The Importance of Context Towards Mobile Services Adoption

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***Abstract*—Along with the popularity of mobile devices and advances in wireless technology, mobile services have become more and more prevalent. Although many analysts have predicted that mobile systems will become mainstream, the adoption of mobile services has been slower than expected. The main objective of this research is to study the influence of context on mobile services adoption. The importance of context towards mobile services adoption was explored by looking at two newly developed mobile services. The findings from the exploratory study demonstrate that context is a significant factor to affect people's adoption of mobile services.**

Keywords-Context; Mobile Services Adoption

I. INTRODUCTION

Along with the popularity of mobile devices and advances in wireless technology, mobile services have become more and more prevalent. Although many analysts have predicted that mobile systems will become mainstream [1], the adoption of mobile services has been slower than expected. Despite all the technological possibilities, the number of successful context-aware mobile services in the commercial market is still limited [2]. Building successful strategies for promoting mobile services stems from understanding the context in which potential users prefer to use mobile services. Key factors for the success of mobile services are to identify the actual and potential customers, to investigate how they are influenced and how they behave (i.e., people's behavior) and to uncover what they really expect (i.e., needs, and preference) [3]. Therefore, it is important to study how users' perception on mobile services is affected by context.

The main objective of this research is to study the influence of context on mobile services adoption. Extensive research on the Technology Acceptance Model (TAM) [4][5] has explained why people accept or reject information systems. However, TAM has limitations when investigating users' adoption of mobile services, which is also confirmed by prior research work [6]. An important goal throughout this work is to investigate the importance of context in the adoption of mobile services. By exploring the role of context towards mobile service adoption in two case studies, the findings of this research will not only help mobile services developer to better understand users' expectations on mobile services, but also provide insights into how to promote new mobile services to potential users.

The remainder of this paper is organized as follows. In Section 2, we review prior literature on mobile commerce, mobile services, and context. Section 3 discusses some related work. In Section 4, we illustrate the role of context in mobile services and propose some contextual factors. Section 5 explores the importance of context towards mobile service adoption by looking at two newly developed mobile services. Section 6 concludes this research work and points out directions for future research.

II. LITERATURE REVIEW

A. Mobile Commerce and Mobile Services

Mobile Commerce [7] refers to e-commerce services, conducted through mobile devices using wireless telecommunications networks and other wired e-commerce technologies. Due to its inherent characteristics such as ubiquity, personalization, flexibility, and dissemination, mobile commerce promises business unprecedented market potential, enhanced productivity, and high profitability. Hence, network designers, service providers, vendors and application developers must cautiously take the needs and considerations of various users into account to provide better services and attract them to mobile commerce [8].

Mobile commerce involves mobile services, mobile technologies, and business models. Mobility implies portability. In other words, users can conduct business on real time bases in mobile commerce environment. Customers as well as vendors can be reached at any time via a mobile device. Ubiquity, convenience, localization, and personalization are characteristics of mobile commerce [9].

With the evolution of mobile technologies and the appearance of new innovative business models, we are seeing the growth of mobile services. Over the past 10 years mobile devices have changed the way that we work and live. Many people consider mobile devices as extensions and attachments of themselves [10]. As technology advances, mobile devices are able to be used to do things and fulfill needs in a more efficient and effective manner.

Mobile services provide an entirely new way for services providers to better serve their users through a variety of mobile devices over a wireless network in a wireless environment. Mobile services will enable users to make purchases, request services, as well as access news and information using mobile devices. Some key

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features of mobile services are: mobility, reachability, localization, personalization [11].

B. Context

Webster's Dictionary defines context as "whole situation, background or environment relevant to some happening or personality." The definition of context in the Free Online Dictionary of computing is "that which surrounds, and gives meaning to something else." Building on those definition from dictionary, Dey et al, [12] crafted a definition that operationlized the concept in terms of the actors and information sources involved in creating context: "Any information that can be used to characterize the situation of entities (i.e., whether a person, place, or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves." Context is typically the location, identity, and state of people, groups, and computational and physical objects.

