International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166

Volume 3 Issue 2 May 2012

Technology, service and user related error affecting the perceived seamlessness of mobile interface

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Abstract

The results presented in this paper outline, in which context the mobile Internet services are used and how services fall into different purposes of use. This paper focuses on identifying the errors, which people experience while using the mobile Internet in different contexts and for different purposes (content). The importance of use context should be seen in the case of mobile services, which are used via mobile devices. The real use environment is not taken too profoundly into consideration as usability tests are conducted. However, we did not find results supporting the claim that mobile Internet services are used in movement. We found three different types of errors: technology, service and user related. Based on Fixed-line users' beliefs on low error rates in the case of mobile Internet, we conclude that usability doubts are not hindering their usage of mobile Internet. The less the customers used a specific service delivery channel, the more they experienced channel specific errors. We found that technology related errors tend to be catastrophic and hinder the use completely. The user related errors tend to be milder and minor by nature. The service related errors can be very irritating and hampering the achievement of goals set on the service usage but rarely completely catastrophic.

Keywords: seamless interface, electronic services, errors, use context, service content

1. Introduction

Concept of usability is often related in the human-computer interaction context (Podd 1995; Park et al. 1999; Catarci 2000; Battleson et al. 2001). Usability is a general term for ergonomic product quality and has been used interchangeably with terms such as seamless user experience and user-friendliness (Dzida 1995). In the human-computer interaction literature, usability has been defined as ease of learning, efficiency of use, memorability, error rates and preferences (Hix and Hartson 1993, Nielsen 1993). Bevan

(1999) has added dimensions of understandability and operability and Han et al. (2000) define perception/cognition and control/action as dimensions of product usability. So far the product's objective performance has been receiving more attention than subjective aspect of usability (Nielsen et al. 1994; Logan 1994; Nagamachi 1995; Hofmeester 1996; Jordan 1997).

Mobile Internet can be used in various contexts whereas the usage of fixed-line Internet is always environmentally pre-determined. Dias (1998) found that enjoyment has a positive effect on ease of use, which has a positive effect on perceived usefulness of a technology-based service. The results presented in this paper outline, in which context the mobile Internet services are used and how services fall into different purposes of use. This paper focuses on identifying the errors, which people experience while using the mobile Internet in different contexts and for different purposes (content).

2. Context affecting the seamless use experience of mobile services

Conventional usability testing does not pay much attention to real use environment (Lindroth et al. 2001). The importance of use context should be seen in the case of mobile services, which are used via mobile devices. The use environment can be very different from an office of any kind and yet it is normally an office environment in which the usability tests are performed. The creation and introduction of user-friendly products that meet the needs of intended users require designers and manufacturers to understand that a user's experience with the product in use is an outcome of interacting elements from the natural, socio-cultural and techno-physical environments (Babbar et al. 2002). Products must be easy to use and fit with the practices, activities and context of the consumer (Bevan 1999).

Context is a key issue in interaction between human and computer, describing the surrounding facts that add meaning (Schmidt et al. 1998). Location of use is central to the understanding of context but context also includes the collection of nearby people and objects as well as changes to those objects over time (Schilit et al. 1994). Kim et al. (2002) defined mobile context as any personal and environmental information that may influence the person when s/he is using mobile Internet. This definition is in line with previous studies, which have defined contextual information as focusing on what is important to user tasks, user actions and user-specific situations (Esteba et al. 1999; Guanling et al. 2000). Kim et al. (2002) further divided the use context under personal and environmental context. The personal context refers to information (emotional or physical state) about the people who are currently using mobile Internet (Ebling et al. 1998; Pascoe 1998) and the environmental context refers to the circumstances surrounding the mobile Internet user (Day 2001; Schmidt 1998).

3. Content definitions and errors related in mobile service usage

Content indicates the relevance of a particular piece of information under a certain context. The dimensions of content include how effectively the information is given, how reliable the information is, and how often the information is updated (Tomonari et al. 1996). Kim et al. (2002) found that usability problems related to the content of mobile Internet occur most frequently and more often when users are stopping rather than moving.

Schoenbachler et al. (2002) found that customers' desire to shop for entertainment will affect motivation to buy from a channel. Content can be also classified as having hedonic or utilitarian values. If a customer has a specific goal for the use, her purpose of use is utilitarian. If a customer is using mobile service for fun, the purpose of use is

hedonic. The division between hedonic and utilitarian purposes of use is not always clear. Suoranta (2002) found when conducting focus group interviews that what customers perceive as hedonic, was originally sold to them for utilitarian purposes and *vice versa*.

