The Impact of Use Situation and Mobility on the Acceptance of Mobile Ticketing Services

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Abstract

This paper presents results from a study of mobile ticketing service acceptance in public transportation. The theoretical background of the study was drawn from technology acceptance and diffusion of innovation theories, which were augmented with issues related to mobile service features, as well as the mobile use situation. The resulting research model was tested with data gathered through a self-administered mail survey with 360 subjects.

Our findings suggest that usefulness and benefits of the mobile ticketing service are perceived differently in different use situations and that use situation has a significant effect on use intention. The results indicate that traditional adoption models should be augmented with the use situation and mobility constructs to better understand and explain the specific factors, which determine the use of mobile services.

1. Introduction

After the slump in early third millennium, e-commerce is now spreading into all walks of life. This is demonstrated, for example, by the rapid movement of travel sales into the web. It can be argued that as the users get used to electronic shopping services, they will probably want to access services regardless of their location, or device in use. This would mean that in a few years time users assume that they can view, select and pay for services online, also when mobile. However, for this to happen, mobile commerce has to develop into forms that the users are willing to accept.

Earlier studies on mobile commerce suggest that there is a general consumer interest toward mobile commerce and banking applications. Purchases on web sites, electronic receipts and tickets, mobile services, routine bank services, peer-to-peer payments, and vending are among the potential applications [1, 14, 24, 34]. However, the adoption of mobile commerce and payments has been slower than expected. It has been argued that this stems from complexity of the transactions, perceived lack of security, lack of user friendly mobile portals, etc. [10, 33]. While it is true that the miniaturization of the screen and keyboard, as well as slow connections and the possibility of lost data pose heavy design challenges, we believe that there are other issues that can explain why some mobile services are successful, and why some others have not performed as expected.

In this study we aim to explain the use intention of mobile services by looking at an area where it has been quite successful; that is, mobile ticketing in public transportation. The theoretical background of the study is based on technology acceptance model (TAM) [8] and diffusion of innovations theory [30], which have been suggested by prior studies as applicable frames of reference for mobile commerce context [17, 36]. Empirical data for the study was collected in the capital of Finland, Helsinki, where the Helsinki public transportation has offered a mobile ticketing service since 2001, first in trams and underground, and lately also in local trains, ferries, and certain buses. A survey research was conducted among 1000 Helsinki citizens, with a result of 360 accepted answers.

Our findings suggest that the use situation, including specific situational conditions, such as, availability of other means to purchase the ticket and time pressure in buying the ticket, is a significant determinant for intention to use mobile ticketing. Furthermore, according to our model, the use situation fully mediates the effect of usefulness and mobility on use intention, suggesting that the benefits of mobile services are dependent on situations where they are used. The results indicate that the general adoption theories need to be augmented with mobile and situational factors which affect the use of mobile services and capture characteristics specific for these services. In our case, for example, people are willing to use mobile

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ticketing when it allows them to solve immediate situational problems, such, as lack of small change for buying tram tickets.

The paper is organized as follows. In the next section we review prior literature on mobile technologies and services adoption, which provides the theoretical background for our study. The third section discusses the unique features of mobile services by looking at earlier research on mobility and mobile use situations. In the fourth section we describe the empirical setting of the study and discuss the instrument development and data collection procedures. Fifth section presents results from the mobile ticketing survey research and section six discusses the findings. The final section concludes the findings and suggests paths for future research.

2. Adoption of mobile technologies and services

In mobile commerce context, several studies have examined the adoption of mobile technologies and services, suggesting that TAM and innovation diffusion theory provide relevant means for explaining mobile services adoption and use [13, 17, 20, 22, 36]. In this section, we review the literature on technology acceptance and adoption, with emphasis on studies on mobile commerce and services adoption.

2.1. Technology acceptance model

Technology acceptance model, TAM, was developed to predict end-user acceptance of information systems within organizations [8]. TAM originates from theory of reasoned action, TRA [9], and proposes a behavioral model where two beliefs, perceived ease of use and perceived usefulness, are the primary predictors of use intentions. TAM postulates that these two beliefs determine the attitude toward using the system and that attitude, together with perceived usefulness, determines use intention. Use intention then predicts the actual system use.

