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What Determines Actual Use of Mobile Web Browsing Services? A Contextual Study in Korea

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Abstract:

The use of mobile Web browsing services is a worldwide phenomenon. The intent of this research is to produce a testable model of Web browsing services use that both identifies unique national market differences and yet is theoretically parsimonious enough to permit future cross-national studies. Specifically, our model examines which factors determine the use of mobile Web browsing services in South Korea. We show that content quality, hardware quality, ubiquity, cost, and relational factors are important predictors of actual use of mobile Web browsing services. However, counter to our model's predictions, network quality and security did not appear to be significant factors in Korea at this point of market maturity. Future empirical examination of the proposed model in different markets worldwide should provide multinational IT vendors with better understanding of the similarities and differences in the global smart phone business.

Keywords: mobile Web browsing service; actual use; unique market differences; content quality; system quality; service quality; perceived cost; subjective norm

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I. INTRODUCTION

With the development of wireless telecommunication infrastructures, mobile devices, and related software technologies, it has become possible to provide mobile Web browsing services quite similar to the Web browsing services provided in the wired Internet environment. Although cell phone manufacturers initially sought market growth through unique feature phones with differentiated functions such as camera, music player, and TV phones, they are now focusing their effort on smart phones that not only offer a multi-feature platform but also facilitate Web browsing. Large portal sites are now providing user interfaces (UI) and content modified for mobile environments. Diverse content providers, such as the "App Store" of Apple, deliver innovative products to mobile Web browsers, and social media companies like Twitter have created entirely new markets with such uses as micro-blogging.

While the global corporate winners in this mobile Internet era are still in flux, platform vendors like Apple, Google, and content providers have been leading the global market [Morgan Stanley, 2009]. As such, the structure of the mobile industry in South Korea, like other national markets, is changing rapidly, and the understanding of mobile users' attitudes, interests, and usage behavior is a major business challenge. Reflective of this dynamic business environment, Korea Telecom merged with KTF (the wireless telecom provider), and LG Telecom recently changed their company name to LG U+ after merging with LG Powercom (an Internet broadband services company). As the voice call-oriented business model changes to fixed-mobile convergent services, the three major South Korean players, Korea Telecom, LG U+, and SK Telecom, are each challenged to understand their mobile Web browsing market and to offer appropriate bundles of services at the best price.

Although Korea is often recognized as an "early adopter" country in many aspects of IT Infrastructures, this is not the case in the area of mobile Internet. According to Korea Communications Commission's report, the percentage of consumers using wireless data in South Korea was 17 percent of the total communication volume as of the fourth quarter of 2009, while the percentage in Japan rapidly increased to 41 percent and that of the USA reached 26 percent [Kim, 2010].[1] With the more recent introduction of the iPhones and other smart phones distributed by Korea Telecom, the Korean telecommunications and content vendors expect heightened market attention on full mobile Web browsing services. However, introduction of full browsing services means changes in the structure of the Korean mobile business with telecom companies converting to an open model [Kim, 2009]. In other words, it means a switch from WAP-based closed mobile Internet to open, full browsing mobile Internet services.

Past studies have shown South Korea as a test bed to examine user IT adoption behaviors [e.g. Cheong and Park, 2005; Kim and Garrison, 2009; Lee et al., 2009]. For example, a previous study on high-speed broadband Internet shows more rapid penetration in Korea than that of other countries [Park and Yoon, 2005]. In terms of the wired Internet and wireless voice-call markets, Korea is a world leader; the market size of telecommunication industry reached about USD 31.5 billion a year, and the penetration rate of mobile phones is projected to have reached over 101 percent in 2010 [KT Research Center, 2009]. Many global IT vendors have released their new products and services in Korea before entering global major markets to test and get critical feedback. For example, Microsoft's instant messenger, Intel's laptop, and Motorola's cellular phone were first launched in Korea based on the assumption that if the products/services were well accepted by Korean customers, they would likewise be well received in other national markets [Kwon, 2006].

Along with the general belief as early IT adopters, Korean IT users are also known to have unique and cultural characteristics in IT usage behaviors that may be different from general user behaviors of adoption and usage worldwide. Past studies have identified Koreans as more "intellectually curious about new IT," "having a strong desire to show off with IT devices," but also "possessing a trend-sensitive collectivism" [Kwon, 2006]. For example, global online services like Second Life, Google, Myspace have not been widely popularized in Korea owing to the existence of preferred local companies, such as Naver and Cyworld, providing similar services. This phenomenon seems to be strengthened by a general tendency of Korean companies to prefer homegrown and locally-customized IT services over global packages [Boyd and Ellison, 2007; Cho, 2009]. The adoption and usage patterns of IT are often influenced by such cultural or national characteristics, as well as the inherent characteristics of the specific

[1] The diffusion of Web browsing smart phones has brought changes to usage behaviors and a great upward change in the Average Revenue per User (ARPU) of mobile data services. For example, while the proportion of data services of average cell phone users in the USA is 30 percent of the total communication volume, that of iPhone (full Web browsing capable) users is 55 percent of the total communication volume [Morgan Stanley, 2009].

technology. Mobile Web browsing services would seem to be a technology particularly influenced by national aspects such as strategies of local telecom companies and those of handset manufacturers, public policies, and regulations. Hence, understanding the unique national differences that predict the adoption and use of mobile Web browsing services is important to global telecommunication vendors and global content providers interested in penetrating into unique national markets.

The effect of these apparent unique cultural and/or national characteristics on actual use of Web services, in part, motivated this study, as global telecommunications companies must navigate the similarities and differences in usage preferences of local markets as they adopt service models from other countries and/or move to offer services across borders. Thus, the purpose of this study is to analyze the effects of factors affecting the post-adoptive use of mobile Web browsing services, such as the quality of content, system, and service in the Korean market.

The research model is developed through extensive literature review on IT adoption worldwide but empirically tested through a survey of users of mobile Web browsing services in South Korea. Specifically, variables that might reflect similarities and differences in use of mobile Web browsing services across countries were theoretically framed, based on the DeLone and McLean's Updated Information System Success Model [DeLone and McLean, 2003] and the Theory of Reasoned Action (TRA) of Fishbein and Ajzen [1975, 1980]. The ultimate intent was to produce a testable model that would both identify unique market differences and be externally valid enough to permit future comparative studies in other country contexts. Validation of findings from this Korean study set the stage for further global application to predict actual use of mobile Web browsing services in different national and regional markets.