Errors as a usability attribute in our context is two-fold like efficiency of use. We refer to two kinds of errors, namely minor and catastrophic errors according to Nielsen (1993, 31). Minor errors hinder the use of the electronic services, but do not affect the outcome. Minor errors include typos, using wrong links, pressing wrong keys and so on. Minor errors are interrelated with efficiency of use (Nielsen 1993, 32). Catastrophic errors lead into a situation, in which the customer is unable to finish the use of electronic service in a desired way. Customers should be able to recover easily from minor errors but catastrophic errors tend to leave long-lasting effects.

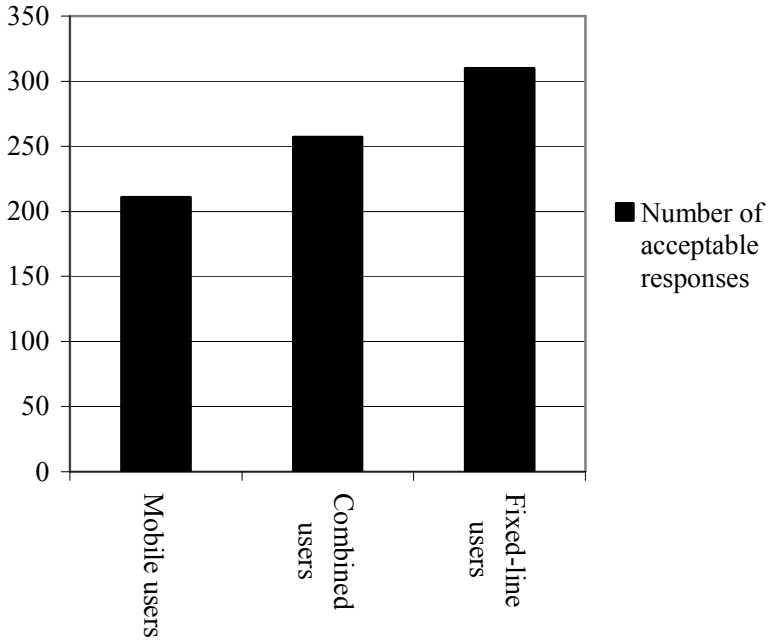
4. Methodology

The usability attributes by Nielsen (Nielsen 1993, 26-37) were chosen as the starting point for our seamless use experience investigation as they constitute a generic model and fit in the service context too. The relation between usability and seamless use experience has been described in detail in Mattila A. (2003). Before the actual data collection, focus group interviews among expert users were conducted. The meaning of these interviews was to map the possible options for survey questions. The questionnaire was pre-tested on a group of 60 students and modified accordingly. A postal survey was conducted in May 2003. The sample was drawn from TeliaSonera[1] Finland's customer database. The sample was stratified in three active user segments of mobile users, fixed-line users and combined users equal in size depending on the

[1] Based on the number of customers, TeliaSonera is the largest mobile operator in Sweden and Finland, the second largest operator in Norway, and the fourth largest operator in Denmark. TeliaSonera is also the largest fixed voice and data provider in the region with leading positions in Sweden and Finland and a significant position in Denmark. TeliaSonera International Carrier is the leading IP wholesaler in Europe with a 10% market share. TeliaSonera is listed on the Stockholm Exchange, the Helsinki Exchange and Nasdaq Stock Market in the USA.

main electronic service delivery channel in their use. The questionnaires were tailored *respectively*.

We call the customers, who did not own according to the database a private fixed-line connection at home, *the Mobile users.* The customers collected under this sample had the highest volume of mobile data transfers (GPRS, high-speed data) during the last six months in comparison to other customers in the database. They represented in every way the most active mobile Internet users the database had. *The Combined users* had a private fixed-line Internet connection in use at home. Further, their customer record showed active usage of mobile Internet (GPRS, high-speed data) connection and WAP-services during the last six months. The Fixed-line users owned a mobile phone and they were using regular mobile phone services such as SMS. There was no sign of Internet related activities during the last six months in their customer record. They had a private fixed-line Internet connection (mainly ADSL) in use at home.



International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166

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FIGURE 1 The division of response rate among the different user segments of customers

After a second follow-up, 778 responses were accepted under further analyses. The final response rate was 25.9%, which is acceptable according to economic science standards. The distribution of the responses in different user segments is presented in figure 1. A small minority of respondents reported using mobile phone (GRPS or high-speed data connection) as a modem in connection with a laptop as their primary electronic delivery channel. Among the Mobile users there were 16 such a customers and among both the Fixed-line users and the Combined users two in each segment. *For the analyses in this paper, the Combined users who were using mobile Internet as their primary service delivery channel, have been joined in the Mobile users and the ones using fixed-line Internet as primary service delivery channel, have been joined in the segment of Fixed-line users.*

The respondents were asked to fill out a structured questionnaire on a 7-point Likert scale concerning their preferences, experiences and beliefs towards usage of mobile and Internet services. Literature (Cooper et al. 1995; Järvenpää et al. 1997; Crisp et al. 1997) as well as prior conducted surveys guided us in defining the scales to measure the customers' perceived seamless use experience. There were up to 27 questions in each tailored questionnaire. The Mobile users were answering mobile Internet specific questions whereas the Fixed-line users were answering fixed-line Internet specific questions. As the Combined users segment had knowledge on both types of electronic services and delivery channels, half of them received a questionnaire regarding the mobile Internet seamless use experience and the other half was answering to questions concerning the fixed-line services.

