Extending UTAUT to Predict the Use of Location-Based Services

Research-in-Progress

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Abstract

The popularization of smartphones has brought about substantial changes in location-based services (LBS). As recent advances in wireless communication technology have allowed affordable data service fees, and current smartphones are equipped with GPS (Global Positioning System), LBS are emerging as next-generation 'killer apps'. However, diffusion of LBS has been increasing potential privacy violations due to the abuse of location information. This research-in-progress aims to verify a research model focusing on actual users of LBS applications; it is to test the effects of LBS attributes, namely ubiquity, accuracy, security, and controllability on performance/effort expectancy, and those of major variables of UTAUT on use of LBS. Most importantly, privacy concern is included in the model as a moderating variable. The results of this study will offer practical implications to LBS providers, application developers, and concerned individuals in the government. The implications will particularly include guidelines on protection of personal location information.

Keywords: Location-based Services (LBS), privacy concern, UTAUT, ubiquity, accuracy, security, controllability

Introduction

The popularization of smartphones has brought about substantial changes in location-based services (LBS). The restricted functions of feature phones confined LBS to simple location-tracking services, whereas smartphones with powerful operating systems and various applications have completely changed the area of LBS. Moreover, as recent advances in wireless communication technology have allowed relatively affordable data service fees, and most current smartphones are equipped with GPS (Global Positioning System), LBS are emerging as next-generation 'killer apps' (Ryu 2011).

LBS are any kind of service that takes into account the geographic location of an entity that can be human or non-human. LBS are largely divided into location-tracking services such as “find person X” and location-aware services such as “find the closest X currently open” (Junglas et al. 2008). They can also be categorized into information searching, entertainment, safe & security, tracking, and commerce, according to the purpose of application (Lee et al. 2005). Early LBS mainly used each telecommunication
company’s own communication network, based on WAP (Wireless Application Protocol). The consequent technical problems, high data service fees, and insufficiency of contents led these early LBS to have limited users and remained simple tracking services, such as tracking users’ young children or shipping goods, and accordingly, profitable business models were absent. However, as the industry entering the era of smartphones, applications with a variety of business models have emerged, and LBS and SNS (social networking service) have been combined. Furthermore, location-based advertisements have appeared, enabling L-commerce (location-based commerce), an enhanced version of mobile commerce. A recent report showed that 60 percent of smartphone applications are LBS-related ones, and Gartner, a market research firm, revealed that the global market size of LBS is expected to grow by 18 times, from $500 million in 2007 to $9 billion, in 2012 (Lee 2010).

Nevertheless, the growth of the LBS market, utilizing personal location information, and advances in LBS technology have been increasing potential privacy violations due to the abuse of location information (Junglas et al. 2008). In Korea, for example, the news, that a company tracked its employees’ and their family members’ location over 650 times without permission, shocked society. In addition, it was allegedly reported that Apple has been regularly recording the position of iPhone and iPad users into a hidden file within the device, leading into very serious security and privacy concern (Allan et al. 2011). Thus, LBS, unlike other new technologies, have constantly been in collision with concerns about privacy, which indicates that the privacy issue may serve as a major determinant of the expansion of the LBS market along with other factors influencing more LBS use.

As conducted before the emergence of LBS as smartphone applications, most prior studies of LBS used experiment or quasi-experiment methods e.g. (Junglas et al. 2008; Keith et al. 2010; Xu et al. 2005), and focused on usage intention of potential users instead of actual users; e.g. (Xu et al. 2009; Xu et al. 2004; Xu et al. 2005; Zhou 2011). This study, however, intends to examine the factors influencing the actual use of LBS, focusing on smartphones’ LBS application users.

The purposes of this study are as follows. First, this study is to identify the distinctive attributes of LBS and the impact of their quality level on the performance expectancy or effort expectancy of LBS. Second, this study aims to determine the antecedents of the LBS use based on an extensively-used UTAUT (Unified Theory of Acceptance and Use of Technology) model. Third, this study intends to set privacy concern as a moderating variable, and to see the relative importance of privacy concern on LBS use. The results of this study are expected to help establish practical marketing strategies for LBS by providing information about perceptions of actual users to LBS professionals or potential market participants, including individuals and companies preparing for relevant businesses.

