MOBILE LOCATION-BASED SERVICES:
BARRIERS TO AND FACTORS INFLUENCING
THE ADOPTION OF LOCATION SHARING ON MOBILE DEVICES

by

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A thesis submitted to the economic faculty of

ERASMUS UNIVERSITY ROTTERDAM

in partial fulfillment of the requirements for the degree of

Master of Science in Economics and Informatics

Master Economics and Informatics

ESE - Erasmus School of Economics

ERASMUS UNIVERSITY ROTTERDAM

2009

ABSTRACT

This thesis explores consumer perceptions of and standpoints towards location sharing on mobile devices. The model used in this study is based upon the widely used unified UTAUT model for User Acceptance. The model is adjusted to analyze usage intention of information technology within a mobile context. A survey is held containing questions regarding each of the model constructs and in-depth questions to investigate specific reasoning behind consumer standpoints towards location sharing. The validity of the constructs is tested, and the results are analyzed using different statistical methods. We found that important predictors in the adoption of location sharing are the expected effort and the perceived enjoyment of the services. Besides that, differences in usage intention were found based on consumers' experience in mobile internet and type of mobile device.

ACKNOWLEDGMENTS

I wish to thank my parents, for supporting me throughout my entire study and the process of writing this thesis. Their knowledgeable insights and good advice has always helped me in my endeavors. Without their help, receiving this degree would not have been possible.

I would also like to acknowledge my supervisor Drs. E.A.M. Caron, for his coaching and encouragement towards a thesis I can be proud of, Alard Weisscher at Vodafone for keeping me sharp and the scope realistic, and Dr. W.H.L.M. Pijls, for reviewing and commenting on this document.

I also want to thank Vodafone for providing me a worthwhile internship, and the respondents of the survey for cooperating. Also, I want to thank my brother Olaf and all of my friends who were there to distract me when I needed it most.

Writing these acknowledgements is the final straw of this thesis. Writing this, I realize that when I will wait until I have covered and finished absolutely everything in this study, it will never be done. Therefore, I hand in my thesis with mixed feelings: on the one hand, I am relieved the work is finally done, and on the other hand, slightly stressed because from this point forward I won't be able to make changes anymore.

Bas Janssen

08-12-2009

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1. Introduction

1.1 Background and Motivation

No longer then twenty years ago, barely anyone had a mobile phone. Since then, developments in cellular networks and the mobile phone market have been enormous, and mobile telecom companies and mobile phone manufacturers emerged around the world. Right now, nearly everyone (in the western world) owns a mobile phone, and it is expected that the possession and use of mobile devices and applications will increase even further in the future. According to the ITU [2004], the number of worldwide mobile phone subscribers (1.14 billion) already surpassed the number of landline telephone subscribers (1.10 billion) in 2002, and is still growing. The usage of the mobile phone and its applications will grow in known, but also in at the moment still unforeseen areas of use, as new technologies come available.

The rapid developments in the engineering of mobile phones are at the moment noticeable by looking at the wide available ranges of so-called pocket pc's and smart phones of the third generation (3G) of mobile phones, like for example the Apple Iphone, HTC Google G1, Samsung Omnia, the Blackberry Storm, or the Nokia N97. The latest developments include touchscreen or sometimes multitouch functionality, accelerometer sensors, handwriting recognition, fast wireless access, and increased computing power. This increase in computing power, as well as the increase in the speed of data-transfer in cellular networks that has become available to mobile devices over the past two decades has been huge.

These sophisticated mobile devices are rapidly taking over functionality from photo cameras, music players and computers, and can therefore be used for a multitude of tasks besides making calls, like emailing, calendar management and surfing the internet. Recent developments within the mobile phone market even enable mobile devices to run applications build by third-party developers, and to make use of mobile data services. Examples of these devices are the Apple iPhone and the recently released HTC Google G1 mobile phone (a collaboration of Google and the Taiwanese smartphone producer HTC). Both these phones can run applications developed by third-party developers, which can be downloaded from designated websites. These technologies are more and more coming available on sophisticated mobile phones, as other mobile phone manufacturers try to keep up with the competition focusing on mobile data using customers. Nokia, the world's largest cell phone maker, opened a virtual application store as well for their Nokia N97 mobile phone in May 2009 [Reardon, 2009]. These kinds of virtual application stores enable developers to upload applications and consumers to download them. According to a survey conducted by The Nielsen Company among 50,000-plus mobile customers in November 2008, mobile data usage will grow very fast in 2009 and 2010 [Goranson, 2009]. The survey found that more than a quarter of the many mobile customers are planning to start using mobile data services, and current existing data users plan to increase their usage.

A study among mobile phone users in Finland learned that the most favorable mobile services desired by consumers are "personalized ads" and "exact price information" [Kesti et al., 2004]. Personalized ads should not be mistaken with personalized greeting messages, which have been rated as the most unfavorable service. This research clearly shows users do not want to be bothered with services that are not useful to them, i.e., do not deliver any personal value. Most mobile phone users seem to be very attached to their mobile device, and regard it as a very personal and sometimes at the same time indispensable tool to everyday life [Wehmeyer, 2007b]. Therefore, the services mobile phone users are interested in, must be in accordance with their personal preferences, and the experienced intrusion must be kept to a minimum.

To facilitate mobile phone users in their future data usage needs, companies have made vast investments in wireless technology. These investments have been made based on very optimistic projections about the usage of Mobile Services. However, according to Kleijnen, it seems that this potential is mainly recognized on the supplier side, leaving many companies with enormous debts. She recommends in stead of pushing mobile technology through the market, marketers should investigate the underlying consumer motivations that will lead to the adoption of wireless technology [Kleijnen et al., 2004].

Because of these vast investments in wireless technology, a huge amount of innovative applications and services is becoming available to mobile phone users. Giaglis states [2003a] that among the most promising ones is the ability to identify the exact geographical location of a mobile user at any time: this ability opens the door to a new world of innovative services commonly referred to as Mobile Location-Based Services (MLS). MLS services are used for location information retrieval or other functionality that makes use of the geographical location of the user. These services are specifically designed to be used on mobile devices, and could potentially be used to for example locate the nearest cash register, retrieve information about public transport, locate a taxi standpoint, or to locate friends that are nearby. These kinds of services, making use of a location through the use of an application on a mobile phone, were unthinkable only a few years ago.

Companies doing business in the wireless industry (such as telecom operators, mobile phone manufactures, and content developers) must determine what kind of MLS services mobile phone users are interested in, so they can provide them with services customized to their needs, and which they are willing to use in practice. Achieving mass-market acceptance for MLS Services is dependent on a complex web of relationships between the various market stakeholders. A number of 'basic' applications can be envisaged (roadside assistance, emergency calls, navigation services), but as with electronic commerce, the real push to the market will happen if and when innovative service provision is matched with real market demand [Giaglis et al., 2003a].

1.2 Purpose and Research Questions

There are many interesting research problems in mobile commerce. Some of these are unique due to the limitations of mobile devices and wireless networks and some are similar to research problems that are currently being addressed by ecommerce researchers and developers. One of the problems that is unique to m-commerce is making use of the context (circumstances and surroundings of the mobile user), and location-awareness, as many of the applications are sensitive to the context they are used in, and the specific location of a user on the move [Varshney and Vetter, 2002]. Due to these specific properties that come into play on mobile devices, it makes an interesting research topic to study some new applications that are now feasible due to the use of geographical location information on mobile devices and wireless networks.

A lot of research has already been done in the area of Location Based Services (LBS) Applications on mobile phones. For example, research focusing on tourist guidance with mobile assistance has been popular [Cheverst et al., 2000], as well as research on mobile shopping assistants [Fano, 1998] and mobile recommender systems [Heijden et al., 2005], and as studies regarding MLS in general [Kaasinen, 2003]. These studies use the location of the user in order to provide contextual information. However, these studies do not focus on the actual market demand for these applications, and it is uncertain if there is a need within a broad public for these kinds of MLS applications. Besides that, the MLS applications might be experienced in different ways on different mobile devices. We were unable to find literature identifying a change in the behaviorial intention to use MLS applications if a 3G mobile phone was used.

This research also specifically focuses on the use location sharing on 3G mobile phones, as we believe this could be a demand driver for such services. If the telecom industry is able to match LBS services with the needs and demands of modern mobile phone users, these services can become a very successful source of revenue. This kind of research is important because the services offered should as much as possible be the kind that consumers are interested in, although it is a challenging task when the research subjects are the services that consumers can only imagine [Kesti et al., 2004]. Also, the mobility factor makes it difficult to do lab experiments, because issues like attentional resources and the mobility of the user need to be included in the usability measures [Avouris et al., 2008]. Therefore, besides literature about Mobile Marketing and LBS Services, literature concerning the evaluation of consumer needs, especially in a mobile context, is also included in the literature review.

The main purpose of this thesis is to explore consumers perceptions of and standpoints towards sharing locations in mobile social networks, or on their mobile devices in general. The aim is to get a comprehensive understanding of Mobile Marketing, LBS Services, and the evaluation of Consumer Acceptance, by means of a literature study. Ongoing, an empirical study in the form of a survey will be used to investigate consumer perceptions.

In order to reach the research purpose the following main research question is formulated:

1. Which factors affect the Usage Intention of mobile phone users to share location information in a mobile social network?

In order to answer this research question, the following supporting research questions are stated:

1. How can mobile commerce be described, and what are mobile services?
2. How can (mobile) Location-based Services be characterized and categorized?
3. How can the factors affecting User Acceptance be effectively studied and analyzed?
4. How can the factors affecting User Acceptance in mobile services be described?
5. How can these factors be validated?

With these supporting questions answered, a model can be build that is used to analyze the factors influencing Usage Intention in mobile services. This analysis is then used to answer the main research question. Some other questions could be answered as well based on the results:

6. What is the matter of experienced benefit or usefulness of location sharing on mobile devices?
7. What is the matter of experienced privacy intrusion of consumers regarding location sharing?
8. What are the differences between different consumer groups regarding location sharing on mobile devices?

1.3 Research Methodology

The research consists of three different stages. The first stage is the extensive literature review (Chapters 2, 3 and 4). The literature review was held to get a comprehensive understanding of Mobile Commerce, LBS Services, LBS Social Networking applications and the evaluation of Consumer Acceptance. A basic understanding of Mobile Commerce was needed in order to establish the playing field of Mobile LBS, the current players in the Dutch Telecom market, and why a company which uses Mobile Commerce effectively can be increasingly successful. Another important aspect was to analyze LBS Services: their application, how it works, and to establish a framework of MLS Services. These different applications of MLS Services are assessed and categorized, and the support structure needed for LBS provision is analyzed. The literature study also focused on how to measure acceptance and adoption by consumers, especially when the research subjects are the services that consumers can only imagine.

The second stage of the research was to empirically investigate which factors are of influence for the adoption of MLS Services would be of importance and are most favorable to mobile phone users, using the UTAUT model.

For this step, an online survey was utilized to investigate consumers' attitudes and their behavioral intention. A survey methodology is used to collect and analyze quantitative data of a (part of a) large population which describes and measures different characteristics such as demographics, opinions, attitudes and orientations [Babbie, 2006]. The survey is employed to investigate what the relationships of different factors of user acceptance of location sharing are with each other, and what their effect is on actual and intended usage. The work for the survey was divided into two parts. The survey analyzes three different aspects: first, questions are asked regarding background information of the respondent, such as age, social network subscriptions, and mobile phone brand and type. To get a thorough view of respondents' experience with mobile internet services, there are also questions asked about their usage of social networks, specific experience with mobile web-services, experience with mobile location services, and about experience with (mobile) Friend Finder services. The second aspect of the survey is to examine the constructs used in the theoretical model. Dissimilar to the research as performed by Venkatesh et al. [2003] this research will only measure on one instead of multiple occasions.

In the third stage, the results from the survey will be processed and critically analyzed. The factors most important for determining mobile location sharing usage demand and success will be identified based on the survey results. The methodology to check if the constructs of the questionnaire are valid will be Cronbachs α. It will be used to make a statement about the internal consistency of the survey. The data retrieved with the survey itself will be analyzed using multivariate analysis. Specific methods that will be used are factor analysis, so that the underlying relationships within the data may be more easily assessed, and regression analysis, which is used to measure how the independent variables interact with each other and their impact upon the dependent variable. The statistical analysis method called partial least squares (PLS) is also considered. This is a powerful second generation statistical technique widely used in the field of technology acceptance. All quantitative tests will be performed using SPSS.

1.4 Scope

This study will focus on mobile phone users in the Netherlands. The mobile devices under study will in general be all mobile phones, and more specifically 3G mobile devices. This term encompasses all phones utilizing large network speed enabling broadband internet access (between 5 and 10 Mbps). A good example of a modern 3G mobile device is the Apple iPhone 3G(S) because of it's large screen display, 3G connectivity (GSM, UMTS/HSDPA, GPRS/EDGE and Wi-Fi), and broad application availability through the online application store, or in other words, technologies making the phone suitable for MLS applications. As we are dependent on respondents possessing such phones, it is not possible to focus solely on one mobile device, but effort is put into establishing a respondent group of which a high percentage utilizes a 3G mobile phone. Other 3G mobile phones currently capable of using an MLS are generally web-capable mobile devices such as one of the most recent 'feature' phones (such as a flip, slider or bar phones), Smartphones (BlackBerry, Windows Mobile, Android, etc.), the iPhone, or a WiFi PDA enabled mobile phone (Windows Mobile, Palm). These phones use a network connection and data plan supplied by the telecom operator, or a WiFi connection, and have the ability to provide geographical location information (e.g. longitude/lattitude variables) over the wireless network.

1.5 Outline of the thesis

The first parts of this thesis consist of an extensive literature study. This is done in Chapters 2, 3 and 4, where mobile commerce, location-based services, and consumer acceptance are discussed. An adjusted theoretical framework is established based on the literature study in Chapter 5. With this framework, hypotheses about location sharing on mobile devices are formed. Ongoing, an online survey is presented, and criteria to which the survey and respondents should adhere. In Chapter 6, the results of the survey are presented. Respondent demographics are discussed and the constructs validity is established. The model and its hypotheses are tested using regression analysis and product-moment correlations in Chapter 7. Finally, in Chapter 8, the conclusion is formed based on the findings. Supporting material can be found in the appendixes.

2. Mobile Commerce and the Mobile Telecom Industry

In this chapter, several definitions of mobile commerce are explored, the history of mobile cellular networks is briefly discussed, and the current state of the Dutch telecommunications market is described. In the last section of the chapter, mobile commerce applications and services are discussed and a categorization is made based on their functionality.

2.1 Mobile Commerce

In the literature, there exist many different definitions which try to define mobile commerce and mobile business. The definition of mobile commerce as provided by Durlacher defines it as "any transaction with a monetary value that is conducted via a mobile telecommunication network" [Muller-Veerse, 2000]. Like this, most of the definitions try to explain mobile business in terms of business transactions through wireless devices, focusing mainly on payments occurring via mobile networks.

Mylonopoulos and Doukidis [2003] argues however that a much more expansive definition is needed to define mobile business, for two main reasons. First, the stumbling growth in commercial transactions on mobile networks shows that mobile business definitions generally represent a vision or target rather than adequately capture contemporary developments in the marketplace. Secondly, the current definitions do not sufficiently focus on the nature of what it is that has to be defined. Mylonopoulos does not try to define mobile business as commercial transactions on wireless devices, but rather as a young realm of sociotechnical activity, involving novel technologies and emerging practices. He states mobile business is not a collection of technologies and services given by an independent authority, but rather defined by the end-users and society. He therefore defines mobile business as: "An ecosystem of individual and business actors, in given historical socioeconomic contexts, engaging in multiple successive technological frames through a learning process of co-creating new experiences of social interaction with the use of wireless and mobile technologies."

Although this definition can be experienced as vague, it does leave room for new developments in the mobile business market, and therefore does not preclude any future directions which mobile business might take. It acknowledges the large variety of involved stakeholders, and focuses on their social interactions, but could at the same time be too broad which might leave too much room for interpretation.

The definition applied in this thesis however does not focus solely on business transactions, the users of mobile commerce, or the collection of technologies. It is stated by Turban et al., and besides mobile business transactions this definition also incorporates business processes occurring before and after these mobile transactions [Turban et al., 2003].

"Mobile e-commerce (also called mobile commerce or m-commerce) is defined as all activities related to a (potential) commercial transaction conducted through communications networks that interface with wireless (or mobile) devices."

Mobile devices are computing devices, in general pocket-sized, having a display screen with touch input or a miniature keyboard. Some mobile devices however do not follow this description. Therefore, the following list provides examples of what at the moment is included in the term "mobile devices":

- wireless phones;

- wireless-enabled handheld computers (so-called pocket, palmtop, and tablet computers);
- laptop computers;
- vehicle-mounted technologies, and;
- personal message pager devices.

Mobile e-commerce can also be conducted using portable non-wireless mobile devices, such as:

- personal digital assistants (PDA's), and;
- laptop computers with a fixed internet connection.

In this thesis however we regard mobile commerce only as the mobile commerce which is carried out through the use of wireless devices, through the use of cellular networks or other line free transmission technologies.

2.2 Mobile Cellular Networks

The developments in mobile commerce can be largely attributed to the technical advancements in mobile devices and mobile cellular network markets. To enable mobile commerce, these large radio-based wireless networks are needed to facilitate business transactions occurring over the wireless internet. Cellular networks need to facilitate huge and fast data transfers from fixed stations to mobile devices providing end-consumers in their ever growing data-needs. Enormous developments in wireless data-transfer speeds occurred during a period of no more then thirty years, and started in 1979 with the deployment of first-generation (1G) analog wireless technology networks. It was based on a cellular service called AMPS (Analog Mobile Phone Service). About ten years later, the second generation (2G) of radio technology made its entrance starting in Finland, and was based upon digital encryption and improved use of the radio-based wireless spectrum. Some of these 2G networks are called D-AMPS, and make use of TDMA, which stands for Time division Multiple Access. Another 2G system technology which emerged at the same time is CDMA, which stands for Code Division Multiple Access, but the main standard used in most 2G cellular networks is GSM, which stands for Global System for Mobile communications. The development of GSM was initiated by the European Conference of Postal and Telecommunications Administrations (CEPT), who started the Groupe Special Mobile (GSM) to developed this standard to be used across Europe. 2G GSM networks which currently account for over 80 percent of the total Mobile communication around the World, tend to operate on several different frequencies. With the deployment of digital cellular networks, the use of data services was made possible, creating new possibilities for Mobile Commerce, such as SMS text messaging, which was the killer application for the 2G networks.

After the second, the third generation came into play (3G). It was originated since the demand for bigger bandwidth was rapidly rising among consumers. Because of this fast rise in bandwidth demand, intermediate cellular generations were launched, to accommodate bandwidth demands, although still based on 2G technology. 2G GSM and GPRS networks progressed towards EDGE networks, which stands for Enhanced Data rates for GSM Evolution (EDGE) and Enhanced GPRS (EGPRS). These networks are called 2.5G and 2.75, of which GPRS (General Packet Radio Services) is one of the standards. This is a radio transmission technology which uses GMS cellular networks, but with a packet-switching protocol. This protocol allocates shorter set-up times for ISP connections, and offers telecom providers the opportunity to charge for consumer data usage.

The actual third generation of mobile cellular networks (3G) is based on the International Telecommunication Union (ITU) standards under the IMT-2000 [Smith, 2001]. Cellular networks based on 3G offer consumers a variety of new services, like for example E-mailing, fast internet browsing, instant messaging, video conferencing, digital television, and LBS services. 3G Networks are networks based on UMTS technology (Universal Mobile Telecommunications System) and HSDPA technology (High-Speed Downlink Packet Access). These technologies enable high bandwidth usage that make all the mentioned services possible.

2.3 The Dutch Telecommunications Market

In late 2004, the Dutch Telecom market consisted of five mobile telecom operators. These were KPN, Vodafone, T-Mobile, Orange and Telfort. After the acquisition of its rival Telfort by KPN in 2005, and the acquisition of Orange in 2007 by T-Mobile, there are currently only three dedicated mobile network operators providing mobile telecommunication services in the Netherlands [Monitor, 2009]. The Dutch Telecommunications market is with only three telecom operators a very consolidated market. However, there are quite a few MVNO's (Mobile Virtual Network Operator's) on the market, operating over the networks of the big three.

The biggest telecom operator in the Netherlands is still the (Royal Dutch) KPN, which serves around 8,5 million mobile subscribers (including Mobile Wholesale) in the Netherlands alone. KPN is market-leader in the Netherlands, and it also active on the German and Belgian markets under the brands E-plus and BASE. Also, KPN is expanding it's business into other European and American markets [KPN, 2009].

It is closely followed by T-Mobile (Deutsche Telekom), which jumped to the second place if ranked in customer size after their acquisition of Orange, which at the moment had 1,9 million mobile subscribers. The combined company at the moment serves 5,2 million mobile customers [T-Mobile, 2009].

Third and last in the row is Vodafone, which is originally an operator from the United Kingdom. Vodafone currently serves 4,6 million mobile subscribers in the Netherlands, of which 41% is a prepaid customer. The percentage of prepaid customers is relatively low, compared to the other markets in which Vodafone operates (e.g. Italy 87.8%) [Vodafone, 2009]. Vodafone strives towards expanding their business in upcoming markets and Europe, with a focus on innovative technology.

2.4 M-Commerce applications / Mobile Services

Mobile commerce exists in many different forms. As mentioned, it consists of all activities related to a commercial transaction conducted through a communications network interfacing with a mobile device. Varshney and Vetter [2002] categorized mobile applications according to their functionality and usage. Examples these m-commerce applications include Mobile Financial Applications, Mobile Advertising, Mobile Inventory management, Product Locating and Shopping, Mobile Games and Mobile Entertainment Services and [Varshney and Vetter, 2002]. An overview of these mobile applications is presented in Table 2.1, alongside some examples that illustrate the usage of such services. It must be noted here, that a lot of different mobile applications can be envisaged, so this list of categorizations is by no means exhaustive.

2.5 Summary

This chapter explored what mobile commerce is and presented a brief overview of the history of Mobile Cellular networks, as well as the current state of the Dutch Telecommunications Market. Also, mobile commerce applications and a categorization based on their functionality were presented and discussed. The next chapter will explore into the concept of using location services (LBS), and explains how mobile devices and applications can make use of geographical information across mobile telecommunication networks.

Table 2.1 Overview of m-commerce applications.

Class of Applications	Examples
Mobile Financial Applications	Banking, brokerage, and payments for mobile users.
Mobile Advertising	Sending user specific and location sensitive advertisements to users.
Mobile Inventory Management	Location tracking of goods, boxes, troops, and people.
Proactive Service Management	Transmission of information related to aging (automobile) components to vendors.
Product Locating and Shopping	Locating/ordering certain items from a mobile device.
Wireless Re engineering	Improvement of business services.
Mobile Auction or Reverse Auction	Services for customers to buy or sell certain items.
Mobile Entertainment Services	Video-on-demand and other services to a mobile user.
Mobile Office	Working from traffic jams, airport, and conferences.
Mobile Distance Education	Taking a class using streaming audio and video.
Wireless Data Center	Information can be downloaded by mobile users/vendors.
Mobile Music/Music-on-demand	Downloading and playing music using a mobile device.