An extensive body of research has demonstrated the explanatory power of TAM in predicting use of various information technologies such as word processing software [8], computer resource center [35], www use [26], and Internet shopping [32].

A number of researchers have applied TAM in different domains of mobile commerce including, for example, acceptance of handheld Internet devices [4] and physicians acceptance of mobile medical information [13]. Prior findings provide evidence on the relevance of ease of use and usefulness in predicting the acceptance of mobile services [17, 36]. Klejnen et al. [20] found evidence of applicability of TAM in a their study on consumer intentions to adopt WAP financial services. Hung et al. [17] studied the adoption of WAP services in Taiwan and found that ease of use and usefulness were among the critical factors affecting WAP services use. Wu and Wang [39] examined mobile commerce acceptance and found that ease of use and usefulness were significant factors affecting mobile commerce use. Based on the prior findings we propose the following hypotheses:

H1. Perceived ease of use has a direct positive effect on consumer intention to use mobile ticketing service

H2. Perceived usefulness has a direct positive effect on consumer intention to use mobile ticketing service

2.2. Diffusion of innovations

Diffusion of innovations theory by Rogers [31] is a multidisciplinary theory frequently applied in IS adoption research. The theory determines five innovation characteristics which affect the adoption of the innovation: relative advantage, complexity, compatibility, trialability, and observability [31]. Moore and Benbasat [27] developed a specific measurement instrument for diffusion theory, namely the perceived characteristics of innovating, PCI, which was especially designed for IS adoption research.

Prior research on information technology innovation and adoption has provided evidence on the applicability of diffusion theory in predicting adoption of different technologies including, for example, spreadsheet software [3], online services [28], and smart cards [30].

Early stage research on mobile banking adoption in UK confirms that relative advantage over existing services, compatibility of mobile banking with consumer needs and lifestyle, and the ability to test a new service and observe the successful outcomes of other users increased positive attitudes towards adopting, whereas perceived complexity and risks had a negative effect on the attitudes towards adoption [22].

Prior research has noted the similarity between perceived usefulness and ease of use beliefs in TAM and the relative advantage and complexity constructs in diffusion theory [27, 35, 38]. The

relative advantage or usefulness and ease of use constructs can be considered as parallel and together with compatibility they have been found as the most constant determinants of adoption [37]. We therefore propose the following hypothesis:

H3. Compatibility has a direct positive effect on consumers' intention to use mobile ticketing service

3. Mobility and mobile use situation

The most significant feature of mobile technology is the mobility *per se*: ability to access services ubiquitously, on the move, and through wireless networks and various devices, such as, PDAs and mobile phones [5, 23]. Compared with traditional electronic commerce, where transactions are commonly conducted through stationary desktop and laptop computers, mobile computing provides users with more freedom, as they can access information and services without having to find a physical space, such as, an office or an Internet café for Internet connection [25].

Kleinrock [21] labeled the benefits provided by mobile technologies as "anytime and anywhere computing" and outlined the two most common dimensions of mobility – independence of time and place. The spatial and temporal dimensions of mobility extend computing and allow, in principle, anytime and anywhere access to information, communication, and services.

Kakihara and Sørensen [19] expanded the concept of mobility into three dimensions of human interaction; spatial, temporal and contextual mobility. The spatial and temporal dimensions correspond to those of Kleinrock's anytime and anywhere computing, whereas the contextual dimension extends the definition further. Contexts in which people reside continuously frame their interaction with others, including people's cultural background, particular situation or mood, and degree of mutual recognition [19].

Perry et al. [29] discuss restrictions that use situations pose to the ubiquitous computing. Specifically, the anytime and anywhere access is dependent on technological and social conditions of the use environment; not all places provide the needed technological infrastructure such as network connections required for ubiquitous computing, and not all social situations are adequate for mobile computing [29].

The effect of use situation has also been studied in consumer behavior literature, where it has been found as an important determinant for consumer choice behavior [2, 6, 11].