**Conceptual Background**

**Location-Based Services and Privacy Concerns**

LBS can be generally defined as network-based services that integrate a mobile device’s location or position with other information so as to provide added value to the user (Barnes 2003; Xu et al. 2009). Supported by advances in wireless communication technology and popularization of mobile phones, LBS have become a global phenomenon (Rao et al. 2003; Xu 2007). In fact, contrary to initial expectations, LBS did not emerge as a ‘killer app’ until recently; however, a growth in the popularity of smartphones including iPhone is increasing attention to the LBS industry (Ryu 2010). According to ABI Research, the size of the global LBS market, which was the $515 million as of the end of 2007, is expected to increase by more than 250 times, to $13.5 billion in 2013 (Ryu 2011).

Unlike previous feature phone environments, the strong operating systems and developing tools of smartphones have made the development of LBS applications relatively easy. Smartphones with GPS equipped, unlike desktop PCs, are able to provide the users with completely new experiences through a variety of LBS applications. Benefits from installing LBS applications on smartphones are countless. Previous LBS were confined to services for tracking location of employees, goods, and certain people, searching for specific places, identifying the current location, and checking the weather or traffic conditions due to technological limitation of feature phones. And the accuracy of the location information they provided was rather low as they used the cell-ID method. However, smartphone-based LBS, using
GPS or Wi-Fi, show high accuracy and can be applied in many areas. They can perform LBS-based target advertising by connecting to ‘searching’ or ‘call connecting’ functions, and also support commerce functions such as automatically paying when the target is near (Ryu 2010). Recently, LBS provide social networking services, practical benefits and hedonic values through combining commerce and entertaining elements (Ryu 2011).

Despite their benefits mentioned earlier, LBS may also bear high risk of privacy violation as users’ location information must be disclosed to use the services (Nam et al. 2009). According to Samuelson (2008), there are four types of privacy which are location privacy, electronic communication privacy, individual information privacy, and public places privacy. This study is to focus on location privacy which means the right to limit the extent that information about your current and past location is tracked and shared with others (Keith et al. 2010) and location privacy concerns, which are emerging as a significant issue alongside the vitalization of LBS.

A number of prior studies endeavored to determine the negative correlation between LBS adoption and privacy concerns. Here are some examples: Zhou (2011) divided privacy concerns into four variables—collection, improper access, errors, and secondary use—as Smith et al. suggested (1996), and then verified the effects of each variable on perceived risk and trust; there are studies that examined the effects of privacy risk on behavioral intention, such as willingness-to-pay for and intention to adopt LBS e.g. (Keith et al. 2010; Nam et al. 2009; Xu et al. 2004; Xu et al. 2005); and Xu et al. (2009) identified the impact of privacy concerns on performance expectancy and effort expectancy in groups of potential and experienced users. Nevertheless, as most studies were carried out before the vitalization of smartphone-based LBS, experimental studies controlling independent variables or methods only measuring usage intention were employed.

**UTAUT to Explain Technology Adoption**

Technology Acceptance Model (TAM) (Davis 1989) has been used in many studies in the MIS area. However, TAM has limitations that it is not capable of sufficiently supporting the validity of the relation among various external variables, and many studies are employing modified versions corresponding to the research context. Considering this, Ventatesh et al. (2003) suggested Unified Theory of Acceptance and Use of Technology (UTAUT), an enhanced, more comprehensive model. The variance in intention explained by TAM was about 40 percent, but the variance in intention explained by UTAUT was about 70 percent, indicating advances of UTAUT in terms of statistical power.

The key variables of UTAUT include three variables affecting intention to use and one variable influencing use behavior. Firstly, performance expectancy means the degree of perception in the usefulness of the technology for performance improvement. Secondly, effort expectancy is the level of ease of use of the technology. Thirdly, social influence means the degree to which an individual believes that he or she is expected to use the new technology by significant others. Lastly, facilitating conditions mean the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of a technology. In addition, Venkatesh et al. (2003) added gender, age, experience, and voluntariness of use as moderating variables to the model.