The article is structured as follows: First, the previous studies of mobile Web browsing services and underlying theories are introduced. Then, our research model and hypotheses are presented, and the research methodology including measurements and samples are introduced. Finally, we present the validity of the measurement model and the results of hypotheses testing, followed by a discussion of the research outcomes and practical implications.

II. CONCEPTUAL AND THEORETICAL BACKGROUND

Mobile Web Browsing Services

Mobile Internet shows important, and sometimes unique, features, including accessibility, ubiquity, security, convenience, location-based service, instant connectivity, and personalization [Lee et al., 2009; Monthly on the Net, 2000]. Some issues, such as accessibility and security, can also be found in the fixed Internet; however, characteristics like ubiquity and location-based service are fairly distinct from the fixed Internet [Park and Koo, 2001].

In this study, mobile Web browsing is narrowly defined as "services that enable users to send/receive content using mobile Web browsers embedded in mobile phones in a similar fashion to Web browsing over the fixed Internet." In this regard, we do not include in our definition earlier closed mobile Web services using WAP (wireless application protocol) or mobile data services such as MMS (multimedia messaging service) and downloading ringtones or ring-back. Mobile Web browsing services have advantages over WAP and these earlier services by better permitting users to access the Internet anytime, anywhere, and surf even while moving. Of course, some technical differences exist between fixed Internet and mobile Web browsing that would affect several aspects of content and system quality.

In the USA, which leads global markets in terms of the number of mobile Internet users and sales volume, Research in Motion's "Blackberry" pioneered the development of mobile data services by supporting convenient e-mailing through the mobile device. The launching of 3G iPhone by Apple brought about a new epoch of mobile Internet services. Around 40 percent of new subscribers of AT&T in the first quarter of 2009 were iPhone subscribers, and as a result, the ARPU (Average Revenue per User) of AT&T increased by as much as 26.8 percent in this period compared to the end of the previous year [Kim, 2010]. Japan, another leading country in the mobile industry, succeeded in activating mobile data services through the formation of content markets specialized in mobile phones.

Alternatively, Korean wireless telecom providers have been slower to transit from the infrastructure-oriented environment of the past to platform and content-oriented structures. The consequence is that mobile data services, including mobile Internet, have not been popularized in Korea to the same degree as other telecom leading countries due to an adherence to closed-systems approaches (e.g., WAP) that restrict use. Under these WAP system, users can access only pre-defined content provided by the telecom companies, and users are restricted to go through only the networks of the telecom companies they subscribe to. Content tended to be simple and text-centered, with expensive data usage charges based on measured rate systems. However, 3G iPhones began to be distributed by Korea Telecom in late 2009. The switch from WAP-based closed mobile Internet to open, full browsing mobile Internet services is now being recognized as enabling users to access to huge amounts of information anywhere and anytime through their mobile devices. With these advances, it is expected that the Korean mobile

industry will follow the global trend such as the adoption of the FMC (Fixed Mobile Convergence), a flat-rate system, and full browsing-based business models [Kim, 2009].

Theoretical Basis of the Research Model

Many theories explain the reasons why users adopt and use new technologies, which have been validated by empirical studies. The Theory of Reasoned Action (TRA) of Fishbein and Ajzen [1975, 1980] and the updated Information System Success Model of DeLone & McLean [2003] are two widely referred theories and are adopted as theoretical backgrounds of this study in order to examine factors that affect actual use of mobile Web browsing.

Theory of Reasoned Action (TRA)

TRA is a theory that has been widely studied in social psychology; it argues that an individual's behaviors are determined by behavioral intention, and behavioral intention is determined by the individual's attitudes and subjective norms toward certain behaviors. Advantages of TRA are that it nomologically positions and explains how the beliefs, evaluations, and subjective beliefs are related to other variables. In addition, it uses a small number of compositional concepts in predicting and explaining behaviors and has been proved in diverse contexts of the IS area [e.g. Ajzen, 2001; Chang, 1998; Karahanna and Limayem, 2000; Taylor and Todd, 1995]. However, since this social psychology-based theory uses the somewhat abstract concepts, beliefs, and evaluation as factors affecting attitudes, other external factors suitable to the context of each study should also be considered.

DeLone and McLean's Updated IS Success Model

DeLone and McLean [1992] synthesized existing theoretical studies and empirical studies of Information Systems to present a research model for the success of Information Systems. They presented six important factors for Information System success including system quality, information quality, use, user satisfaction, individual impact, and organizational impact. In 2003, DeLone and McLean updated their 1992 model to include service quality as an independent variable. The updated IS success model is intended to adapt to changing e-commerce environments, and in this model the quality of information systems consists of three factors, including system quality, information quality, and service quality.

According to this theory, the three variables, system quality, information quality, and service quality, affect intention to use and user satisfaction. User satisfaction affects intention to use in turn and thus eventually, use and user satisfaction bring about benefits. Many empirical studies in various IT contexts support the updated IS Success model and demonstrate that system, information and service quality factors influence attitude and behavior [Wu and Wang, 2006]. In addition, most users of mobile Web browsing services tend to be very sensitive to usage fees compared with other generic information systems since they must purchase or pay for both system and service at the same time. In this sense, several previous studies adopted perceived cost as an additional determinant of mobile Internet adoption [Cheong and Park, 2005; Kim et al., 2007].

III. RESEARCH MODEL AND HYPOTHESES

In this study, the system quality, information quality, service quality factors presented in DeLone and McLean's updated IS success model were applied as independent variables of mobile Web browsing services use. Since system quality dimension involves different service levels of multiple vendors such as manufacturers, network service vendors, and content service providers, the system quality dimension is further divided and defined as four variables—network quality, hardware quality, ubiquity, and security. Additionally, perceived cost was added to the model as indicative of TRA's ability to customize for appropriate contextual beliefs and evaluations.

Our research model is composed of seven independent variables influencing actual use, the dependent variable, which is mediated by attitude. In the context of mobile Web browsing services, information quality was redefined as content quality, and behavioral intention (intention to use) was omitted from the original TRA, since the sample is composed of actual users. Taking into account the logical reasoning discussed above, we generated the research model as shown in Figure 1.

