pu_e			0.782			
	pu_p			0.780			
	pu_u			0.638			
	pu_q			0.603			
Perceived Ease of Use	peou_s				0.815		
	peou_eu				0.798		
	peou_el				0.621		
	peou_c				0.558		
Perceived Playfulness	pp_e					0.767	
	pp_curi					0.646	
	pp_con					0.595	
	si_m					-	
Behavior Intention	bi_c						0.816
	bi_f						0.627
Eigen value		9.166	1.347	2.241	1.653	1.176	1.068
Extraction Method: Maximum Likelihood,		Rotation Method: Varimax with Kaiser Normalization					

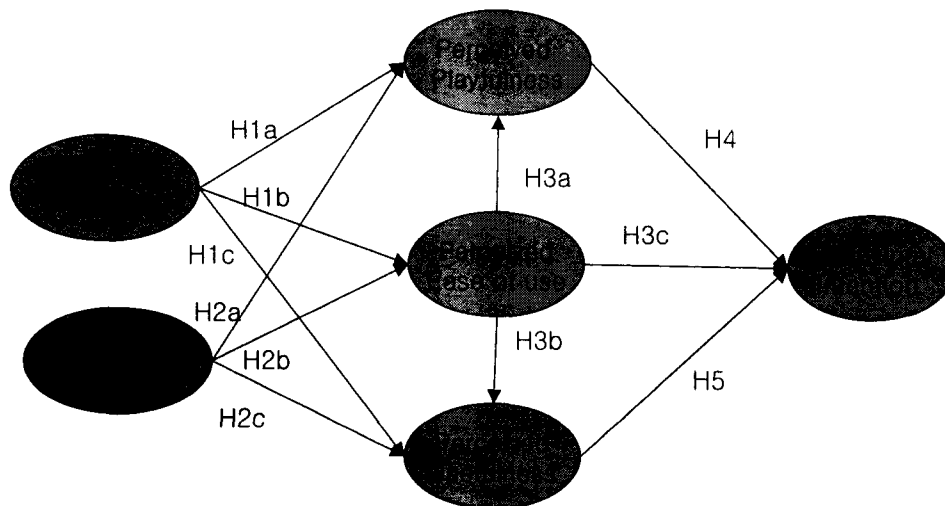
In order to ensure that the variables comprising each proposed research construct were internally consistent, reliability assessment was carried out using Cronbach's alpha. The internal consistency reliability coefficients for the research constructs in this study are all well above the 0.80 level. The Cronbach's alpha values indicated a satisfactory reliability by a widely used rule of thumb of 0.60 suggested by Nunnally (1978).

<Table 5> Reliability

Factors	Item	Cronbach's alpha
system quality	5	0.8264
information quality	4	0.8333
perceived usefulness	4	0.8765
perceived ease of use	4	0.8625
perceived playfulness	3	0.8037
behavior intention	2	0.9083
social influence	2	excluded

4.5. Adjusted Research Model and Hypotheses

The adjusted research model excluded social influence construct was indicated to propose and examine the actual hypotheses. <Figure 3> shows the adjusted research model.



<Figure 3> Adjusted Research Model

According to the adjusted research model, we propose the following hypotheses:

Hypothesis 1a. System quality will be directly related to perceived playfulness in the mobile Internet.

Hypothesis 1b. System quality will be directly related to perceived ease of use in the mobile Internet.

Hypothesis 1c. System quality will be directly related to perceived usefulness in the mobile Internet

Hypothesis 2a. Information quality will be directly related to perceived playfulness in the mobile Internet.

Hypothesis 2b. Information quality will be directly related to Perceived ease of use in the mobile Internet.

Hypothesis 2c. Information quality will be directly related to perceived usefulness in the mobile Internet.

Hypothesis 3a. Perceived ease of use will be directly related to perceived playfulness in the mobile Internet.

Hypothesis 3b. Perceived ease of use will be directly related to perceived usefulness in the mobile Internet.

Hypothesis 3c. Perceived ease of use will be directly related to the behavioral intention in the mobile Internet.

Hypothesis 4. Perceived playfulness will be directly related to behavioral intention in the mobile Internet.

Hypothesis 5. Perceived usefulness will be directly related to the behavioral intention in the mobile Internet.

5. Analysis

This chapter examined the research model fitness and hypotheses by using LISREL 8.12.

5.1. Research Model Analysis

A confirmatory factor analysis using LISREL 8.12 was conducted to test the measurement model.