In the present study we use the term mobility to express the benefits of time and place independent computing and service access. The use situation is treated as a separate construct representing the specific circumstantial conditions that users meet when they move around and use mobile services in different places at different times.

Use situations are expected to mediate the benefits of mobility and perceived usefulness of mobile services. At home or in an office context a user is likely to find a laptop or desktop computer more convenient for accessing email, for example. When the person is on the move, however, and needs to access the email quickly, the benefits of mobility, that is, anytime and anywhere computing, actualize, and the mobile service is perceived as useful.

Similarly, in the present case of the mobile ticketing service, situational factors, such as, lack of alternative payment methods, urgency for getting the ticket, or unexpected need for the ticket, are likely to mediate the effects of mobility and perceived usefulness on intention to use the mobile ticketing service.

We therefore expect that use situations intensify the perceived usefulness and benefits of mobility and affect the intention to use mobile ticketing. We thus propose the following hypotheses:

H4. Use situation mediates the effect of usefulness on consumer intention to use mobile ticketing service

H5. Use situation mediates the effect of mobility on consumer intention to use mobile ticketing service

H6. Use situation has a direct positive effect on consumer intention to use mobile ticketing service

3.1. Proposed research model

Based on the literature discussed above and relations hypothesized between different variables, we constructed a research model depicted in Figure 1. The model is based on TAM [8] and diffusion of innovations theory [30] and it is augmented with factors that characterize the specific features of mobile services adoption; mobility [13, 19] and situational factors [2, 6].

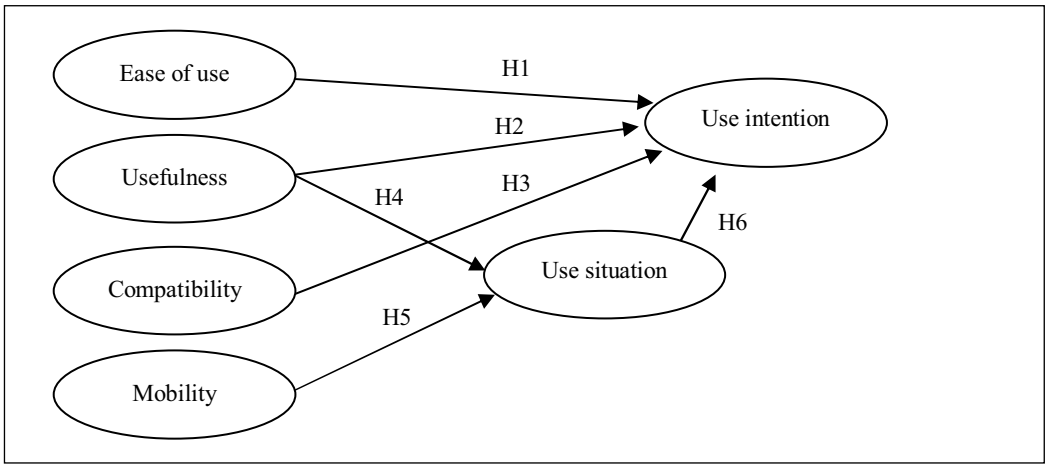

Figure 1. Proposed research model

4. Research method

We studied the use of mobile payments in practice through a survey of the users of mobile ticketing service in the public transport of Helsinki city. In this chapter we describe the mobile ticketing service and discuss the instrument development and data collection procedures. The following chapter presents the empirical findings of the survey research.

4.1. The mobile ticketing service

In this study, the mobile service under study is a mobile ticketing service provided by the public transport system in Helsinki, Finland. In 2001 Helsinki Public Transport launched a short message (SMS) based system for selling public traffic tickets. Last year, close to 1 900 000 mobile tickets were sold and, at present, 17 percent of all adult single tickets are purchased through the mobile channel.