Perceived Quality of Mobile Web Browsing Services

Content Quality

Information quality, according to DeLone and McLean [1992, 2003], can be operationalized as the quality of the Information System output. The indicators of information quality include output accuracy, precision, currency, timeliness, reliability, completeness, conciseness, format, scope, and relevance [Bailey and Pearson, 1983; Lee et al., 2009]. Content, in mobile Web browsing, refers to any types of information, including texts, image, and multimedia provided by websites through mobile devices. In several current studies conducted in a mobile Internet

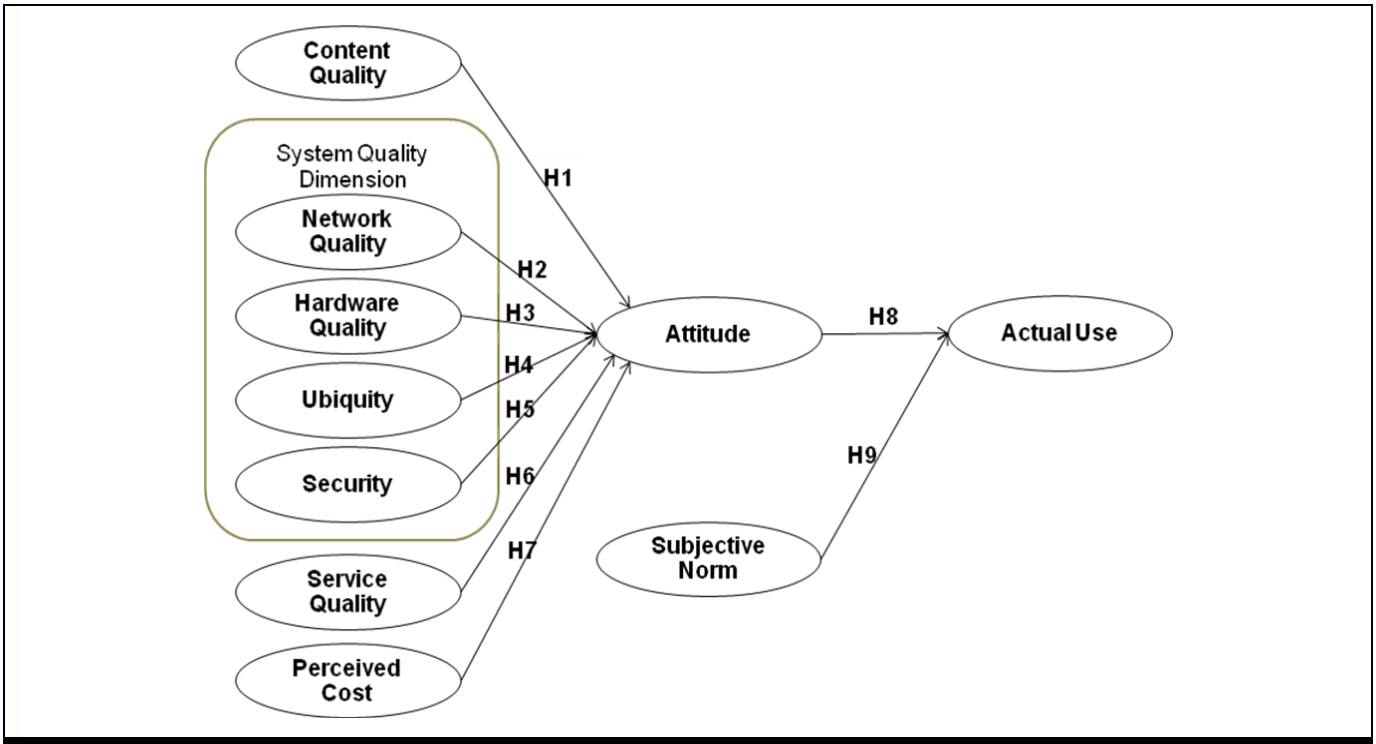

Figure 1. Determinants of Actual Use of Mobile Web Browsing Services

context, the information quality construct was renamed as content quality, and content quality was shown to be an antecedent of user attitudes [Chae and Kim, 2001; Cheong and Park, 2005].

Hypothesis 1. Content quality of mobile Web browsing service is positively related to attitude.

System Quality

System quality has received less attention than information quality in the IS literature [Nelson et al., 2005]; furthermore, it has been typically measured through a surrogate variable, ease of use or user-friendliness [e.g. Moon and Kim, 2001; Rai et al., 2002; Wang, 2008; Wu and Wang, 2006] or system reliability/stability [Cheong and Park, 2005]. In this study, the system quality concept is divided into four dimensions, which are hardware quality, network quality, ubiquity, and security, to reflect the unique aspects of mobile Web browsing services.

Various mobile technologies, including WAP-based mobile Internet, mobile data services, and mobile commerce, show unique features which include ubiquity, accessibility, security, convenience, location-based service, instant connectivity, and personalization [Lee et al., 2009]. In this study, hardware quality refers to the convenience of using mobile devices to browse mobile Web; network quality means to what extent mobile Web is accessible and stable in terms of the Internet network; ubiquity is defined as an individual's perception regarding the extent to which mobile technology provides personalized and uninterrupted connection, whenever and wherever users want to use [Kim and Garrison, 2009]; and security means the degree of ensuring security and privacy when using mobile Web. Location-based feature, such as services using GPS (global positioning system), refers to providing information based on users' current location. This feature was excluded in this research project because GPS and Cell-ID methods embedded in mobile phones were not prevalent in Korea at the time this study was conducted.

Concerning the network quality of mobile Internet services, network speed and system stability result in user satisfaction and increased perceived value [Kim and Kim, 2002, 2003]. Hardware quality has also been studied in mobile Internet contexts. Ryoo et al. [2009] examined and found a causal relationship between ease of use of mobile Web browsing devices and positive attitude for the service. One of the most outstanding advantages of mobile technology is the ability to enable anytime, anywhere access [Sarker and Wells, 2003], and the capability of ubiquity can affect behavior intention to use [Kim and Garrison, 2009; Looney et al, 2004]. Security is the last construct of system quality of mobile Web browsing; customer perception of security and privacy control is the important antecedent of customer trust in m-commerce contexts like e-commerce [Siau and Shen, 2003], and it is proved that security affects customer satisfaction of the mobile Internet [Chung and Kang, 2006]. Following earlier discussion, we hypothesize:

Hypothesis 2. Network quality of mobile Web browsing service is positively related to attitude.