Structural equation model is difficult to use the only one measurement values the fit of the research model. Therefore, many studies proposed the various measurement indices (i.e., Bentler and Bonett, 1980; Fornell, 1983; Hayduk, 1987). The fit of the overall measurement was estimated by the various indices provided by using LISREL 8.12. χ^2 statistic was not used because of its sensitivity to large sample size.

The goodness-of-fit (GFI) and adjusted goodness-of-fit (AGFI) were 0.909 and 0.882, respectively. The normalized fit index (NFI), non-normalized fit index (NNFI), and comparative fit index (CFI) are three other indices of fit. Values generally range from 0 to 1, with values greater than 0.9 representing reasonable model fit. For the measurement model, we observed values of 0.914, 0.915, and 0.929 for NFI, NNFI, and CFI, respectively, all indicating good model fit.

Finally, root mean square residual (RMR) provides an indication of the proportion of the variance not explained by the model, whereas root mean square error of approximation (RMSEA) describes the discrepancy between the proposed model and the population covariance matrix. RMR and RMSEA were 0.0852 and 0.0687, respectively, which were within the recommended cutoff values of 0.10 (RMR) and 0.08 (RMSEA) for good fit (Byrne, 1998).

A similar set of fit indices was used to examine the structural model <Table 6>. Comparison of fit indices with their corresponding recommended values provided evidence of a good model fit (GFI = 0.904, AGFI = 0.877, NFI = 0.909, NNFI = 0.910, CFI = 0.904, RMR = 0.0965, RMSEA = 0.0706). This leads the structural model in this research to be an adequate model fit.

<Table 6> Fit Indices for Structural Model

Fit Indices	Recommended Value	Measurement Model	Structural Model
Goodness-of-fit(GFI)	≥0.90	0.909	0.904
Adjusted goodness-of-fit(AGFI)	≥0.80	0.882	0.877
Normalized fit index(NFI)	≥0.90	0.914	0.909
Non-normalized fit index(NNFI)	≥0.90	0.915	0.910
Comparative fit index(CFI)	≥0.90	0.929	0.904
Root mean square residual(RMR)	≤0.10	0.0852	0.0965
Root mean square error of approximation(RMSEA)	≤0.08	0.0687	0.0706

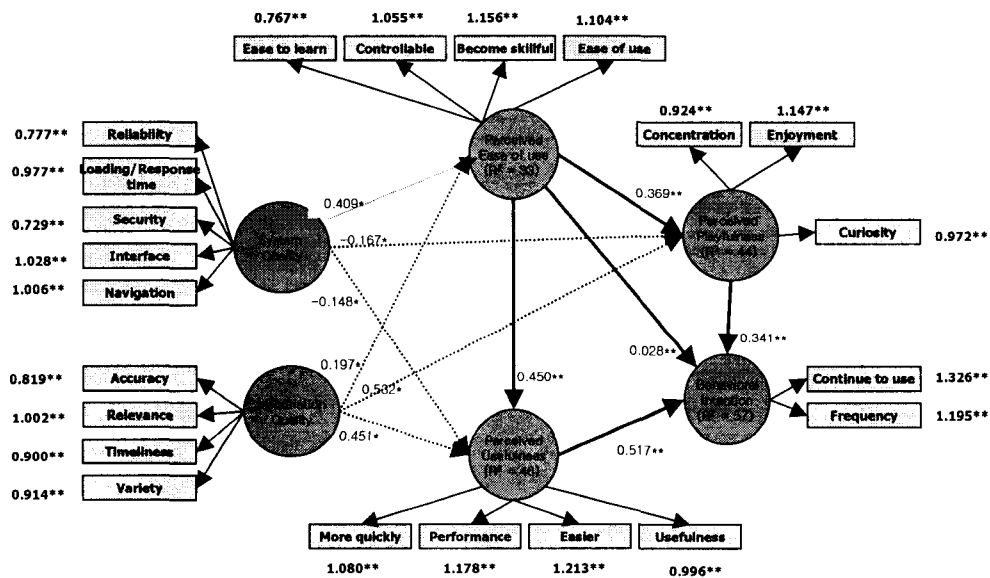
5.2. Hypotheses Testing

In this section, we examined the hypotheses of the structural model. <Table 7> and <Figure 4> show the results of hypotheses testing.