3. Location-Based Services

In the previous chapter, we discussed mobile commerce applications and services. In this chapter, we will specifically focuses on LBS Services. This chapter is organized in several different sections. It starts with an explanation of what LBS exactly comprehends, followed by the technical and methodical aspects of LBS provisioning (i.e. positioning systems and methods). Furthermore, a taxonomy of LBS Services is presented, and descriptions of these LBS Services are provided.

3.1 Introduction to Location-Based Services

In the literature, there exist several different definitions of LBS. Koeppel [2001] describes LBS Services as "any service or application that extends spatial information processing, or GIS capabilities, to end users via the internet and/or wireless network" [Koeppel, 2001]. Koeppel further describes how one can identify three different generations of LBS. In the first generation of LBS, users have to input their geographical location to the used system themselves. This represents very low accuracy. The second generation of LBS consists of automatic geographical location retrieval, but still with low accuracy in the location determination. The third and final generation of LBS consists of systems that automatically determine the user location, just as in the second generation, but with very high accuracy. Besides that, users do not have to actively start the LBS application on their devices, but can opt in for automatic service execution when they are in a certain geographical domain.

In other research by Shiode et al. [2004], LBS is desribed as "geographically-oriented data and information services to users across mobile telecommunication networks" [Shiode et al., 2004].

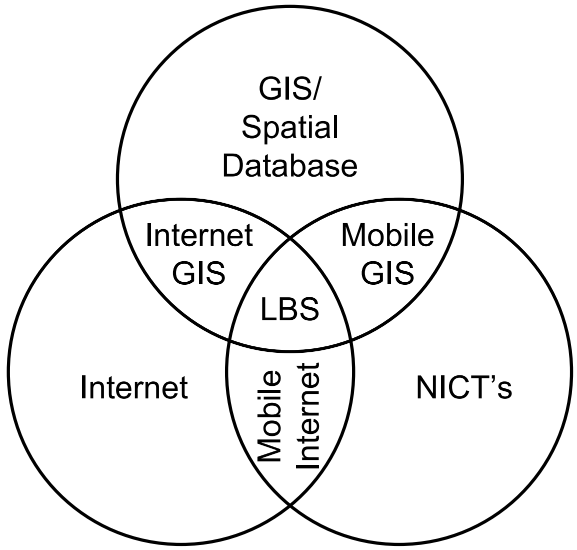

Figure 3.1 Convergence of technologies creating LBS (Brimicombe 2002 in [Shiode et al., 2004]).

In contrary to the former definition, the focus here lies on the information services that can be deployed over mobile networks, rather then the capabilities which GIS provides. They further state LBS can be seen as a convergence of three new technologies. It consists of New Information and Communication Technologies (NICTs) (e.g. mobile telecommunication systems and new mobile devices), location aware technologies (e.g. Global Positiong Systems (GPS) and Geographical Information Systems (GIS) with spatial databases) and connectivity to the Internet (Brimicombe 2002 in [Shiode et al., 2004]). This is illustrated in Figure 3.1.

To provide LBS Services to users, several different infrastructure elements must be deployed which are necessary to support location services. These components are:

1. Mobile devices.

   The devices used to retrieve information. Content can be delivered in different forms, such as text, pictures, speech, etc. Mobile devices do not necessarily have to be mobile phones: they can for example also consist of single-use tracking devices, as utilized in the logistics industry.

2. Telecommunication networks.

   To provide the transfer of data and service requests, (high speed) communication networks are needed. These networks also provide links with other networks and access to the internet.

3. Geographic Positioning component.

   To derive the user's geographical position, a position component is needed in LBS provision. This can be done in several different ways: by using the mobile communication network, the GPS, or Wi-Fi networks. Section 3.2 elaborates on the methods and technologies used to derive the geographical location in LBS applications.

4. Service and application providers.

   The services offered to users on mobile devices are offered by providers that process the service request and calculate the user's position. In LBS, there exists a multitude of different sorts of services, that are elaborated in Section 3.3.

5. Data and content providers.

   The data and content provided through LBS services is generally not maintained by the service providers themselves. The geographic database and location information data will usually be requested from either the maintaining authority, or business and industry partners.

3.2 Positioning in LBS Services

The ability of an LBS Service to identify the geographical location of the user depends on two different systems. First, there is the positioning system, and second, there is the geographical information system [Turban et al., 2008]. Locating the user can thus be handled in a number of different ways, depending on these systems. Positioning systems are available in three different forms. There is Satellite Positioning, Cell based positioning, and Assisted GPS. These systems can in turn use different methods to define the longitude and latitude of the receivers geographical location. The description of these methods is available for the interested reader in Appendix C. The systems using these methods are outlined in the following paragraphs.

3.2.1 Satellite Positioning

According to Turban et al., a GPS System is based on a worldwide satellite-based tracking system that enables users to determine exact positions anywhere on Earth [Turban et al., 2008]. At the moment, there are four main satellite systems in the World, which are either fully installed, or still in deployment. These are the American NAVSTAR system, the Russian GLONASS system, the European Galileo system, and the Chinese Beidou system.

Satellite Positioning Systems work with the method trilateration (see Appendix C) to define the receivers geographical location. To successfully determine the longitude and latitude coordinates, four satellites and the clock bias of the receiver are needed [Parkinson and Spilker, 1996] . The GPS satellite-based radionavigation system is currently the most well-known and the most used satellite system. GPS permits land, sea, and airborne users to determine their three-dimensional position, velocity, and time 24 hours a day, in all weather, anywhere in the world with superior precision and accuracy. GPS consists of three segments: space, control, and user [Dana, 2000]:

The Space Segment of the system consists of 24 GPS satellites that each orbit the Earth in 12 hours, the Control Segment consists of a system of tracking stations located around the world, and the User Segment consists of the GPS receivers and the user community.

Besides the NAVSTAR GPS system there are other satellite systems being developed around the World, such as the Global Navigation Satellite System (GLONASS), deployed by the Russian Federation, and Galileo, the European Satellite system. Although China is partner in the Galileo project, they have also been working on their own Satellite positioning system called Beidou.

3.2.2 Cell-Based Positioning

Another method widely used in location determination next to GPS positioning is Cell-based positioning. It is positioning based on telecommunications base stations (cell towers), and the basic technique to provide MLS Services to mobile devices. Mobile networks can identify the approximate position of a mobile device by extracting which cell site of the network (base station) the device is using at a given time. The accuracy of this method is low in rural areas (approximately 200 meters accurate depending on the cell size) but higher in densely covered areas [Giaglis et al., 2003a]. Each cell has the shape of a circle, and the signal coverage of the base stations may overlap. When communicating with a mobile device, the base station receives signals, which are in turn send to a central system. Each base station signal contains a cell number from the base station, with which the location of a user can be determined. For example, if a mobile phone user is making a connection with base station A, but at the same time this connection is picked up by base station B, the system can determine the user's position must be between A and B. Thus, the accuracy of cell-based positioning method can be defined as the size of distinguishable area by base stations. The maximal size of the distinguishable area is the accuracy of positioning for the network system. Cell based positioning can be done in wireless local area networks as well as in cellular networks, usually involving signal measurements from several base stations [Chu and Jany, 2002].

3.2.3 Assisted GPS Positioning

Next to Cell-based positioning and GPS, there is another methods that outperforms both in positioning accuracy: Assisted GPS. This is a method designed to establish a GPS reference network (or a wide area DGPS network) with receivers that have clear views of the sky and can operate continuously. It continuously monitors the real-time constellation status and provides precise data such as satellite visibility, ephemeris and clock correction for each satellite at a particular epoch time. Upon the request of the mobile device or location-based application, the assist data derived from the GPS reference network are transmitted to the GPS receiver in the mobile device to aid fast start-up and to reduce terminal power consumption. The reduction in acquisition time and power consumption is due to that fact that the Doppler versus code phase uncertainty space is much smaller than that in a conventional GPS receiver as a limited search space has been predicted by the reference receiver and the network [Zeimpekis et al., 2003].

3.3 Mobile LBS applications

In LBS Services, there are exist many different categorizations. From a geographic point-of-view, LBS services can be simplified into indoor and outdoor categories, but this taxonomy is very narrow in scope [Wang, 2008]. Another differentiation that could be made, is the division of LBS Services into either those requested by the user once their location has been defined, and those that start automatically once specific conditions have been met [D'Roza and Bilchev, 2003]. Out of this division, other authors like Steinfield [2004] have developed a categorization in MLS Services based on so called 'push' and 'pull' services [Vrcek et al., 2008]. However, one of the most frequently used categorizations in the literature, is the categorization of LBS into three different types of services: emergency services, services of mobile operators, and value added services (VAS). This taxonomy focuses on the last category (VAS) as a primary opportunity for development of m-business, because VAS LBS services are those services that increase location information value to customers through specific services [van de Kar and Bouwman in Vrcek et al. [2008]]. This group of services consists of the following types of LBS Services: information, entertainment, communication, transaction, mobile office, and business processes support services. Another categorization provided by Levijoki [2000] differentiates on another level. Here, the difference between LBS services is made on a more simpler basis: the groups in which the services are divided are collection, security, information, monitoring and proximity services. In this thesis however, we follow the categorization as provided by Giaglis et al. [2003b]. Here, the services are categorized into several different groups of services, of which the categorization is based upon the functional use of the services. This taxonomy follows and expands the differentiation into groups as provided by van de Kar and Bouwman. Currently this seems as the best classification of MLS Services. A few examples of the described services and their respective positioning methods has been given by Zeimpekis et al. [2003], and are provided in Table C.1. These categorizations of the MLS services as used in Giaglis et al. [2003b] are described below, and summarized in Table 3.1 [Zeimpekis et al., 2003].

Public Safety or Emergency Services

Individuals in emergency situations are often not capable of providing their location information, either because they are unaware of it, or not able to reveal it because of their situation. In October 2001, the US Federal Communication Commission (FCC) declared the E-911 mandate stating that every mobile operator must be able to accurately locate individuals calling for emergency assistance on their mobile phone. An accuracy of 50 meters for 67% of emergency calls and within 150 meters for 95% of the calls is mandated [Solanki and Hu, 2005]. Apart from providing accurate location information in case of an emergency, there was also the need to effectively monitor offenders on parole and trial. A simular mandate, E-112, has been put into place in Europe. For telecom providers to provide emergency assistance agencies with location information, their systems are required to automatically determine the exact location of the mobile user after receiving an emergency call and transfer the location information.

Besides the need for location information in individual emergency situations, other applications of public safety, medical help, or roadside assistance can also be imagined. For example, emergency warnings can be provided to mobile users by broadcasting alerts to specific geographical areas in case of an emergency or disaster.

Navigation Services

Navigation services are based on a mobile user's need for directions within their current geographical location. The ability of a mobile network to locate the exact position of a mobile user can be manifested in a series of navigation-based services [Giaglis et al., 2003b].

1. By positioning a mobile phone, the user can know exactly where is, as well as get directions about how to get to a desirable destination.

2. Coupled with the ability of a network to monitor traffic conditions, navigation services can be extended to include destination directions that take account of current traffic conditions

(for example, traffic congestion or a roadblocking accident) and suggest alternative routes to mobile users.

3. The possibility to provide detailed directions to mobile users can be extended to support indoor routing as well. For example, users can be assisted in their navigation in hypermarkets, warehouses, exhibitions, and other information rich environments to locate products, exhibition stands, and so on.

4. Similarly, group management applications can be provided to allow mobile users to locate friends, family, coworkers, or other members of a particular group that are within close range and thus, create virtual communities of people with similar interests [Giaglis et al., 2003b].

Information Services

Location-sensitive information services generally refer to the digital distribution of content to mobile devices based on their location, time specificity and user behavior [Giaglis et al., 2003b]. The following types of services can be identified within this category:

1. Travel services such as guided tours (either automated or operator-assisted), notification about nearby places of interest (monuments etc.), transportation services, and other services that can be provided to tourists moving around in a foreign city.

2. The application of mobile yellow pages that provide a mobile user, upon request, with knowledge regarding nearby facilities is another example of information services..

3. Infotainment services such as information about local events or multimedia content specified for a certain location, etcetera [Giaglis et al., 2003b].

Advertising Services

From a commercial point of view, Location-based mobile advertising provides interesting opportunities. Consumers can be segmented by geographical areas, or be provided with ads based on their proximity to a certain store or place. This makes targeting the right customer a lot easier, especially when the location information can be coupled with customer specific information, so personal advertising can be established. With personal advertising, new opportunities are offered to advertisers to place effective and efficient promotions on mobile environments [Kalakota and Robinson, 2002]. However, advertising on mobile devices still has some difficult issues to resolve, because customers regard their mobile devices generally as very personal [Wehmeyer, 2007b], and are only interested in advertising options for which they have opted in. There are programs however that can deliver benefits to the customer, such as reduced call rates, in exchange for advertising on their devices [Giaglis et al., 2003b] [Giaglis et al., 2003a].

Tracking Services

Tracking persons or properties is one of the larger recognized benefits that has become available with LBS. Especially in the logistics industry, where companies want to keep track of their trucking fleets, so management knows at all times exactly where their goods are and can thereby organize their business. These kinds of the applications can also be utilized by companies in order to locate and manage their working teams, which is known as field management. Also, within product chains, LBS can enable indoor and outdoor product tracking [Kalakota and Robinson, 2002]. This can for example enable an organization to take better control over its production processes: it gives insight in which processes are lagging the production line, or find lost products. On the consumer level, LBS can be used to track social network contacts, friends, children, cars and pets as well.

LBS Social Networking

Many online social networks are extending their software to be used on mobile devices. When available on mobile devices, user location information can be included in their applications. Sharing geographical and contextual information in online social networks is described as location-based social networking. With this functionality, social network contacts can share their current location information, or track their whereabouts over time. It is also possible for them to 'geotag' certain

Table 3.1 Overview of consumer MLS Services.

Services	Examples	Accuracy Needs	Application Environment
Emergency	Emergency calls	Medium to High	Indoor/Outdoor
	Automotive Assistance	Medium	Outdoor
Navigation	Directions	High	Outdoor
	Traffic Management	Medium	Outdoor
	Indoor Routing	High	Indoor
	Group Management	Low to Medium	Outdoor
Information	Travel Services	Medium to High	Outdoor
	Mobile Yellow Pages	Medium	Outdoor
	Infotainment Services	Medium to High	Outdoor
Advertising	Banners, Alerts, Ads	Medium to High	Outdoor
Tracking	People Tracking	High	Indoor/Outdoor
	Vehicle Tracking	Low	Outdoor
	Product Tracking	High	Indoor
Social Networking	Friend Finder	High	Outdoor
	Content sharing	High	Outdoor
Billing	Location-sensitive Billing	Low to Medium	Indoor/Outdoor

content. Geotagging content means adding geographical data to content. Currently, Flickr and Picasa are the two main photo sharing websites that support geotagged photos. Some popular mobile social network systems are Twitter, Jaiku, and Friendzone [Burak and Sharon, 2003], but also Facebook, Hyves and LinkedIn are already represented on mobile devices with their own applications. There also exist mobile applications that are specifically targeted at location sharing through a social network, such as Brightkite, Centrl, Foursquare and Rummble. With these applications, it is possible to search for social network contacts and see their location, or receive automatic notifications when contacts are nearby. Specific content can be shared, such as recommendations for places (e.g. restaurants, bars, shops, etc.).

Charging Services

Location-sensitive charging or billing refers to the ability of a mobile location service provider to dynamically charge users of a particular service depending on their location when using or accessing the service. These services would be based on proximity awareness. For example, mobile network operators may price calls based on the knowledge of the location of the mobile phone when a call is made. Location-sensitive billing includes the ability to offer reduced call rates to subscribers that use their mobile phone at home, thereby allowing mobile operators to compete more effectively with their fixed telephony counterparts. [Giaglis et al., 2003b].

3.4 Summary

This Chapter presented an introduction to LBS Services, the support structure needed for such services (several positioning options), and finally presented an overview of different forms of MLS Services. In the final section, seven different services were discussed, and several examples of these services were introduced. These services are often very different in context and usage. Positioning a person making an emergency call is, although probably using exactly the same positioning technology, very different from mobile MLS advertising. Therefore, acceptance of each of these different services should be investigated separately. Empirical research has also showed that the context a service is used in affects user attitude and therefore influences acceptance of the service [Mallat et al., 2009]. The context mediates the effect of the perceived benefits on user intention to adopt the technology. This means, it is impracticable to study all MLS Services together in a generic model. Each MLS Service described in Section 3.3 has a different usage and different contexts it can be used in. Therefore, the choice has been made in this study to focus on one specific MLS exclusively. This MLS service are so-called ‘mobile social networking’ services or ‘friends tracking’ services. These services can also be described as “location sharing in mobile social networks” services. Basically these services can provide location information for contacts in a social network, based on their current (cell phone) location. It is assumed respondents will be familiar with social networking from experiences from the internet, and therefore are probably very well able to envision such a location sharing service on a mobile device. Basically, the services under investigation are existing (mobile) social networks expanded with a location sharing component.

4. Evaluating Consumer Acceptance

User acceptance is crucial for the success of new technologies. It is however hard to predict in what matter a certain technology will be utilized by the intended users. Of course, for vendors of new technologies or technology services it is very important to comprehend what user's experience with and expectations for a certain technology will be. To gain an understanding in what matter new technologies will prosper or not when presented to the market, researchers have established several models to measure potential user acceptance using a wide variety of determinants. This chapter identifies the main models that currently exist in literature to measure and predict consumer acceptance, and explains their differences.

4.1 Methods of Assessing User Acceptance

In consumer acceptance literature, many approaches exist regarding the evaluation of user acceptance for information systems. In the human-computer interaction discipline, there is a shared understanding of concepts for systems evaluation. The techniques used by researchers performing experiments are often field or laboratory evaluations. Figure 4.1 presents the basic conceptual framework underlying user acceptance models which try to explain individual acceptance of information technology [Venkatesh et al., 2003].

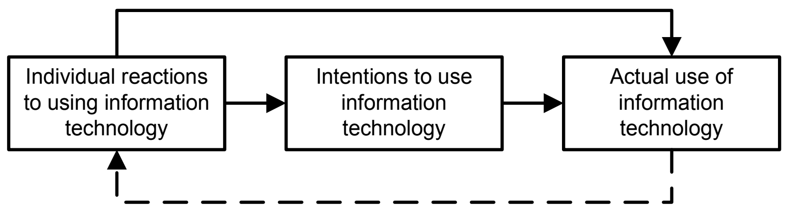

Figure 4.1 Basic concept underlying User Acceptance models [Venkatesh et al., 2003].

4.1.1 Innovation Diffusion Theory (IDT)

One of the most widely used theories in acceptance and innovation research is the Innovation Diffusion Theory (IDT) by E.M. Rogers (1995). Rogers describes diffusion as "the process by which an innovation is communicated through certain channels over time, and are transferred and adopted among the members of a social system". The theory consists of four different elements:

1. the Innovation,
2. Communication Channels,
3. Time, and
4. Social system

The essence of the IDT lies in the process of reduction of insecurity around the acceptance of an innovation. The stages an individual passes from awareness of an innovation to acceptance and implementation are described by as follows [Rogers, 1995]:

1. *Knowledge*: the individual learns about the existence of the innovation and gains some understanding of how it functions and its functioning principles.
2. *Persuasion*: the individual forms a favorable or unfavorable attitude towards the innovation, based upon the perceived characteristics.
3. *Decision*: the choice for adopting or rejecting the innovation.

4. *Implementation*: Implementing and using the innovation.

5. *Confirmation*: Determine the meaning and benefits of the innovation. Also, learn lessons through evaluation, improve the implementation, and consider other innovations.

If the innovation process leads to a success, the innovation is adopted. The definition of adoption as provided by Rogers [1995] is: “The decision by an organization to start making full use of an innovation”.

4.1.2 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action [Fishbein and Ajzen, 1975] is one of the most influential theories about human behavior. The theory is used in a lot of different fields, including the field of adoption of new technologies [Venkatesh et al., 2003]. The theory of reasoned action is based upon the presumption that people are rational in their decision making, and make consistent use of the information available to them. This supposes people will think about the consequences of their actions before deciding to do it, i.e. to adjust their behavior based upon reasoning. Fishbein and Ajzen [1975] describe how the components of the theory are basically constructed out of three different determinants. These are:

- Behavioral Intention (BI),
- Attitude (A), and
- Subjective Norm (SN).

Basically, the theory states how a person’s behavioral intention is a function of a consumer’s attitude and subjective norms. Behavioral Intention measures a person’s relative strength of intention to perform a behavior. Attitude consists of beliefs about the consequences of performing the behavior multiplied by his or her valuation of these consequences. Subjective norm is seen as a combination of perceived expectations from relevant individuals or groups along with intentions to comply with these expectations. In other words, “the person’s perception that most people who are important to him or her think he should or should not perform the behavior in question” [Fishbein and Ajzen, 1975]. Furthermore, Fishbein and Ajzen [1975] state that a person’s behavior can be predicted out from intention, thus leading to actual behavior.

4.1.3 Theory of Planned Behavior (TPB)

The theory of Planned Behavior [Azjen, 1991] builds upon the Theory of Reasoned Action. In TPB, another construct is added to better explain behavioral intention. The construct added is “Perceived Behavioral Control” (PBC), which has a direct connection with Intention to Use and Use Behavior. Perceived Behavioral Control is described as the ease or difficulty perceived of performing a certain behavior. It is also assumed to reflect past experience as well as anticipated obstructions people might have against performing the behavior. In general TPB states that the more favorable the Attitude and Subjective Norm with respect to a behavior and the greater the Perceived Behavioral control, the stronger the intention will be to perform the behavior under consideration [Azjen, 1991].

4.1.4 Technology Acceptance Model (TAM)

A widely used model for user acceptance of information systems is the Technology Acceptance Model (TAM). The model explains perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes. It finds its basis on the Theory of Reasoned Action model (TRA), as developed by Fishbein and Ajzen [1975], and it employs scales for two specific variables: specifically Perceived Usefulness and Perceived Ease of Use, which Davis proved to be fundamental and distinct constructs that are influential in decisions to use information technology. Perceived Ease of Use is defined as “the degree to which a person believes that using a particular system will be free of effort”, and Perceived Usefulness is defined as “the degree to which a person believes that using a particular system will enhance his or her job performance”. Also, Perceived Ease of Use can be seen as a predictor of perceived usefulness.

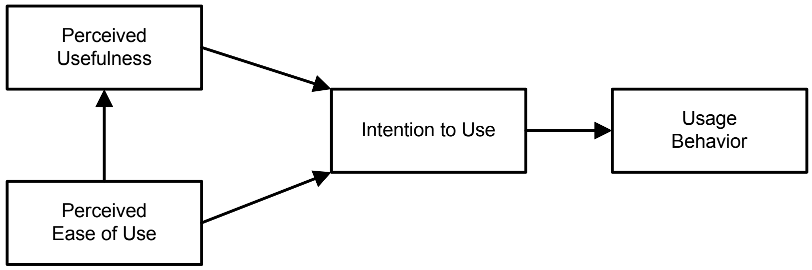

Figure 4.2 Technology Acceptance Model.