Hypothesis 3. Hardware quality of mobile Web browsing service is positively related to attitude.

*Hypothesis 4***.** Ubiquity of mobile Web browsing service is positively related to attitude.

*Hypothesis 5***.** Security of mobile Web browsing service is positively related to attitude.

Service Quality

DeLone and McLean added service quality in their updated IS success model because Information System providers are not only information providers but also service providers in the e-commerce environment [2003]. Service quality is theorized to be an important determinant of users' attitudes of mobile Web browsing services since users' perceptions of service quality are influenced by a seamless integration of different service providers (mobile telecommunication companies, mobile phone manufacturers, and content providers). In this study, service quality is defined as the perceived quality toward customer service such as quality of call center services or instruction manuals [Kettinger and Lee, 2005] in order to distinguish from the aspects of system quality.

*Hypothesis 6***.** Service quality of mobile Web browsing service is positively related to attitude.

Perceived Cost

To use mobile Web browsing services completely, customers should purchase mobile phones with full Internet browsing function and also pay Internet usage fees at a flat rate or a measured rate; moreover, some content (e.g. games), also has usage fees. Therefore, perceived cost is expected to be negatively related to the attitude toward mobile Web browsing services. If customers perceive the fees or costs are not reasonable, or believe the price will be dropped soon, their attitude toward certain products will be negatively affected [Sweeney and Soutar, 2001]. In other words, consumers consider how much they should pay when they evaluate the quality or value of products/services [Doods et al., 1991; Zeithaml, 1988]. Some recent studies on mobile Internet services show that perceived cost has negative effects on attitude, intention to use, or perceived value [Cheong and Park, 2005; Kim et al., 2007]; although perceived cost was not related to user satisfaction in Kim and Kim's [2002]. Therefore, we hypothesize as follows:

*Hypothesis 7***.** Perceived cost of mobile Web browsing service will have a negative effect on attitude.

Antecedents of Actual Use

Attitude

Studies using TRA and TAM (Technology Acceptance Model), have empirically verified that attitudes toward technologies directly affect actual use or intention to use [e.g. Ajzen, 2001; Davis, 1989; Karahanna and Limayem, 2000; Taylor and Todd, 1995]. Most of the recent studies on the acceptance of mobile technologies, including mobile data services and mobile Internet, tested the relationship between attitude and behavioral intention, since, at the time of the studies, mobile technologies were still in their early stage of diffusion [Nysveen et al., 2005; Ryoo et al., 2009]. In this study, however, we further verify the theorized relationship between attitudes and actual use in the mobile Web browsing services context by directly measuring self-reported actual use rather than behavioral intention to use mobile services.

Hypothesis 8. Attitude toward mobile Web browsing services will have a positive effect on actual use.

Subjective Norm

Subjective norm refers to the degree to which individuals think that people surrounding them regard use of the technology as important [Fishbein and Ajzen, 1975]. As verified in previous studies on mobile Internet services, subjective norms are hypothesized to directly affect actual use [Kim et al., 2009; Lu et al., 2005].

Hypothesis 9. Subjective norm of users will have a positive effect on actual use of mobile Web browsing services.

IV. RESEARCH METHODOLOGY

Operational Definition of Constructs

The research constructs used in this study were measured using operationalized constructs confirmed reliability and validity in previous studies. These measures were slightly modified to fit the unique research context and were

translated to Korean from English, if needed. Table 1 shows the operational definitions and sources of these variables. All the variables were measured using a Likert 5-point scale.

Table 1: Operational Definition of Research Constructs

Construct		Operational Definition	Reference
Content Quality		The degree to which the quality of the content provided by mobile Web browsing services satisfy users' needs	[Cheong and Park, 2005] [Nelson et al., 2005]
System Quality	Hardware Quality	The degree to which the input functions, resolution, and screen size of mobile devices are believed to be convenient to use without any problem or difficulty	[Wu and Wang, 2006] [Ryoo et al., 2009]
	Network Quality	The degree to which networks of mobile Web browsing services are believed to be fast, stable, and reliable systems	[Cheong and Park, 2005]
	Ubiquity	The ability to enable anytime, anywhere usage of mobile Web browsing services	[Kim and Garrison, 2009]
	Security	The extent to ensure security and protect privacy of mobile Web browsing service users	[Chung and Kang, 2006]
Service Quality		The degree to which customer service support of mobile Web browsing services is fast and accurate while quickly responding to complaints	[Noh and Lee, 2005]
Perceived Cost		The degree to which economic burdens are felt in using mobile Web browsing services	[Cheong and Park, 2005] [Kim et al., 2007]
Attitude		The degree to which users think positively or negatively about mobile Web browsing services	[Ajzen, 2001]
Subjective Norm		The degree to which people think that most of other thought to be important by them would accept mobile Web browsing services	[Ajzen, 2001] [Chang, 1998]
Actual Use		The degree to which mobile Web browsing services are used	[DeLone and McLean, 1992] [Burton-Jones and Straub, 2006]

Samples

In this study, data were randomly collected from people younger than forty years of age who were subscribers of "OZ," a mobile Web-browsing service offered by LG Telecom. LG Telecom introduced OZ, a full browsing mobile Internet service that enables users to directly send and receive content through their mobile terminals in the same manner as that of fixed Internet. As a first-mover vendor in the Korean market, LG Telecom offered full Web browsing services and introduced a flat-rate system enabling customers to use content up to 1GB at KRW 6,000 (about USD 5.2, EUR 3.3) per month in 2008. If you used 1GB in mobile Web surfing through 2G/3G network in a traditional measured rate, it could cost up to about KRW 1 million. While LG Telecom ranks third in mobile voice call markets in Korea, it gained a leading role with the highest market share in full-browsing mobile Internet services through its OZ service. OZ provided the first flat rate in Korean mobile Internet market. In this vein, it was generally viewed as more affordable for young people, such as teenagers and college students, and as such considered a suitable sample for this study.

The sample frame are panels of an online research company named *Panel Insight.* The online research company randomly selected five hundred people out of 17,905 OZ users from their panels and sent e-mails to them. Within the survey period, 198 people answered, a response rate of 39.6 percent. Twenty-eight subjects were excluded due to incomplete responses; 170 subjects are used for the analysis. The online survey was conducted for three days from November 26, 2009, to November 28, 2009. The demographic characteristics of the sample are in Table 2 shown below.