So far, many studies predicting intention to use of an emerging technology have been conducted by using UTAUT or TAM, and also done in the LBS context; Junglas et al. (2008) compared mobile devices with LBS function with those without LBS function in terms of perception of usefulness and ease of use. The results revealed that mobile devices with LBS showed significantly higher perception of usefulness in location-tracking tasks and location-aware tasks, and ease of use was significantly higher only in location-tracking tasks. According to the results of Keith et al. (2010), the usefulness of LBS had significant effects on willingness to pay for LBS and intention to use LBS, while ease of use only affected the usefulness, not behavioral intentions. A study conducted in the Korean context (Nam et al. 2009) also indicated that usefulness and ease of use are significant antecedents of LBS usage intention. Furthermore, a recent study employing UTAUT verified the significant influences of performance expectancy and effort expectancy on intention to use LBS (Xu et al. 2009). These studies, however, excluded social influence, one of the UTAUT variables, and did not take account of external variables, which are specialized for the LBS...
Research Model and Hypotheses

This study aims to verify a research model as seen in Figure 1 focusing on perception of actual users of LBS applications; this study is to test the impact of LBS attributes, namely ubiquity, accuracy, and security on performance expectancy, that of controllability on effort expectancy, and those of major variables of UTAUT, which are performance expectancy, effort expectancy, and social influence, on use of LBS. Privacy concern, which is relatively important in the LBS context, is included in the research model as a moderating variable.

**LBS Attributes and Their Effects**

Generally, LBS is composed of three technologies, including LDT (location determination technology), LEP (location enabled platform), and LAP (location application program) (Ryu 2011). Ubiquity and accuracy is related to the quality of wireless communication network and GPS, so they are drawn from LDT, and security is decided by the quality of LEP and LAP. Controllability, “the degree to which people control the activation and deactivation of LBS” is up to the quality of mobile devices, which are usually smartphones.

**Ubiquity**

One of the most remarkable attributes of LBS installed in mobile devices is ubiquity, an attribute enabling users to use relevant services through the network anytime and anywhere (Kim et al. 2009; Lyytinen et al. 2002; Morimoto 2000; Shafer 2001). The popularization of smartphones with enhanced functions compared to previous feature phones, in particular, has led to broadened coverage and improved speed of wireless Internet and lowered service fees. This has facilitated ubiquitous access allowing users to use LBS apps installed in smartphones anytime and anywhere.

LBS users have to search for location information instantly regardless of where they are currently. Prior research suggested that primary motivations for using LBS are timely accessibility and mobility (Junglas et al. 2008; Xu et al. 2009). Accordingly, we suggest a hypothesis as follows:
H1: Ubiquity will positively affect performance expectancy of LBS.

Accuracy

Accuracy is a typical measurement item of information quality e.g. (Delone et al. 2003; Seddon et al. 1994). The accuracy of location information has been greatly improved since recently released smartphones mostly have GPS functions and utilize various location determination technologies depending on the current location (Ryu 2010). This study operationally defines “accuracy” as the accuracy of location information recognized by LBS through location determination technology rather than that of information quality provided by LBS, because the latter may overlap with the concept of performance expectancy.

LBS performance is expected to increase when the location determination technology of LBS accurately recognizes the location information of a place. Therefore, we hypothesize:

H2: Accuracy will positively affect performance expectancy of LBS.

Security

Security means, in this study, the degree of ensuring security when using LBS. It captures the level of general security including personal information protection, authentication, and location information.

In the e-commerce environment based on non-face-to-face transactions, perceived security is closely related to trust. According to Pavlou (2003), trust plays a crucial role in online transactions because the Internet basically has technical uncertainty and fragile security as its origin is not commercial. Prior studies proved that in the e-commerce environment, users’ perception of information security had significant effects on trust (Hoffman et al. 1999; Suh et al. 2003), and customer perception of security is the important antecedent of trust in mobile commerce context like e-commerce (Siau et al. 2003). Therefore, we can expect the security level of LBS will influence its performance expectancy.