The goal of the TAM model is to predict if users are willing to use a certain information system. The model has been widely applied in information system acceptance studies, and in several studies it has been able to explain more then 40% of users intentions to use office software [Legris et al., 2003].

The TAM model is employed in survey studies regarding user acceptance, which in turn can explain eventual usage behavior. Figure 4.2 shows the model, and how the underlying variables affect each other. The questions presented in user acceptance surveys working with TAM are constructed so that they all measure different aspects of the TAM model. For instance, questions which measure the Perceived Usefulness can be about the user's expectations regarding the time he can save, or possible quality improvements, resulting from using the software application under study. Questions linked to the Perceived Ease of Use could be about the user's experiences with interacting with the software, number of errors made using the software, or if the user needs to consult the user manual often when working with the software.

4.1.5 Extended Technology Acceptance Model (TAM2)

Venkatesh and Davis [2000] expanded the TAM model to explain the key forces that lie behind the earlier presented variables Perceived Usefulness and Perceived Ease of Use. The model includes a Subjective Norm as an additional predictor of intention in the case of mandatory settings. The key forces in the TAM2 model are described in two groups of social influence processes, with determinants 'Subjective Norm', 'Voluntariness', and 'Image', and the cognitive instrumental processes, with determinants 'Job Relevance', 'Output Quality', 'Result Demonstrability', and 'Perceived Ease of Use'. These determinants significantly influenced user acceptance, explaining for 40% - 60% of the variance in usefulness perceptions and 34% - 52% of the variance in Usage Intentions.

The description for the determinant 'Subjective Norm' has been drawn from research by Fishbein and Ajzen [1975], who describe it as a "person's perception that most people who are important to him think that he should or should not perform the behavior in question". The determinant Voluntariness is defined as "the extent to which potential adopters perceive the adoption decision to be non-mandatory". The Image determinant has been drawn from research on diffusion of innovations and is described as "the degree to which use of an innovation is perceived to enhance one's status in the social system" [Venkatesh and Davis, 2000].

4.1.6 A unified model: UTAUT

Venkatesh, Morris, Davis, and Davis [2003] reviewed and compared eight models of user acceptance and their extensions. Based on this review, they formulated a unified model that integrates elements across the eight models. This model, proposed as the Unified Theory of Acceptance and Use of Technology (UTAUT), was formulated out of seven constructs, that appeared to be significant direct determinants of Intention or Usage in one or more of the individual models. Four of these constructs have been identified by Venkatesh et al. [2003] to play a significant role as direct determinants of user acceptance and usage behavior. These are: 'Performance Expectancy', 'Effort Expectancy', 'Social Influence' and 'Facilitating Conditions'. The other three determinants, 'Attitude toward using technology' 'Self-efficacy' and 'Anxiety' have not been recognized as being direct determinants of Usage Intention. The unified model was empirically tested and found to outperform the eight

Table 4.1 The eight User Acceptance models used in the unified UTAUT model.

Model	Abbreviation	Authors	Year
Theory of Reasoned Action	TRA	Fishbein and Ajzen	1975
Technology Acceptance Model	TAM	Davis	1989
Motivational Model	MM	Davis et al.	1992
Theory of Planned Behavior	TPB	Taylor and Todd	1995
Combined TAM and TPB	C-TAM-TPB	Taylor and Todd	1995
Model of PC Utilization	MPCU	Thompson et al.	1991
Innovation Diffusion Theory	IDT	Moore and Benbasat	1991
Social Cognitive Theory	SCT	Compeau and Higgins	1995

individual models [Venkatesh et al., 2003]. This proves the UTAUT model is an applicable tool to be used in user acceptance studies. The model is depicted in Figure 4.3, and the eight models of user acceptance of which UTAUT is derived are shown in Table 4.1. All determinants included in the UTAUT model are discussed in detail below:

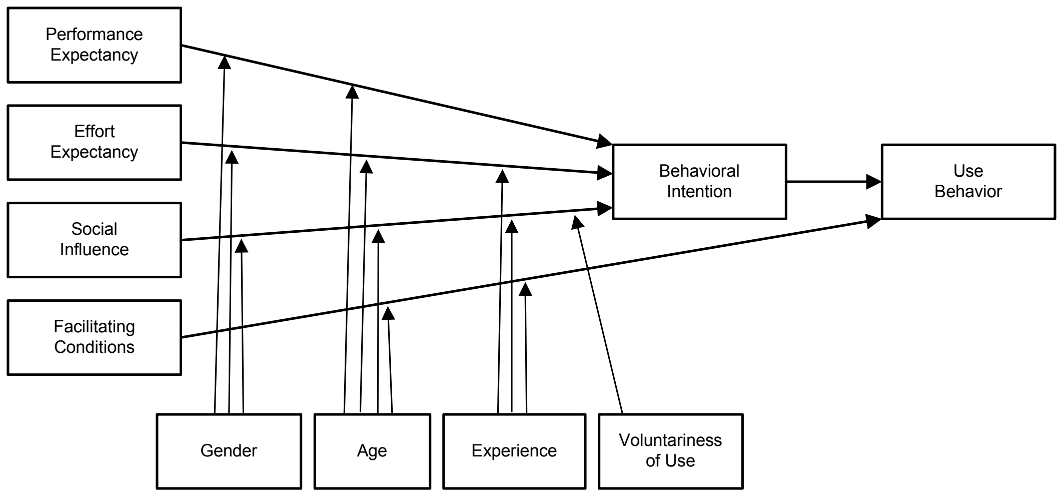

Figure 4.3 The UTAUT research model [Venkatesh et al., 2003].

Performance Expectancy

Performance Expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance. There are five constructs from the different models on which the UTAUT finds its basis that pertain to Performance Expectancy. These are Perceived Usefulness (TAM/TAM2 and C-TAM-TPB), Extrinsic Motivation (MM), Relative Advantage (IDT), and Outcome Expectations (SCT) [Venkatesh et al., 2003]. Statements included in a typical UTAUT survey would consist of for example:

1. I would find the system useful in my job.
2. Using the system enables me to accomplish tasks more quickly.
3. Using the system increases my productivity.
4. If I use the system, I will increase my chances of getting a raise.

Effort Expectancy

Effort Expectancy is defined as the degree of ease associated with the use of the system. Three constructs from the existing models capture the concept of effort expectancy: Perceived Ease of Use (TAM/TAM2), complexity (MPCU), and Ease of Use (IDT). There is substantial similarity among these construct definitions and measurement scales. Effort-oriented constructs are expected to be be more salient in the early stages of a new behavior, when process issues represent hurdles to be overcome, and later become overshadowed by instrumentality concerns [Venkatesh et al., 2003]. Statements included in a typical UTAUT survey would consist of for example:

1. My interaction with the system would be clear and understandable.
2. It would be easy for me to become skillful at using the system.
3. I would find the system easy to use.
4. Learning to operate the system is easy for me.

Social Influence

Social influence is defined as the degree to which an individual perceives that important others believe he or she should use the new system. Social influence as a direct determinant of behavioral intention is represented as Subjective Norm in TRA, TAM2, TPB/DTPB and C-TAM-TPB, Social Factors in MPCU, and Image in IDT Venkatesh et al. [2003]. Statements included in a typical UTAUT survey would consist of for example:

1. People who influence my behavior think that I should use the system.
2. People who are important to me think that I should use the system.
3. The senior management of this business has been helpful in the use of the system.
4. In general, the organization has supported the use of the system.

Facilitating Conditions

Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system. This definition captures concepts embodied by three different constructs: Perceived Behavioral Control (TPBI, DTPB, C-TAM-TPB), Facilitating Conditions (MPCU), and compatibility (IDT). Each of these constructs is operationalized to include aspects of the technological and/or organizational environment that are designed to remove barriers to use. In the UTAUT model it is assumed that when Performance Expectancy and Effort Expectancy are included in the model, Facilitating Conditions becomes nonsignificant in predicting Usage Intention, but does have an effect on usage beyond that explained by behavioral intentions Venkatesh et al. [2003]. Statements included in a typical UTAUT survey would consist of for example:

1. I have the resources necessary to use the system.
2. I have the knowledge necessary to use the system.
3. The system is not compatible with other systems I use.
4. A specific person (or group) is available for assistance with system difficulties.

Moderators

The constructs of the UTAUT model are also build up with determinants that have a moderating role in predicting user acceptance. These are 'Gender', 'Age', 'Experience', and 'Voluntariness of Use'. The UTAUT model incorporates both the determinants 'Perceived Utility' and 'Perceived Ease of Use' from the TAM model (which were also recognized in some of the other eight models), and replaced them with 'Performance Expectancy' and 'Effort Expectancy'. Figure 4.3 shows the way these factors influence each other, and have their effect on the users behavioral intention and use behavior.

4.2 Summary

For this study, the unified UTAUT model was chosen as the basis for analyzing location sharing in mobile social networks, because of its proven results in prior research. The UTAUT model has been used to accurately predict the adoption of company information systems on desktop computers, making use of fixed line internet connections. Information systems designed for mobile devices are however in many ways different. Such differences are for example that mobile services are ubiquitous, mobile devices are portable, and mobile services can be used to send and receive personalized and location-aware information. Information Systems or Services designed for mobile devices are generally designed to be used while on the move, which will generate a very different user experience compared to working on a desktop computer. Also, in this thesis the service under study is not designed to be used in a work environment, which means that use of the service is not mandated. This on the other hand does bring up another factor that should be taken into account: the cost of using such services. In contrast to on the job use of Information Systems, consumers have to pay for owning and using mobile devices and services. In this study, adjustments to the UTAUT research model have to be made to account for these differences. Chapter 5 therefore discusses and presents the adjusted theoretical model used in this thesis.

5. Research Model, Hypotheses, and Survey design

The objective of this chapter is to describe the research model and survey used in this study. The chapter is organized into four different sections. The first section presents the adjusted model used as a theoretical basis for the study, and the hypotheses which are under consideration. Specific determinants to analyze user acceptance of devices and services operating in a mobile context will be explored. It is important to recognize specific issues when assessing user acceptance of new mobile technologies and mobile services. The second section is focused on the survey design, and explains in detail the questions from the survey and the tools used. The third section describes the selection of respondents and stratification criteria, and the fourth section details the reliability aspects of the study.

5.1 Theoretical framework and Hypotheses

To study user acceptance of mobile services, a framework is needed to analyze the individual findings on factors that affect user acceptance and intention to start using a service. This framework can then be used to communicate key user acceptance factors and their implications for the design of future services [Kaasinen, 2005]. The underlying constructs of the UTAUT model cannot be directly transferred to be used in mobile services research. Some constructs might not be applicable to study mobile services, and other constructs might have to be added to form a reliable theoretical framework. Based on other research in mobile services, the following section discusses and adds to the UTAUT model to find the barriers for and predict the adoption of location sharing in mobile social networks. The result is an adjusted theoretical model, specifically designed to be used in Mobile Services acceptance studies, in environments where usage is non-mandatory.

Usage Intention

The dependent variable in the theoretical framework is Usage Intention. Usage Intention can be described as the individuals willingness to perform a specific behavior. Although used as a critical concept in the UTAUT model, it is not specifically defined by Venkatesh et al. [2003]. It has however been defined by Fishbein and Ajzen [1975] as "The subjective probability of behavior". The role of intention as a predictor of behavior (i.e. usage) is extensively used and has been well-established in previous research [Venkatesh et al., 2003] [Azjen, 1991] [Sheppard et al., 1988] [Taylor and Todd, 1995]. Moreover, Azjen [1991] states that a user's 'behavioral intention' is the *most influential* predictor of behavior. In this research, the goal is to understand Usage Intention as the dependent variable.

Performance Expectancy / Perceived Usefulness

In each of the separate eight models of which the UTAUT model was constructed, Performance Expectancy is the strongest predictor of intention of use. Performance Expectancy is defined by Venkatesh et al. [2003] as the degree to which an individual believes that using the system will help him or her to attain gains in job performance. In this thesis however, the respondents are not likely to be utilizing mobile location sharing in a business setting, as the service is targeted at consumers. Besides that, we assume a large majority of the respondents to have no experience with the services under research, as they are relatively new to the market. Therefore, we propose a slight adjustment to the used definition of Performance Expectancy. In stead of exploring the degree to which the services help attain gains in job performance, we will consider Performance Expectancy to be "the degree to which an individual believes the services are expected to be beneficial", or in other words, Perceived Usefulness. In previous mobile services research, it has also been defined as “the degree to which an individual perceives new mobile services to provide benefits in everyday situations” [Knutsen, 2005], which also provides ground for the adjustment to Perceived Usefulness. The difference between the introduced term Perceived Usefulness compared to the original Performance Expectancy definition is the removal of the term ‘job performance’, and transpose the focus on the actual ‘performance of the service’. The determinant will nevertheless still measure the same aspects: the gains that will be achieved in performing a certain task. In this case however we do not expect the performed tasks to be easily comparable to tasks that could otherwise be performed on other systems, because Mobile LBS introduces a new form of conducting certain tasks by combining technology and location-based information and/or functionality, for which there is really no alternative (but to use combined systems - off location). The hypothesized relationship for direct effects is:

H1: Perceived Usefulness has a significant and positive effect on Usage Intention.

Effort Expectancy

Effort expectancy, also referred to as perceived ease of use, is defined as the degree of ease associated with the use of the system [Venkatesh et al., 2003]. Three constructs from the models incorporated in UTAUT capture the concept of effort expectancy. These constructs are: Perceived Ease of Use, Complexity, and Ease of Use. In mobile services research, effort expectancy represents the degree to which individuals associate freedom of difficulty with the use of mobile technology and services in everyday usage [Knutsen et al., 2005]. Mobile services that are easy to use will be less threatening to individuals, in that they might find them less complex or tedious to use. Mobile services which are perceived to be easier in use than others are more likely to be accepted by end users. Our hypothesized relationship for this determinant therefore is:

H2: Effort Expectancy has a significant and positive effect on Usage Intention.

Social Influence

Social Influence is defined as the degree to which individuals perceive that important or significant others believe they should use an innovation [Rao and Troshan, 2007]. This means, that opinions of referents that are important to the user of a system could constitute the bases for how they feel about a certain innovation or system. If for example a close friend would suggest a particular system or service might be useful, this suggestion could affect the prospective user's perception on the usefulness of the innovation. In the literature there is a lot of strong empirical support for the relationship between social pressure and usage behavior [Ishii, 2004] [Venkatesh and Davis, 2000]. Given that support for social influence, we form the following hypothesis:

H3: Social Influences have a significant and positive effect on Usage Intention.

Facilitating Conditions

Facilitating Conditions constitutes the degree to which an individual user believes that an organizational and technical infrastructure exists to support use of the system. The constructs of this determinant are 'perceived behavioral control', 'facilitating conditions', and 'compatibility'. Each of these constructs is operationalized to include aspects of the technological and/or organizational environment designed to remove barriers of use [Venkatesh et al., 2003].

When consumers are sharing their locations in mobile social networks, it means that individual users use the services in a private environment; they do not have to comply with company regulations placed upon the use of such services. This implies there will be no such organizational infrastructure available to the user as would be in a business environment. Moreover, there will most likely be no guidance in operating the service, or any technical support available other than optional 'help directions' included in the service options itself or potential (online) documentation available to the user. Therefore, with regard to the context of mobile services, this construct should only consist of the determinants 'perceived behavioral control' and 'compatibility'. For that matter, only questions regarding these two determinants have been included in the survey. Besides these matters, there is also another important consideration to be made. In the original UTAUT model it is assumed that when Performance Expectancy and Effort Expectancy are included in the model, Facilitating Conditions becomes nonsignificant in predicting Usage Intention, but does have an effect on usage beyond that explained by behavioral intentions Venkatesh et al. [2003]. The original model depicted in Figure 4.3 shows no direct connection between Facilitating Conditions and Usage Intention, but provides a relation of Facilitating Conditions with 'Actual Usage'. In this study, Actual Usage is not taken into consideration, because of the assumed lack of experience with location sharing in mobile social networks by consumers. The construct Facilitating Conditions is however incorporated, to investigate its suggested non-significance in its relation with Usage Intention as claimed by [Venkatesh et al., 2003]. Provided with this, we form the following hypothesis:

H4: Facilitating Conditions have a significant and positive effect on Usage Intention.

Perceived Enjoyment

Perceived enjoyment of using a mobile service appears to be an important intrinsic motivation for behavioral intention toward mobile services [Nysveen et al., 2005]. It can be seen as the relative fun a user has or entertainment which is experienced in performing a certain task or using a certain service. In mobile services research it has been described as "a reward derived through the use of the technology or service" [Igbaria et al., 1996]. Besides reaching a certain goal with an MLS service, we anticipate that users of MLS services also expect the usage of a service to be entertaining in some way. Empirical research indicates that this determinant plays an important role within the use of IT systems, such as online shopping contexts [Koufaris, 2002], but has also specifically demonstrated to significantly influence consumers' use of mobile services in gratification research (Höflich and Rössler [2001] in Nysveen et al. [2005]). Therefore, Perceived Enjoyment is included in the model as a predictor of Usage Intention, and we propose Perceived Enjoyment has a strong and positive effect on consumers' intentions to share locations in mobile social networks.

H5: Perceived Enjoyment has a significant and positive effect on Usage Intention.

Trust and Privacy

Consumer trust is recognized as one of the most important factors in the studies of both e-commerce and marketing. Previous studies had introduced the concept of "perceived risk" [Qinfei et al., 2008], which is actually not very different from trust as a determinant. If the perceived risk of a user is higher, there is a lower level of trust associated with a system of service. In the original UTAUT model, risk and trust are not specific constructs of acceptance factors, but can be associated with 'attitude toward using technology', and 'anxiety'. Anxiety is described here as "evoking anxious or emotional reactions when it comes to performing a behavior". However, in UTAUT these determinants are explained to be non-significant determinants of user adoption. In this thesis we adopt a separate determinant focussing on the measures trust and privacy, because in MLS Services users are required to share certain information about themselves which can be considered as confidential or private information. Therefore, it could be a barrier for adoption of MLS Services, and is included in our theoretical model. If the user is willing to share such information, it is assumed that a certain level of trust must exist between the user and the party with which the information is shared. 'Trust and privacy' are therefore considered to have a significant effect on the adoption of MLS Services. Our hypothesized relationship for this determinant is:

H6: Trust and Privacy have a significant and positive effect on Usage Intention.

Expected Cost

The price associated with using an MLS might significantly influence the adoption. In the UTAUT model, there is no price or cost factor, because the model is specifically designed to investigate information systems designed for work environments. Empirical research has indicated that the cost factor is negatively related with the intent of users to adopt mobile commerce services [Wu and Wang, 2005], as well as mobile banking [Luarn and Hsin-Hui, 2005]. We believe this determinant can be translated to the acceptance of MLS services, because the price a user must pay to use or access an MLS service might significantly influence the adoption of the service. Respondents who think that the usage of MLS Services is expensive, will be reluctant to use it. Therefore, our model is expanded with a price factor, forming the base for the following hypothesis:

H7: Expected Costs have a significant and negative effect on Usage Intention.

Moderators

The moderators used in the original UTAUT model are 'gender', 'age', 'experience', and 'voluntariness of use'. In our theoretical model we only incorporate 'age' from the UTAUT model as a moderating variable. As mentioned before, the moderator 'experience' has been transformed into a new moderator called 'User Predisposition', and 'voluntariness of use' is not applicable in consumer acceptance research, as the adoption of consumer services is per definition voluntary. We do however incorporate another moderator in our model. We believe the possession of a 3G mobile device might be a demand driver for MLS Services, and this variable is therefore included in the model as a moderator. To determine if a particular mobile device is a so-called '3G' device or not, the website www.gsmarena.com is used to test each mobile device for certain criteria, such as screen size and connectivity options. Of course, we could include potentially more moderating factors in future studies, such as other demographic characteristics.

The moderating determinant 'experience' from the UTAUT model will for some respondents be less influential in determining the acceptance of MLS Services, because the services are relatively new. This determinant is therefore expanded in the adjusted model. Besides experience with MLS Services, users could have a predisposition when it comes to using services on a mobile device. They might have had bad experiences with other mobile services, or for example be in general reluctant to use mobile devices. Therefore, in stead of just actual experience, this determinant consists also of "prior knowledge". Combined, we can state that this determinant should be translated to "User Predisposition", which we expect to have a direct influence on adoption of MLS Services. In Rao and Troshan [2007], the choice has been made take up "perceived enjoyment" as well into the User Predisposition factor. We feel however that the measure of perceived or expected enjoyment does not belong within User Predisposition, because we expect it to have a significant influence that can be seen apart from experience or prior knowledge. Therefore, we define User Predisposition here as the collection of the factors prior knowledge and experience with the mobile internet. In contrast to the mobile services research framework as developed by Rao and Troshan [2007] we do not include the factor 'behavioral control' into this determinant because it has already been covered by 'Effort Expectancy'. Based on these assumptions, we state the following hypotheses:

H8: User Experience in Mobile Internet has a significant and positive effect on Usage Intention.

And:

H9: Possession of a 3G Mobile phone has a significant and positive effect on Usage Intention.

Overview of constructs

The constructs discussed are expected to be of influence on Usage Intention of location sharing on mobile social networks by consumers. Specific constructs that apply to study adoption of services on mobile phones have been added to the model. These constructs are: "Perceived Enjoyment", "Trust and Privacy", and "Expected Costs". Because of the different context used in this study compared to the original UTAUT model study settings, the original construct "Performance Expectancy" has been changed into "Perceived Usefulness". These constructs are in principle the same, but the questions in the survey will undergo slight adjustments. The dependent variable "Actual Usage" from the original UTAUT model will not be under investigation in this study, due to the fact that it is expected that none of the respondents will have experience sharing their location in mobile social networks. This is assumed, because as of yet none of the social networks under study has either implemented such functionality into their applications, or has not been able to gain a substantial user base for the service. Therefore, only "Usage intention" will be the dependent variable under

Table 5.1 The constructs and their definitions.

Construct	Meaning
Perceived Usefulness (PU)	The degree to which an individual believes the use of the service is beneficial.
Effort Expectancy (EE)	The degree of ease associated with the use of the service.
Social Influence (SI)	The degree to which an individual perceives that important or significant others believe they should use the service.
Facilitating Conditions (FC)	The degree to which an individual user believes that a technical infrastructure exists to support use of the services.
Perceived Enjoyment (PE)	The degree to which an individual believes to experience a reward derived through the use of the services.
Trust and Privacy (TP)	The degree to which an individual experiences privacy risks and trust issues associated with the use of the services.
Expected Costs (EC)	The degree to which an individual expects costs to be related with the use of the services.
Usage Intention (UI)	The intention of consumers to start sharing their location within mobile social networks.