The survey questionnaire included questions concerning the respondent's basic demographic variables, psychological determinants such as level of innovativeness and mobile Internet usage, which was further categorized under for main themes: usage context, service content, seamless interface dimensions and use experience. To get a more accurate and objective results, the mean value of the respondents' subjective responses were calculated and used as the basis of our evaluation. Statistical methods such as ANOVA, crosstabulation, correlation coefficients, rotated factor analyses, Chi squares and finally structural modeling (AMOS) were applied to our data. Cronbach's alpha was used to measure the reliability of the results. Only results relevant to this paper are presented in here.

5. Results

The demographic profile of the respondents is presented in table 1.

One third (33.9%) of the respondents were women and two thirds (64.8%) were men. The majority (59.8%) of the respondents were 25-49 years old and their annual household income (28.1%) before taxes fell within the range of 20 000 – 30 000 euros, which matches with the average annual income of two adults family in Finland (Statistics Finland 2003). Only every fifth (18.2%) of the respondents had two or more children living at home. The majority of all the respondents were workers (40.6%). This result is compatible with the result of the educational background of the respondents, which was in most cases (29.0%) vocational school. Obviously, Internet and its services are becoming available for all the consumer segments regardless of their annual household income or educational background.

TABLE 1 Profile of respondents

Demographic characteristics	Mobile users	Combined users	Fixed-line users	Total

International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166

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	No	%	No	%	No	%	No	%
Total	211	100.0	257	100.0	310	100.0	778	100.0
Gender								
Male	157	74.4	192	74.7	155	50.0	504	64.8
Female	54	25.6	55	21.4	155	50.0	263	33.9
Missing	0	0	10	3.9	0	0	10	1.3
s.d.	*0.437*		*0.417*		*0.501*			
Age								
Under 24 years of age	64	30.3	33	12.9	43	13.9	140	18.0
25-34 years	81	38.4	96	37.4	62	20.0	239	30.7
35-49 years	43	20.4	83	32.3	100	32.3	226	29.1
Over 50 years of age	20	9.5	41	15.9	104	24.5	129	16.6
Missing	3	1.4	4	1.6	1	0.3	8	1.0
s.d.	*0.998*		*0.974*		*1.196*			
Annual household income								
Less than 10 000 euros	33	15.6	21	8.2	43	13.9	97	12.3
10 001 – 20 000 euros	54	25.6	48	18.7	82	26.5	184	23.7
20 001 – 30 000 euros	59	28.0	87	33.9	73	23.5	219	28.1
30 001 – 40 000 euros	25	11.8	37	14.4	40	12.9	102	13.1
More than 40 001 euros	29	13.8	53	20.5	60	19.3	142	18.3
Missing	11	5.2	11	4.3	12	3.9	34	4.5
s.d.	*1.650*		*1.875*		*1.741*			
Marital status								
Married	27	12.8	101	39.3	128	41.3	256	33.0
Cohabitation	60	28.4	69	26.8	58	18.7	187	24.0
Single (incl. widow, divorced)	115	54.5	80	31.1	116	37.5	311	39.9
Missing	9	4.3	7	2.7	8	2.6	24	3.1
s.d.	*0.940*		*1.154*		*1.397*			
Number of children living at home								
0	165	78.2	152	59.1	176	57.0	493	63.4
1	21	10.0	45	17.5	71	23.0	137	17.6
2	14	6.6	29	11.3	42	13.6	85	11.0
3 or more	8	3.8	28	10.9	20	6.5	56	7.2
Missing	3	1.4	3	1.2	1	0.3	7	0.8
s.d.	*0.791*		*1.074*		*1.019*			
Education								

Elementary school	24	11.4	31	12.1	48	15.5	103	13.2
Secondary education	34	16.1	63	24.5	64	20.7	161	20.7
Vocational school	69	32.7	85	33.1	72	23.2	226	29.0
University degree	48	22.8	39	15.2	82	26.4	169	21.7
Other	33	15.6	36	14.1	41	13.2	110	14.2
Missing	3	1.4	3	1.2	3	1.0	9	1.2
s.d.	*1.952*		*1.916*		*2.063*			
Profession								
Leading position	10	4.7	20	7.8	20	6.5	50	6.4
Worker	96	45.5	116	45.1	104	33.5	316	40.6
Public servant	28	13.3	31	12.1	40	12.9	99	12.7
Other	71	33.6	85	33.0	144	46.3	300	38.5
Missing	6	2.8	5	1.9	2	0.6	13	1.8
s.d.	*2.367*		*2.526*		*2.547*			