V. DATA ANALYSIS AND RESULTS

In this study, descriptive statistics, factor analysis, and testing of the measurement model and structural model were conducted using SPSS 13.0 and Smart PLS.

Table 2: Demographic Attributes of the Respondents			
Attributes		**Frequency**	**Percentage (%)**
Gender	Female	86	50.6
	Male	84	49.4
Age	Under 19	8	4.7
	20–29	96	56.5
	30–39	66	38.8
Job	Employed	94	55.3
	Self-employed	4	2.4
	Professional	9	5.3
	Undergraduate/Graduate Student	41	24.1
	Middle school/High school Student	7	4.1
	Homemaker	7	4.1
	Others	8	4.7
Average usage fee per month (KRW)	Less than 50 thousand	52	30.6
	50–100 thousand	98	57.6
	100–150 thousand	16	9.4
	150–200 thousand	3	1.8
	Over 200 thousand	1	0.6
Most frequently used content	Information gathering	125	73.5
	Online community, SNS	21	12.4
	E-mail/IM/Chatting	13	7.6
	Game	7	4.1
	Shopping/Ticketing	3	1.8
	Others	1	0.6

Reliability and Validity of Measurement Model

To assess the common method bias problems in the survey design, we ran one of the most widely used approaches, Harman's single-factor test [Podsakoff et al., 2003]. In this test, all variables are entered into a principal components factor analysis. If a substantial common method bias is present, a single factor emerges or one general factor explains the majority of the total variances. Our analysis revealed multiple factors in the results with the first factor accounting for only 31.99 percent of the total variances; therefore, it did not indicate common method bias as an issue.

In component-based structural equation modeling using PLS, convergent validity is evaluated by factor loadings, AVE (average variance extracted) and composite construct reliability [Chin, 1998]. In general, if factor loadings and AVE are 0.5 or higher and composite construct reliability is 0.7 or higher, it can be said that convergent validity and internal consistency are confirmed [Gefen et al., 2000]. Discriminant validity generally requires that each of item-latent construct loadings should be higher than cross-loadings, and the square root of AVE of each concept should be larger than correlation coefficients with other variables [Chin, 1998; Gefen et al., 2000].

As a result of initial confirmatory factor analysis (CFA), three items (SEC3, CST1, CST5) showing lower than 0.6 factor loading were removed and reanalysis was done. Based on the results, the AVEs of all the latent variables are over 0.5, composite construct reliability values are more than 0.7; hence, convergent validity and reliability are ensured. Discriminant validity of all the latent constructs is also confirmed by comparing item-latent construct loadings to cross-loadings, and square roots of AVE to correlation coefficients of other variables. The results are as shown in Table 3 and the second table of the Appendix.

Hypothesis Test

PLS uses bootstrapping method to test the significance of path coefficients. In this study, 500 re-samples were created to test the hypotheses, and the results are summarized as shown in Figure 2 and Table 4. It is most desirable to measure the statistical power of PLS with R^2 values of endogenous variables using at least 0.10 as the reference value [Falk and Miller, 1992, Chin, 1998]. The R^2 values of the predictive variables in this study are over 0.10 with 0.534 for attitude, 0.584 for actual use as shown in Figure 2.

Table 3: Descriptive Statistics, Reliability and Validity of Research Constructs													
Constructs	**Mean**	**S.D.**	**C.C.R.**	Content Quality	Network Quality	Hardware Quality	Ubiquity	Security	Service Quality	Cost	Attitude	Subjective Norm	Actual Use
Content Quality	3.58	0.63	**0.907**	**0.788**									
Network Quality	2.91	0.79	**0.894**	0.455	**0.860**								
Hardware Quality	3.42	0.88	**0.884**	0.414	0.344	**0.847**							
Ubiquity	3.97	0.77	**0.942**	0.495	0.173	0.491	**0.943**						
Security	3.04	0.64	**0.793**	0.507	0.556	0.418	0.211	**0.814**					
Service Quality	3.18	0.62	**0.879**	0.670	0.573	0.531	0.497	0.579	**0.771**				
Perceived Cost	3.37	0.71	**0.812**	-0.216	-0.027	-0.064	-0.202	0.036	-0.077	**0.769**			
Attitude	3.60	0.74	**0.923**	0.618	0.365	0.506	0.533	0.380	0.595	-0.300	**0.894**		
Subjective Norm	3.47	0.71	**0.885**	0.401	0.239	0.467	0.308	0.305	0.467	-0.114	0.548	**0.812**	
Actual Use	3.85	0.76	**0.920**	0.530	0.234	0.372	0.450	0.277	0.452	-0.285	0.715	0.616	**0.862**
AVE				**0.621**	**0.739**	**0.718**	**0.890**	**0.662**	**0.594**	**0.591**	**0.799**	**0.660**	**0.743**

Note: Diagonals are the square roots of AVE.

As a result of path analysis, H1, H3, H4, H6, and H7, which propose that content quality, hardware quality, ubiquity, service quality, and perceived cost would affect attitude, were supported. In other words, the higher content quality user perceives; the easier and the more convenient mobile devices are; the more ubiquitous access mobile Web service provides, the more favorable the attitude toward mobile Web browsing services. Also, if users feel usage fees or the cost to purchase mobile handsets are too expensive, the attitude toward mobile Web browsing services will be negatively affected. H8 and H9 which proposes that attitude and subjective norm would be antecedents of actual use were both supported.

However, H2 which assumes a positive relationship between network quality and attitude and H5 regarding the causal relationship between security and attitude were rejected. These might be caused by relatively low mean value of network quality (mean = 2.91) and security (mean = 3.04). Alternatively, these factors may be affected by the relative immaturity of the Web browsing market in Korea and these factors might prove to be more significant as time goes on. Future cross-sectional studies over time would determine if this could be a possible explanation.

