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INTERNET ON MOBILES: EVOLUTION OF USABILITY AND USER EXPERIENCE

Doctoral Dissertation

Anne Kaikkonen

Helsinki University of Technology
Faculty of Information and Natural Sciences
Department of Computer Science and Engineering

Nokia Corporation

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Anne Kaikkonen

Dissertation for the degree of Doctor of Philosophy to be presented with due permission of the Faculty of Information and Natural Sciences for public examination and debate in Auditorium T2 at Helsinki University of Technology (Espoo, Finland) on the 11th of December, 2009, at 12 noon.

Helsinki University of Technology
Faculty of Information and Natural Sciences
Department of Computer Science and Engineering

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Internet on Mobiles: Evolution of Usability and User Experience

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Faculty	Faculty of Information and Natural Sciences
Department	Department of Computer Science and Engineering
Field of research	Usability
Opponent(s)	Prof. Kari Kuutti, Dr. Mark Dunlop
Supervisor	Prof. Marko Nieminen

The mobile Internet is no longer a new phenomenon; the first mobile devices supporting web access were introduced over 10 years ago. During the past ten years technology and business infrastructure have evolved and the number of mobile Internet users has increased all over the world. Service user interface, technology and business infrastructure have built a framework for service adaptation: they can act as enablers or as barriers. Users evaluate how the new technology adds value to their life based on multiple factors.

This dissertation has its focus in the area of human-computer interaction research and practices. The overall goal of my research has been to improve the usability and the user experience of mobile Internet services. My research has sought answers to questions relevant in service development process. Questions have varied during the years, the main question being: How to design and create mobile Internet services that people can use and want to use? I have sought answers mostly from a human factors perspective, but have also taken the elements form technology and business infrastructure into consideration. In order to answer the questions raised in service development projects, we have investigated the mobile Internet services in the laboratory and in the field. My research has been conducted in various countries in 3 continents: Asia, Europe and North America. These studies revealed differences in mobile Internet use in different countries and between user groups. Studies in this dissertation were conducted between years 1998 and 2007 and show how questions and research methods have evolved during the time.

Good service creation requires that all three factors: technology, business infrastructure and users are taken in consideration. When using knowledge on users in decision making, it is important to understand that the different phases of the service development cycle require the different kind of information on users. It is not enough to know about the users, the knowledge about users has to be transferred into decisions.

The service has to be easy to use so that people can use it. This is related to usability. Usability is a very important factor in service adoption, but it is not enough. The service has to have relevant content from user perspective. The content is the reason why people want to use the service. In addition to the content and the ease of use, people evaluate the goodness of the service based on many other aspects: the cost, the availability and the reliability of the system for example. A good service is worth trying and after the first experience, is it worth using. These aspects are considered to influence the 'user experience' of the system. In this work I use lexical analysis to evaluate how the words "usability" and "user experience" are used in mobile HCI conference papers during the past 10 years. The use of both words has increased during the period and reflects the evolution of research questions and methodology over time

Keywords Mobile Internet, usability, user experience, mobile phone

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VÄITÖSKIRJAN TIIVISTELMÄ	TEKNILLINEN KORKEAKOULU PL 1000, 02015 TKK http://www.tkk.fi
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Käsikirjoituksen päivämäärä 5.5. 2009	Väitöstilaisuuden ajankohta 11.12.2009
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Internetin käyttö matkapuhelimella ei ole enää uusi ilmiö. Markkinoille tuli matkapuhelimia, joilla pääsi webbiin jo yli 10 vuotta sitten. Vuosien aikana aikana yhä useampi on alkanut käyttää Internettiä matkapuhelimella. Näiden vuosien aikana sekä teknologia että liiketoimintamallit ovat kehittyneet ja muuttuneet. Palvelun käyttöliittymä, teknologia ja liiketoimintamalli voivat toimia sekä palveluadaptaation mahdollistajina että niiden esteinä. Hyödyntäen tietoa näistä, käyttäjät arvioivat palvelun arvoa elämässään.