The tickets can be bought by sending a four character SMS to a premium service number. As a return message, the customer receives a single ticket, which is then valid for one hour on trams, subway, local trains, and certain ferries and buses. The ticket costs €1.90 and is cheaper than a single ticket bought in the vehicle and paid in cash. The SMS ticket has to be bought before entering the vehicle or the subway platform area. The tickets are billed through mobile phone operators' billing systems. Currently the availability of the service is limited to subscribers of the top five mobile phone operators operating in the area. Other options for purchasing a public transport ticket are cash and a smart card system called travel card.

4.2. Instrument development

For the purposes of our data collection, a self-administered mail survey was designed. Measurement scales for the ease of use, usefulness, compatibility, and use intention items were taken from existing TAM [7, 35] and PCI [27] scales, with modified wordings to adapt the items to the current topic.

The basis for the use situation measurement items was the literature review of related studies [2, 6, 19]. The theoretical view was complemented with findings of Helsinki Public Transport customer survey for the mobile ticketing service users [15], which suggested that users perceive mobile ticket as especially valuable under certain situational conditions, such as, when they are in a hurry or do not have cash or a travel card available.

Development of the mobility scale was equally based on literature review [19, 21] and the findings were complemented with results from the customer survey [15]. All scale items were measured on seven-step Likert scales, ranging from *totally agree* to *totally disagree*.

In a pretest phase, the questionnaire was first reviewed by a small group of information systems science faculty and doctoral students at Helsinki School of Economics, and the scales were modified as a result of their suggestions. The questionnaire was next tested with a sample of 47 business school students and personnel. The test resulted in some further modifications to the question and scale item wordings. The purpose of the pretests was to confirm that all relevant aspects were included in the study and to enhance the clarity and readability of

the questionnaire. The final questionnaire included 26 items measuring six latent variables, as presented in Appendix 1.

4.3. Data collection

The target population for the actual survey was all Helsinki citizens. According to a prior customer survey of Helsinki Public Transport [15], there were more mobile ticketing users in relation to population in the inner city area. As it was important for our study to reach a representative sample of both users and non-users of the mobile ticketing service, we used stratified sampling method where the population is divided into non-overlapping strata, samples are randomly drawn from each stratum, and the results are pooled. The two strata in our study were Helsinki inner and outer city regions, identified and separated by postal codes.

Respondents were selected with a random sampling in both strata among 15 to 50 year old citizens. Younger and older age groups were excluded from the sample because they are entitled to reduced public transport fares and are therefore not target groups for the mobile ticketing service. A self-administered mail survey was sent to 500 inner city and 500 outer city citizens in December 2004.

For an extra incentive to participate, a draw of a mobile phone and 15 public transport travel cards was organized among the respondents. Questionnaires were mailed with addressed, stamped return envelopes, a reply coupon to the draw, and a cover letter. A reminder letter was sent during the second week of the two week response time period to those who had not returned their questionnaire. Of the 1000 mailed questionnaires 373 were returned and 360 accepted. The response rate of the survey was 36 %, which is at par with recent social sciences studies and, hence, acceptable.

5. Results

5.1. Descriptive statistics

The demographic profile of the respondents presented in Table 1 below shows that 62 percent of the respondents were female and 38 percent male. Average age of the respondents was 32 years, with a range between 15 and 50 years. Approximately half of the respondents had used the mobile ticketing service during the time of the survey. Compared to the population of Helsinki, the survey sample provides a reasonable representation of the city population, with the exception that females are slightly overrepresented in the data. It is possible that females use public transportation more and it was therefore easier for them to answer the questionnaire.

Following the examination of descriptive data, the proposed research model was then evaluated using structural equation modeling (SEM). The analysis followed a two step procedure: first, a measurement model was composed to establish the validity and reliability of the theoretical constructs.

Second, a structural model was used to conduct a path analysis and to test the hypothesis proposed in the research model.