In order to reflect the benefit of samples composed of actual users and provide practical implications, additional analyses examining correlations between actual use and other usage measures such as usage frequency and duration are performed. System usage has been measured by various measures such as method, extent, proportion,

Table 4: Hypotheses Testing Results					
	Path	**Path Coefficient**	**t-value**	**p-value**	**Result**
H1	Content Quality → Attitude	0.270	2.947	0.004	Supported
H2	Network Quality → Attitude	0.027	0.343	0.732	Rejected
H3	Hardware Quality → Attitude	0.181	2.067	0.040	Supported
H4	Ubiquity → Attitude	0.168	2.204	0.029	Supported
H5	Security → Attitude	0.006	0.081	0.936	Rejected
H6	Service Quality → Attitude	0.202	1.929	0.055	Supported
H7	Perceive Cost → Attitude	-0.180	3.569	0.000	Supported
H8	Attitude → Actual Use	0.540	8.924	0.000	Supported
H9	Subjective Norm → Actual Use	0.320	4.863	0.000	Supported

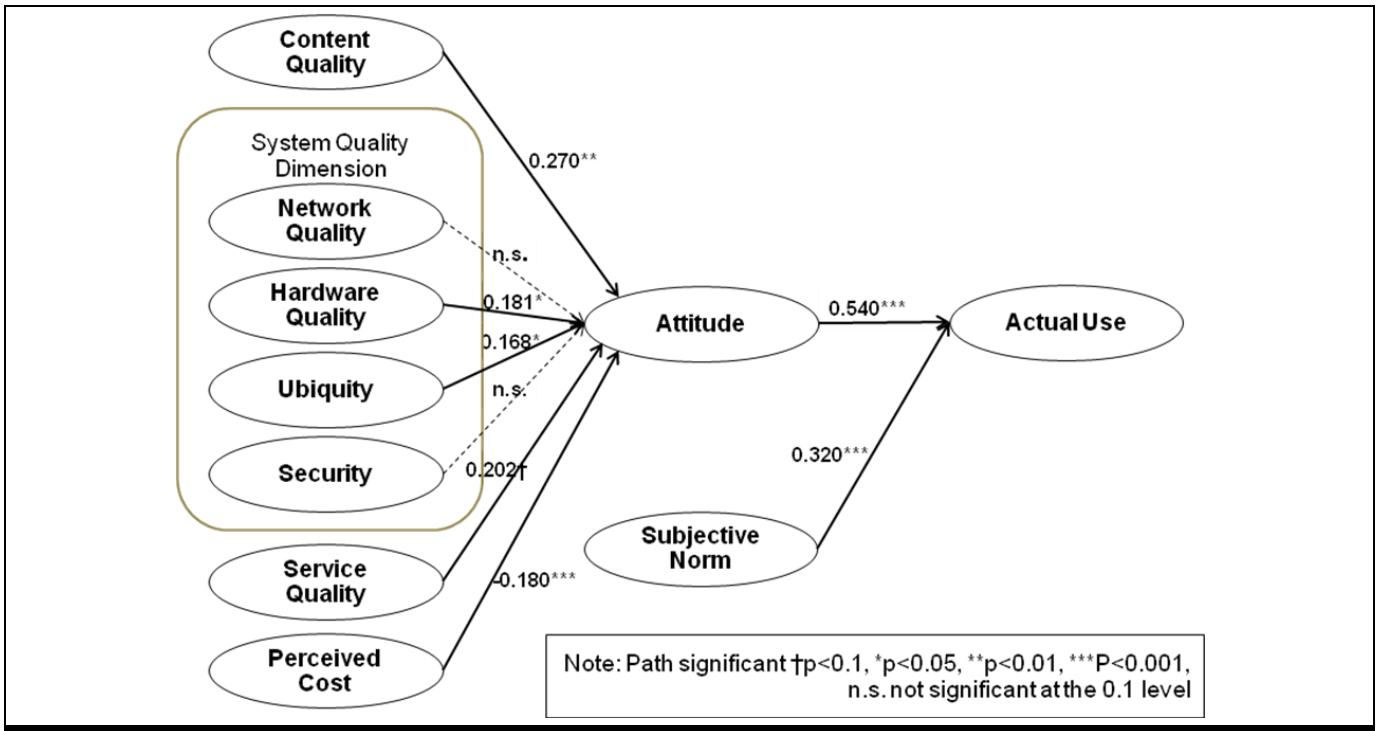

Figure 2. Path Coefficients of the Structural Model

duration, and frequency of use in IS literature [Burton-Jones and Straub, 2006]. To capture mobile Web browsing usage patterns more accurately, not only users' subjective report about their extent of actual use but also use frequency operationalized *the number of use in a week* and duration defined *average connection time per use* are measured. Correlation analyses among antecedents of actual use--attitude and subjective norm, actual use, usage frequency, and usage duration are done, and the results are as Table 5.

Table 5: Correlation Coefficients of Usage Frequency and Usage Duration

	Attitude	Subjective Norm	Actual Use	Usage Frequency	Usage Duration
Usage Frequency	**0.279****	**0.261****	**0.445****	1	
Usage Duration	0.042	0.092	0.094	**0.354****	1

Note: Path significant: **p<0.01

Significant correlations are shown between usage frequency and all other variables; however, usage duration is significantly correlated only with usage frequency. From this analysis, we find that the users' subjective report of actual use has predictive validity as shown by the high correlation with usage frequency. On the other hand, actual use is not significantly related to how long users are connected. This result may be caused by the fact that users of mobile Web browsing seem to be primarily focused on immediate information searching and communication rather than long lasting Web surfing episodes typically associated with traditional fixed line Internet use. Also, users may have a heightened sense that usage cost based on their experiences with data usage fees when using mobile phones. Both of these explanations demand further examination in future research on mobile Web browsing consumer behaviors.

VI. DISCUSSION

Research Findings, Implications, and Limitations

We examined how quality variables and perceived cost affect actual use of mobile Web browsing services in the Korean market. This theoretically driven model based on TRA and DeLone and McLean's updated IS success model moves beyond determining post-adoptive behavioral intentions to use mobile Web browsing to predicting actual use in a unique national market. Below are our major findings of the application of our model to the Korean mobile Web browsing market. Several factors proved more important while other theorized factors were less significant in this unique market as summarized:

First, we found in the Korean market, content quality is positively related to the attitude toward mobile Web browsing services. This means that the limited content in previous WAP-based Internet services could be a major bottleneck

for mobile data service use in Korea, implying the content provided by mobile Web browsing services must comply with users' actual needs. Although Web surfing itself is the content and the core function provided by full browsing-based mobile Internet [Kim, 2009], the need for activating supplementary features such as multimedia files, flash, and ActiveX has been achieved only to a limited extent. In this respect, efforts should be made toward technical improvements in order to provide the same content quality as that in the existing wired fixed Internet environment. In addition, the development of diverse content that appeals primarily to mobile Internet users is also important. A variety of games and programs sold in the App Store of Apple are good examples.