H3: Security will positively affect performance expectancy of LBS.

Controllability

In many senses, privacy risks inherent in LBS lie with the “always on” nature of mobile devices and their LBS function (Keith et al. 2010; Sheng et al. 2008). In this regard, Korea Communications Commission recently established industry regulations for personal location privacy protection including ‘on/off function of GPS’ in 2010. However, many users still cannot easily activate and deactivate LBS due the inconvenient UI (user interface) or functional problems of smartphones.

For this reason, it is assumed that the degree of users’ perceived ease of LBS use will be positively influenced by controllability of LBS.

H4: Controllability will positively affect effort expectancy of LBS.

Antecedents of LBS Use and LBS Use as a Dependent Variable

Distinct from prior studies of LBS examining behavior intentions only e.g. (Xu et al. 2009; Xu et al. 2004; Xu et al. 2005; Zhou 2011), this study focused on actual use behaviors. The following is the justification of hypotheses about LBS use and its determinants.

Performance Expectancy

Performance expectancy is defined as the degree to which one believes that the use of a certain technology will be useful for enhancing task performance, and is similar to perceived usefulness of TAM (Venkatesh et al. 2003). In the LBS context, performance expectancy captures the notion of the ability of LBS to provide the intended services appropriately; in other words, it is instrumental value of using LBS (Xu et al. 2009). Therefore, it can be presumed that the unique attributes of LBS, which are ubiquity, accuracy, and
security, may motivate the expectancy about performance in using LBS and that the anticipation of benefits will have effects on LBS use.

\[ H_5: \text{Performance expectancy will positively affect LBS use.} \]

**Effort Expectancy**

Effort expectancy means the degree of perceived efforts as using a system (Venkatesh et al. 2003). Perceived ease of use of general information systems is users' evaluation of the interface, in terms of ease of use of input and output function, ease of use in searching and analyzing process, and the degree of complexity (Davis 1989). Furthermore, prior studies commonly revealed that this construct is a significant antecedent of behavior intention e.g. (Agarwal et al. 1997; Davis 1989; Venkatesh et al. 2000; Venkatesh et al. 2003), and pointed out that the importance of effort expectancy variable stands out in the early stage of a new technology in particular.

In the LBS context, effort expectancy is about an individual's expectation of using LBS without much effort (Xu et al. 2009). Therefore, LBS use is expected to increase if not much effort is required in learning about or using LBS.

\[ H_6: \text{Effort expectancy will positively affect LBS use.} \]

**Social Influence**

Social influence can be defined as the degree to which an individual believes that he or she is expected to use the technology by significant others; it is similar to social norm of other technology adoption theories (Venkatesh et al. 2003). Prior studies reported that an individual will more likely to behave corresponding to others' expectations especially when they are able to reward for carrying out expected behaviors or punish for not doing so (Venkatesh et al. 2000; Venkatesh et al. 2003). In a recent study of mobile web browsing services, subjective norm is proved to be a significant driver of actual use of the service (Yun et al. 2011).

LBS providers are, recently in particular, concentrating on providing social networking services among users rather than mere location-tracking services (Ryu 2011). For example, Foursquare, which is receiving much attention today, is a new kind of service as 'LBS plus SNS' (Ryu 2010). In case of using such services, their value will increase as the number of people around them using LBS increases, thus the following hypothesis is suggested.

\[ H_7: \text{Social influence will positively affect LBS use.} \]

**Privacy Concern as a Moderating Variable**

In the LBS context, privacy-related issues will function as more significant determinants compared with the other conditions, and the UTAUT-based previous study also referred to privacy concern as a specific driving factor of performance expectancy and effort expectancy (Xu et al. 2009). However, though the privacy risks is one of the most influential inhibitors in adopting LBS, the moderating effect of privacy concerns has not been examined in prior studies before.