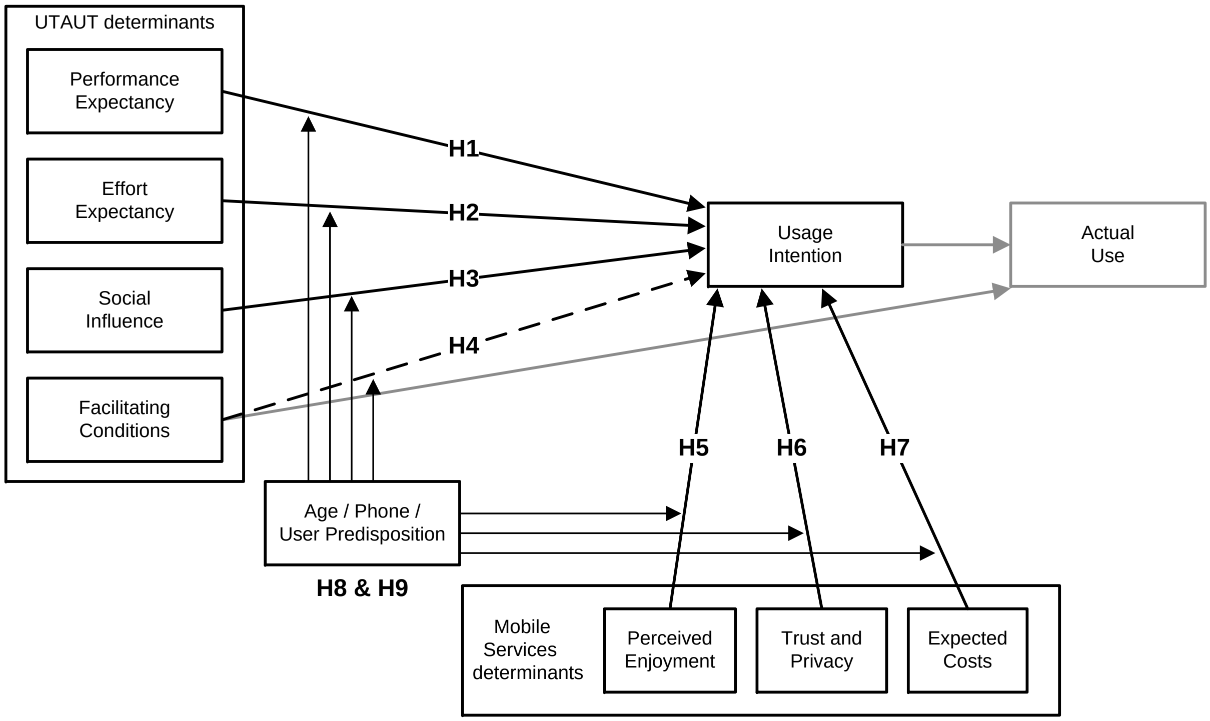

Figure 5.1 Adjusted UTAUT model for Mobile Location-based Services.

study. "Facilitating Conditions" is included in the adjusted model and associated with Usage Intention, although the relationship is expected to be nonsignificant. All relevant constructs under study as depicted in Figure 5.1) are presented with their definitions in Table 5.1. Along these constructs the questions used in the survey from this study are designed. These determinants, their constructs, and moderating variables are shown in Figure 5.1.

5.2 Survey Design

The extended UTAUT model is used to do explorative research based on a survey. The survey contains statements about sharing geographical location information in mobile social networks. The survey analyzes three different aspects: first, questions are asked regarding background information of the respondent, such as age, social network subscriptions, and mobile phone brand and type. To get a thorough view of respondents' experience with mobile internet services, there are also questions asked about their usage of social networks, specific experience with mobile web-services, experience with mobile location services, and about experience with (mobile) Friend Finder services. The second aspect of the survey is to examine the constructs used in the theoretical model. The answers on these questions are used to compose and analyze the theoretical model. The third aspect in the survey is to get more in-depth information behind the answers given by respondents to the general questions. These answers are used to get a more comprehensive understanding about respondents' answers. These questions determine specific reasoning behind choices respondents make. For example, if a respondent answers a specific question about Perceived Usefulness with 'totally agree' or 'agree', another question will be presented in which the specific goals of location sharing are to be judged on by the respondent.

The survey questions related to the theoretical model constructs are mostly answered on a five point Likert scale, where '1' stands for 'strongly agree', and '5' stands for 'strongly disagree'. All construct questions are scaled in the same direction. If one is neutral on a subject, option '3' can be checked, which stands for 'neither agree nor disagree'. Some questions have a dichotomous scale with options 'Yes' and 'No' (e.g. 'Do you plan use this service in the future?'). Open-ended questions were used to obtain additional explanations, were no option was applicable to a respondent. The final questionnaire contained 46 questions of which 33 were related to constructs from the theoretical model explaining Usage Intention. The survey can be found in Appendix A, the analysis of the data is presented in Chapter 6.

5.3 Data Collection Method

The data used for this research is collected using an online survey. The survey was build using Qualtrics Survey Software (www.qualtrics.com), which was selected based on its extensive functionality, and easy to use web2.0 user interface. The questions for the survey are based on the questions used in the original UTAUT model, with exceptions for the specific mobile determinant questions. These are derived from literature about mobile services research, as described in Section 5.1.

To test the extended UTAUT model, the research design from [Venkatesh et al., 2003] is roughly followed. There are some significant changes however, because of the changes in context and the domain used in this thesis. As we investigate the acceptance and factors influencing the sharing of location information in a mobile social networking context, the way we collect data differs significantly from the original UTAUT research design. In the original research design, [Venkatesh et al., 2003] test their model in four different organizations, on four different IT implementations, with measurements on three different points in time. Most, if not all of the respondents used for this research are however expected to have no experience with sharing their location in mobile social networks. Therefore the respondents are asked to fill out the questionnaire on only one point in time.

SSI (Survey Sampling International) was hired to collect the right stratification and number of respondents. SSI is a well-known and dedicated company for data collection, that collect respondents out of their own pool of selected panels. The stratification criteria that formed the basis for respondent selection were as follows:

- Respondents must possess and use a mobile phone;
- Respondents must use one of the social network sites Hyves, Facebook or Twitter at least once a week;
- Respondents must be between the ages of 18 and 65;
- Respondents were not selected based on gender.

By selecting respondents on these stratification criteria it is expected that respondents have an understanding of who their contacts are with whom they share information on the internet. Besides that, these stratification criteria assure us that they will be able to envision the experience they would have using such a system on a mobile phone.

At this moment the Dutch population consists of approximately 16,5 million people. In 2009, the Dutch population between 18 and 65 years old is approximately 10,5 million people, of which 85% possesses a mobile phone [CBS, 2009]. This means, the population for this study is roughly 9 million people. Because a confidence level was determined upfront, the sample size needed to get relevant results could be calculated to represent the population, because a normal distribution is assumed. With a confidence level of 95% and an error margin 0f 10% we believe to have a strong enough sample with minimal 97 respondents with the formula depicted below [McDaniel Jr. and Gates, 2009]. In this formula, 'n*' is the minimum sample size. The spread in the formula below (p) is the percentage of the sample size compared to its population. The spread used is 50%, because this is the most conservative choice. This population is represented in this study by a sample of 300 respondents, and a level of confidence of 95% is desired. As can bee seen from the formula, a minimal sample size of 96 respondents is needed to have a strong enough sample. In this study, 310 respondents completed the survey, of which 236 could be used.

$$moe\ (margin\ of\ error) \pm 1.96\sqrt{\frac{p\ \cdot\ (1-p)}{n^*}} = moe \pm 0.10$$

$$1.96\sqrt{\frac{0.50\ \cdot\ 0.50}{n^*}} = 0.10$$

$$\sqrt{\frac{.25}{n^*}} = \frac{.10}{1.96}$$

$$\frac{.25}{n^*} = \left(\frac{.10}{1.96}\right)^2$$

$$n^* \approx \frac{.25}{0.51^2} \approx 96.1$$

Formula: Sample size determination.

5.4 Reliability

Before conducting the survey, the research model and the survey questions have been discussed with two industry specialists and after that tested on a group of respondents. This *pre-test* of the survey is performed to validate the survey questions, and to make sure there is a shared understanding among respondents regarding the survey questions. After the pre-test interviews, two questions were changed to improve understanding, and one question was dropped because the same question was already asked in a different manner. To perform the survey pre-test, the survey was distributed among a total of sixteen randomly selected respondents. These interviews and pre-test survey distributions had two distinctive goals: first, they were necessary to find out if there would be differences between persons in interpreting the survey questions and respondents understood the concept of sharing location information, and secondly it was important to test the survey on the time it would take respondents to answer all questions. Some questions needed revision, to prevent misunderstanding. From the pre-test also stemmed there was one question that turned out to be scaled in the wrong direction. Changing the questions has resulted in the final questions as presented in Appendix A.

The results of the survey pre-test are analyzed to test the internal consistency of the constructs. A Cronbach's alpha analysis is performed to test if the questions that are proposed to form constructs measure the same concept. This is the most common approach for testing the reliability of the a scale consisting of several Likert-type items. For two of the eight items the Cronbach's α lies between 0.7 and 0.8 which is considered sufficient, and all other items have Cronbach's α's above 0.8, which is considered good [McDaniel Jr. and Gates, 2009]. Based on these results, the survey was considered valid, and was ready to be sent out to the full batch of respondents. The results of the Cronbach's alpha consistency test used for this pre-test can be seen in Table 5.2.

Table 5.2 Cronbach's α pre-test results.

Construct	No. of Questions	Cronbach's α
Perceived Usefulness	4	0.916
Effort Expectancy	4	0.860
Social Influence	3	0.836
Facilitating Conditions	3	0.822
Perceived Enjoyment	3	0.992
Trust and Privacy	5	0.757
Expected Costs	1	1.000
Usage Intention	4	0.715

6. Survey Findings and Model Validity

In this chapter the findings of the study are discussed and analyzed. The first section describes the respondent characteristics, and is followed by a description of the collected data. Ongoing, the Reliability Analysis and Factor Analysis are presented described. With these methods the hypothesized constructs are validated. Furthermore, the answers to the survey questions are discussed, and the in-depth questions of the survey are presented and discussed to get a comprehensive view on respondents attitude towards location sharing in mobile social networks.

6.1 Response Rate and Respondent Characteristics

During the respondent selection process, SSI reported that there was a relatively low incidence rate, probably related to the criterium of social network site usage (respondents must use a social network at least once a week). At that moment there were already 92 completed questionnaires. To improve the incidence rate, SSI proposed to send out following batches targeted at respondents between the ages 18 and 40. Therefore, the group of respondents can not be seen as a typical representation of the Dutch society, as discussed in Section 5.3. In total, a number of 310 respondents completed the survey. Of these completed surveys, 68 were removed because the respondent did not fill out the brand and/or type of the mobile phone they possessed. This left 236 usable completed surveys for analysis. The age distribution of all respondents can be seen in Figure 6.1. As can be seen from this table, most respondents belonged to the age categories 25-34 and 35-44. There was only one respondent in the survey belonging to the age category 65 and above.

		Frequency	Percent	Cumulative Percent
Valid	< 25	53	22.5	22.5
	25 - 34	59	25.0	47.5
	35 - 44	78	33.1	80.5
	45 - 54	33	14.0	94.5
	55 - 64	12	5.1	99.6
	65 +	1	.4	100.0
	Total	236	100.0	

Figure 6.1 Respondents age distribution.

In the survey, several questions were asked about the respondent's personal experience with social networking, and with utilizing mobile internet or other mobile data services. What shows from the analysis of the results is that most respondents do not have experience with internet on mobile phones. Respondents that do have experience using mobile internet, have it mostly in surfing the internet. This is the most common activity, followed by the utilization of email on a mobile phone. These results are depicted in the frequency table in Figure 6.2. If the experience in mobile internet is categorized by age group, it becomes clear that among all generations the experience is generally the same among different services, except for the respondents from the age category 35-44. In this group, the second most popular activity on a mobile phone is surprisingly not emailing but using social networks, as can be seen from Figure 6.3.

Other forms of experience mentioned by respondents are 'Mobile Navigation support' and 'Buienradar', which is a tool to view the weather (specifically areas with rain) on a map.

All respondents in this study have been selected because they have experience with either Hyves, Facebook or Twitter. Table 6.1 shows the frequency table for experience in social networks. As one respondent can have accounts on several social networks, the total number of registered users in this figure is bigger than the total number of respondents. From the results presented in this figure it becomes clear that although there is some diversity in usage, the Hyves social network is the most commonly used social network. Almost every respondent is a registered user on Hyves,

		Responses		Percent of Cases
		N	Percent	
Experience in Mobile Internet	Mobiel surfing on the internet	71	19.6%	30.1%
	Mobile emailing	40	11.0%	16.9%
	Mobile Social Networking (Hyves / Twitter / Facebook)	45	12.4%	19.1%
	Mobile internet radio	26	7.2%	11.0%
	Mobile internet games	23	6.4%	9.7%
	No experience	155	42.8%	65.7%
	Other	2	.6%	.8%
Total		362	100.0%	153.4%

Figure 6.2 Frequency table: experience in mobile internet usage.

		Experience in Mobile Internet							Total
		Mobile surfing on the internet	Mobile emailing	Mobile Social Networking	Mobile internet radio	Mobile internet games	No experience	Other	
AGE	< 25	15	8	11	5	6	36	0	53
	25 - 34	21	9	11	5	6	35	0	59
	35 - 44	25	16	18	14	8	51	0	78
	45 - 54	7	6	2	1	2	23	1	33
	55 - 64	2	1	3	1	1	10	1	12
	65 +	1	0	0	0	0	0	0	1
Total		71	40	45	26	23	155	2	236

Figure 6.3 Experience in mobile internet usage categorized by age group.

		Responses		Percent of Cases
		N	Percent	
Experience with Online Social Networks	Facebook	63	15.0%	26.7%
	Hyves	226	53.9%	95.8%
	Twitter	19	4.5%	8.1%
	LinkedIn	18	4.3%	7.6%
	Myspace	14	3.3%	5.9%
	Schoolbank	62	14.8%	26.3%
	Other	17	4.1%	7.2%
Total		419	100.0%	177.5%

Table 6.1 Frequency table: experience with online social networks.

and utilizes it at least once a week. When experience in social networks is categorized by age group in Figure 6.4, it becomes clear that in the age group 25-34 Facebook is the second most popular social network, with a relatively high usage rate. Almost 50% of the registered Hyves users in this age group also have an account on Facebook. What also shows from Figure 6.4, is that the social network Schoolbank seems to attract a lot more users from older age groups. This could probably be explained by the fact that Schoolbank is specifically targeted at people who want to find their old classmates from lower and middle schools to reconnect with. Most younger people currently in lower and middle school do not have to 'reconnect' with classmates, because they already share a network together. It seems that the youngest age group (younger than 25) is not well represented in the LinkedIn social network, which could be explained because of the target group LinkedIn is trying to reach: this social network is generally targeted at professional business users.

Since this survey is about sharing locations in mobile social networks, attention was also paid to respondents' experience with MLS services. As is shown in Table 6.2, most respondents in this survey did not have any experience with location services on mobile phones: 181 from a total of 236 respondents. From the respondents that did have experience with one or more mobile location services, the most popular and most used services are navigation services, followed by information

		Experience with Online Social Networks							Total
		Facebook	Hyves	Twitter	LinkedIn	Myspace	Schoolbank	Other	
AGE	< 25	18	51	7	2	9	7	3	53
	25 - 34	22	55	3	5	3	13	4	59
	35 - 44	14	76	3	6	1	22	6	78
	45 - 54	7	32	5	5	0	15	2	33
	55 - 64	2	11	1	0	1	5	2	12
	65 +	0	1	0	0	0	0	0	1
Total		63	226	19	18	14	62	17	236

Figure 6.4 Experience with online social networks categorized by age group.

		Responses		Percent of Cases
		N	Percent	
Experience Location Services	Local search	24	8.2%	10.2%
	Navigation services	47	16.2%	19.9%
	Information services	35	12.0%	14.8%
	Tracking services	7	2.4%	3.0%
	Other	3	1.0%	1.3%
	No experience	175	60.1%	74.2%
Total		291	100.0%	123.3%

Table 6.2 Frequency table: experience with location services.

services. Among the other location services that have been mentioned by respondents was the interesting service of 'tagging photos by location'. Specific experience with mobile friend finder services was analyzed apart from the location services, to gain an understanding about specific tools that are used for sharing locations among friends.

From the results depicted in Table 6.3, it is concluded that the recently released Google Latitude service is the most popular. Most respondents however did not have any experience at all using friend finder services. Therefore, it is not possible to compare experienced friend finder services users with unexperienced users of these services in this study.

		Responses		Percent of Cases
		N	Percent	
Experience friend finder services	Google Latitude	13	5.5%	5.5%
	Brightkite	1	.4%	.4%
	Loopt	1	.4%	.4%
	Other	5	2.1%	2.1%
	No experience	218	91.6%	92.4%
Total		238	100.0%	100.8%

Table 6.3 Frequency table: experience with friend finder services.

6.2 Internal Validity

In surveys in which the items are constructed categorical, such as the Likert scale questions in this survey, it is common to construct scales (i.e. constructs) by adding the individual responses to the items together. Because the items are scaled in the same direction (1 = totally agree, 5 = totally not agree), they are considered to be uni-dimensional. Testing the reliability with Cronbach's alpha (α) is the standard approach for summated scales built from grouped ordinal items. After Cronbach's α is computed for all the proposed constructs, Factor Analysis is conducted, which has an empirical relation with Principal Components Analysis (PCA). PCA is better suited if the goal is data reduction, where common Factor Analysis is preferred for causal analysis, which is the goal in this study. Grouped items with a high Cronbach's α are considered homogeneous, and will probably form as one factor when analyzed with Factor Analysis. The reason for this is that Cronbach's α increases with the average correlation between items, so optimization of it tends to select items that have correlations of similar size with most other items. Cronbach's α analysis and Factor Analysis are performed in the following paragraph.

6.2.1 Construct Internal Consistency

The different constructs were tested for their internal consistency after completion of the survey, to test if the proposed constructs are valid. The Figures in which these tests are represented can be found in Appendix B. The results of these tests are discussed below:

First, Perceived Usefulness was tested, which consists of four different questions. Cronbach's α was sufficient: the items together were responsible for a Cronbach's α of 0.870, meaning this scale is homogeneous. Removing any of the four items of which Perceived Usefulness is constructed will not increase the α value, so this construct is left as it is. Effort Expectancy was also tested for internal consistency. It consisted of four different questions, which together were responsible for a high value of Cronbach's α of 0.838. Removing question EE2 would improve Cronbach's α to 0.843. Because this increase is marginal, it was decided to keep all of the four questions for Effort Expectancy within this construct. Also, a slight increase in internal consistency does not weigh out the power we would lose by shortening the test with a question, given the fact that there are only four questions in this construct.

The next construct tested for internal consistency was Social Influence. This construct only consists of three questions. Cronbach's α was very high: the items together were responsible for a Cronbach's α of 0.922. Removing question SI3 would improve Cronbach's α to 0.955. Like with Effort Expectancy, this increase would be marginal, and therefore it was decided not to remove this question from the construct Social Influence.

Facilitating Conditions is tested as well. It's Cronbachs α proved to be high (0.854), and no questions could be removed to improve the construct. This means the three items measuring Facilitating Conditions do seem to measure the same aspects, and the construct has internal consistency. Cronbach's α analysis for the factor Perceived Enjoyment proved to deliver a high internal consistency as well. The α value is 0.962. There were no questions that could be removed

Cronbach's Alpha	N of Items
.695	7

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
TP1	14.69	17.070	.048	.754
TP2	14.62	13.281	.612	.606
TP3	15.00	12.307	.782	.557
TP4	14.61	12.961	.564	.614
TP5	15.02	12.385	.771	.561
TP6	15.34	13.703	.561	.621
TP7	13.88	19.603	-.211	.807

Figure 6.5 Cronbach's α for Trust and Privacy.

to gain a substantial increase in the α value.

Cronbach's value for Trust and Privacy shows some interesting results. With all questions regarding Trust and Privacy taken into account, the α value turned out to be 0.695. As shown in the Cronbach's α analysis in Figure B.6, questions TP1 and TP7 should definitely be removed from the factor, which meaningfully increases the α value which translates as an improved internal consistency for this factor. With questions TP1 and TP7 removed, we performed another Cronbach's α analysis with the result of an increased Cronbach's α value of 0.863, as can be seen in Figure B.7.

The final Cronbach's analysis performed considered the construct Usage Intention. This construct also contains one question (UI1) with low loadings on its hypothesized factor. As can be seen from Figure B.8, the α value with all questions taken into account is 0.833, and a removal of UI1 could improve the α value to the more reliable value of 0.855. Therefore, UI1 was removed from the construct Usage Intention, and the final constructs were established for further analysis. All Cronbach's α's for the remaining constructs (factors) in the model are summarized in Table 6.4. Note here that because Expected Costs is measured by only one question in the survey, it's α value by nature is 1.

Cronbach's Alpha	N of Items
.863	5

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
TP2	8.80	11.272	.662	.839
TP3	9.18	10.454	.822	.798
TP4	8.79	11.337	.550	.870
TP5	9.20	10.417	.832	.795
TP6	9.52	11.877	.573	.860

Figure 6.6 Cronbach's α for Trust and Privacy with removed items TP1 and TP2.

Cronbach's Alpha	N of Items
.833	5

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
UI1	7.31	1.587	.396	.855
UI2	7.37	1.273	.666	.793
UI3	7.44	1.097	.760	.761
UI4	7.44	1.106	.725	.772
UI5	7.47	1.125	.653	.797

Figure 6.7 Cronbach's α for Usage Intention.

Table 6.4 Constructs established for further analysis.

Construct	Items	Cronbach's α
Perceived Usefulness	4	0.870
Effort Expectancy	4	0.838
Social Influence	3	0.922
Facilitating Conditions	3	0.854
Perceived Enjoyment	3	0.962
Trust and Privacy	5	0.863
Expected Costs	1	1.000
Usage Intention	4	0.833

The next step is describing the variability among observed theoretical constructs by performing Factor Analysis, and assessing the loadings of all variables on the proposed factors. This is done in the next paragraph.

6.2.2 Factor Analysis

With all Cronbach's α's established, confirmatory Factor Analysis is conducted using principal component analysis with varimax rotation to test if all the questions within a single construct measure the same aspect of Usage Intention. Factor Analysis is used to determine whether the factors established in the theoretical model are also recognized in the survey data, and therefore are suited factors to be used in analysis. As the factors in the theoretical model are all believed to measure a different aspect of Usage Intention, it is expected that these factors will load separately when performing Factor Analysis. Although all constructs showed to have a high internal consistency, Cronbach's α analysis does not provide insight in the differences between constructs. For each item Factor Analysis determines what its loading is on each specified factor. Varimax rotation is used here to minimize the complexity of the components by increasing the larger loadings and decreasing the smaller loadings on the factors. This is done for each component that is recognized as a factor. The Factor Analysis is set to look for eight different factors that theoretically can be discovered from analyzing the data: PU, EE, SI, FC, PE, TP, EC, and UI. Factor loadings are considered significantly high when their score is above 0.350 or below -0.350 [McDaniel Jr. and Gates, 2009]. The gray areas in Figure B.10 represent these scores for this study.