5.2. Measurement model

The purpose of the measurement model is to describe how well the observed indicators serve as a measurement instrument for the latent variables [18]. The hypothesized model included 26 observed items measuring six latent constructs: ease of use, usefulness, compatibility, mobility, use situation, and use intention. Before analyzing the measurement model, the constructs were tested using principal axis factoring with varimax rotation in Lisrel 8.5. Three items were dropped due to high cross loadings. Next, we estimated the measurement models for the independent and dependent constructs separately. To determine a fixed scale, one loading was set as equal to one in each factor. The estimated loadings for all remaining items were significant: t-values between 9.15 and 34.45 supported individual item reliability. Subsequently, we calculated the Cronbach alpha values, composite reliability and variance extracted measures to assess construct reliability as suggested by Hair et al. [12]. Composite reliability depicts the internal consistency of the construct indicators, whereas variance extracted reflects the overall amount of variance in the indicators accounted for by the latent construct [12]. All measures clearly exceeded the recommended minimum values, as shown in Table 2. In the light of the results, reliability and validity of the constructs employed in the model was deemed satisfactory.

Table 1. Respondent demographics

	Sample	Helsinki population
Gender	**%**	**%**
Female	62	53
Male	38	47
Region		
Inner city	54	-
Outer city	46	-
Education		
Elementary school	14	33
High school and lower occupational	42	34
Higher occupational	15	12
University	27	21
Age		
< 20	10	9*
20-30	40	33*
31-40	29	30*
41-50	22	27*
Experience in mobile ticket use		
Yes	48	-
No	52	-

* calculated among 15-50 year old citizens to correspond those of sample data

Table 2. Construct reliability measures

Construct	Item t-values	Item R^2	Items dropped	Cronbach α (>0.7)	Composite reliability (>0.7)	Variance extracted (>0.5)
Ease of use	22.76-26.99	0.71-0.92	-	0.95	0.95	0,82
Usefulness	20.35-34.45	0.66-0.86	2	0.92	0.92	0,79
Compatibility	21.05-27.24	0.69-0.87	-	0.93	0.93	0,78
Mobility	13.73-16.13	0.45-0.76	1	0.84	0.86	0,61
Use situation	11.85-13.95	0.43-0.74	-	0.86	0,87	0,57
Use intention	9.15-49.11	0.33-0.94	-	0.88	0,91	0,78

5.3. Structural model

The next step of the analysis was to test the causal hypotheses presented in the research model by using structural equation modeling. We examined the structural model in terms of model goodness of fit, overall explanatory power, and hypothesized individual causal links.

First, the overall goodness of fit of the model was evaluated using different fit criteria. We used seven goodness of fit indices: normalized fit index (NFI), comparative fit index (CFI), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), root mean square error of approximation (RMSEA), 90-percent confidence interval for the RMSEA, and Chi-square divided by degrees of freedom, which was used instead of Chi-square as Chi-square is sensitive to large sample sizes. The recommended acceptance criteria for different goodness of fit indices and results of our analysis are presented in Table 3 (for a detailed description of the different indices see, e.g., [18]). While GFI and RMSEA measures did not quite meet the minimum levels of recommended values, the test statistics demonstrate good enough values to suggest reasonably adequate model fit. Specifically, the 90-percent confidence interval for RMSEA shows that the RMSEA stays within the suggested limits of 0.05 and 0.08 [18] and the measure was able to meet the alleviated 0.06 acceptance criteria proposed by Hu and Bentler [16].

Table 3. Overall model goodness of fit

Model goodness-of-fit index	Decision criteria	Result
Chi-square/degrees of freedom	< 3.0	2.32
NFI	> 0.9	0.97
CFI	> 0.9	0.98
GFI	> 0.9	0.87
AGFI	> 0.8	0.83
RMSEA	< .05 (.06)	0.06
90% confidence interval for RMSEA	0.05 ; 0.08	0.05 ; 0.07

Second, the overall explanatory power of the model was estimated by looking at the R^2 values for the two dependent variables. The usefulness and mobility constructs were able to explain 42 percent of the variance observed in consumers' perceptions of mobile tickets' applicability in different use situations. Furthermore, ease of use, compatibility, and use situation explained 55 percent of the variance in consumers' intention to use mobile tickets in the future. Compared with earlier TAM studies, these explanation rates demonstrate highly satisfactory values.