<Table 7> Hypotheses Testing

		Hypotheses	Beta	t-value(p-value)	R ²
Perceived Ease of Use	System Quality	H1b	0.409*	7.012(0.058)	0.325
	Information Quality	H2b	0.197*	3.351(0.056)	
Perceived Usefulness	Perceived Ease of Use	H3b	0.450**	10.798(0.042)	0.458
	System Quality	H1c	-0.148*	-2.638(0.056)	
	Information Quality	H2c	0.451*	7.961(0.057)	
Perceived Playfulness	Perceived Ease of Use	H3a	0.369**	8.661(0.043)	0.444
	System Quality	H1a	-0.167*	-2.796(0.060)	
	Information Quality	H2a	0.532*	8.551(0.060)	
Behavioral Intention	Perceived Ease of Use	H3c	0.0281**	0.746(0.038)	0.570
	Perceived Usefulness	H5	0.0517**	12.426(0.042)	
	Perceived Playfulness	H4	0.341**	9.089(0.038)	

Note: ** p < 0.05, *p < 0.10; Beta: standardized coefficients



Note: ** p < 0.05, * p < 0.10

<Figure 4> Path Diagram

As indicated in <Table 7>, some hypotheses were supported at 0.05 significant level, others, system quality and information quality(weakly supported, p < 0.10), were not supported at 0.05 significant level.

As for the paths from the external variables to TAM constructs, all of system and information quality's six hypotheses, H1a to H2c, were not supported for perceived usefulness, perceived ease of use, and perceived playfulness at 0.05 significant level. But hypotheses H1a to H2c were weakly supported at 0.10 significant level. System quality had a negative effect on perceived playfulness ($\beta = -0.167$) and perceived usefulness ($\beta = -0.148$) but had a positive effect on perceived ease of use ($\beta = 0.409$). Information quality had a positive effect on perceived playfulness ($\beta = 0.532$), perceived usefulness ($\beta = 0.451$), and perceived ease of uses ($\beta =$

0.197).

As expected, perceived ease of use had a positive effect on perceived playfulness ($\beta = 0.369$, H3a) and perceived usefulness ($\beta = 0.450$, H3b), respectively. H3c, H4 to H5 were supported in that all of them had a significantly positive effect on behavioral intention at 0.05 significant level. Altogether, they accounted for 57 percent of the variance in behavioral intention with perceived usefulness ($\beta = 0.517$) contributing more to intention than perceived playfulness ($\beta = 0.341$) and perceived ease of use ($\beta = 0.028$). And the total effect of perceived ease of use on behavioral intention was 0.177 ($=0.028 + 0.369 \times 0.341 + 0.450 \times 0.517$). Even after the indirect was accounted for, perceived usefulness still had a stronger explanatory power of the intention to use the mobile Internet than perceived ease of use.

6. Research Findings

In order to understand the user's behavioral intention to mobile Internet use, this research proposed a theoretical model and examined this model.

System characteristics are recognized as another category of external variables that are capable of influencing user's intention to adopt new IS. Davis et al. (1989) proposed that effects on perceived usefulness in addition to indirect effects via perceived ease of use. Prior research on TAM has supported this argument by showing that system characteristics can significantly affect the intention to use IS via beliefs from the users (Lederer et al., 2000; Hong et al., 2001-2002).

Lederer et al. (2000) found that information quality has a significant effect on perceived usefulness and system quality has a significant effect on perceived ease of use in WWW. Hong et al. (2001-2002) examined the system characteristics such as relevance, terminology, and screen design in digital library. The result was that the relevance related to information quality had a positive effect on perceived usefulness and perceived ease of use. But terminology and screen design, which are similar to system quality, only had a positive effect on perceived ease of use.

However, contrary to the results from the previous research, this research showed that system quality and information quality were not significant for the beliefs at the 0.05 significant level. While system quality and information quality weakly supported to the beliefs at the 0.10 significant level. System quality only had a positive effect on perceived ease of use and information quality had a positive effect on perceived ease of use, perceived usefulness, and perceived playfulness. According to path coefficients, information quality had a strongest effect on perceived playfulness, then perceived usefulness and perceived ease of use.

Igbaria et al. (1995b) examined intrinsic motivation, that is, perceived enjoyment at the computer use in workplace. They argued that perceived ease of use has an effect on perceived enjoyment. But perceived enjoyment has a non-significant effect on behavioral intention. Teo et al. (1999) said that perceived ease of use can influence perceived usefulness and perceived enjoyment, and the beliefs has a positive effect on Internet usage. Teo et al. (1999) were supported by Moon and Kim (2001) where intrinsic motivation which is playfulness has a strong effect on behavioral intention to WWW.