Over third (37.3%) of the Mobile users use mobile services weekly and four out of five (83.8%) Fixed-line users use fixed-line electronic services weekly. The Mobile users think that they are mostly going to add using search engines (50.2%) via mobile Internet. The Mobile users also believe that they are going to use reservations (31.5%) and e-mail (25.0%) more in the near future via mobile Internet. The Fixed-line users were also asked how they feel about starting to use mobile Internet services in the near future. Every fifth (21.1%) of the Fixed-line users believed that it is likely that they will start using mobile services related in home and living, children and family, or traveling in the near future. The second most popular future mobile services among current fixed-line heavy users were search engines and real-time chat. The Fixed-line users also believed that they are likely to start using services for pleasure (comics, horoscope, puzzles) via mobile Internet.

Customers were asked to classify services according to their purpose of use. Even though it was not specified in which context the service was expected to be used, we have a reason to believe that because of the content of the questionnaire, the respondents may have been thinking using services in an electronic environment when they classified them according to the purpose of use. Some of the services such as real-

time chat and remote diagnostics can be used only via electronic (or more specifically via mobile) channels. It was of an utmost importance to ask the customers their perception of the content, because previous studies have found that, what customers use for fun in mobile Internet has been classified as utility by the service providers (see for example Suoranta 2002).

There were no differences in opinion between user segments how they classified the services. Shopping was seen as purely hedonic by 12 percent of the respondents. If the customers were thinking about shopping through the Internet, this finding makes sense. Sports news was also classified as hedonic whereas news in general was used for more utilitarian purposes. The mobile Internet services with the most hedonic purpose of use in the minds of the customers were: real-time chat, relationship, downloaded services, gambling and games (see figure 2). The mobile Internet services with the most utilitarian purpose of use in the minds of the customers were: search engines, remote diagnostics, traveling, finance, e-mail, health, career and education, news and reservations. The content of the mobile Internet services was seen more utilitarian than hedonic. This finding is challenging the general opinion, which relates the use of mobile Internet services more often in hedonic purposes than utilitarian ones.

The customers were asked what is their *primary* channel in use to access a list of services. They were given several channel options (mobile Internet, fixed-line Internet, mobile phone as a modem, PDA, self-service, personal service) to choose from. The most popular service delivery channels were electronic, which is no surprise knowing the sample structure. Even the heavy users of mobile Internet services use more fixed-line connection than mobile Internet connection. In fact, the Mobile users use fixed-line Internet more for the needs of home and family and shopping than the Fixed-line users themselves (see table 2).

International Journal of Computing and Business Research (IJCBR)
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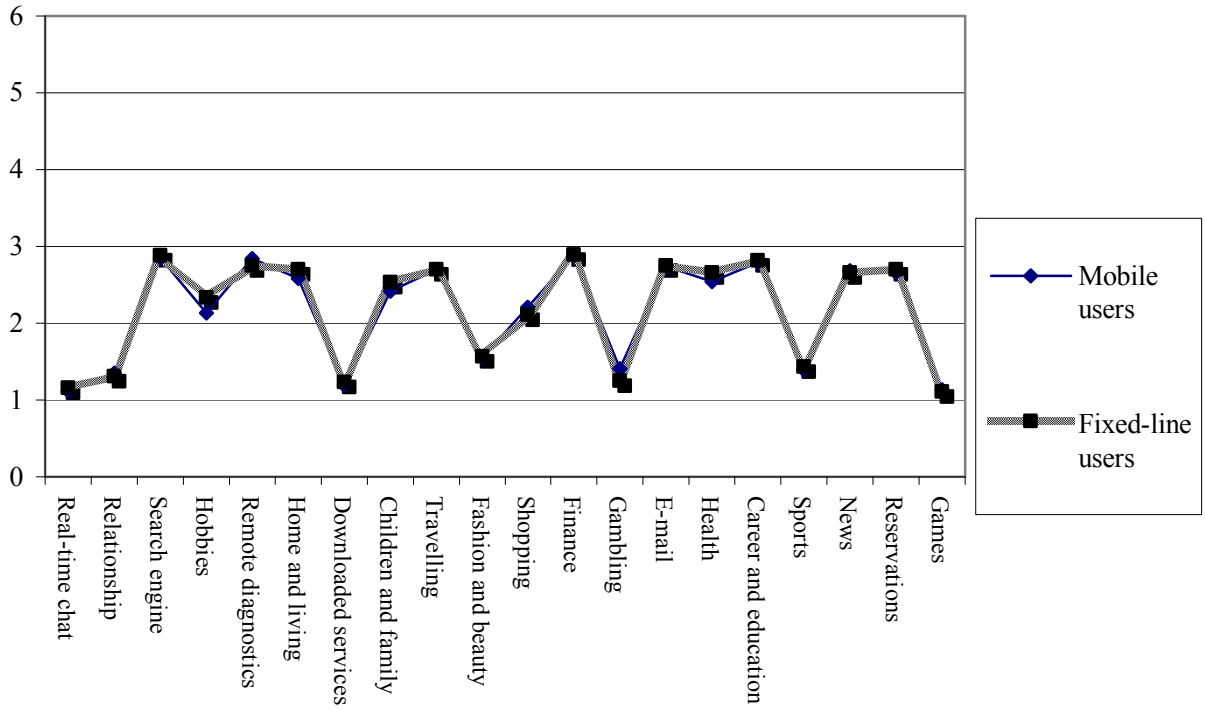