Context is a key issue in the interaction between users and mobile devices, describing the surrounding facts that add meanings. Location can be regarded as one part of the context. In [13], the authors create a working model for context. At the top level of this model, they propose two contexts related to human factors in widest sense and physical environment respectively. Human factors related context is structured into three categories: information on the user (i.e., knowledge of habits), the user's social environment (i.e., co-location of others, social interaction), and the user's tasks (i.e., spontaneous activity). Likewise, context related to physical environment is structured into three categories: location (i.e., absolute position, relative position), infrastructure (i.e., surrounding resources for computation), and physical conditions (i.e., noise, light). Furthermore, how context relates to requirements specification and analysis and design of mobile information system was discussed in [14][15].

III. Related Work

Mobile services adoption is a relatively new field of research. When introducing new information technology, it is critical to study factors that influence user intention to adopt the new services. Developers and vendors can apply this knowledge throughout the design and implementation process to create a better service. Various technology acceptance models and theories, for example, the Technology Acceptance Model (TAM) [4][5], Theory of Planned Behavior (TPB) [16], Innovation Diffusion Theory (IDT) [17], Unified Theory of Acceptance and Use of Technology (UTAUT) [18], have been suggested to assist developers in the evaluation of new software applications. Further, the authors proposed a mobile services acceptance model [19] by extending traditional technology acceptance and diffusion theories above to assess users' adoption to mobile services.

While acceptance and adoption of IT services has been one of the most prevailing IS research topics (e.g., [5], [20], [21]), the pervasiveness of mobile systems raises new questions in exploring the adoption of mobiles services, such as what are the key factors determining the adoption of mobile services, and how contextual factors affect users' adoption of mobile services.

Because of these, some context related theories and frameworks were proposed to address the issue of mobile service adoption. Figge [22] introduced situation dependency as a new concept to adapt mobile services according to spatial, personal, and temporal context in which the user accesses a service. Situation dependency may be conceived as a three dimensional space, with user identity (personal profile, background, preferences, etc.), access position, and access time. In [23], they proposed contextual perceived usefulness as a new construct to enhance the understanding of an individual's mobile commence acceptance behavior.

However, the number of studies using individual consumer samples to investigate and observe the importance of contextual factors towards the adoption of newly developed technologies and services specifically provided on mobile devices and ubiquitous systems is small. Most previous studies on the significance of contextual factors towards mobile services adoption focus on general mobile services like voice, data services and messaging. Therefore, we believe that the contextual determinants for mobile services adoption with some newly developed mobile services is still worthy of examination. In this research work, we examine some contextual factors for mobile services adoption on two mobile services.

Concerning the two mobile services used in our exploratory studies, it might be equal to some existing mobile services on the commercial market. Moreover, the functions in these two mobile services are quite advanced and are able to offer some interesting applications to university students. Considering the fact that university students will become major customers on mobile business market soon, the role of context in these two mobile services is worthy to explore.

IV. The Role of Context in Mobile Services

The term context has been extensively used in the research of mobile related technologies. A unique feature of mobile services is that it can be applied in different contexts. A context often describes the surrounding circumstances of mobile services, which receives increasing attention in mobile computing.

Context provides an understanding of the way and circumstances for performing an activity [24]. Mobile services are often developed to provide an alternative channel for accessing services, not to replace the existing channels completely. The use of mobile services is able to provide time and place independent service access. When a service needs to be accessed immediately regardless of time and place, the usefulness of the mobile service is perceived as the highest, so that it would implicitly influence user's intention to use the service. Because a user's concerns and needs vary with the context in which he/she uses a service, the services that can meet the user's

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needs in a specific context will provide the best value to the user [22]. Therefore, we believe that context plays an important role in the adoption of mobile services. Some contextual factors would influence the usage of mobile services.

Based on the context, a user can decide whether the mobile services are useful or not. For example, if people have no access to a desktop computer, they will perceive accessing information systems via mobile devices as useful. Prior research [25] found that there were significant differences between experienced users and inexperienced users in the influence of intention to use. In [26], the authors also indicated that, for experienced users, there was a stronger intention to use the technology/service. It is also believed that users' perception of the ease of use and usefulness of mobile services may vary in different contexts.