The results of this paper were also similar to these prior research (Teo et al., 1999; Moon and Kim, 2001) in that perceived ease of use, perceived usefulness, and perceived playfulness had a positive effect on users' behavioral intention to mobile Internet use.

According to the path coefficients, Perceive ease of use had a strongly effect on perceive playfulness and perceived usefulness but had a weekly effect on behavioral intention at the 0.05 significant level. This result shows that users' behavioral intention is more strongly made by perceived usefulness and perceived playfulness than perceived ease of use. Perceived playfulness had a strong effect on behavioral intention in the context of the mobile Internet. This means that the intrinsic motivation plays a prominent role to behavioral intention.

We found that the intrinsic motivation as well as extrinsic motivation played a key role to behavioral intention in the context of the mobile Internet.

7. Conclusions

The purpose of this study is to extend the technology acceptance model (TAM) to the field of the mobile Internet.

Applying the extension to the technology acceptance model as a theoretical framework, critical external variables consisting of system quality and information quality turned out to have a non-significant effect on the intention to use the mobile Internet via perceived usefulness, perceived ease of use, and perceived playfulness at the 0.05 significant level. However, beliefs constructs had a significant effect on behavioral intention to use the mobile Internet.

The contributions of this study are twofold. First, TAM was successfully applied to the field of the mobile Internet, which is quite different field from the previous research. Perceived ease of use, perceived playfulness, and perceived usefulness were found to be significant antecedents of the behavioral intention to mobile Internet use. Second, we found intrinsic motivation, which is perceived playfulness, is a important determinant of behavioral intention to mobile Internet use.

Although our findings provide meaningful contributions for the mobile Internet, our research has some limitations. First, the prominent characteristic of the mobile Internet such as accessibility, which means access to the mobile Internet at anywhere and anytime, was excluded by factor analysis because the variable of system characteristics was divided into just two constructs. Second, social influence construct was also excluded because of the problem of measurement variables. Third, we excluded actual usage behavior in the proposed model.

Future research may include the social influence into the research model. Second, system quality and information quality are classified in detail. Third, we can apply the research model proposed in this paper in the workplace environment.

References

- Adams, D., R. Nelson, and P. Todd, "Perceived Usefulness, Ease of Use, and Usage of Information Technology: A Replication," *MIS Quarterly* (16:), 1992, pp. 227~247.
- Agarwal, Ritu, Elena Karahanna, "Time Flies When You're Having Fun: Cognitive Absorption and Beliefs about Information Technology Usage," *MIS Quarterly* (24:4), 2000, pp. 665~694.
- Agrwal, Ritu and Jayesh Prasad, "Are Individual Differences Germane to the Acceptance of New Information Technologies?," *Decision Sciences* (30:2), 1999, pp. 361~391.
- Ajzen, I. "From intentions to Actions: a Theory of Planned Behavior," in *Action Control: From Cognition to Behavior*, J. Kuhl and J. Beckmann(eds.), Springer Verlag, New York, 1985, pp. 11~39
- Ajzen, I. "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Process* (50), 1991, pp. 179~211.
- Ajzen, I., and Fishbein, M., *Understanding Attitude and Predicting Social Behavior*, Prentice-Hall, Englewood Cliffs, NJ, 1980.
- Anderson, J. C. and D. W. Gerbing, "Structural Equation Modeling in Practice: a Review and Recommended Two-step Approach," *Psychological Bulletin* (103:3), 1988, pp. 411~423.
- Bailey, James E. and Sammy W. Pearson, "Development of a Tool for Measuring and Analyzing Computer User Satisfaction," *Management Science* (29:5), 1983, pp. 530~535.
- Bagozzi, Richard P., Fred D. Davis, Paul R. Warshaw, "Development and Test of a Theory of Technological Learning and Usage," *Human Relations* (45:7), 1992, pp. 659.
- Bentler, P. M. and D. G. Bonett, "Significance Tests and Goodness of Fit in the Analysis of Covariance Structure, *Psychology Bulletin* (88), 1980, pp. 588~606.
- Byrne, B. M., *Structural Equation Modeling with LISREL, PRELIS, and SIMPLIS Basic Concepts, Applications, and Programming*. Mahwah, NJ: Lawrence Erlbaum, 1998.
- Carmines, E. G. and J. P. McIver, *Analysing models with unobserved variables: Analysis of covariance structures*. In G. W. Bohrnstedt and E. F. Borgatta (Eds.), *Social Measurement: Current Issues*. Newbury Park, CA: Sage, 1981, pp. 185~110.
- Chau, Patrick Y.K and Paul Jen-Hwa Hu, "Investigating Healthcare Professionals' Decisions to Accept Telemedicine Technology: Empirical Test of Competing Theories," *Information & Management* (39), 2002, pp. 297~311.
- Csikszentmihalyi, M., *Flow: The Psychology of Optimal Experience*, Harper and Row, New York, 1990.
- Davis, Fred D., "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* (13:), 1989, pp 319~340.
- Davis, Fred D., Bagozzi, R. P., and Warshaw, P.R., "User Acceptance of Computer Technology: a Comparison of Two Theoretical Models," *management Science* (35:8), 1989, pp. 982~1003.
- Davis, Fred D., Bagozzi, R.P., and Warshaw, P.R., "Extrinsic and Intrinsic Motivation to Use Computers in the Workplace," *Journal of Applied Social Psychology* (22), 1992, pp. 1111~1132.
- Deci, E. L., and R. M. Ryan, *Intrinsic Motivation and Self-determination in Human Behavior*, Plenum, New York, 1985.