FIGURE 2 Service contents according to purpose of use
(0 = purely hedonic … 6 = purely utilitarian)

TABLE 2 Delivery channel in use depending on the service content

SERVICE CLASSIFICATION: Purpose of use (content)	DELIVERY CHANNEL IN USE	**Mobile users**	**Fixed-line users**
Relationship (e.g. dating services)	Mobile Internet	29.4 %	10.1 %
	Fixed-line Internet	51.7%	68.7 %
Search engines	Mobile Internet	12.1 %	0.7 %
	Fixed-line Internet	76.3 %	94.4 %
Hobbies and leisure time	Mobile Internet	17.6 %	8.7 %
	Fixed-line Internet	62.2 %	69.1 %
Communication	Mobile Internet	18.3 %	4.2 %
	Fixed-line Internet	67.0 %	91.3 %
Home and family	Mobile Internet	13.5 %	12.1 %

	Fixed-line Internet	*54.7 %*	51.0 %
Shopping	Mobile Internet	4.3 %	2.8 %
	Fixed-line Internet	*38.0 %*	32.4 %
Games	Mobile Internet	26.5 %	4.4 %
	Fixed-line Internet	48.8 %	71.1 %
Financial services	Mobile Internet	9.4 %	0.7 %
	Fixed-line Internet	61.3 %	83.5 %
Career or studying	Mobile Internet	6.8 %	2.4 %
	Fixed-line Internet	69.9 %	73.7 %
News	Mobile Internet	21.7 %	2.0 %
	Fixed-line Internet	52.2 %	72.9 %
Entertainment	Mobile Internet	10.7 %	1.7 %
	Fixed-line Internet	58.0 %	61.1%
Reservation	Mobile Internet	12.5 %	9.1 %
	Fixed-line Internet	52.3 %	53.8 %

The rates of shopping were low for both user segments and via both channel options. Mobile Internet seems to be used more for hedonic purposes such as relationship and games and less for utilitarian purposes such as career or studying. News makes an exception as they were classified as having a utilitarian purpose of use and yet they are used actively (21.7%) also via mobile Internet. This can be explained by the ease of use related in mobile news services. Most operators offer WAP-enabled news services, which are build in the mobile phone menu.

Despite the common belief that mobile Internet services are used in movement, we did not find results supporting that claim. It appears that even though the newest versions of mobile phones have calorie meters, thermometers and other features for use when exercising, customers have not adopted using mobile services when actually moving or exercising. Over half of the respondents (50.5%) never used mobile services in movement. However, some respondents (17.0%) reported of using mobile Internet services among other people. It is common in Finland that whenever people get together, somebody starts showing new features and mobile Internet services with his

or her phone. Further, the mobile Internet games are often played with several players as teams, which may require usage among people. Over half of the respondents (53.6%) informed that they never use mobile Internet services with children. We found this surprising simply because of our impression from real life situation we have observed in playgrounds, and further investigation revealed that this finding was because of most of the respondents had no children living at home. However, majority of the respondents (58.1%) who had children did also use mobile Internet services with children.