**Privacy Concern**

In the e-commerce context, the negative impact of privacy concerns on behavioral intention has been empirically proved (Chellappa et al. 2005; Dinev et al. 2006; Malhotra et al. 2004). In addition, many studies in the LBS context also have proved the negative effects of privacy concerns on usage intention of LBS e.g. (Keith et al. 2010; Nam et al. 2009; Xu et al. 2004; Xu et al. 2005). In particular, the possibility of invasion of location privacy and users' privacy concerns are recently swelled due to the increase of LBS use.

In this regard, it is expected that users' privacy concerns will do the moderating role on the relationships between UTAUT variables and LBS use. In other words, the LBS users showing high privacy concern will be less influenced by the level of UTAUT variables in using LBS. Thus, we hypothesize as follows:
H8a: The positive impact of performance expectancy on LBS use will be stronger in low privacy concern than high privacy concern.

H8b: The positive impact of effort expectancy on LBS use will be stronger in low privacy concern than high privacy concern.

H8c: The positive impact of social influence on LBS use will be stronger in low privacy concern than high privacy concern.

Research Methodology

Operational Definition of Research Constructs

All of the research constructs, except accuracy and controllability, used in this study are adopted from previous studies with confirmed high validity and reliability. These measures are slightly modified to fit the unique research context. The accuracy construct and controllability construct will be developed by the authors since we could not find relevant previously validated measures. “Table 1” shows the operational definitions and sources of these variables.

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<thead>
<tr>
<th>Construct</th>
<th>Operational Definition</th>
<th>References</th>
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<tbody>
<tr>
<td>Ubiquity</td>
<td>The degree to which people can use LBS with no spatial and temporal limitations</td>
<td>(Kim et al. 2009)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>The degree of accuracy of location information that LBS recognize</td>
<td>(Self-developed)</td>
</tr>
<tr>
<td>Security</td>
<td>The degree to which people believe that their personal information and data are protected when using LBS</td>
<td>(Pavlou et al. 2007)</td>
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<tr>
<td>Controllability</td>
<td>The degree to which people can control the activation and deactivation of LBS</td>
<td>(Self-developed)</td>
</tr>
<tr>
<td>Performance Expectancy</td>
<td>The degree to which people believe that their using LBS can help them accomplish their goals</td>
<td>(Venkatesh et al. 2003)</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>The degree of users’ perceived ease of LBS use</td>
<td>(Venkatesh et al. 2003)</td>
</tr>
<tr>
<td>Social Influence</td>
<td>The degree to which people that are important to them think they should use LBS</td>
<td>(Venkatesh et al. 2003)</td>
</tr>
<tr>
<td>Privacy Concern</td>
<td>The degree to which an individual concerns about the collection, improper access, errors, and secondary use of personal location information</td>
<td>(Xu 2007)</td>
</tr>
<tr>
<td>LBS Use</td>
<td>The degree to which LBS are used</td>
<td>(Burton-Jones et al. 2006; Delone et al. 2003)</td>
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Data Collection and Analysis

This study is to survey actual users or experienced users of LBS applications installed in their smartphones. Toward this end, a sample will be accessed by posting notices in online communities of the users of smartphones like iPhone or other Android-based smartphones.

For statistical analysis, descriptive statistics analysis, exploratory factor analysis, and common method variance test are to be conducted through SPSS, and confirmatory factor analysis and path analysis are to be performed through the structural equation model (SEM) package.
**Expected Contribution**

In this research-in-progress paper, we have suggested a UTAUT-based research model to predict the actual use of LBS. When the following survey is well executed as explained above, this study is expected to determine the effects of ubiquity, accuracy, security, and controllability of LBS on the expectancy about the performance/effort of LBS, as well as the relationship between LBS use and performance expectancy, effort expectancy, and social influence. With regards to privacy issues, which are recently emerging in the LBS area, this study will also empirically test the moderating role of privacy concern on the relationships between UTAUT variables and LBS use. The results of this study will offer practical implications to LBS providers, application developers, and concerned individuals in the government. The implications will particularly include guidelines on protection of personal location information.

**References**


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