- Delone, William H., and Ephraim R. Mclean, "Information Systems Success: The Quest for the Dependent Variable," *Information Systems Research* (3:1), 1992, pp. 60~95.
- Dishaw, M. T. and D. M. Strong, "Extending the Technology Acceptance Model with Task-technology Fit Constructs," *Information & Management* (36:1), 1999, pp. 9~21.
- Doll, William J., Weidong Xia and Gholamreza Torkzadeh, "A Confirmatory Factor Analysis of the End-User Computing Satisfaction Instrument," *MIS Quarterly* (18:), 1994, pp. 453~461.
- Fornell, C. A., *Second Generation of Multivariate Analysis, Volume 1: Methods*, New York: Praeger special Studies, 1982.
- Fornell, C. A. and D. F. Larcker, "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research* (18:1), 1981, pp. 39~50.
- Fishbein, M., and I. Ajzen, *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesley, Reading, MA, 1975.
- Gefen, D., Detmar W. Straub, "Gender Differences in the Perception and Use of E-mail: an Extension to the Technology Acceptance Model," *MIS Quarterly* (21:4), 1997, pp. 389~400.
- Hair, J. T., R. E. Anderson, R. L. Tatham, and W. C. Black, *Multivariate Data Analysis with Readings*, 3d ed. New York: Macmillan, 1992
- Harkwick, J., and H. Barki, "Explaining the Role of User Participation in Information System Use," *Management Science* (40), 1994, pp. 440~465.
- Hayduk, I. A., *Structural Equation modeling with LISREL*, Johns Hopkins Press, 1987.
- Hong, W., James Y.L. Thong, Wai-Man Wong, and Kar-Yan Tam, "Determinants of User Acceptance of Digital Libraries: An Empirical Examination of Individual Differences and System Characteristics," *Journal of Management Information Systems* (18:3), 2001~2002, pp. 97~124.
- Igbaria, M., Tor Guimaraes, and Gordon B. Davis, "Testing the Determinants of Microcomputer Usage via a Structural Equation Model," *Journal of Management Information Systems* (11:4), 1995a, pp 87~114.
- Igbaria, M., Juhani Iivari, and Hazem Maragahh, "Why Do Individuals Use Computer Technology? A Finnish Case Study," *Information and Management* (29), 1995b, pp 227~238.
- Igbaria, M., N. Zinatelli, P. Cragg and A. Cavaye, "Personal Computing Acceptance Factors in Small Firms: A Structure Equation Model," *MIS Quarterly* (21:), 1997, pp 279~305.
- Intermarket Group, *Mobile Wireless Internet Briefing: a guide to the marketplace technologies & solutions*, Intermarket Group, August 2001.
- Jackson, C.M., S. Chow and R.A. Leitch, "Toward an Understanding of the Behavioral Intention to Use an Information System," *Decision Sciences* (28:2), 1997, pp 357~389.
- Lai, Arun, Sandra S. Lang, and Robert B. Welker, "Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis," *Information Systems Research* (13:1), 2002, pp. 50~69.
- Lederer, Albert I. and Donna J. Maupin, Mark P. Sena, Young Zhuang, "The Technology Acceptance Model and the World Wide Web," *Decision Support Systems* (29:3), 2000, pp.269~282.
- Li, Eldon Y, "Perceived Importance of Information System Success Factors: A Meta Analysis of Group Differences," *Information and Management* (32), 1997, pp. 15~28.