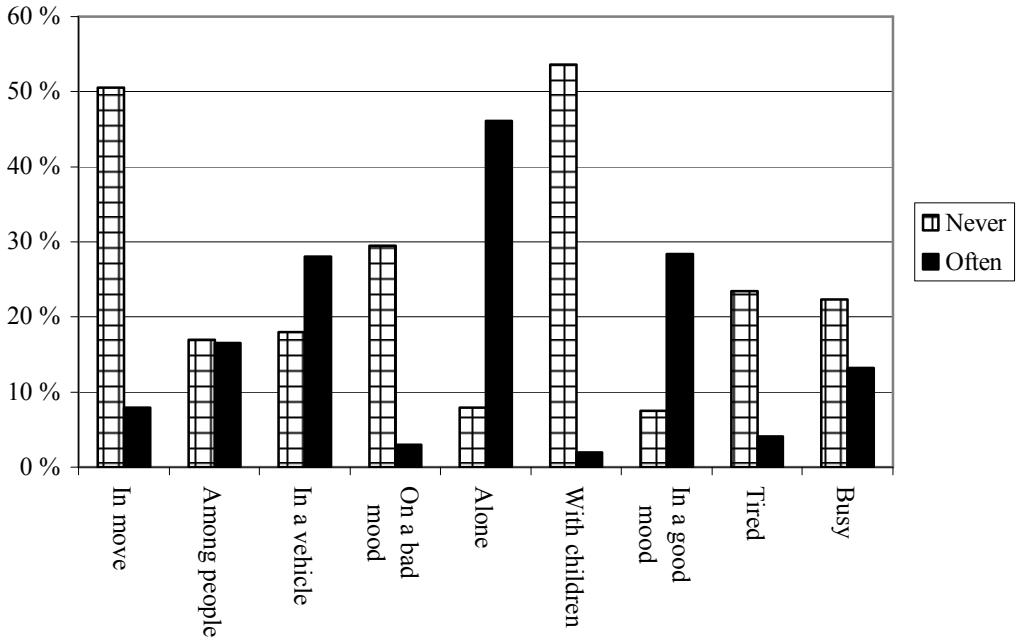


FIGURE 3 The use context of mobile Internet services

We found three different types of errors: technology (device or connection) related, service related and user related. No connection and dead battery were common technology related errors. If service was not operating or there were no suitable payment methods available, it was a question of service related errors. User related

errors had to do with user's bad memory and computer/mobile device illiteracy. We found that technology related errors tend to be catastrophic and hinder the use completely. The user related errors tend to be milder and minor by nature. The service related errors can be very irritating and hampering the achievement of goals set on the service usage but rarely completely catastrophic. The findings are presented in table 3. The less the customers used a specific service delivery channel, the more they experienced channel specific errors (minus correlation coefficients on table 3). The Mobile users are identified with bolded figures and the Fixed-line users with italic.

TABLE 3 Errors related in electronic service delivery channels: MOBILE USERS and *FIXED-LINE USERS*

CORRELATION MATRIX **Service delivery channel in use ⇒** **Errors in seamless use experience ⇓**	**Mobile Internet**	**Fixed-line Internet**	**Mobile phone as a modem**	**PDA**
Runs out of electricity in the middle of service usage	**-.200**,** *-.230***		*-.136**	
Unsuitable device in terms of service usage		**-.199****		*-.134**
The connection keeps breaking			**.167***	
Service downloads slowly	**-.152*,** *-.118**		**.248****	
Compatibility problems between device and service	*-.115***	*-.145**		*-.200***
No recollection about the needed information to operate the service			**.202****	*-.171***
Cannot find the appropriate keys	*-.125**			*-.306***
Service is not working	**-.224**,** *-.163***	*-.147**		*-.249***
No suitable payment method available				*-.251***

Data gets lost, no confirmation about a (un)successful transfer				-.198**

** Correlation is significant at the 0.01 level.
* Correlation is significant at the 0.05 level.

In the case of all the errors, over half (from cannot find the right keys 52.9% to service is not working 82.1%) of the Mobile users related them primarily in mobile Internet. The Mobile users related the second most errors in mobile phone usage as a modem and only few errors were related in fixed-line Internet in this user segment: 37.5 percent related an error of not remembering how the service is operated in the fixed-line Internet. It appears the Mobile users related catastrophic errors such as technology errors in their primary delivery channel, mobile Internet, and minor errors such as user specific errors in the secondary service delivery channel, fixed-line Internet.

Vice versa, the Fixed-line users related most of the errors in fixed-line Internet with three exceptions. They felt that mobile phone as a modem runs most often out of electricity in the middle of service usage (67.9%). They also experienced problems with unsuitable devices (49.4%) most often in the case of accessing Internet services via mobile phone as a modem. Also the Fixed-line users had a strong belief that it's difficult to find proper keys to operate mobile Internet services (61.5%) and that they don't remember how to use a fixed-line Internet service (64.6%). It is worth remembering that the Fixed-line users may have tried using mobile Internet services but are not currently actively using them. Based on their beliefs on low error rates in the case of mobile Internet, we conclude that usability doubts are not hindering their usage of mobile Internet. In fact, previous study has found that the Fixed-line users are satisfied with their current situation and simply have no reason to start using mobile services. As they have fixed-line Internet connection daily in use usually both at home and work, and if needed via mobile phone as a modem in connection with laptop, they already feel independent from time and place (Mattila M. 2003).

Table 4 presents the significant variables of errors related in specific service contents. It appears that customers experienced most errors in services they used the most (financial services) and the least (shopping). The errors the Fixed-line users[2] relate in mobile Internet services are mostly based on their beliefs and perceptions instead of extensive use experience. There were only few significant correlations between service content and errors in the Fixed-line users segment. They related user specific errors (such as not remembering how to use the service) and therefore minor errors in hedonic purpose of use (traveling). In fact, traveling services were the mobile Internet services that the Fixed-line users believed to start using in the near future.