Finally, the data provided support for most of the hypothesized causal paths of the research model. Ease of use and compatibility had a direct positive relationship to use intention with standardized path coefficients being 0.12 and 0.68, respectively. The result provides support for hypotheses H1 and H3. A surprising result was, that the direct hypothesized path between usefulness and use intention was insignificant, and the hypothesis H2 was therefore rejected. Instead, the effects of usefulness and mobility to use intention were fully mediated by use situation with path coefficient values being 0.30 and 0.42. Hypotheses H4 and H5 were thus supported. Finally, use situation had a direct positive effect on use intention with 0.12 path coefficient, providing support for hypothesis H6. The results are depicted in Figure 2.

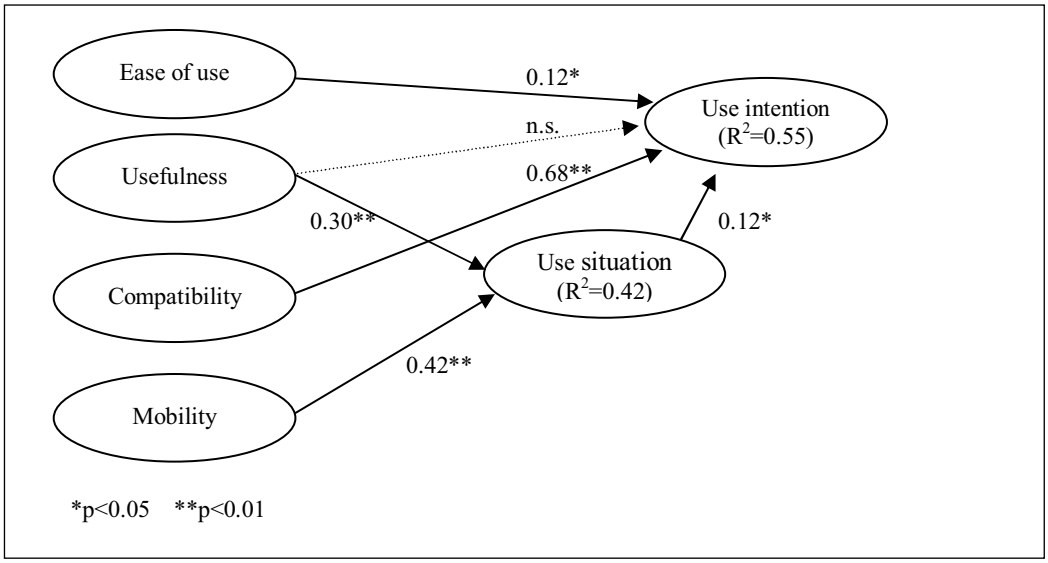

Figure 2. The estimated structural model

6. Discussion

Mobile technologies and services are often developed to augment existing technologies and to provide an alternative channel for accessing services, not to replace the existing technologies or service channels completely. Examples of services used through both mobile and other channels include email, news, weather reports, stock market information, music, and games. As mobile channel is used in parallel with others such as radio, TV or Internet, the use of mobile channel is dependent on the special benefits that mobile technologies are able to provide. These benefits include time and place independent computing and service access, and are incorporated in the mobility construct in our study. The benefits actualize in use situations, where independence of time and place are important: when the service needs to be accessed immediately and when other, perhaps more convenient alternatives,

are not available. In these situations the usefulness of mobile services and the benefits of mobility are the highest, thus determining the mobile channel use.

The results obtained in our study provide support for the above theorizing. Use situation was found to be a significant determinant for consumers' intention to use mobile ticketing service. Furthermore, the use situation fully mediated the effect of mobility and usefulness on use intention. The result implies that public transportation users value the benefits of mobility and perceived the mobile ticketing service as useful in situations where they are in a hurry, where cash or travel card is not available, where the need for a ticket is unexpected or where there are queues at points of sale. In these situations the mobile ticketing service is perceived as useful and the benefits of mobility – ability to purchase a mobile ticket in the given place at the given time, substitute need for cash or travel card and avoid queues, is valued.