- Liu, C., and K.P. Arnett, "Exploring the Factors Associated with Web Site Success in the Context of Electronic Commerce," *Information & Management* (38), 2000, pp. 23 ~ 33.
- Lucas, Henry C. and V. Spitler, "Technology Use and Performance: a Field Study of Broker Workstations," *Decision Sciences* (30:2), 1999, pp. 291 ~ 311.
- Lucas, Henry C. and V. Spitler, "Implementation in a World of Workstations and Networks," *Information & Management* (38), 2000, pp. 119 ~ 128.
- Mathieson, K., "Predicting User Intentions: Comparing the Technology acceptance Model with the Theory of Planned Behavior," *Information Systems Research* (2), 1991, pp 173 ~ 191.
- Moon, J.W and Y.G Kim, "Extending the TAM for a WWW Context," *Information & Management* (38), 2001, pp. 217 ~ 230.
- Nunnally, J. C., *Psychometric Theory, 2nd Edition*, McGraw-Hill, New York, 1978.
- Parthasarathy, Mdhavan and Anol Bhattacharjee, "Understanding Post-Adoption Behavior in the Contest of Online Services," *Information Systems Research* (9:4), 1998, pp. 362 ~ 379.
- Rai, Arun, Sandra S. Lang, and Robert B. Welker, "Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis," *Information Systems Research* (13:1), 2002, pp. 50 ~ 69.
- Rice, R. E., Grand, A. E., Schmitz, J., and Torobin, J., "Individual and Network Influences on the Adoption and Perceived Outcomes of Electronic Messaging," *Social Networks* (12:1), 1990, pp. 27 ~ 55.
- Rogger, M. E., *Diffusion of Innovation(4th ed.)*, Free Press, New York, 1995.
- Seddon, Peter B., "A Respecification and Extension of the DeLone and Mclean Model of IS Success," *Information Systems Research* (8:3), 1997, pp 240 ~ 253.
- Skok, W., Andrew K., and Ian R., "Diagnosing Information Systems Success: Importance-Performance Maps in the Health Club Industry," *Information and Management* (38), 2001, pp 409 ~ 419.
- Straub, D., M. Limayem and E. Karahanna Evaristo, "Measuring System Usage: Implications for IS Theory Testing," *Management Science* (41:4), 1995, pp 1328 ~ 1342.
- Straub, D., Make Keil, and Walter Brenner, "Testing the Technology Acceptance Model across Cultures: A Three Country Study," *Information and Management* (33), 1997, pp 1 ~ 11.
- Szajna, B., "Empirical Evaluation of the Revised Technology Acceptance Model," *Management Science* (42:1), 1996, pp 85 ~ 92.
- Taylor, Shirley and Peter A. Todd, "Understanding Information Technology Usage: A Test of competing Models," *Information Systems Research* (6:2), 1995, pp. 144 ~ 176.
- Teo, Thompson S. H., Vivien K. G. Lim, Raye Y. C. Lai, "Intrinsic and Extrinsic Motivation in Internet Usage," *Omega, The International Journal of management Science* (27), 1999, pp. 25 ~ 37.
- Teo, Thompson S. H., and Wing Yee Choo, "Assessing the Impact of Using the Internet for Competitive Intelligence," *Information and Management* (39), 2001, pp. 67 ~ 83.
- Vallerand, R. J., "Toward a Hierarchical Model of Intrinsic and Extrinsic Motivation," *Advances in Experimental Social Psychology* (29), 1997, pp. 271 ~ 374.
- Venkatesh., V. and F. Davis, "A Model of the Antecedents of Perceived Ease of Use: Development and Test," *Decision Science* (27), 1996, pp 451 ~ 481.
- Venkatesh., V. and F. Davis, "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field," *Management Science* (46:2), 2000, pp. 172.

- Venkatesh, V. and Michael G. Morris, "Why don't men ever stop to ask for directions? Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior," *MIS Quarterly* (24:21), 2000, pp. 115~139.
- Venkatesh, V. and Susan A. Brown, "A Longitudinal Investigation of Personal Computer in Homes: Adoption Determinants and Emerging Challenges " *MIS Quarterly* (25:1), 2001, pp. 71~103.
- Webster EJ., and J.J. Martocchio,, "Microcomputer Playfulness: Development of a Measure with Workplace Implications," *MIS Quarterly* (16:1), 1992, pp. 201~224.
- Zhang, P. and Gisela M. Von Dran, "User Expectations and Rankings of Quality Factors in Different Web Site Domains," *International Journal of Electronic Commerce* (6:2), 2001-2002, pp. 9~33.