TABLE 4 Dependencies between error types and service content: MOBILE USERS and *FIXED-LINE USERS*

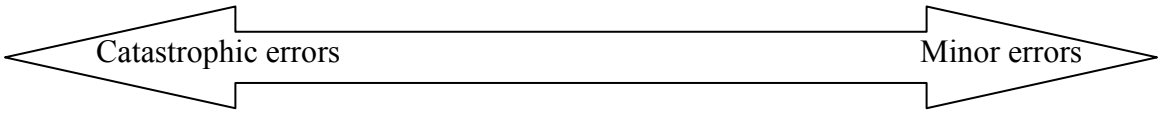
CORRELATION MATRIX Service content ⇒ Errors ⇓	**Real-time chat**	**Remote diagnostics**	**Shopping**	**Financial services**	**Gambling**	**E-mail**	**News**	**Traveling**
Runs out of electricity in the middle of service usage		**.305****	**-.333****	**.221***				
Unsuitable device in terms of service usage						**-.220***		
The connection keeps breaking	**.180***	**.209***			**.209***			
Service downloads slowly		**.179***					**.175***	*.167**

[2] 13.8% of the Fixed-line users were occasionally or seldom using mobile Internet services

No recollection about the needed information to operate the service								*.170**
Cannot find the appropriate keys								*.258***

** Correlation is significant at the 0.01 level.
* Correlation is significant at the 0.05 level.

There was no clear interdependency between service content and experienced errors in the segment of Mobile users. They seemed to relate both catastrophic (technology specific) and service specific errors in both utilitarian and hedonic purposes of use. However, the user specific errors did not have a significant correlation with the service content at all. For example, there was a significant correlation between breaking connection and remote diagnostics ($r=.209$, $p<.05$) in use as well as with real-time chat ($r=.180$, $p<.05$). News services were experienced to download slowly, which may be due to the large pictures they usually entail. Suoranta (2002) found that customers would like to be able to choose, which pictures in news they want to download on their mobile device, if any. Mobile e-mail services were found having problems with unsuitable devices especially when used via Personal Digital Assistants (PDA). It goes without saying that accessing one's e-mail via PDA or any other mobile device cannot be as usable as via personal computer due to message contents (long, pictures, charts), smaller keys and screen, and one key sharing several alphabets.