Second, in the Korean market, hardware quality and ubiquity from the system quality dimension were determined to be important determinants of attitude toward mobile Web browsing services. That is, the ubiquitous environments that enable use of mobile Web browsing services anytime, anywhere should be provided along with the improvement of the hardware quality. To this end, handsets for mobile Web browsing should be appropriate for the service in terms of input function, resolution, and screen size. Also, "ubiquitous" computing should be realized by supporting diverse communication networks such as WiFi, similar to wireless LAN, and Wibro (i.e. mobile Wimax), as well as existing 3G networks, by telecom carriers and manufacturers of mobile devices. However, network quality, representing network speed and reliability, and perceived security of mobile Web browsing services are not significant drivers of actual use of the service; it may imply that users' expectations on these issues in the context of mobile Web browsing are so low that it results in insignificant effects on actual use. As mentioned earlier, these factors may be affected by the relative immaturity of the mobile Web browsing market in Korea and these factors may prove to be significant as the market matures and users become more circumspect in their usage decisions.

Third, users' attitudes are negatively influenced by perceived cost of mobile Web browsing services. That is, since users of mobile Web browsing services have the triple burdens of purchasing costs of devices, wireless data usage fees, and content use charges, they are sensitive to costs. In this respect, the current flat-rate payment system (fixed-rate system) in Korea would seem to be in conflict with dealing with different price-sensitiveness levels of users. Therefore, for light users of only limited content, or users who mostly access mobile Web through free WiFi networks, enabling the selection of a measured rate system would seem more appropriate. Also, operating measured rate systems efficiently might prevent network congestions due to overloads of data traffic, thereby also helping the enhancement of system quality.

Next, it has been verified that subjective norms would affect actual use. If one sees that socially influential people, such as family members, friends, and colleagues, frequently use mobile Web browsing services, their use will also increase. In Korea, group purchases and adoptions in company-levels have been increasing recently. The role of social norms will become more important in organization-level mandatory or quasi-voluntary use than that in individual-level usages; under this circumstance, all the major players, including telecom carriers, platform vendors, and content providers, will be able to expect network effects. If the services such as micro-blogging, SNS (social networking services), location-based services, and mobile enterprise portal systems using mobile Web browsing services are popularized hereafter, it is expected that the services with the nature of network externality will become important revenue sources of various players in the mobile ecosystem.

Finally, distinct from prior studies about mobile technologies examining behavior intentions only, this research focused on actual use behaviors. The research findings verify positive attitudes toward the services directly influence the steady use of mobile Web browsing services; our results can provide useful theoretical insights to future research based on TRA. Furthermore, taking advantage of actual user samples, correlations between actual use, which is a subjective report from users about their extent of use, and other usage measures such as usage frequency and duration were analyzed. Heavy and regular users access mobile Web frequently; however, actual use are not significantly related to usage duration. It seems that mobile Web browsing is not yet appropriate for longer Web surfing sessions. In sum, the practical implications from this research, which used a Korean sample, shows dynamic patterns in using mobile Web browsing services and should facilitate deeper understandings for global vendors in the mobile industry.

This study has several limitations. First, the sample was limited to people aged in the 40s or lower and thus, the study sample cannot sufficiently represent all mobile Web browsing service users. To generalize the results of this study beyond Korea, it is necessary to enlarge the sample population to different national and cultural contexts in future research. Second, all the variables of usage dimension including actual use, frequency, and duration are measured by subjective report from respondents. If users' actual page views or data usage volumes of mobile Web browsing are obtained, more insightful findings based on deep usage data can be provided. Third, as a cross-sectional survey it represents only a snap shot in time. Future studies should test the model over time in South Korea and cross-nationally to begin to gather insights about similarities and differences in the long-term adoption and usage patterns of alternative mobile Web browsing markets.

Conclusion

From a practical perspective , this study offers a research model predicting mobile Web browsing use that provides insights to local and global mobile telecommunication companies, mobile phone manufacturers, and content providers. Vendors can use the findings of this study to test for local differences and then customize their service offering to best meet the differentiated demand of their local market. It also provides global telecommunication vendors and content providers unique perspectives concerning market entry and customizing service offerings.

From a theoretical perspective, we generated a research model to analyze the factors affecting the post adoptive use of mobile Web browsing services in the Korean market by successfully combining the IS success model and TRA. Ultimately, this framework can be replicated to identify unique market differences. The derived model appears to be comprehensive and parsimonious, permitting the testing of user behaviors of mobile Web browsing services in comparative studies across national or cultural contexts. In extending this framework to a new context, the unique economic and cultural attributes of the local target market must be carefully considered and, if additional and/or modified variables need to be included, they should be theoretically justified relative to the existing model. As more cross market studies are accumulated, researchers should begin to make comparisons across markets to gain additional insights concerning the similarities and differences associated with the delivery of mobile Web services globally.

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the article on the Web, can gain direct access to these linked references. Readers are warned, however, that:

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APPENDIX A

Table A-1: Constructs and Measurement Items

Constructs	Item#	Measures
Content Quality	CQ1	The content provided by mobile Web browsing services is accurate.
	CQ2	Mobile Web browsing services provide timely content.
	CQ3	The content of mobile Web browsing services is useful.
	CQ4	Mobile Web browsing services provide interesting content.
	CQ5	The content of mobile Web browsing services is varied.
	CQ6	The content provided by mobile Web browsing services fits me well.
Network Quality	NW1	I feel the speed of the mobile Web browsing services is fast.
	NW2	The speed of mobile Web browsing services is convenient to use.
	NW3	The mobile Web browsing services is stable.
Hardware Quality	HW1	The input function of my mobile phone is convenient to use mobile Web browsing services.
	HW2	The resolution of my mobile phone is high enough to use mobile Web browsing services.
	HW3	The screen size of my mobile phone has no difficulties to use mobile Web browsing services.
Ubiquity	UBQ1	I can use mobile Web browsing services whenever and wherever.
	UBQ2	When I need to use it, I can use mobile Web browsing services regardless of time and places.
Security	SEC1	The system of mobile Web browsing services is securable.
	SEC2	Mobile Web browsing services are trustworthy in terms of security.
Service Quality	SQ1	Service manuals of mobile Web browsing are provided.
	SQ2	Service manuals of mobile Web browsing are easy to understand.
	SQ3	Customer service of mobile Web browsing service providers is prompt and adequate.
	SQ4	The response time toward customer complaints about mobile Web browsing services is short.
	SQ5	Various optional services are provided by mobile Web browsing service providers.
Perceived Cost	CST2	I think mobile phones supporting mobile Web browsing services are expensive.
	CST3	Many people do not want to purchase mobile phones supporting mobile Web browsing services because of the high price.
	CST4	Usage fee of mobile Web browsing services is expensive compared with the actual service provided.