Results further provide support for the direct and significant effect of ease of use and compatibility on use intention. This is plausible as ease and convenience of using a service are important factors in all situations. If a mobile service is too complex, the user will not be able to use it, no matter how critical the situation is. Similarly, the compatibility of a mobile service with users' ways to access and use services, use of mobile phone, and general habits and conducts is a precedent condition for service adoption and therefore independent from different use situations.

7. Conclusions

This paper presents results from a study of mobile ticketing service acceptance in public transportation. The theoretical background for the study was adopted from technology acceptance and diffusion of innovation theories, which were complemented with issues related to benefits of mobile technologies as well as mobile use situation.

The use situation, including specific circumstantial conditions, such as availability of other alternatives and time pressure in the service use situation, was found to be significant in determining intention to use mobile ticketing. Furthermore, the use situation fully mediated the effect of usefulness and mobility on use intention, suggesting that the benefits of mobile services are dependent on situations where they are used.

The results of our study provide several theoretical contributions to mobile commerce and adoption research. First, the study presents two empirically tested, reliable, and valid constructs which were found significant in predicting mobile service use. These constructs - mobility and use situation - capture the mobile dimension of the service adoption and explain the competitive advantage of mobile service use compared with other service options. While previous research on mobile commerce adoption exists [17, 39], it has operated with existing TAM and diffusion constructs without examining features specific to mobile technologies or services. The model developed and tested in the present study addresses the specific features of mobile technologies and services that affect the adoption and it is therefore expected to be especially useful for mobile commerce and services research.

Subsequently, and as a second theoretical contribution, we claim that while the traditional measures of technology adoption and diffusion are important for mobile services, the private nature and the new contexts, where the mobile devices can be used warrant the augmenting of traditional models with the mobile and situational factors.

Finally, our results suggest the need for acceptance models which are tailored for specific technologies. The general models may not be adequate enough to explain the adoption and use of different types of technologies and service channels where the specific features of the technology or a channel play an important role.

From a managerial point of view, our results suggest that relative advantage of mobile services lies on the ubiquitous service access and on the ability to react to demands posed by different use situations. The findings indicate that, when developing new mobile services, the mobile service developers should build on the benefits of mobility and situational responsiveness. Successful mobile services are therefore likely to provide users with localized, timely services which are easily accessed and tailored to the needs of the specific user.

While our study provided several interesting findings for both practical development and academic research on mobile services, the study has a few limitations. Most notably, the current study examined only one type of mobile service, mobile ticketing. More research is needed to test the presented model with other types of mobile services including, for example, mobile email and localized information, such as weather. Hence, our future research interests are directed at further testing of the mobile service adoption model presented here.

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Appendix 1

Table 4. Measurement items

Ease of use	
Learning to use the mobile ticket is easy	
Purchasing a mobile ticket is easy	
Purchasing a mobile ticket is clear and understandable	
It is easy for me to perform the actions required to purchase a mobile ticket	
Usefulness	
It's faster to buy tickets with mobile phone	
It's easier to buy tickets with mobile phone	
It's more effective to buy tickets with mobile phone	
Mobile phone enhances my possibilities for buying a ticket	dropped
Mobile phone is a useful device for purchasing tickets	dropped
Compatibility	
Purchasing mobile tickets is compatible with my other use of mobile phone	
Purchasing mobile tickets is a suitable method for me to purchase tickets	
Using mobile tickets is compatible with my style and habits	
Mobile ticket is compatible with my way to use public transportation	
Mobility	
Purchasing a ticket with a mobile phone reduces queuing	
Purchasing mobile tickets is independent of time	
Purchasing mobile tickets is independent of place	
I can substitute the need for cash or travel card by purchasing a mobile ticket	
Purchasing mobile tickets is convenient because the phone is usually with me	dropped
Use situation	
I use / expect to use mobile tickets if..	
Travel card has no value or the period is expired	
I have no cash for purchasing the ticket	
I'm in a hurry or need the ticket fast	
I need the ticket unexpectedly and have not prepared for purchasing it	
If there are queues in points of ticket sale	
Use Intention	
I intend to purchase single tickets with mobile phone during the next three months	
I believe I will use mobile tickets during the next three months	
I believe my interest towards mobile tickets will increase during the next three months	