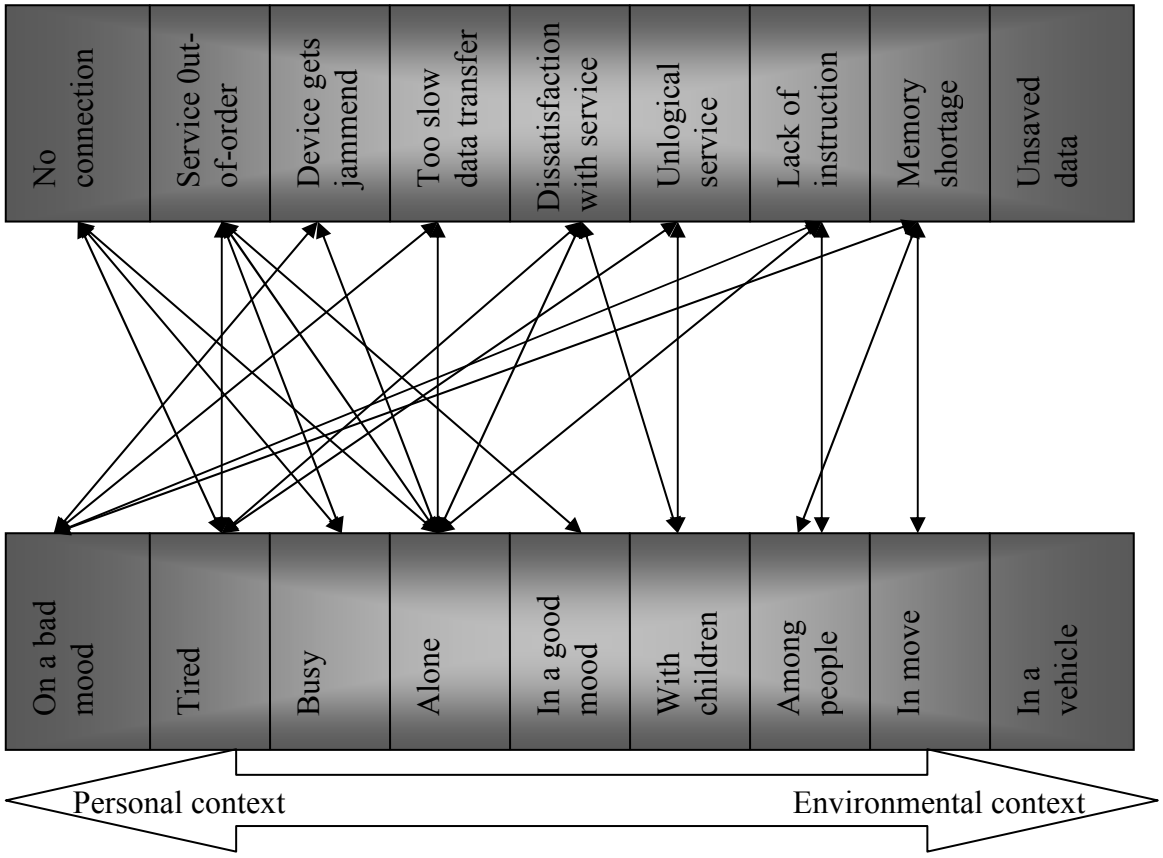


FIGURE 4 Dependencies between error types and use context

Catastrophic errors seem to relate closely in personal context whereas minor errors relate in environmental context (see figure 4). The figure entails all the respondents who informed having used mobile Internet services. The correlation matrix in full is presented in Appendix. For example, there was a significant correlation ($r=.198$, $p<.01$) between being alone (personal context) and having no connection established at all (catastrophic technology specific error). Furthermore, there was a significant correlation ($r=.166$, $p<.05$) between lack of instructions (minor error) and using mobile services in a group of

people (environmental context). There are more errors having dependencies with personal context of mobile Internet service use than with environmental context.

Even though mobile Internet services are often used in a vehicle, the respondents did not related any errors in such a use context. Perhaps they were feeling relaxed and using mobile services for hedonic purposes. They had not experienced any problems with unsaved data in relation to use context either. It goes without saying when you are on a bad mood, you are bound the experience more errors of all sort. When users were alone, they felt more errors than average. Using mobile Internet services in a group of people correlated with memory shortage ($r=.196$, $p<.01$) and lack of instructions ($r=.166$, $p<.05$). It is easy to understand the possible pressure from the reference group when one is showing them how to use mobile Internet services and realizes that there is too little memory on device to get the most spectacular features out. Tiredness seems to correlate with many experienced errors as well.

6. Conclusions

The results presented in this paper outline, in which context the mobile Internet services are used and how services fall into different purposes of use. We focus on identifying the errors, which people experience while using the mobile Internet in different contexts and for different purposes (content).

We found three different types of errors: technology (device or connection) related, service related and user related. We found that technology related errors tend to be catastrophic and hinder the use completely. The user related errors tend to be milder and minor by nature. The service related errors can be very irritating and hampering the achievement of goals set on the service usage but rarely completely catastrophic.

The less the customers used a specific service delivery channel, the more they experienced channel specific errors. In the case of all the errors, over half of the Mobile users related them primarily in mobile Internet. The Mobile users related the second most errors in mobile phone usage as a modem and only few errors were related in fixed-line Internet in this user segment. It appears the Mobile users related catastrophic errors such as technology errors in their primary delivery channel, mobile Internet, and minor errors such as user specific errors in the secondary service delivery channel, fixed-line Internet.

On the other hand, the Fixed-line users related most of the errors in fixed-line Internet. Based on the Fixed-line users' beliefs on low error rates in the case of mobile Internet, we conclude that usability doubts are not hindering their usage of mobile Internet. There was no clear interdependency between service content and experienced errors in the segment of Mobile users. They seemed to relate both catastrophic (technology specific) and service specific errors in both utilitarian and hedonic purposes of use. However, the user specific errors did not have a significant correlation with the service content at all.

Mobile e-mail services were found having problems with unsuitable devices especially when used via Personal Digital Assistants (PDA). Catastrophic errors seem to relate closely in personal context whereas minor errors relate in environmental context. There are more errors having dependencies with personal context of mobile Internet service use than with environmental context. When users were alone, they felt more errors than average. Tiredness seems to correlate with many experienced errors as well.

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APPENDIX Correlation matrix related in figure 4.

International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166

Volume 3 Issue 2 May 2012

CORRELATION MATRIX Service use context ⇒ Errors in seamless use experience ⇓	**In move**	**Among people**	**In a vehicle**	**On a bad mood**	**Alone**	**With children**	**In a good mood**	**Tired**	**Busy**
Device gets jammed				.192**	.172*				
Too little memory on the device	.173*	.196**		.154*					
Speed of data transfer is lower than promised				.195**	.140*				
Connection cannot be established at all					.198**			.241**	.145*
Downloaded program is not working					.199**		.163*	.254**	.161*
Service is not what expected					.152*	.146*		.226**	
There is no logic in service performance						.155*		.163*	
Insufficient instructions on use of service		.166*		.152*	.157*				
Data which was entered didn't get saved									

** Correlation is significant at the 0.01 level.

* Correlation is significant at the 0.05 level.