The growing interest on the part of practitioners and academics alike in developing context-aware mobile services underlines the importance of context [27]. It is believed that the added value of mobile services depends on the context in which users are using. This inspired us to study the potential contextual factors which may impact mobile services adoption.

Furthermore, the authors in [28] classify the frequent changes in the context with regards to the usage of mobile information systems into six categories. We list three of them which are of relevance to the design of mobile services. Firstly, the environmental (physical) context, which captures the entities that surround the user, for example, the absolute or relative location of the user, plays an important role. Secondly, the task context describes what the user is doing. The task context may refer to the tasks people are interested. This view is also empirically confirmed by [29]. Thirdly, the social context describes the social aspects of the user context. It may, for instance, contain information about friends, neighbors, co-workers, and relatives. The role that the user plays is an important aspect of social context.

People's profile/lifestyle plays an important role in mobile services adoption. The extent to which users are inclined to mobile services adoption in a given situation may vary depending on people's profile/lifestyle. For example, party people may be much more interested to use mobile services in social situations, while as professional individuals may prefer to use mobile services which are able to help them with their daily tasks.

Task oriented context is also important for all groups of mobile users. For instance, students may like to use mobile social services to keep in touch with their friends and use mobile student information systems to keep updates about class related information, while professional individual may aim to use mobile services to ease their daily tasks whenever they are on the move.

Based on the definitions of context provided in Section 2 and context related concepts in this section, we decompose context into two dimensional constructs: people-centered context and place-centered context. Each dimension can then further divide into four categories (see Table 1). People-centered context mainly refers to personal profile (e.g., gender, personal preference, cultural background), past experiences people have (past impression or perception with similar systems), social status and roles, and personal tasks or goals. Place-centered context refers to a specific location, what kinds of resources the place has, what kind of environment people are in (e.g., weather, sound-level), and network condition (e.g., network connectivity).

TABLE I. CONTEXTUAL FACTORS

Context	
People-Centered Context	***Place-Centered Context***
Personal Profile/Lifestyle	Location
Past Experience	Physical Condition
Social Status	Available Resources
Personal Tasks or Goals	Network Condition

V. EXPLORATORY STUDIES

We have carried out two exploratory studies to study users' impressions and perceptions on mobile services in different contexts. The aim of these two exploratory studies is to study the importance of context towards mobile services adoption and test some of the contextual factors proposed in the last section. Two mobile services were presented to the participants in two daily life scenarios at a Norwegian university campus.

A. Study 1- Mobile Students Information Systems(MSIS)

The main purpose of the Mobile Students Information Systems (MSIS) is to offer a number of mobile services that can assist students in their daily activities in a university campus environment. The system makes use of contextual information such as location, time, and personal preferences to provide the user with relevant and timely information. MSIS consists of three parts: a lightweight client application for deployment on mobile devices, a Web-based portal for system configuration, and a backend server which provides database storage, business logic, and a number of public web services.

Three basic functions are offered by the system:

1). Location Finder: Allow users to search for different type of locations on campus, e.g. lecture rooms, computer labs, dining halls, etc. It provides a short description of the location with an option to show the position of the location on a map.

2). Lecture Planner: Allow users to view current lectures for a given day.

3). Announcement: News, notifications, and other information relevant to the user are published on an announcements board. The list supports sorting according to different "flags", such as importance or category.

Figure 1 shows screenshots of the MSIS main menu and the location finder service as they appear on a Windows Mobile 6 Professional emulator. This is quite similar to how it appeared on the actual test devices.

In order to assess the importance of contextual factors on the MSIS system, a survey was conducted to all the