Cronbach's α analysis showed that several questions should be removed from their proposed constructs. We decided to leave these items out of the model, and perform Factor Analysis with the remaining items. The results of the Factor Analysis performed with no items removed can be found in Appendix B. In the following Factor Analysis, the items U1, TP1 and TP7 are left out of the model. As can be seen in the Rotated Component Matrix in Figure B.10, this substantially improved the loadings of the constructs on their prospected factors, compared to having none of the items removed.

Some interesting observations can be made from looking at the Factor Analysis performed. As can be seen from the Rotated Component Matrix Figure B.10, the loadings for each factor can be differentiated out, and all items load with a specific loading on each factor. The items measuring Perceived Usefulness all load highly on factor 1, with items PU1 and PU2 having item factor loadings of 0.737 and 0.750 and items PU3 and PU4 both above 0.800. The other survey items do not load as significantly on factor 1 as the items measuring Perceived Usefulness, but there are some significant loadings that must be taken into consideration. Specifically, the theoretical construct Social Influence has factor loadings of its items on factor 1 of respectively 0.495, 0.528 and 0.639. In addition, the construct Perceived Enjoyment also has very high loadings on factor 1. The factor consists of item PE1 with a factor loading of 0.736, and also of 0.714 PE2 and 0.671 PE3, which can all be considered significant. This means that according to this analysis, the items from the construct Performed Usefulness, Social Influence and Perceived Enjoyment measure the same kind of underlying aspects to some extent.

	Component							
	1	2	3	4	5	6	7	8
PU1	.792	.157	-.129	.217	.050	-.069	.074	.156
PU2	.774	.126	.005	.312	.084	.053	-.002	.125
PU3	.783	.085	-.005	.061	.156	-.112	-.054	-.029
PU4	.859	.056	-.059	.043	.076	-.110	.070	-.124
EE1	.134	.699	.027	.125	.197	-.100	-.070	.198
EE2	.295	.515	-.062	.011	.146	-.039	.055	.589
EE3	.168	.782	-.048	.185	.103	-.177	.121	.103
EE4	.137	.812	-.006	.151	.117	-.206	.033	.144
SI1	.495	.168	-.094	.123	.785	.031	.062	-.005
SI2	.528	.190	-.119	.158	.749	.045	.053	.016
SI3	.639	.189	-.075	.296	.478	.188	-.009	.060
FC1	.159	.745	.134	.001	.084	.380	-.055	.064
FC2	.070	.798	.176	.067	-.010	.235	-.052	-.196
FC3	.062	.762	-.015	.070	-.076	.280	-.080	-.276
PE1	.736	.176	-.078	.260	.242	.439	.059	.086
PE2	.714	.172	-.063	.268	.256	.437	.014	.079
PE3	.671	.173	-.162	.327	.237	.412	.041	.016
TP2	-.051	-.097	.792	-.110	-.136	-.121	.047	-.093
TP3	-.066	-.029	.921	-.025	-.024	-.018	-.010	-.027
TP4	.029	.127	.585	-.003	.113	-.097	.038	-.619
TP5	-.037	.073	.898	.090	-.027	.024	-.003	-.112
TP6	-.181	.282	.709	.082	-.019	.188	-.103	.169
EC	.077	-.047	-.009	-.062	.054	.002	.970	.006
UI2	.147	.178	-.117	.742	.161	.001	.128	.106
UI3	.195	.105	.050	.861	.047	.145	-.037	-.048
UI4	.197	.101	.048	.814	.022	.101	-.198	-.068
UI5	.280	.063	.044	.758	.054	-.129	.016	.034

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Figure 6.8 Factor Matrix with Varimax Rotation. Removed items: TP1, TP7 and UI1.

Factor 2 in Figure B.10 has high loadings from the construct Effort Expectancy (0.699 EE1, 0.515 EE2, 0.782 EE3, 0.812 EE4), but also from the construct Facilitating Conditions (0.745 FC1, 0.762 FC2, 0.762 FC3). Theoretically this could be explained by the fact that in the original UTAUT model, Facilitating Conditions has no direct effect on Usage Intention, but is linked with Actual Usage. In this study, there are no respondents that already make use location sharing in mobile social networks, and therefore the answers from respondents regarding the items in the construct Facilitating Conditions are actually based on the *expected* Facilitating Conditions. As mentioned in section 5.1, Facilitating Conditions consists of "the degree to which an individual user believes that an organizational and technical infrastructure exists to support use of the system". This construct however consists in itself of the constructs 'perceived behavioral control', 'facilitating conditions', and 'compatibility', which might measure the same underlying aspects as Effort Expectancy. It makes sense to state that if one has no experience using the system or service, a statement about these aspects would be based upon what one would expect of using the service in the future, which would explain the high loadings of both constructs on the same factor.

Factor 3 is the first of the factors that has is mainly composed out of only one measurement scale: Trust and Privacy. All items belonging to other theoretical constructs do not load high on this factor, and are therefore measurements of different dimensions. Although most items of Trust and Privacy load very high on this factor, the removed items TP1 and TP7 however do not (See Figure B.10 in Appendix B). As can be seen from Figure B.10, item TP2 has a high factor loading of 0.792, just like TP3 with loading of 0.921, TP4 with 0.585, TP5 with 0.898, and TP6 with 0.709. This factor therefore is established as the theoretical construct Trust and Privacy.

Usage Intention is the construct that loads very high on factor 4. All (but the removed) items have very high loadings (0.742 UI2, 0.861 UI3, 0.814 UI4, and 0.758 UI5). There are however some influences in here as well, from some of the items belonging with the Perceived Usefulness and Perceived Enjoyment constructs. These factor loadings are however not above 0.400, so these are not considered significant.

Factor 5 has only high loadings from items belonging to the construct Social Influence. With high loadings from all of the construct items (0.785 SI1, 0.749 SI2, and 0.478 SI3), this factor is composed of only major influences from this construct. Although the items from Social Influence also loaded substantially on factor 1, it seems that in factor 5 the construct Social Influence is singled out, and is therefore considered to be significantly different then either Perceived Usefulness or Perceived Enjoyment.

Factor 6 can also be explained mostly by one construct; Perceived Enjoyment. The items from this theoretical construct have the highest loadings on this factor (0.439 PE1, 0.437 PE2, 0.412 PE3). This proves that Perceived Enjoyment is a substantially different construct then Perceived Usefulness, although the latter did have high loadings on factor 1, which consists mainly of the items from the construct Perceived Usefulness. Therefore, the construct Perceived Enjoyment is singled out, and retained as an important construct of the theoretical model.

Factor 7 seems devoted to one single item as well, specifically Expected Costs, which loads very high on this factor with a loading of 0.970. The final, and most insignificant factor in this model is factor 8, which only has a high loading of Effort Expectancy item EE2 (0.589) and Trust and Privacy item TP4 (-0.619). As these items are both better represented within their respective constructs and are not likely to load together as one determinant, it seems that only 7 factors are sufficient in this analysis to retain all significant constructs from the model.

All the hypothesized constructs loaded good on their corresponding factors, although some problems did occur. All factors and item loadings are summarized below:

Factor 1: Mainly consists of high loadings from Perceived Usefulness items (0.737 PU1, 0.750 PU2, 0.827 PU3, 0.854 PU4). It also consists of some high loadings from the construct Social

Influence and Perceived Enjoyment. However, because of the explicit loadings of Social Influence and Perceived Usefulness on other factors, these constructs are retained as separate influencers of Usage Intention.

Factor 2: Consists of the constructs Effort Expectancy (0.699 EE1, 0.515 EE2, 0.782 EE3, 0.812 EE4) and Facilitating Conditions (0.745 FC1, 0.762 FC2, 0.762 FC3). Other influences have been largely mitigated. As explained before, it seems that both constructs measure the same dimension, because both constructs load very high on factor 2, and not on any other factor.

Factor 3: Trust and Privacy (0.792 TP2, 0.921 TP3, 0.585 TP4, 0.898 TP5, 0.709 TP6).

Factor 4: Usage Intention (0.742 UI2, 0.861 UI3, 0.814 UI4, 0.758 UI5).

Factor 5: Social Influence (0.785 SI1, 0.749 SI2, 0.478 SI3).

Factor 6: Perceived Enjoyment (0.439 PE1, 0.437 PE2, 0.412 PE3). Although Perceived Enjoyment has high loadings on factor 1, it is the only construct of which the questions load significantly on factor 6.

Factor 7: Expected Costs (EC 0.970).

Factor 8: No substantial factor loadings, except for item EE2 (0.589) and TP4 (-0.619).

The construct Perceived Usefulness showed to have a high correlation with Perceived Usefulness. These constructs either measure the same dimension, as it can be difficult for respondents to differentiate between questions regarding usefulness and enjoyment, or it can be coincidental that respondents that consider sharing locations to be useful also consider it fun to do. Then again, as this study only focuses on consumers and their perceptions and attitudes towards location sharing, usefulness could be experienced in a different matter compared to business users. The construct Perceived Enjoyment is however preserved for further analysis because of its importance in the theoretical model, and its separate loadings on factor 6. Facilitating Conditions showed to load very high on factor 2 as well as Effort Expectancy. As made clear earlier, this could be explained by the inexperience of respondents with location sharing. It is assumable that respondents cannot answer questions about Facilitating Conditions, if they have no experience with location sharing services. Therefore, Facilitating Conditions is dropped from the model and further analysis. With Facilitating Conditions removed from the factor matrix, it represents a so-called simple structure, wherein each construct loads highly on only one factor.

7. Analysis and Results

In this chapter the analysis of the findings is presented and discussed. The first section describes the Regression Analysis, followed by the Correlation Analysis. Each hypothesis is tested and analyzed within both methods individually. The results of the survey are analyzed with the statistical software package SPSS 16, which is chosen because of its powerful options for univariate and multivariate analysis and its easy to use graphical user interface.

7.1 Regression Analysis

In this section, the effect of independent variables in the model on the dependent variable Usage Intention are analyzed. For this examination, Multiple Regression Analysis was chosen as procedure, because it is used to examine the relationship between two or more independent predictor variables and one dependent criterion variable. It is very well suited to analyze the effects of the predicting constructs on Usage Intention and can be used for hypotheses testing. Regression Analysis enables detailed analysis of the variables, and is based upon the correlations between the variables. The constructs that were formed after Factor Analysis and Cronbach's α analysis are Perceived Usefulness, Effort Expectancy, Social Influence, Perceived Enjoyment, Trust and Privacy, Expected Costs and of course, Usage Intention.

ANOVA analysis is used to examine the statistical significance of the correlations between the predictor constructs and the dependent construct Usage Intention. The adjusted R^2 is a value which explains the proportion of variance in the dependent variable as accounted for by the independent

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.538[a]	.289	.271	.27192

a. Predictors: (Constant), EC, TP, EE, PU, SI, PE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.895	6	1.149	15.543	.000[a]
	Residual	16.932	229	.074		
	Total	23.827	235			

a. Predictors: (Constant), EC, TP, EE, PU, SI, PE

b. Dependent Variable: UI

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.020	.106		9.618	.000
	PU	.022	.031	.063	.703	.483
	EE	.036	.024	.094	1.499	.135
	SI	.023	.031	.068	.729	.467
	PE	.121	.030	.380	4.016	.000
	TP	.030	.023	.076	1.338	.182
	EC	.019	.014	.080	1.426	.155

a. Dependent Variable: UI

Figure 7.1 Linear Regression Analysis (UI explained by EC, TP, EE, PU, SI, PE).

(predictor) variables (as a percentage). The p-value of the model is a measure to explain the significance of the model. The model is generally considered significant when the p-value is less than 0.05. This means that the adjusted R^2 - the explained variance in the dependent variable by the independent variables - has a 95% chance of being true. A p-value between 0.05 and 0.10 is considered weakly significant, and a p-value above 0.10 is considered not to be statistically significant.

The regression analysis of the adjusted model used in this study is shown in Figure 7.1. It reveals that the adjusted $R^2 = 0.271$. This means that the model explains 27.1% of the variance in the dependent variable Usage Intention, which is considered high. A high R^2 means the fitness of the model in explaining Usage Intention is strong. This analysis of variance suggests that the model is reliable in predicting the dependent variable ($p = 0.000$, $F = 15.543$).

As can be seen from Figure 7.1, the significance limit of the p-value at 0.10 is causing three of the constructs to be just out of range for significance. Therefore, in the analysis of the individual constructs, the p-value limit of 0.10 for significance is not leading in reporting the results. As this study is based upon a survey, it is legitimized to look at the results that fall within a greater span of significance. The cutoff for reporting on effects for individual constructs is chosen at 0.20. The hypotheses based on these constructs will however not be accepted, but labeled as 'plausible', because of the exceeded p-values.

Table 7.1 Associations of factors with Usage Intention

Factor	β	*sig. (p)*	direction
Effort Expectancy	0.094	0.135**	positive
Perceived Enjoyment	0.380	0.000*	positive
Trust and Privacy	0.076	0.182**	positive
Expected Costs	0.080	0.155**	positive

** significant at p-level ≤0.05*
*** significant at p-level ≤0.20*

Figure 7.1 shows that Effort Expectancy ($p = 0.135$), Perceived Enjoyment ($p = 0.000$), Trust and Privacy ($p = 0.182$) and Expected Costs ($p = 0.155$) were either significant or on the edge of significant predictors of the intention of respondents to use location sharing in mobile social networks, while Perceived Usefulness ($p = 0.483$) and Social Influence ($p = 0.467$) were certainly not. The β values of the factors convey the directions and the strength of the directions of the relationship between the examined factor and the dependent variable Usage Intention within the model. The relationships from the significant factors influencing Usage Intention are summarized in Table 7.1.

The directions from Table 7.1 indicate the relationships of the significant factors are positive. Using the results of the regression analysis, in which associations between each of the independent factors and Usage Intention have been explored, the hypotheses can be tested. First, we recapitulate on the hypotheses formed in Chapter 5. These are:

H1: Perceived Usefulness has a significant and positive effect on usage intention.

H2: Effort expectancy has a significant and positive effect on usage intention.

H3: Social Influences have a significant and positive effect on usage intention.

H4: Facilitating Conditions have a significant and positive effect on usage intention.

H5: Perceived Enjoyment has a significant and positive effect on usage intention.

H6: Trust and Privacy have a significant and positive effect on usage intention.

H7: Price considerations have a significant and negative effect on usage intention.

H8: User Experience in Mobile Internet has a significant and positive effect on usage intention.

H9: Possession of a 3G Mobile phone has a significant and positive effect on usage intention.

From these hypotheses, we are unable to test H4 because the construct Facilitating Conditions has been dropped from the model (As explained in Section 6.2.2). The hypotheses H1 and H3 can not reliably be proven, because the relationship between the factors Perceived Usefulness and Social Influence has turned out to be of no significance in the regression analysis. Hypothesis H8 will be assessed later after a comparison has been made between the results of respondents on the basis of their experience and type of mobile phone (either a '3G' mobile device or not). Hypotheses H2 H5 H6 and H7 can be assessed:

H1: Perceived Usefulness is *not significant* and H1 is therefore *rejected.*

H2: Effort expectancy is *positively* associated with Usage Intention, and nearly significant: H2 is *plausible*[1].

H3: Social Influences is *not significant* and H3 is therefore *rejected*.

H5: Perceived Enjoyment is *positively* associated with Usage Intention, and H5 is *accepted*.

H6: Trust and Privacy is *positively associated* with Usage Intention, and nearly significant: H6 is therefore *plausible*[1].

H7: Expected Costs is *positively* associated with Usage Intention, and nearly significant: H6 is therefore *plausible*[1].

To test H8 and H9, a comparison must be made between respondents on the basis of their experience and type of mobile phone. To analyze the effects of 'more experience in mobile internet' on Usage Intention, another regression analysis was conducted, in which all the respondents claiming to have no experience in mobile internet were excluded. Among all respondents, there are 87 with experience in mobile internet (155 do not). The results of this regression analysis is shown in Figure 7.2. The explaining power of this model is about 28% and is significant at $p = 0.000$. The regression shows furthermore that there are three factors which can be considered significant or nearly significant. These are: Perceived Usefulness ($p = 0.123$), Perceived Enjoyment ($p = 0.031$) and Expected Costs ($p = 0.072$). The β for Perceived Usefulness is 0.240, which means this factor is of more importance in the model of respondents with experience in using Mobile Internet. They could conceive the usefulness of sharing their locations considerably higher compared to the overall respondents group with a β of 0.063 (although PU was not significant for the overall respondents model). The β of Perceived Enjoyment however is 0.305, and seems to have a lower influence on the model compared to Perceived Enjoyment in the overall respondents group ($\beta = 0.380$), which is a surprising result. When the β's of factors with low significance are compared as well, the difference in the explaining power of the factor Social Influence seems to be worth mentioning as well. Where

[1]Accepted under the adjusted significance limit at p = 0.20 instead of the regular p=0.05 / p=0.10.

the model explaining Usage Intention for the overall respondents has a β of 0.068 for this factor, the model that predicts Usage Intention for only the respondents with mobile internet experience has a β with the value of 0.022. Besides that, Expected Costs seems to have more influence on the overall respondents, probably because those respondents do not have experience in acquiring mobile applications or services, and might therefore have different expectations regarding the price that will be charged. This β is 0.080, wherein the 'experienced' model it is 0.029. Based on these differences, we can assume that experience with mobile internet does provide a stronger basis for Usage Intention of location sharing in mobile social networks.

H8: User Experience is *positively* associated with Usage Intention, and H8 is therefore *accepted.*

To test the difference in explaining power of the model between respondents based on their type of mobile phone they possess, two more regression analysis have been performed. In the survey results, every mobile phone device has been categorized as either a '3G mobile device', or an 'older device'. The distinction has been made upon several different variables, such as screen size, Wi-Fi and 3G connectivity capabilities, computing power, etc. The results of the regression analysis for respondents that do not have a 3G mobile phone can be seen in Figure 7.3, and the analysis for respondents that do have a 3G mobile phone in Figure 7.4. In this analysis, there are 98 respondents that possess a 3G mobile phone (144 do not).

When the results of the different respondent groups ('3G' and 'no 3G' mobile phone) are compared, it becomes clear what the influence of possession of a 3G mobile phone is on Usage Intention. Figures 7.3 and 7.4 show that both models '*no* 3G' and '*only* 3G' are significant, at $p = 0.000$. These models explain approximately 20% (no 3G) and 35% (only 3G). It is interesting to see how much more explanatory the model is for respondents that possess a 3G mobile phone. The significant factors for '*no* 3G' are: Social Influence ($p = 0.098$), Perceived Enjoyment ($p = 0.067$) and Trust and Privacy ($p = 0.096$). Respondents from the category '*only* 3G' however have only two significant factors: Perceived Enjoyment ($p = 0.004$), and Expected Costs ($p = 0.059$).

Model	R Experienced in Mobile Internet (selected)	R Square	Adjusted R Square	Std. Error of the Estimate
1	.580[a]	.336	.281	.30448

a. Predictors: (Constant), ECnew, TP, PE, EE, SI, PU

ANOVA[b,c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.379	6	.563	6.074	.000[a]
	Residual	6.675	72	.093		
	Total	10.054	78			

a. Predictors: (Constant), ECnew, TP, PE, EE, SI, PU

b. Dependent Variable: UI

c. Selecting only cases for which Experience Mobile Internet - no experience ~= 1

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.720	.201		3.580	.001
	PU	.093	.060	.240	1.561	.123
	EE	.039	.044	.094	.882	.381
	SI	.008	.053	.022	.150	.881
	PE	.105	.048	.305	2.197	.031
	TP	.031	.040	.077	.782	.437
	EC	.050	.027	.029	1.826	.072

a. Dependent Variable: UI

b. Selecting only cases for which Experience Mobile Internet - no experience ~= 1

Figure 7.2 Linear Regression Analysis for respondents with experience in mobile internet.

Model	R 3G = No (Selected)	R Square	Adjusted R Square	Std. Error of the Estimate
1	.492[a]	.242	.209	.24233

a. Predictors: (Constant), EC, TP, EE, PE, PU, SI

ANOVA[b,c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.573	6	.429	7.302	.000[a]
	Residual	8.045	137	.059		
	Total	10.618	143			

a. Predictors: (Constant), EC, TP, EE, PE, PU, SI

b. Dependent Variable: UI

c. Selecting only cases for which 3G = No

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.227	.123		9.973	.000
	PU	.029	.038	.096	.768	.444
	EE	-.002	.030	-.006	-.069	.945
	SI	.063	.038	.219	1.668	.098
	PE	.065	.035	.229	1.844	.067
	TP	.044	.026	.128	1.678	.096
	EC	-.004	.016	-.019	-.256	.799

a. Dependent Variable: UI

b. Selecting only cases for which 3G = No

Figure 7.3 Linear Regression Analysis with *no* 3G users

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	3G = Yes (Selected)			
1	.627[a]	.394	.351	.29857

a. Predictors: (Constant), EC, PU, TP, EE, SI, PE

ANOVA[b,c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.920	6	.820	9.198	.000[a]
	Residual	7.577	85	.089		
	Total	12.497	91			

a. Predictors: (Constant), EC, PU, TP, EE, SI, PE

b. Dependent Variable: UI

c. Selecting only cases for which 3G = Yes

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.768	.183		4.195	.000
	PU	.038	.054	.093	.707	.481
	EE	.050	.039	.122	1.284	.203
	SI	-.001	.053	-.004	-.027	.978
	PE	.162	.055	.460	2.965	.004
	TP	.021	.040	.047	.535	.594
	EC	.046	.024	.165	1.910	.059

a. Dependent Variable: UI

b. Selecting only cases for which 3G = Yes

Figure 7.4 Linear Regression Analysis with *only* 3G users

These differences could be explained by the different attitudes toward sharing locations in mobile social networks that both groups hold. The β for Perceived Enjoyment in the '*no* 3G' group is substantially lower then in the 'emphonly 3G' group (β of 0.229 compared to β of 0.460), which could largely be explained by the experience these respondent groups have utilizing mobile applications. Also, although not significant for the '*only* 3G' respondents, the difference in model influence of Trust and Privacy on Usage Intention is interesting: in the model for 3G phone possessors it has an influence of β 0.047, compared to '*no* 3G' where the influence is β 0.128, which is considerably higher. It seems the group of respondents that possess a 3G mobile phone have a lower fear for their privacy being invaded compared to respondents that do not possess a 3G mobile phone. Based on these findings, we can state that:

H9: Possession of a 3G mobile phone is *positively* associated with Usage Intention, and H9 is therefore *accepted*.