Table A-1: Constructs and Measurement Items - Continued		
Attitude	ATT1	Overall, I feel good about mobile Web browsing services.
	ATT2	My attitude toward mobile Web browsing services is positive.
	ATT3	I am proud of using mobile Web browsing services.
Subjective Norm	SN1	My close friends think I should use mobile Web browsing services.
	SN2	People who are important to me believe I should use mobile Web browsing services.
	SN3	People who are influential to me believe I should use mobile Web browsing services.
	SN4	People around me think it is nice that I use mobile Web browsing services.
Actual Use	AU1	I am using mobile Web browsing services in general use.
	AU2	I am using mobile Web browsing services regularly.
	AU3	I am using mobile Web browsing services whenever I have a chance to use it.
	AU4	Whenever I need to use it, I am using mobile Web browsing services.
Usage	FRQ	How many times do you use mobile Web browsing services in a week?
Usage	DUR	How long do you stay connected per usage of mobile Web browsing services?

Table A-2: Factor Loadings and Cross Loadings of the Latent Constructs

	Content Quality	Network Quality	Hardware Quality	Ubiquity	Security	Service Quality	Cost	Attitude	Subjective Norm	Use
CQ1	**0.690**	0.274	0.237	0.326	0.422	0.438	-0.109	0.397	0.234	0.353
CQ2	**0.841**	0.353	0.304	0.353	0.462	0.509	-0.227	0.500	0.332	0.423
CQ3	**0.813**	0.264	0.374	0.418	0.356	0.522	-0.160	0.519	0.334	0.493
CQ4	**0.818**	0.417	0.407	0.447	0.455	0.624	-0.174	0.500	0.367	0.422
CQ5	**0.803**	0.414	0.313	0.431	0.334	0.526	-0.212	0.520	0.324	0.451
CQ6	**0.754**	0.423	0.307	0.357	0.382	0.541	-0.129	0.471	0.293	0.350
NW1	0.396	**0.893**	0.290	0.175	0.476	0.504	-0.051	0.354	0.214	0.201
NW2	0.403	**0.855**	0.311	0.109	0.454	0.476	-0.042	0.261	0.147	0.150
NW3	0.377	**0.829**	0.291	0.151	0.502	0.496	0.024	0.313	0.246	0.244
HW1	0.302	0.289	**0.770**	0.383	0.348	0.470	0.028	0.354	0.333	0.217
HW2	0.382	0.252	**0.891**	0.455	0.415	0.449	-0.097	0.463	0.442	0.410
HW3	0.363	0.339	**0.876**	0.410	0.304	0.443	-0.075	0.457	0.403	0.301
UBQ1	0.452	0.156	0.450	**0.933**	0.191	0.414	-0.159	0.456	0.255	0.358
UBQ2	0.481	0.169	0.475	**0.953**	0.207	0.515	-0.217	0.542	0.321	0.482
SEC1	0.471	0.528	0.388	0.190	**0.927**	0.527	0.026	0.384	0.243	0.305
SEC2	0.343	0.354	0.285	0.155	**0.682**	0.413	0.040	0.197	0.284	0.094
SQ1	0.463	0.448	0.400	0.327	0.493	**0.781**	-0.030	0.452	0.269	0.308
SQ2	0.518	0.400	0.396	0.455	0.422	**0.836**	-0.054	0.481	0.409	0.372
SQ3	0.581	0.459	0.433	0.437	0.461	**0.791**	-0.077	0.455	0.435	0.392
SQ4	0.471	0.494	0.296	0.283	0.461	**0.653**	-0.034	0.366	0.226	0.210
SQ5	0.545	0.431	0.498	0.393	0.414	**0.780**	-0.095	0.519	0.430	0.427
CST2	-0.155	-0.065	-0.043	-0.106	-0.055	-0.096	**0.682**	-0.113	-0.065	-0.122
CST3	-0.227	-0.071	-0.031	-0.215	0.042	-0.062	**0.798**	-0.241	-0.100	-0.236
CST4	-0.128	0.039	-0.070	-0.132	0.050	-0.045	**0.820**	-0.281	-0.092	-0.255
ATT1	0.555	0.314	0.471	0.499	0.358	0.509	-0.227	**0.918**	0.502	0.649
ATT2	0.507	0.308	0.429	0.502	0.333	0.504	-0.310	**0.906**	0.457	0.614
ATT3	0.591	0.354	0.453	0.428	0.326	0.579	-0.268	**0.856**	0.508	0.652
SN1	0.378	0.142	0.378	0.317	0.232	0.433	-0.086	0.468	**0.851**	0.557
SN2	0.198	0.193	0.300	0.159	0.186	0.324	-0.074	0.368	**0.823**	0.423
SN3	0.304	0.238	0.408	0.241	0.285	0.393	-0.039	0.412	**0.870**	0.517
SN4	0.400	0.208	0.417	0.262	0.278	0.352	-0.175	0.521	**0.695**	0.484
AU1	0.477	0.169	0.317	0.388	0.293	0.376	-0.282	0.605	0.508	**0.880**
AU2	0.449	0.199	0.301	0.307	0.220	0.348	-0.230	0.608	0.563	**0.873**
AU3	0.480	0.254	0.371	0.490	0.243	0.481	-0.234	0.660	0.520	**0.883**
U4	0.419	0.182	0.293	0.365	0.194	0.349	-0.234	0.591	0.534	**0.810**

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