Tämä väitöskirja kuuluu ihmisen ja koneen vuorovaikutuksen tutkimusalaan. Tutkimuksen päämääränä on ollut matkapuhelimella käytettävien Internet palveluiden käytettävyyden ja käyttäjäkokemuksen parantaminen. Tutkimukseni on pyrkinyt vastaamaan nimenomaan tuotekehityksestä nouseviin kysymyksiin. Pääkysymys on ollut: Miten tulisi kehittää ja suunnitella matkapuhelimella käytettäviä Internet palveluita, jotta ihmiset osaisivat ja haluaisivat käyttää niitä? Olen tutkinut aluetta erityisesti ihmisen näkökulmasta, mutta pyrkinyt huomioimaan myös teknologiasta ja liiketoiminnasta nousevia kysymyksiä siltä osin, kuin ne näkyvät loppukäyttäjälle. Saadaksemme vastauksia kysymyksiin, joita palvelukehitysprojekteissa on tullut esiin, olemme tutkineet matkapuhelimella käytettäviä Internet palveluita sekä laboratoriossa että kenttäolosuhteissa. Tutkimukset on tehty useassa maassa, kolmella mantereella: Aasiassa, Euroopassa ja Pohjois-Amerikassa. Tutkimukset ovat paljastaneet eroja mobiilin Internetin käytössä sekä eri maissa että erilaisten käyttäjäryhmien välillä. Väitöskirjaan kuuluvat tutkimukset on tehty vuosien 1998 ja 2007 välillä.

Hyvä palvelukehitys edellyttää, että teknologiset, liiketoimintaan ja käyttäjiin liittyvät seikat huomioidaan oikealla painoarvolla päätöksentekotilanteessa. Hyödynnettäessä käyttäjätietoa päätöksentekotilanteessa on tärkeää ymmärtää, että eri tuotekehityksen vaiheissa käyttäjiin liittyvät kysymykset ovat erilaisia ja niihin saadaan vastaukset erilaisilla menetelmillä. Tieto käyttäjistä ei riitä, vaan oleellista on se, miten tietoa osataan hyödyntää päätöksenteossa.

Palvelun tulee olla helppokäyttöinen, jotta ihmiset osaisivat sitä käyttää. Tämä kuuluu käytettävyyden osa-alueeseen. Vaikka käytettävyys on tärkeää, se ei yksin takaa sitä, että ihmiset käyttäisivät palvelua. Käyttäjän tulee myös pitää palvelun sisältöä hyödyllisenä. Lisäksi palvelun tulee olla luotettava, sen tulee olla saatavilla ja hinnan tulee olla kohdallaan. Hyvä palvelu on kokeilemisen arvoinen ja kokeilun jälkeen käyttämisen arvoinen. Nämä seikat kuuluvat käyttäjäkokemuksen piiriin. Viime vuosina ihmisen ja koneen vuorovaikutuksen tutkimusala on siirtynyt käytettävyydestä tutkimaan myös käyttäjäkokemusta, koska erityisesti kulutuselektroniikan kehityksessä vaaditaan kokonaisvaltaisempaa ymmärrystä ihmisestä. Tässä työssä selvitän leksikaalisen analyysin avulla miten alan tutkimuspapereissa on viimeisen 10 vuoden aikana käytetty sanoja ”käytettävyys” ja ”käyttäjäkokemus”. Molempien sanojen käyttö on yleistynyt vuosien aikana ja heijastaa hyvin sitä, miten tutkimuskysymykset ja -menetelmät ovat vuosien aikana muuttuneet

Asiasanat Mobiili Internet, käytettävyys, käyttäjäkokemus, matkapuhelin	
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Preface

I started my work with mobile Internet service development in 1998, one year before the launch of the first WAP (Wireless Application Protocol) phones. During the first years, I moderated WAP workshops together with Nokia's business consultants. My work was a combination of research and practical participation in mobile service development projects. I also participated in a European Communitys project called Wishes, which was investigating ways to develop new mobile services. In that period, there was very little information available on mobile service user interface design, so in addition to project work it was necessary for me to investigate questions arising from these projects. During this period we presented an Industry paper in British HCI (Human –Computer Interaction) conference with Pirjo Törmänen, from Merita Bank (currently Nordea). I gathered data from all the usability tests I had been running during the first years and used this information to create Nokia's first WAP user interface guideline document. Later Virpi Roto and I were asked to update the document, when the markup language for WAP changed from WML (Wireless Markup Language) to XHTML (eXtensible Hypertext Markup Language) causing some changes to the interaction of services created with WAP. We were not able to run the tests with services of external partners, so we had to create service user interfaces ourselves. After the tests we found that the browser that had initially been designed for WAP 1.1 with WML did not work on WAP 2.0 with XHTML. We conducted another study to see how the existing browsers would work with HTML sites designed for computer browsers. We found that the mobile browser needed major changes and decided that Virpi would be focusing on supporting the browser development and I would continue to work with services.