7.2 Product-Moment Correlations

Several of the constructs in the adjusted UTAUT model did not have significant relations with Usage Intention in regression analysis. Although it is still possible to make cautious statements about insignificant influences within the model, another analysis is needed to conduct the individual relations of the independent construct relations with Usage Intention more thoroughly. Therefore, the choice has been made to also produce Pearson product-moment correlations of each of the factors with the dependent variable Usage Intention. The Pearson product-moment correlation coefficient is a measure of the correlation, i.e. linear dependence, which is widely used in science as a measure of the strength of linear dependence between two variables. This section discusses these correlations, and reevaluates the hypotheses.

In Figure 7.5 the Pearson product-moment correlations for all factors are depicted. In this table, the individual correlations of all independent constructs with Usage Intention are given, as well as correlations of each construct with other constructs. A Pearson correlation relationship

		UI	PU	EE	SI	PE	TP	EC
UI	Pearson Correlation	1	.426	.305	.435	.512	-.008	-.052
	Sig. (2-tailed)		.000	.000	.000	.000	.898	.423
PU	Pearson Correlation	.426	1	.379	.722	.741	-.130	.116
	Sig. (2-tailed)	.000		.000	.000	.000	.046	.076
EE	Pearson Correlation	.305	.379	1	.439	.407	-.040	.028
	Sig. (2-tailed)	.000	.000		.000	.000	.545	.664
SI	Pearson Correlation	.435	.722	.439	1	.753	-.153	.124
	Sig. (2-tailed)	.000	.000	.000		.000	.019	.057
PE	Pearson Correlation	.512	.741	.407	.753	1	-.158	.073
	Sig. (2-tailed)	.000	.000	.000	.000		.015	.262
TP	Pearson Correlation	-.008	-.130	-.040	-.153	-.158	1	-.047
	Sig. (2-tailed)	.898	.046	.545	.019	.015		.474
EC	Pearson Correlation	-.052	.116	.028	.124	.073	-.047	1
	Sig. (2-tailed)	.423	.076	.664	.057	.262	.474	

Figure 7.5 Pearson product-moment correlations for all factors.

is considered small when it has a value between 0.10 and 0.29, medium if its between 0.30 and 0.49, and large if its between 0.50 to 1.0. Several of the constructs correlate significantly with each other, which suggests some of the constructs influence Usage Intention through another construct. As can be seen from Figure 7.5, four out of six independent constructs have a significant relationship with Usage Intention. Those four are Perceived Usefulness, Effort Expectancy, Social Influence, and Perceived Enjoyment. The constructs Trust and Privacy and Expected Costs (both with a negative correlation with Usage Intention) do not have a significant relationship with Usage Intention. Each of the significant constructs and their individual influence on Usage Intention is analyzed and discussed here in more detail, and the hypothesis stated earlier concerning the constructs' influence is retested against these results.

A statistically significant relationship is discovered for the construct Perceived Usefulness in the Pearson correlation analysis. Its correlation with Usage Intention is 0.426, with $p = 0.000$, which means the strength of the relationship is medium (between 0.30 and 0.49). Perceived Usefulness also correlates with other constructs as can be seen in the correlations table. It has a medium correlation with Effort Expectancy (0.379) and large correlations with Social Influence (0.722) and Perceived Enjoyment (0.741). These correlations are all significant at $p = 0.000$. With the positive and significance influence of Perceived Usefulness on Usage Intention, we can state that within product-moment correlations:

H1: Perceived Usefulness *positively* associated with Usage Intention, and H8 is therefore *accepted*.

Effort Expectancy correlates also significant with Usage Intention, with a medium correlation at significance $p = 0.000$. The relationship is positive, which means that respondents tend to make more use of location sharing on their mobile phones, if they expect it is more easy for them to operate. Effort Expectancy also correlates with other constructs as well. As mentioned, it has a medium but significant correlation with Perceived Usefulness (0.379), Social Influence (0.439) and with Perceived Enjoyment (0.407).

In this correlations test, Social Influence has one of the highest relations with Usage Intention. The correlation between Social Influence and Usage Intention is significant at $p = 0.000$, and has a positive relationship of with a correlation of 0.435. Other constructs that seem to correlate significantly with Social Influence are as mentioned Perceived Usefulness (high: 0.722), Effort Expectancy (medium: 0.439) and Perceived Enjoyment (high: 0.753). Furthermore, it has a negative but insignificant correlation with Trust and Privacy (low: -0.153).

The last construct with a significant correlation with Usage Intention is Perceived Enjoyment. This construct has a large correlation of 0.512 at significance level $p = 0.000$. This is the construct that has the largest correlation with Usage Intention, and is therefore within this correlations test the most influential determinant in predicting Usage Intention. It also has large correlations with the constructs Perceived Usefulness (0.741) and Social Influence (0.753), and a medium correlation with Effort Expectancy (0.407).

The Pearson product-moment correlations are used to test the hypotheses stated in Chapter 5. The hypotheses that can be tested here are the ones that make statements about constructs that have significant influenced on Usage Intention. Based on the findings from the correlations test, these are presented below. Both hypotheses H8 and H9 could not be tested within this correlations test, as there is no model generated in which these determinants can be of influence. A direct correlation with these two determinants and Usage Intention could not be modeled.

H1: Perceived Usefulness has a *medium positive* correlation with Usage Intention: H1 is *accepted*.

H2: Effort expectancy has a *medium positive* correlation with Usage Intention: H2 is *accepted*.

H3: Social Influence has a *medium positive* correlation with Usage Intention: H3 is *accepted*.

H5: Perceived Enjoyment has *large positive* correlation with Usage Intention: H5 is *accepted*.

H6: Trust and Privacy has a *small negative* but *non significant* correlation with Usage Intention and H6 is therefore *rejected*.

H7: Expected Costs has a *small* and *negative* but *non significant* correlation with Usage Intention and H7 is therefore *rejected*.

After these product-moment correlations tests for the overall respondents group, two other tests were performed to analyze the difference between respondent groups. The first test is performed to compare respondents with experience in the mobile web (80 respondents), and those that do not have any experience (155 respondents). The second correlations analysis compares correlations between the respondent group with a 3G mobile device (92 respondents), and the other respondents that do not possess a mobile device (144 respondents).

		EC	PU	EE	SI	PE	TP	UI
UI	Pearson Correlation	.171	.465	.264	.397	.508	-.006	1
	Sig. (2-tailed)	.129	.000	.018	.000	.000	.959	

Figure 7.6 Pearson product-moment correlations for all respondents with experience in mobile web.

		EC	PU	EE	SI	PE	TP	UI
UI	Pearson Correlation	.043	.372	.253	.432	.491	-.050	1
	Sig. (2-tailed)	.596	.000	.002	.000	.000	.536	

Figure 7.7 Pearson product-moment correlations for all respondents with *no* experience in mobile web.

As can be seen from Figure 7.6 and Figure 7.7, the differences between respondents with and without experience is obvious. Among all respondents, there are 87 with experience in mobile internet (155 do not). Respondents that do have experience in the mobile web, have a larger correlation between Perceived Usefulness and Usage Intention (0.465) compared to the respondents without experience (0.372). Both are significant at $p = 0.000$. This is also the case for Effort Expectancy (0.264 compared to 0.253) and Perceived Enjoyment (0.508 compared to 0.491). It is however interesting to see how respondents without experience have a higher correlation between Social Influence and Usage Intention. Experienced respondents have a correlation here of 0.397, where those without experience have a correlation of 0.432. This could be explained by the assumption that the group of respondents that have experience in the mobile web contain more 'early adopters', compared to the no experience group. Early adopters are people that adopt a technology or service even when their social connections are not yet adopting. The laggards on the other hand, of which probably can be found more in the group of unexperienced users, lag behind on adopting new technology, and experience a higher added value if their social connections are using the technology. They need to be convinced of the added value, before adopting. Based on these results we can state that:

H8: User Experience in Mobile Internet has a *significant* and *positive effect* on usage intention. H8 is *accepted*.

		EC	PU	EE	SI	PE	TP	UI
UI	Pearson Correlation	.234	.471	.378	.469	.589	-.087	1
	Sig. (2-tailed)	.025	.000	.000	.000	.000	.408	

Figure 7.8 Pearson product-moment correlations for all respondents with a 3G mobile device.

		EC	PU	EE	SI	PE	TP	UI
UI	Pearson Correlation	.024	.406	.225	.438	.448	.049	1
	Sig. (2-tailed)	.774	.000	.007	.000	.000	.557	

Figure 7.9 Pearson product-moment correlations for all respondents with *no* 3G mobile device.

The differences between respondents that either do possess a 3G mobile device, and those that do not, can be seen in Figure 7.8 and Figure 7.9. In this analysis, there are 98 respondents that possess a 3G mobile phone (144 do not). A similar result can be seen here as in the mobile web experience correlations comparison. The correlations between the significant constructs and Usage Intention are constantly higher for the group of respondents that possess a 3G mobile device. For example, the correlation between Perceived Usefulness and Usage Intention for 3G mobile device possessors is 0.471; the respondents without a 3G mobile device have a correlation of 0.406. Also, the correlation between Perceived Enjoyment and Usage Intention is much higher among respondents with a 3G mobile device (0.589 compared to 0.448). What is interesting to see however, is that the difference between correlations in Social Influence and Usage intention doesn't show the same results as in the mobile web experience comparison: respondents with a 3G mobile device have a higher correlation with Social Influence and Usage Intention (0.469) compared to the non-3G group (0.438). With these results from the comparison between correlations with Usage Intention, we can safely state that:

H9: Possession of a 3G Mobile phone has a *significant* and *positive effect* on usage intention. H9 is *accepted.*

Based on the strengths of the relationships with with Usage Intention found in the correlations analysis, we can state that there are two constructs that are certainly of importance in explaining Usage Intention of adopting location sharing in mobile social networks, and some others that are seemingly of minor importance. The final section of this Chapter discusses the overall results from both regression and correlation analysis. The next section explores the answers given by respondents in the survey.

7.3 Survey Findings

In this section the answers given to the survey questions are presented and discussed, without further statistical analysis. Only percentages are presented. This section also explores the underlying reasoning more profoundly by discussing respondent's answers to the in-depth questions of the survey. The results of the answers given to the User Predisposition questions have already been presented in the foregoing paragraphs, and will therefore not be discussed here. As mentioned in Chapter 5, questions used to explore the adjusted UTAUT model constructs are based on a Likert scale. All answers to the survey questions can be found in detail in Appendix A.

Perceived Usefulness results

The statements about Perceived Usefulness were regarded by about 15% of the 236 respondents positively with options 'strongly agree', or 'agree'. Most respondents however did not recognize location sharing on mobile devices as useful: 60% answered either 'disagree' or 'totally disagree'. From the respondents that answered question PU1 positively (31), 58% believe it is useful if contacts from their social network know where they are at. Approximately 65% saw value in location sharing, if their contacts were able to estimate their time of arrival, or if messages would be send to their contacts when they would be in their proximity. From the 20 respondents that answered question PU4 positively, only 4 were indifferent or negative about improving the connections with friends in terms of making more contact, improving friendships, or making appointments faster, by means of location sharing.

Effort Expectancy results

The largest portion of respondents either agreed or was indifferent towards the statements about Effort Expectancy. Only approximately 32% believed they fully understood the concept of location sharing, or thought it would be easy to control and use it. 25% of the respondents disagreed, and believe location sharing is not easy to control or use. From all respondents, almost 40% believes that location information will update automatically while on the move. Almost 60% believes permission has to be given each time a location will be shared, as stemmed from question EE3b and EE3c.

Social Influence results

43% of the respondents believe that their family and friends think that sharing their locations is useful. It is interesting to see, that a bigger percentage believes that people that are important to them think it is advantageous to share location information: 52%. A big part of the respondents was however indifferent: around 37% answered 'agree/disagree' to the Social Influence statements. 45% did however believe they would start using location sharing, if their friends would use it.

Facilitating Conditions results

Although the construct Facilitating Conditions was dropped from the model because of its overlap with Effort Expectancy (see section 6.2.2), the results from the survey are presented here for completeness. About 44% expect they can easily find information about location sharing, and 50% believes a technical infrastructure exists that makes sharing locations easy and fast. Only 20% believes they do not have the knowledge necessary to operate a location sharing service, were 45% expects this will be not be a problem.

Perceived Enjoyment results

From regression and correlation analysis, Perceived Enjoyment proved to be the most important predictor of Usage Intention. This means that if Perceived Enjoyment rises, the usage of location sharing on mobile devices also rises. Although this has been empirically proven, only 15% believes sharing locations with contacts is fun. About the same percentage believes it is fun to share information about locations with contacts, or that it is fun to operate such a service. About 36% is indifferent, and 49% answered negatively. When the respondents that answered positively are asked about their specific opinions behind the 'fun part' in location sharing on mobile devices, almost 90% would enjoy to see were their friends currently are (30 out of 35 respondents). Around 75% answered they believe it is fun to see where their friends have been, enjoy receiving tips and recommendations about locations from their friends, and would also enjoy having more spontaneous visits with friends. One person suggested that it would be enjoyable to send and receive images or videos to all friends nearby at the same time.

Trust and Privacy results

From the survey results it becomes clear that 48.7% of the respondents fear for misuse of their location information if it is shared publicly. Of these respondents, 85% fear for an increased chance of a burglary in their house, or that others could be able to derive information about them when their location is public. Also, a very large portion of these respondents (90%) believe that their location information is private, and sharing it publicly would therefore form a privacy intrusion. Of all respondents, more then 75% wants to control who can access their location information. It also seems that many of the respondents fear that government agencies might access their location information without permission (approximately 46%), or that companies might do this (66%), or even people with malicious intent (64%). Only approximately 20% believes the benefits associated with publicly sharing their location outweighs the privacy risks.

When the respondents are asked who they would be willing to share their location information with, some interesting results come forward, as can be seen from Figure A.15 on page 111. Respondents are very resistant to sharing their location publicly, or with their employer and coworkers. They are willing to share it with their spouses (65%), children (62%) and selected friends from their social network (41%), but then again not from all contacts from the social network: 73% answered here negatively.

Expected Costs results

When asked for expectations regarding the costs of location services provided on mobile devices, 17.8% expects a one time fee has to be paid to make use of location sharing. Only 8.9% expects that an extra fee has to be paid per location service that is used, and 34% expects that a regular fee has to be paid for the usage of location sharing, on top of data costs. Most respondents however, expect location services will to become freely available without extra costs (39%).

Usage Intention

From all the respondents in the survey, only 5.5% is already sharing their location information and will continue to do it. The rest of the respondents are overall not likely to start sharing location information on a mobile device in the near future: only 11.9% plans to do so, and 18.2% predicts they will do so. When it comes to sharing locations in general, with no specific reference to a mobile device, 19.1% predicts they will share their location within a social network in the future. Although these scores seem low, 21.2% does prefer a mobile phone on which they could make use of location sharing when they have to choose their next mobile phone.

7.4 Summary

Table 7.2 Hypotheses summary.

Hypothesis	Construct	Regression Analysis	Product-moment correlations
H1	Perceived Usefulness	rejected	**accepted**
H2	Effort Expectancy	**plausible**[2]	**accepted**
H3	Social Influence	rejected	**accepted**
H5	Perceived Enjoyment	**accepted**	**accepted**
H6	Trust and Privacy	**plausible**[3]	rejected
H7	Expected Costs	**plausible**[4]	rejected
H8	Experience	**accepted**	**accepted**
H9	3G mobile device	**accepted**	**accepted**

Two different methods were used to analyze the empirical results collected: regression analysis and Pearson product-moment correlations. In order to test the influences of all constructs it was necessary to use both methods, as there were some constructs that showed insufficient significance in regression analysis. The results from both statistical methods are summarized in Table 7.2. In this Table, all hypotheses from the adjusted UTAUT model from Section 5.1 are depicted (except for the hypothesis H4, stated about the removed construct Facilitating Conditions (see Section 6.2.2)). The last two hypotheses H8 and H9 are accepted, but it must be noted the regression and correlation tests have been performed with less respondents than the other hypotheses. There were in total 236 respondents, of which 98 possess a 3G mobile phone (144 do not), and of which 87 have experience in mobile internet (155 do not). The results and statements about hypotheses are further discussed in the next Chapter.

[4] Accepted under the adjusted significance limit at p = 0.20 instead of the regular p=0.05 / p=0.10.

8. Conclusion

This Chapter will attempt to provide an answer on the main research questions of this study. The results from the study are contemplated, and the analysis of factors influencing Usage Intention are discussed. Finally, the implications of the study and future work are addressed.

8.1 Conclusion

The purpose of this thesis is to explore consumers perceptions of and standpoints towards sharing locations sharing on mobile devices. Companies doing business in the wireless industry (such as telecom operators, mobile phone manufactures, and content developers) must determine what the main factors are that influence adoption of such services, to provide consumers with services customized to their needs which they are willing to use in practice. In order to find these factors of influence, several research questions are answered. The main research question is:

1. Which factors affect the Usage Intention of mobile phone users to share location information in a mobile social network?

To answer this question, several supporting questions are answered as well:

1. How can mobile commerce be described, and what are mobile services?

2. How can (mobile) Location-based Services (MLS) be characterized and categorized?

3. How can the factors affecting User Acceptance be effectively studied and analyzed?

These first three supporting questions are answered in Chapter 2, 3 and 4, which contain the literature study. The second Chapter contemplates about mobile commerce, and defines it in terms of commercial transactions conducted over wireless communications networks. It also describes the Dutch current telecommunications market, and provides insight in the different mobile applications and services that currently exist.

The third Chapter answers how LBS services can be described. It starts with an explanation of what LBS exactly comprehends, followed by a summation of the most important positioning technologies that currently exist. It also provides a taxonomy of MLS applications and their functionalities.

Chapter 4 identifies which User Acceptance models are known in the literature, and specifically in the information technology acceptance research field. It provides an overview of the different models, and provides a detailed description of the UTAUT model used in this study. The literature study answers the first three supporting questions, and with the UTAUT model chosen as the model for this study, the following supporting research questions are answered:

4. How can the factors affecting User Acceptance in mobile services be described?
5. How can these factors be validated?

In Chapter 5, the adjusted theoretical model is presented, specifically designed to be used in Mobile Services acceptance studies, in environments where usage is non-mandatory. The UTAUT model is adjusted to analyze Usage Intention of information technology within a mobile context. The adjustments made consist of adding the constructs 'Perceived Enjoyment', 'Trust and Privacy' and 'Expected Costs' to the model, and modifying the moderators of the model. This model is the basis for the survey, also presented in Chapter 5. The full survey can be found in Appendix A.

[1] Accepted under the adjusted significance limit at $p = 0.20$ instead of the regular $p=0.05$ / $p=0.10$.

Table 8.1 Construct effects on Usage Intention.

		Regression Analysis		Pearson correlations		
Hypothesis	Construct	β	*sig. p*	ρ_x, y	*sig. p*	conclusion
H1	Perceived Usefulness	0.063	0.483	0.426	0.000	rejected
H2	Effort Expectancy	0.094	0.135	0.305	0.000	accepted[1]
H3	Social Influence	0.068	0.467	0.435	0.000	rejected
H5	Perceived Enjoyment	0.380	0.000	0.512	0.000	accepted
H6	Trust and Privacy	0.076	0.182	-0.008	0.898	rejected
H7	Expected Costs	0.080	0.155	-0.052	0.423	rejected

With the results of this survey, the main research question can be answered:

Which factors affect the Usage Intention of mobile phone users to share location information in a mobile social network?

The statistical methods used in this study showed some interesting and sometimes surprising results. All used constructs proved to be valid and also scale as different factors in the Cronbach's α and Factor analysis in Chapter 6. In regression analysis the model proved to be significant in predicting the variance in the dependent variable Usage Intention for approximately 27.1% which is a good score in survey studies. The individual constructs however were not all as significant as expected. Therefore, Pearson product-moment correlations between the independent variables and Usage Intention were also investigated for their effects. Both tests were used to make statements about the hypotheses derived from the adjusted UTAUT model. Table 8.1 depicts the effects of the individual constructs on Usage Intention, and the associated significance. The hypotheses that were either plausible or accepted in both statistical methods are those about 'Effort Expectancy', 'Perceived Enjoyment', 'User Predisposition' and 'Mobile device used'. The last two are not based on constructs, but have been tested as moderators. This means, the tests consists of model and correlation comparisons between experienced and non-experienced users, in stead of measuring a single effect on Usage Intention. The two hypotheses about constructs predicting Usage intention that are accepted, are:

H2: Effort Expectancy has a *significant* and *positive* effect on Usage Intention: H2 is *accepted*[1].

H5: Perceived Enjoyment has *significant* and *positive* effect on Usage Intention: H5 is *accepted.*

With these hypotheses accepted, we can state that the most important factors for mobile phone users in the Netherlands affecting the adoption of sharing locations on mobile devices are:

- Effort Expectancy (EE): The degree of ease associated with the use of the service.
- Perceived Enjoyment (PE): The degree to which an individual believes to experience a reward derived through the use of the services.

Effort Expectancy proved to be plausible in regression analysis. Plausible here means, that the significance level was not enough to fully accept the hypothesis, but it scored just above the cutoff limit (0.135) as can be seen in Table 8.1. This means that we suspect the construct to be a significant predictor, although it it is not empirically proven in regression analysis. In the correlation analysis however, Effort Expectancy showed to influence Usage Intention sufficiently to accept the hypothesis. It is therefore believed to be of big influence in the adoption of location sharing on mobile devices. We recommend that when deploying location sharing services, the effort in operating the service should be reduced as much as possible in order to make adoption easy even for unexperienced users.

A surprising fact is that the construct 'Perceived Usefulness' did not prove to be a significant influencer of Usage Intention in the model generated in regression analysis. This is surprising, because it was suspected to be one of the most strongest predictors of Usage Intention, as it was in each of the separate eight models of which the UTAUT model was constructed [Venkatesh et al., 2003]. A possible explanation would be that sharing locations on a mobile device is not yet recognized as a value adding activity in the form of task performance. One can imagine that location information could be of great value in commercial or organizational context, but it seems that in a consumer context the most important factors are not the usefulness of a service, but rather the enjoyment and ease of use one perceives when operating such a service. In correlation analysis it did prove to be of influence, but this is insufficient to accept the hypothesis.

Also, the in this research introduced constructs 'Expected Costs' and 'Trust and Privacy' were no significant predictors in the correlation analysis. In regression analysis, both were found to be plausible predictors. They might have an important influence although not empirically proven in this research. When analyzing the survey findings, some statements can however be made about these constructs, with which the following research questions can be answered:

6. What is the matter of experienced benefit or usefulness of location sharing on mobile devices?
7. What is the matter of experienced privacy intrusion of consumers regarding location sharing?
8. What are the differences between different consumer groups regarding location sharing on mobile devices?

From the survey results discussed in Section 7.3, these questions could be answered. Respondents do not seem to recognize location sharing as a useful activity. There is however a recognized benefit with sharing locations on mobile devices, although this is in the form of enjoyment related to the use of such services. It does seem that consumers are still worried about privacy intrusion when it comes to location sharing. Although practically all location sharing services offer options to control who can access location information, consumers with no experience in these services have not yet recognized this yet.