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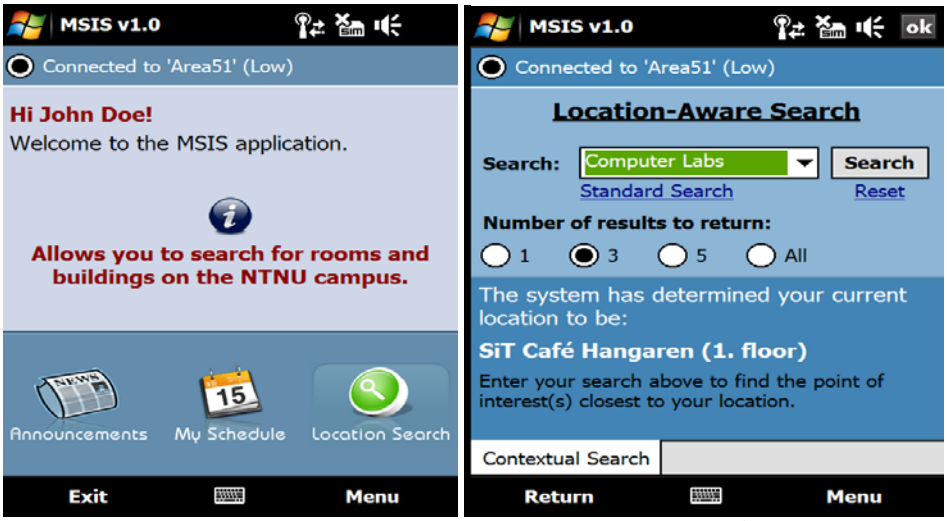

(a) The main menu (b) The location finder

Figure 1. The screenshots of the MSIS

invited participants after using the MSIS in two specific realistic scenarios in the university campus environment for around 45 minutes. The first scenario utilizes the location finder and map services within campus, whereas the second scenario utilizes the course schedule service. Respondents were also informed that the data being collected was part of a research study.

25 university students participated in this study. The students were from various study programs, including students with both technical and non-technical background. Fifteen of the participants were students majoring in computer science, whereas the other 10 participants were students with non-computer science background. Most of the survey participants had at least one mobile device and had some previous experience with mobile services.

It is believed that the adoption of mobile services is likely to be more affected by context than traditional desktop applications. As expected, our findings show that students are more likely to use the system if they are in a situation where they do not have access to a desktop computer or a laptop. According to the survey results, all the participants would use the system if they were out of their office or home. Both of the situations above can be considered as place-centered context. The first situation is related to the available resources in place-centered context, while the second situation is related to the location in place-centered context.

Another interesting observation was made from another contextual related measurement item, which concerned the users' previous experience with mobile services. 36% of the respondents did not regard this to be a critical factor. 12% were neutral to this matter, while 52% agreed that they would more likely use the system if they previously had had a nice experience with mobile services. This demonstrates the importance of people-centered context (i.e., past experience) on mobile services adoption.

Further, most respondent (24 out of 25 participants) indicated that they would also more likely use the service if it would be meaningful in the current situation and help increase task efficiency. This finding proves the significance of fulfilling personal goals, which is a people-centered contextual factor, on the adoption of mobile services.

36% of the participants agreed that they would use the MSIS system if most people around them are using the system. 32% were neutral to this determinant, while another 32% disagreed with this. According to our survey result, this people-centered contextual factor is the least important contextual determinant for mobile service adoption. This shows that, given the fact that the service has a value for them, the users are generally not affected by others' decisions to use a mobile service or not.

B. Study 2- FindmyFriends

FindMyFriends was a project developed by Accenture for UKA-07 (a student festival in Trondheim, Norway) that allowed students to locate each other at Samfundet, the building where the student society is located. Samfundet was constructed in 1929, has three and a half floors, and contains 10 main rooms. The most prominent arrangement at Samfundet is the biennial student festival UKA.

It is a known problem among students in Trondheim that it is difficult to find each other inside Samfundet. The system was particularly aimed towards the more than 2000 voluntarily workers of UKA-07, to make it easier for the workers to keep track of each other.

In brief, the FindMyFriends system offered the possibility of keeping track of your friends in the main venue of the festival. Just before UKA-07 started, the users received their tag used for positioning. In order to connect to other users, the user needed to link the tag with his/her profile, and registers the tag at the FindMyFriends system. Then, users could start connecting to each other,

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much like Facebook or any other social network service. When a user moved around Samfundet wearing the tag, the user's friends could log on the FindMyFriends or one of the terminals to check out the user's position. A user can only locate the users that have accepted to be friends with him/her. In addition to the FindMyFriends system, there are some terminals placed at Samfundet, which allowed the users to log into the system and keep track of their friends. Moreover, the system could generate statistics based on the user profiles, which allowed the users to see which rooms that had most girls, the average age of the users in a room, where you should be if you want to meet most single boys and similar statistics.