Merita/ Nordea bank service was among the first services I had worked on when starting my work in the mobile service area. I was happy when Tuuli Hyvärinen and Mika Hiltunen from Nordea contacted me and asked me to help in a study they were about to conduct. The focus of the study was to discover mobile service navigation information that would be used in the improvement of the mobile site. Tuuli used the study in her master's thesis.

During the past years, I have been as much a practitioner as a researcher. I have used research as a tool to get answers when I could not find them from literature or guidelines. The papers I have published demonstrate what kind of questions mobile service design has faced. The first papers are about user interface and service design. After the user interface focused papers, I published papers on methodology with colleagues from TeliaSonera and Idean. When miniature cameras made it possible to run user tests in the field, we were wondering if the field tests were really worth the effort. Aki Kekäläinen, Mihael Cankar, Titti Kallio, Anu Kankainen and I had experiences that made us wonder if there were differences in usability findings in field and laboratory situations. We wrote two papers based on the empirical data we had gathered. The second paper was actually rejected once from one conference as one reviewer did not want our results to be published. This study was also conducted and paper written from a practical point of view. It is very important for a practitioner to use the best method in their work when answering the questions arising during development.

For several years I participated in mobile service design projects in different countries, on three continents. When evaluating and testing the services of different service providers and network operators, I found that the same usability flaws were found everywhere. I ended external consulting work in 2005 and wanted to have closure to my work. I decided to produce a report summarizing usability problems that were common in most mobile portals. Evaluations were conducted while working on mobile service development projects. The

tested mobile portals were the original portals of the customer service provider and the ones of their local competitors.

Cost has always been an issue for mobile service users. It has been a very obvious barrier in service use, and was brought up by most users in the mobile service usability tests and user studies. I was happy to support Virpi Roto and other colleagues to discuss this issue in a conference paper we wrote together.

The reason for the last study I conducted for this work was also very pragmatic. In paper 4 we studied with Virpi Roto the perception of the web pages in narrow layout, and found many problems that could be fixed by re-designing the browser. Virpi had worked with browser developers and the team she worked with managed to influence the design in such way, that many of the problems we found were fixed. My last study focused on the use of mobile browsing, but also evaluated the experience with Nokia Minimap browser and other browsers available for mobile phones. At the time of the study I was working in Nokia Multimedia, the part of Nokia making Nseries devices at time. Nseries devices had Nokia Minimap browser and my manager, Harri Kiljander, thought that it would be useful to get information on use and the experience of different browsers.

Acknowledgements

This work has been a long journey. During these years many people have walked with me, some people for a longer period of time, some shorter. I want to thank them all for their support and companionship. I have done my dissertation while working in Nokia, and even if it has not been easy to combine family, work and studies, it might not have been possible at all when working in other kind of organization. I owe this thesis to various people in Nokia, Nokias partners, academia, and home.

First I want to thank my supervisor, Professor Marko Nieminen from Helsinki University of Technology. Without his patience and support, I would never have completed this work.

I was honored to have Professor Kaisa Väänänen-Vainio-Mattila from Tampere University of Technology and Doctor Matt Jones from Swansea University, Wales as the pre-examiners of my dissertation. Both professor Väänänen-Vainio-Mattila and Dr. Jones have a long experience on mobile usability. Their constructive and valuable comments helped me in clarifying the focus and finalize this work.