This might however also be partly due to the discussions that have recently been held in the Netherlands about privacy sensitive services. In the past summer, a government campaign was held to create awareness about online privacy. Also, the transformation of the public transport towards to the OV-chipcard and the recently introduced idea concerning GPS trackers build in cars in order to pay traffic taxes have both raised discussions about privacy. The two hypotheses that are not about the adjusted model constructs are:

H8: User Experience in Mobile Internet has a significant and positive effect on Usage Intention.

H9: Possession of a 3G Mobile phone has a significant and positive effect on Usage Intention.

From comparison in regression analysis as well as in correlation analysis it stemmed that consumers with experience in mobile internet as well as consumers with a more advanced (3G) mobile device are more likely to adopt location sharing services. As mentioned in Chapter 7, this could be explained by the assumption that the among consumers with experience in the mobile web as well as 3G mobile phone users there are more 'early adopters', i.e. people that are amongst the first to adopt new technologies.

It seems that consumers are reluctant to use technology on their mobile devices, if it doesn't offer any clear value to them. Wehmeyer [2007a] stated that most mobile phone users seem to be very attached to their mobile device, and regard it as a very personal and sometimes at the same time indispensable tool to everyday life. With the results from this study, one could conclude that mobile phone users will only accept location services if the privacy invasion and effort to operate the service is mitigated as much as possible.

8.2 Implications and Future Work

Although the goodness of fit of the adjusted UTAUT model was good, it must be noted that the statements made about the model must be made cautious, because correlation analysis showed the model might suffer from some multicollinearity because of high correlations between different constructs. Low reliability and high multicollinearity of the predictor variables increase the bias in standardized and unstandardized regression weights reducing interpretability of the data [Pedhazur, 1982]. In future research, the chances for multicollinearity can be mitigated by studying the combined effects of constructs on the independent variable. For example, the effects of the constructs Perceived Usefulness Perceived Enjoyment could be combined into an extra construct called 'Perceived Value', which in turn has a direct effect on Usage Intention. Multicollinearity could also be mitigated by enlarging the sample.

Also, future research could look more closer to other statistical methods that could also be used to analyze a research based upon a UTAUT model. For example, structural equation modeling would be suited, and could extend the results found in this study. The differences between mobile devices or even mobile operating systems and the use of location services could also be more explored in future research. As mobile devices become more and more sophisticated, and the barrier between home computers, laptops, and mobile phones is getting smaller and smaller, we expect the use of location in mobile services and the coupling of the intangible internet with physical location information will grow enormously. Especially when the telecom and developer industry is able to match their services with real market demand, by focusing on the intentions of consumers to start using such technology.

Future research could also do more analysis into the practical area of the acceptance of location sharing on mobile devices. Case studies could be performed regarding specific location sharing services that exist, to analyze the adoption factors from the viewpoint of users that have actual experience with these services. Different aspects might be of importance when users have experience with (several) location sharing services.

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A. Appendix: Survey

This appendix presents all questions belonging to the survey conducted in this study. The survey contains statements about sharing geographical location information in social networks utilized on a mobile device.

The survey analyzes three different aspects: first, questions are asked regarding background information of the respondent, such as age, social network subscriptions, and mobile phone brand and type. To get a thorough view of respondents' experience with mobile internet services, there are also questions asked about their usage of social networks, specific experience with mobile web-services, experience with mobile location services, and about experience with (mobile) Friend Finder services. The second aspect of the survey is to examine the constructs used in the theoretical model. The answers on these questions are used to compose and analyze the theoretical model. The third aspect in the survey is to get more in-depth information behind the answers given by respondents to the general questions. These answers are used to get a more comprehensive understanding about respondents' answers. These questions determine specific reasoning behind choices respondents make. For example, if a respondent answers a specific question about Perceived Usefulness with 'totally agree' or 'agree', another question will be presented in which the specific goals of location sharing are to be judged on by the respondent. The final questionnaire contained 46 questions of which 33 were related to constructs from the theoretical model explaining Usage Intention.

A.1 Online Survey

SURVEY | Location Sharing in Mobile Social Networks

Introduction - ***Sharing your location in a mobile social network***
As a Facebook or Hyves user, you are familiar with the concept of social media contacts. These are the people that belong to your online social network, and to which you are linked through this network. Because of technological innovations over the recent years, it is possible to access Facebook, Twitter or Hyves on mobile phones. This provides the possibility of sharing your `current location' with contacts from your network. This means, that within your network, you are able to see the whereabouts of your contacts, and they are able to see yours. At this moment, this functionality has not been implemented in either Facebook or Hyves. This questionnaire is designed to measure consumer standpoints regarding several aspects of location sharing in mobile social networks.

Background information
What is your age? [18 – 70]
What kind of mobile phone do you have? Brand: ____ model: ____
Which of the following social networks do you use?

- Facebook
- Hyves
- Twitter
- LinkedIn
- MySpace
- Schoolbank
- Other: ____

User Predisposition
UP1 Which web-services do you have experience with on your mobile phone?

- Browsing the internet
- Email on my mobile phone
- Social network applications on my mobile phone
- Mobile internet radio
- Mobile internet games
- Other: ____

UP2 Which location services do you have experience with?

- Local search application (search for things like nearby (shops, gas stations, etc)
- Navigation services (routes, maps, etc.)
- Information services (retrieve specific info like local news)
- Tracking services (locating persons / vehicles / products)
- Other: ____
- I don't have experience with such services

UP3 Which of the following 'Friend Finder' services have u used on your mobile phone?

- Google latitude
- Foursquare
- Brightkite
- Aka-aki
- Other: ____
- I don't have experience with such services

Figure A.1 Survey Questions part 1.

Performance Expectancy / Perceived Usefulness

PU1 I believe it is useful to share my location information with contacts from my social network.
PU2 I believe it is useful to be able to see the locations of my contacts on my mobile device.
PU3 I could more easily get together with my friends if I knew their geographical location.
PU4 If I use the service, I will improve the connections with my friends.

PU1b (*if PU1a = totally agree / agree*)
Which purpose of sharing your location do you think is useful?

- I believe it is useful if my contacts will know where I'm at.
- I believe it is useful if my contacts can estimate my time of arrival
- I believe it is useful my friends get a message when I am in their proximity

PU4b (*if PU4 = totally agree / agree*)
If so, in what way do you think you will improve the connections with your friends?

- We will be more in contact with each other.
- Such a service will improve friendships.
- We will make appointments faster, because we know we are near each other.
- We will be more aware of what others are doing.

Effort Expectancy

EE1 I believe the concept of sharing my location sharing is clear and understandable.
EE2 I believe it is easy to control which people will have access to my location information
EE3 I expect that sharing my location in a mobile social network is easy.
EE4 I believe that learning to operate a location sharing service on my mobile is easy.

EE3b I expect that my location information will update automatically while on the move.
EE3c I expect that I have to give permission each time a location will be shared.

Social Influence

SI1 My family and friends think that sharing their locations is useful.
SI2 People that are important to me think it is advantageous to share location information.
SI3 If many of my friends would share their location, I would probably do it as well.

Facilitating conditions

FC1 I expect I can easily find information about location sharing .
FC2 I believe a technical infrastructure exists that makes sharing locations easy and fast.
FC3 I believe I have the knowledge necessary to operate a location sharing service.

Perceived Enjoyment

PE1 I believe it is fun to share locations with my contacts.
PE2 I believe it is fun to share information about locations with my contacts.
PE3 I believe it is fun to operate a location sharing service on my mobile phone.

PE3b (*if PE3 = totally agree / agree*)
Specifically, which items would you believe to be enjoyable?

- I would enjoy seeing were my friends currently are.
- I would enjoy seeing where my friends have been.
- I would enjoy receiving tips and recommendations about locations from my friends.
- I would enjoy having more spontaneous visits with my friends.
- Other: ____

Figure A.2 Survey Questions part 2.

Trust and Privacy

TP1 I would feel confident in sharing my location information with friends from my social network.
TP2 I believe sharing my location information publicly will pose a threat.
TP3 I believe people with malicious intent could gain access to and misuse my location information.
TP4 I fear that government agencies might use my location information without my permission.
TP5 I fear that companies might use my location information without my permission.
TP6 If I share my location information I want to control who can access this information.
TP7 I believe the benefits associated with publicly sharing my location outweigh the privacy risks.

TP2b (*if TP2 = totally agree / agree*)
In what way do you feel this is a threat?

- I believe sharing my location increases the chance of a burglary in my house.
- I believe my location is private information and sharing it would threaten my privacy.
- I believe that people can derive information about me when they know my location.
- Other: ____

TP6b (*if TP6 = totally agree / agree*)
Who would you consider to share location information with, and how accurate?
(*precise | street level | city level | region level | none*)

- Everyone
- All contacts from my network
- Selected friends from my network
- My spouse
- My children
- Other family members
- My co-workers
- My employer
- Other: ____

Expected Costs

EC1 I expect that a one-time fee has to be paid to make use of location sharing.
EC2 I believe an fee has to be paid to per location service.
EC3 I expect that a regular fee has to be paid for the usage of location sharing, on top of data costs.
EC4 I expect that location services will become freely available without extra costs.

Usage Intention

UI1 I'm already sharing my location information and I'll continue to do it.
UI2 I plan to share my location on a mobile social network in the future.
UI3 I predict that I will share my location on a mobile phone in the future.
UI4 I predict that I will share my location within a social network in the future.
UI5 When I choose my next mobile phone, I prefer one on which I could make use of location sharing.

Figure A.3 Survey Questions part 3.

A.2 Survey Results

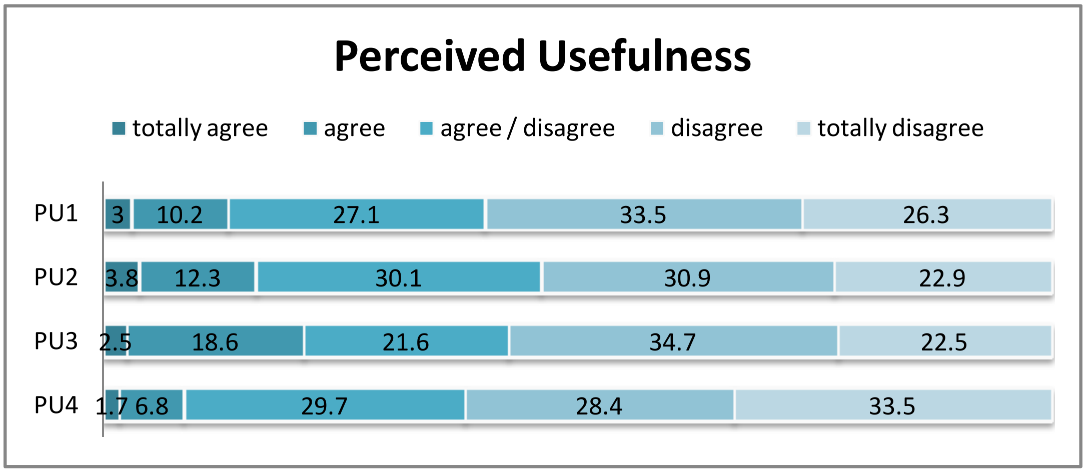

Figure A.4 Results from construct Perceived Usefulness.

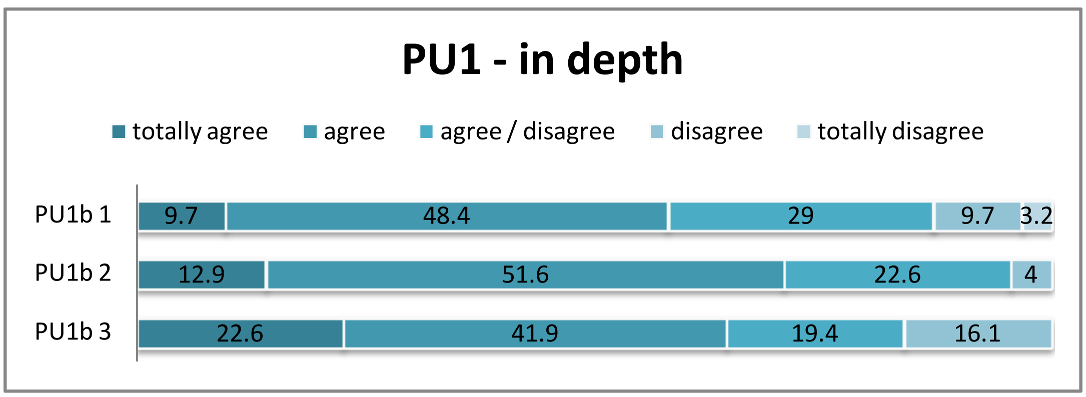

Figure A.5 Results from Construct PU1 in-depth.

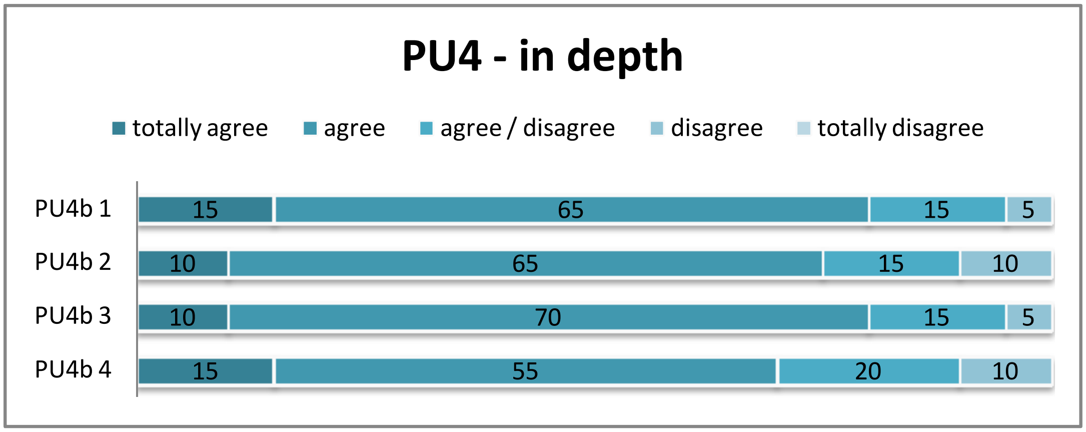

Figure A.6 Results from Construct PU4 in-depth.

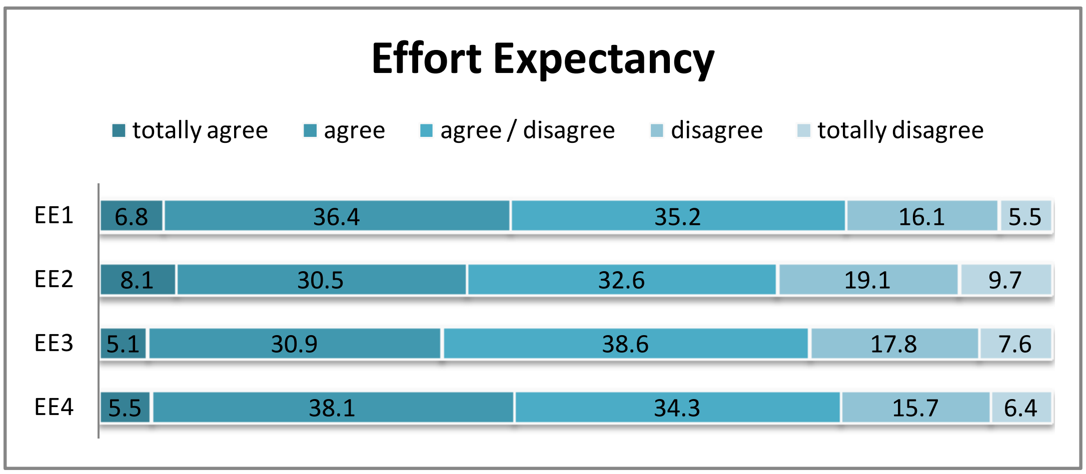

Figure A.7 Results from construct Effort Expectancy.

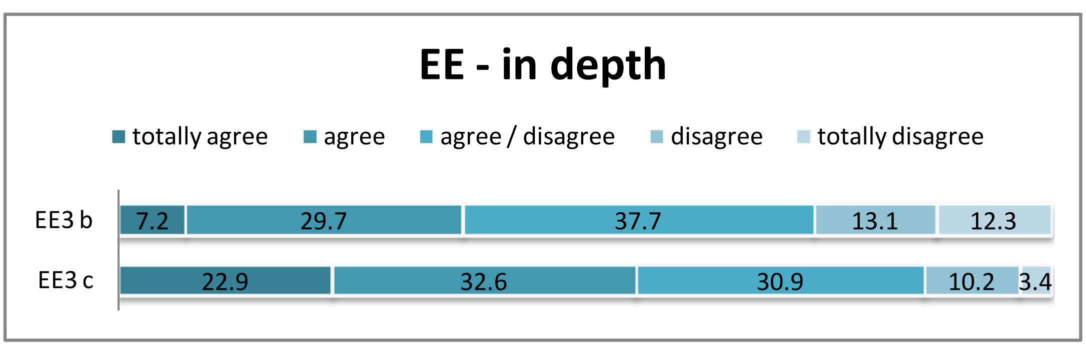

Figure A.8 Results from Construct Effort Expectancy in-depth.

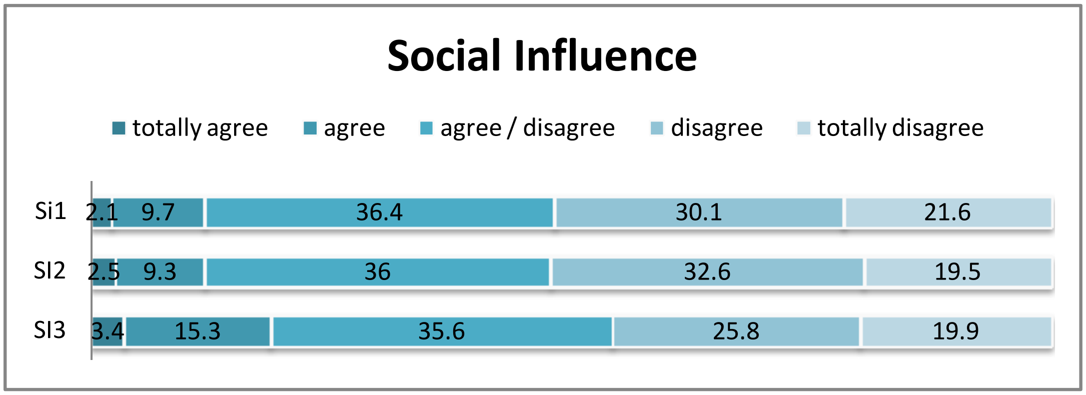

Figure A.9 Results from construct Social Influence.

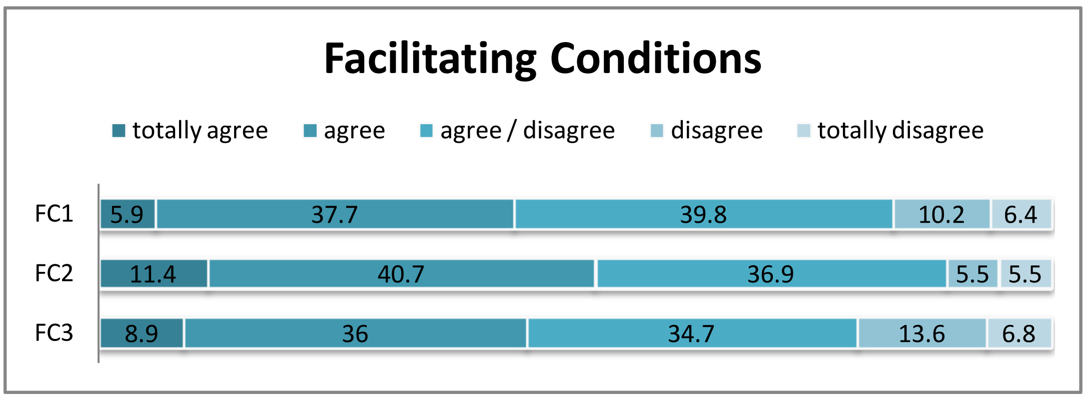

Figure A.10 Results from construct Facilitating Conditions.

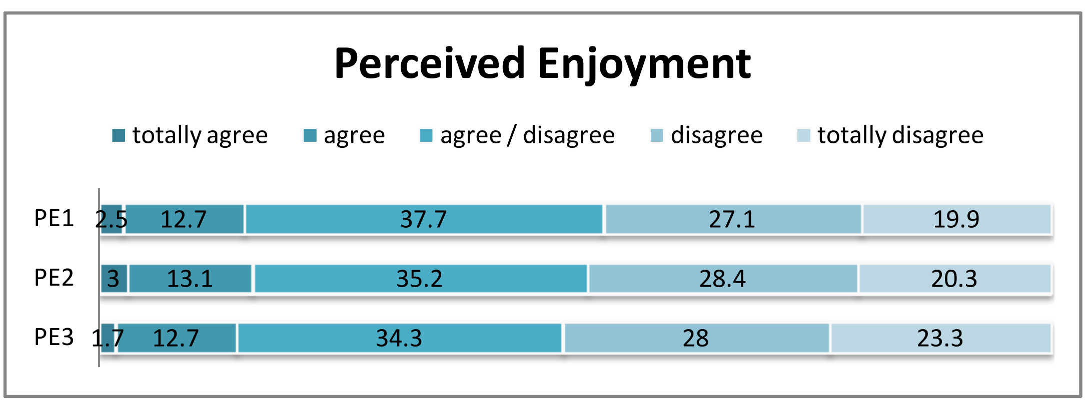

Figure A.11 Results from construct Perceived Enjoyment.

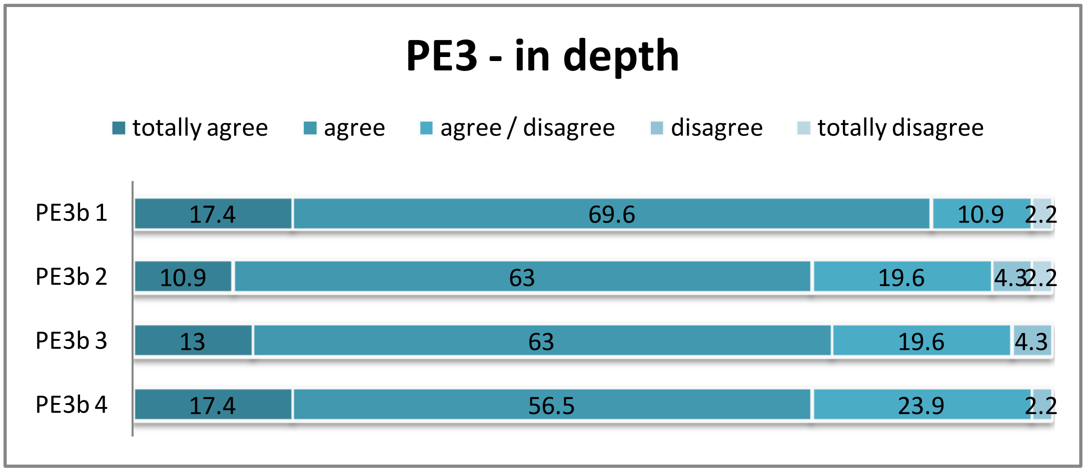

Figure A.12 Results from Construct PE3 in-depth.