The technology used for positioning of tags inside Samfundet is ultrasound indoor positioning system (IPS). Ultrasound makes it possible to locate users precisely by room using wireless detectors. Each tag has its own unique identification sound, which is transmitted periodically or by moving. This sound is detected by one of the 63 detectors ("microphones") spread around in the rooms of Samfundet.

As reported in [30], we did a study to investigate the usability of this system. A questionnaire was distributed to the registered users at the FindMyFriends system after the student festival and face-to-face interviews with some respondents were carried out as well. Here we only present the observations and results that are of relevance to this paper. More specifically, we did some follow-up studies in connection to one of the research questions in the questionnaire: RQ1. Are people willing to use a system with functionality for locating and interacting with their friends and family using a mobile device connected to a wireless network in a city environment?

There were 2769 users registered in the FindMyFriends system, but only 1661 registered tags. 207 users answered the questionnaire. Over one third had between 10 and 29 friends, and approximately 60 % had 10 or more friends. This number corresponds well with the overall distribution of friends for all users. 55% of the participants indicated they would use this kind of system if it was available in the city environment.

The results show that the more a user visited Samfundet, the more friends the user has. This can indicate that the users who did not use the system so much, actually never got the chance to use it, because they visited Samfundet none or only a few times during UKA. This situation is related to the location and available resources aspects of place-centered context. This finding indicate that the users are inclined to keep using the system once they get chance to know and use the system.

Some users expressed great enthusiasm about using the system, and many of them would probably use the system without thinking too much about privacy mechanisms. Most users, who indicated the statement above, thought that it would be useful tool for finding their friends, especially when they were out partying. And six respondents explicitly mentioned that they only would use the system when they were out partying, which is also confirmed by the interviewees of this study. It is believed that this is of relevance to the place-centered context in terms of partying.

Some respondents mentioned that they had no joy from using FindMyFriends and they did not think that this service would give them any value individually. However, one of the interviewee indicated that he may attempt to use the application if some of their closest friends or family is starting to use it. We believe that this impression is of relevance to people-centered context (i.e., personal profile, personal task).

VI. CONCLUSION AND FUTURE WORK

This study presents the results from an exploratory study of the importance of contextual factors on mobile services adoptions in two newly developed mobile services. The theoretical background for the proposed contextual factors was adopted from the existing theories on context.

The findings of our study provide some contributions to mobile services adoption research. First, the study proposed some contextual factors which might influence people's adoption of mobile services based on existing research work on context. Second, the observations obtained from two studies provide support for the fact that context is a significant factor to affect people's impression and perception on mobile services. People tend to use mobile services in the situations, such as, when the services need to be accessed immediately and when other more advanced and convenient alternatives are not available. In these situations the usefulness of mobile services and benefits of mobility are the highest. Third, the results also imply that the general research model on mobile services adoption and diffusion needs to be augmented with contextual related factors which affect the use of mobile services. In the MSIS study, most respondents perceived the MSIS service as useful when it allows them to access lecture information and location of the classroom in a timely manner on the move, particularly in the case that mobile devices as the only possible means to access information. Last but not least, it is believed that the proposed contextual factors in Section 4 would be useful as a foundation to create contextual related instrument items to assess people's adoption of mobile services. It can also offer some insights to compose contextual related questions to test the usability of mobile services.

While our study provided some interesting findings on the importance of context towards mobile services adoption, we are also aware of some limitations of this research work. The respondents in two explorative studies were students at a university. This means that the results do not represent views from other users. Therefore, the generalizability of the results to other potential users remains to be determined. Further, the current study only examined two mobile services in university based environment. More research is needed to test the importance of context in some other commercial mobile services.

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There exist some opportunities for future research. First, generalization can be increased by expanding the study to include individuals representing different countries and cultures. Second, we have improved the instrument developed in [31] by taking these contextual factors into consideration. Then, we will try to use the enhanced instrument to measure the importance of the contextual factors towards mobile services adoption in some other context-aware mobile services.

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