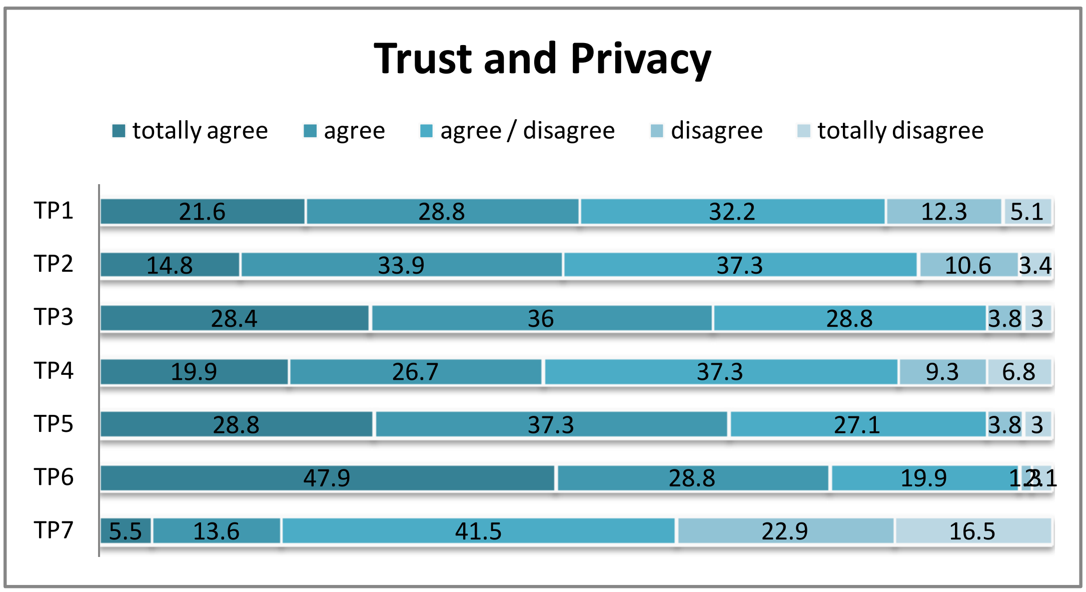

Figure A.13 Results from construct Trust and Privacy.

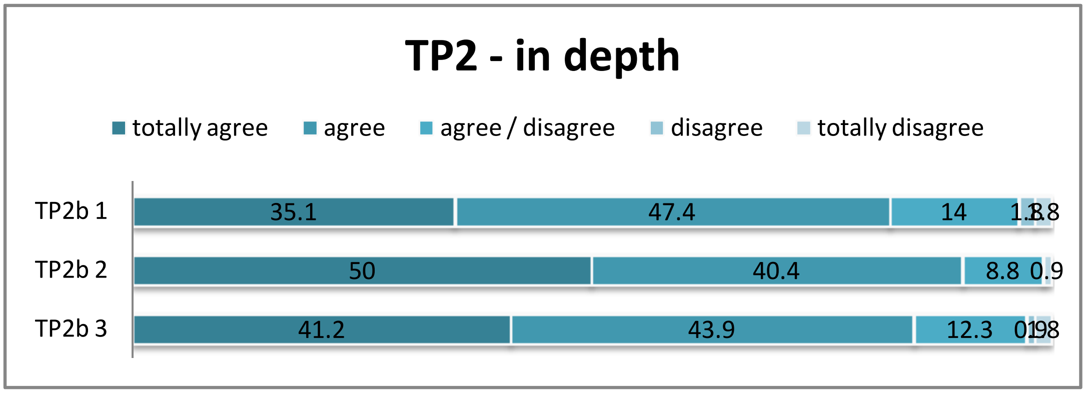

Figure A.14 Results from construct TP2 in-depth.

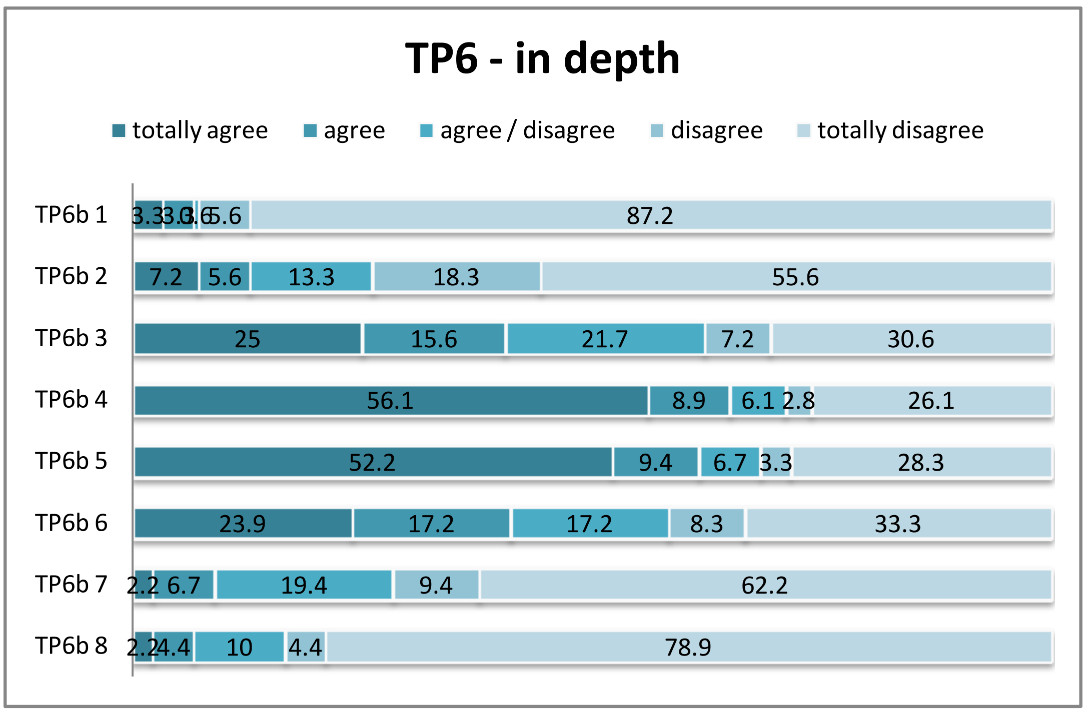

Figure A.15 Results from construct TP6 in-depth.

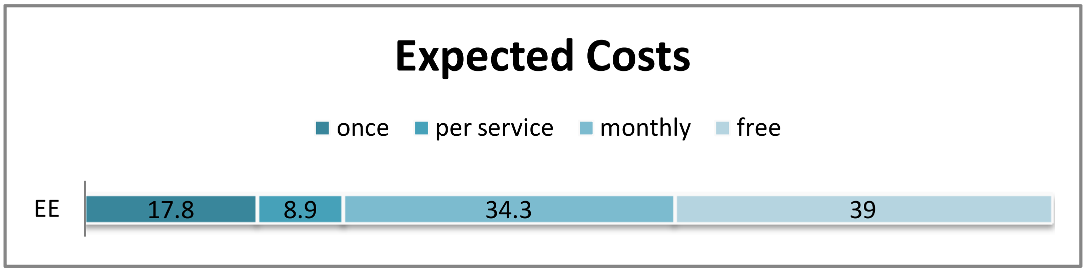

Figure A.16 Results from construct Expected Costs.

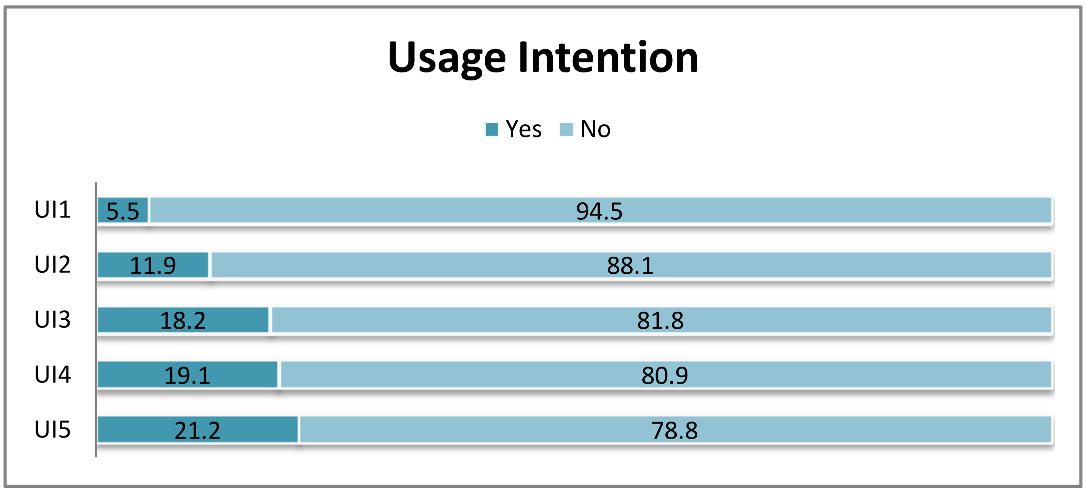

Figure A.17 Results from construct Usage Intention.

B. Appendix: Statistics

This appendix presents all relevant statistics belonging to the research methods conducted in this study.

B.1 Cronbach's α Analysis

Below the test outcomes for all Cronbach's α are presented, which are discussed in section 6.2.1.

Cronbach's Alpha	N of Items
.870	4

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PU1	10.96	7.638	.747	.825
PU2	11.10	7.454	.752	.822
PU3	11.11	7.668	.679	.853
PU4	10.82	7.959	.718	.837

Figure B.1 Cronbach's α for Perceived Usefulness.

Cronbach's Alpha	N of Items
.838	4

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
EE1	8.67	6.851	.649	.804
EE2	8.53	6.731	.569	.843
EE3	8.52	6.499	.722	.772
EE4	8.66	6.409	.755	.758

Figure B.2 Cronbach's α for Effort Expectancy.

Cronbach's Alpha	N of Items
.922	3

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SI1	7.01	3.734	.863	.869
SI2	7.03	3.663	.906	.835
SI3	7.16	3.746	.762	.955

Figure B.3 Cronbach's α for Social Influence.

Cronbach's Alpha	N of Items
.854	3

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
FC1	5.30	3.332	.720	.802
FC2	5.50	3.180	.763	.761
FC3	5.30	3.148	.698	.825

Figure B.4 Cronbach's α for Facilitating Conditions.

Cronbach's Alpha	N of Items
.962	3

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PE1	7.09	4.005	.941	.928
PE2	7.07	3.953	.932	.935
PE3	7.00	4.145	.885	.969

Figure B.5 Cronbach's α for Perceived Enjoyment.

Cronbach's Alpha	N of Items
.695	7

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
TP1	14.69	17.070	.048	.754
TP2	14.62	13.281	.612	.606
TP3	15.00	12.307	.782	.557
TP4	14.61	12.961	.564	.614
TP5	15.02	12.385	.771	.561
TP6	15.34	13.703	.561	.621
TP7	13.88	19.603	-.211	.807

Figure B.6 Cronbach's α for Trust and Privacy.

Cronbach's Alpha	N of Items
.863	5

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
TP2	8.80	11.272	.662	.839
TP3	9.18	10.454	.822	.798
TP4	8.79	11.337	.550	.870
TP5	9.20	10.417	.832	.795
TP6	9.52	11.877	.573	.860

Figure B.7 Cronbach's α for Trust and Privacy with removed items TP1 and TP2.

Cronbach's Alpha	N of Items
.833	5

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
UI1	7.31	1.587	.396	.855
UI2	7.37	1.273	.666	.793
UI3	7.44	1.097	.760	.761
UI4	7.44	1.106	.725	.772
UI5	7.47	1.125	.653	.797

Figure B.8 Cronbach's α for Usage Intention.

B.2 Factor Analysis

Below the test outcomes for Factor Analysis with no items removed are presented, which are discussed in section 6.2.2.

	Component							
	1	2	3	4	5	6	7	8
PU1	.737	.134	-.105	.195	.140	.149	.032	.246
PU2	.750	.124	-.005	.307	.142	.044	-.036	.172
PU3	.827	.092	-.010	.074	-.083	-.034	-.046	.051
PU4	.854	.033	-.033	.029	-.033	.046	.018	.005
EE1	.202	.715	.014	.102	-.004	.106	-.010	.207
EE2	.293	.525	-.086	.009	.194	.004	.098	.558
EE3	.191	.767	-.024	.147	-.010	.135	.147	.159
EE4	.183	.800	.004	.110	-.011	.105	.061	.208
SI1	.684	.193	-.075	.040	.329	.306	.202	-.136
SI2	.701	.215	-.101	.082	.329	.322	.173	-.118
SI3	.723	.211	-.069	.272	.328	.089	.051	-.049
FC1	.146	.761	.126	.027	.303	-.057	-.074	-.053
FC2	.069	.802	.176	.097	.119	-.043	-.078	-.214
FC3	.033	.767	.009	.092	.118	-.038	-.128	-.303
PE1	.719	.193	-.086	.290	.469	-.109	.046	-.023
PE2	.710	.195	-.074	.302	.430	-.131	.021	-.041
PE3	.673	.191	-.168	.348	.401	-.077	.023	-.088
TP1	-.275	-.133	.105	-.103	-.759	-.135	.041	-.122
TP2	-.108	-.084	.824	-.125	-.049	.085	-.010	.005
TP3	-.073	-.018	.916	-.013	-.055	-.060	.001	-.008
TP4	.097	.115	.616	.000	-.193	-.036	.078	-.518
TP5	-.043	.079	.896	.099	-.045	-.056	-.009	-.081
TP6	-.162	.334	.683	.104	.080	-.184	-.081	.100
TP7	.377	.136	-.032	.094	.656	-.015	.004	.060
EC	.097	-.048	-.021	-.044	-.011	-.035	.945	.018
UI1	.138	.103	-.132	.323	.054	.798	-.072	.034
UI2	.165	.182	-.104	.695	.113	.350	.135	.052
UI3	.207	.122	.026	.865	.105	-.054	-.023	-.055
UI4	.189	.115	.045	.823	.073	.067	-.174	-.067
UI5	.260	.058	.057	.743	.027	.133	.045	.108

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Figure B.9 Factor Matrix with Varimax Rotation. No items removed.

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.101	33.709	33.709	5.420	20.074	20.074
2	3.849	14.255	47.964	4.209	15.589	35.664
3	2.629	9.737	57.701	3.291	12.190	47.853
4	1.934	7.165	64.866	3.166	11.728	59.581
5	1.108	4.103	68.969	1.791	6.633	66.214
6	.904	3.347	72.317	1.096	4.058	70.272
7	.807	2.988	75.305	1.074	3.979	74.251
8	.778	2.883	78.188	1.063	3.937	78.188
9	.618	2.287	80.475			
10	.599	2.219	82.695			
11	.514	1.904	84.599			
12	.507	1.880	86.479			
13	.468	1.732	88.210			
14	.421	1.559	89.770			
15	.400	1.481	91.251			
16	.373	1.383	92.634			
17	.321	1.187	93.821			
18	.258	.954	94.775			
19	.253	.936	95.712			
20	.221	.818	96.530			
21	.204	.757	97.287			
22	.179	.663	97.949			
23	.167	.620	98.570			
24	.150	.556	99.125			
25	.111	.411	99.537			
26	.079	.292	99.829			
27	.046	.171	100.000			

Figure B.10 Total variance explained (belonging to Figure B.10).

C. Appendix: Basic Positioning Methods

A positioning system uses a certain method to determine the location of a user or an object. These methods may vary, depending on the goal they are trying to establish. For example, a household robot needs to determine its distance towards a ball, so it is able to pick it up and put it away. An airplane on the other hand must be able to determine its position in air above the clouds, so the pilot knows its distance towards the designated airport. Some methods are specificly usable for indoor environments, and others for outdoor environments. Outdoor methods usually determine longitude and lattitude variables to describe the exact location, using GPS infrastructure and the mobile telecommunication network, whereas indoor methods usually determine distances to objects, using small radio or infrared cells, or sensor arrays in the environment. The methods described are depicted in Figure C.1 [Wang, 2008], which describes the positioning accuracy and coverage of these technologies in LBS services.

C.1 Dead Reckoning

Dead reckoning (DR) is the process of estimating one's current position based upon a previously determined position, or fix, and advancing that position based upon known or estimated speeds over elapsed time, and course. While traditional methods of dead reckoning are no longer considered primary in most applications, modern inertial navigation systems, which also depend upon dead reckoning, are very widely used [Astronomy, Accessed August 24, 2009].

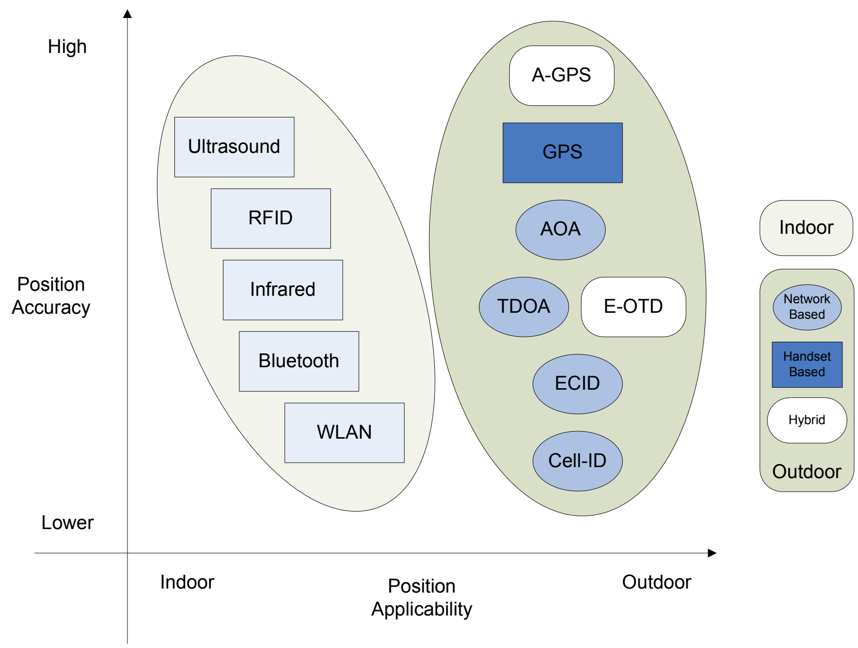

Figure C.1 Indoor and Outdoor Positioning Technologies [Wang, 2008].

C.2 Trilateration: Signal Strength Analysis and TOA

A trilateration system also consists of a series of joined or overlapping triangles. For trilateration the lengths of all the sides of the triangles are measured and few directions or angles are measured to establish azimuth. Trilateration has become feasible with the development of electronic distance measuring (EDM) equipment which has made possible the measurement of all lengths with high order of accuracy under almost all field conditions [Chandra, 2006].

C.3 Multilateration: TDOA

Multilateration, also known as hyperbolic positioning, is the process of locating an object by accurately computing the time difference of arrival (TDOA) of a signal emitted from the object to three or more receivers. It also refers to the case of locating a receiver by measuring the TDOA of a signal transmitted from three or more synchronized transmitters [Astronomy, Accessed August

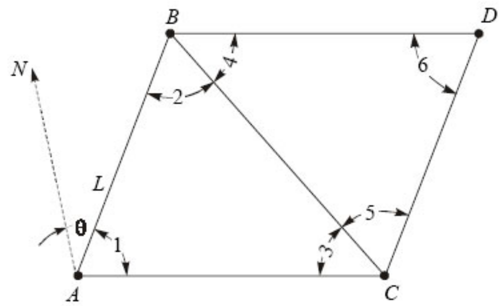

Figure C.2 Principle of triangulation.

23, 2009].

Multilateration should not be confused with trilateration, which uses distances or absolute measurements of time-of-flight from three or more sites, or with triangulation, which uses a baseline and at least two angles measured e.g. with receiver antenna diversity and phase comparison.

C.4 Triangulation: AOA

The method of surveying called triangulation is based on the trigonometric proposition that if one side and two angles of a triangle are known, the remaining sides can be computed. Furthermore, if the direction of one side is known, the directions of the remaining sides can be determined. A triangulation system consists of a series of joined or overlapping triangles in which an occasional side is measured and remaining sides are calculated from angles measured at the vertices of the triangles. The vertices of the triangles are known as triangulation stations. The side of the triangle whose length is predetermined, is called the base line. The lines of a triangulation system form a network that ties together all the triangulation stations (See Fig. C.2) [Chandra, 2006].

C.5 Combined Triangulation and Trilateration

A combined triangulation and trilateration system consists of a network of triangles in which all the angles and all the lengths are measured. Such a combined system represents the strongest network for creating horizontal control. Since a triangulation or trilateration system normally covers very large area, the curvature of the earth has to be taken into account. Therefore these surveys are invariably geodetic.[Chandra, 2006].

CATEGORY	EXAMPLE APPLICATIONS	APPLICATION ENVIRONMENT	ACCURACY REQUIREMENT	PROPOSED LOCATION METHOD	POSITION CALCULATION	TECHNOLOGY
Business -to- consumer (B2C)	Emergency calls	Outdoor	Medium to high	TDOA	Terrestrial Network or Device	Triangulation
	Automotive assistance	Outdoor	Medium	AOA/TOA	Terrestrial Network or Device	Triangulation
	Travel services	Outdoor	Medium to high	Cell-ID	Terrestrial network	Cell proximity
	m-yellow pages	Outdoor	Medium	Cell-ID	Terrestrial network	Cell proximity
	Banners, Alerts, Marketing	Outdoor	Medium to high	TOA	Terrestrial Network or Device	Triangulation
	People tracking	Indoor / Outdoor	High	GPS/Indoor GPS	Device from satellite data/ Pseudo Satellite	Triangulation
	Indoor routing	Indoor	High	Indoor GPS	Pseudo Satellite	Triangulation
Business -to- business (B2B)	Vehicle tracking	Outdoor	Medium	GPS/A-GPS/MT over S-UMTS	Device from satellite data	Triangulation
	Product tracking	Indoor / Outdoor	Medium to high	GPS/Indoor GPS	Pseudo- satellite /Device from satellite data	Triangulation
	Traffic management	Outdoor	Medium	GPS/A-GPS/MT over S-UMTS	Device from satellite data	Triangulation
	Product replenishment	Indoor	High	Indoor GPS	Pseudo- satellite	Triangulation
	Mobile sales	Outdoor	Medium to high	Cell-ID	Terrestrial network	Cell proximity
	m- customer support	Outdoor	Medium	GPS/TOA	Terrestrial/Satellite Network or Device	Triangulation
	Field personnel support	Outdoor / Indoor	Medium to high	Indoor GPS	Pseudo Satellite	Triangulation

Table C.1 Appropriate positioning methods for mobile location services [Zeimpekis et al., 2003].

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