It has not always been easy to compose the doctoral thesis while working in industry. Without supporting managers it would not have been possible at all. During these years I have had many managers in Nokia; all of them have been both great managers and good colleagues. My first paper was published when Panu Korhonen was my manager, and if Panu would not have encouraged me to organize tutorial in CHI conference, this journey would not have started at all. I am also grateful for having Panu as my manager during the difficult period in my life. His flexibility and common sense made it possible for me to combine my work and personal life. Harri Kiljander has supported my work in multiple ways, as a manager he has supported the research projects I have conducted alongside my work and as a colleague he has given insightful comments to my argumentation. Mika Röykkee, Satu Väinämö, Randy Kerr and Johanna Järnstöm have been patient managers during the years, and their encouragement and practical advices have helped me to prioritize my work in such way that I had energy to write.

I have published a large number of papers which are included into this work. I am grateful to each and every colleague for the co-work I have done with them.

The first paper published was related to Merita Bank (Nordea today) mobile banking service development. It was enjoyable and useful to work with Pirjo Törmänen, when the area was not familiar to me. I continued to work with Nordea Bank few years later, when Tuuli Hyvärinen (Tuuli Karjalainen today) and Mika Hiltunen asked me to support the study related to the redesign of the mobile banking service Tuuli and Mika, it was delightful to co-operate with you.

With Virpi Roto we have had long path together. Originally we were asked to update the Nokia's WAP design guidelines, I had written few years earlier. We ended up not only doing what was asked, but investigate mobile Internet use and design much deeper. Virpi defended her doctoral thesis three years before me and her advices have been valuable for me. I also want to thank Roland Geisler, Andrei Popescu and Elina Vartiainen for the co-operation during the writing of the paper we authored together.

I conducted a study together with Titti Kallio, Aki Kekäläinen and Mihael Cankar from TeliaSonera and Anu Kankainen from Idean. I enjoyed our conversations during the ad-hoc project we built up, to investigate the question we all had encountered in our work.

In addition to my managers and the fellow authors of the papers, I have a number of colleagues who have supported me during the years. I have published a number of papers that are not part of this work. The discussions with co-authors these other papers has influenced my perception and thinking. I want to thank Eija Kaasinen from VTT, Pekka Ketola from Nokia, David Williams from

Asentio, ex-nokian Mia Lähteenmäki and Jaakko Lehikoinen from LeadIn for co-operation. I want to thank Katariina Kalatie, Heidi Wahl and Leena Vesterinen for the help they have offered during the latest studies I conducted, as well as friendship during the years. I loved working with you so much, that it did not feel like work at all. Pekka Isomursu, Timo Tokkonen, Mika Rautava and Juhani Vitikkala have been colleagues whose knowledge and support has helped me to clarify my thoughts during the years. Kate Freebairn gave valuable help when I was checking the language of my thesis.

Finally I want to thank my family for being patient during these years. When the mother writes doctoral thesis alongside her work, it means more household responsibilities for the rest of the family. I want to thank my family for the patience. Particularly I want to thank my life partner Timo Joutsenvirta, for being the voice of reason in my life, helping me to prioritize the life and for overall support. I also want to thank Timo for explaining the technical issues during the years and preventing me of writing nonsense about the technology in my thesis. I want to thank my beautiful daughters Laura and Vilhelmiina for their support during my thesis work. Laura has done interview transcriptions for the mobile Internet studies I conducted and proof-read the language of this work. Vilhelmiina has helped me to keep my papers in order and my mood up during the writing process.

I end this journey by quoting Laura after she had read the introduction part to my dissertation:

"I did not know you could make a doctoral thesis from the use of common sense"

Anne Kaikkonen

List of Original Publications

This thesis consists of an overview and of the following publications which are referred to in the text by Latin numerals in bold italic.

1. Kaikkonen, A and Törmänen P. 2000: User Experience in Mobile Banking. Industrial case study in *14th Annual Conference of the British HCI Group*, British HCI 2000. Sunderland, UK

   The paper is describes the development process of one of the first commercial Mobile Internet services and the first interactive service, Merita WAP bank. This work was done together with Pirjo Törmänen, but I paper authored almost entirely the paper.

2. Kaikkonen, A., and Roto, V. 2003: Navigating in a Mobile XHTML Application. *Proceedings of Human Factors in Computing Systems conference,* CHI'03, Fort Lauderdale, USA, pp. 329-336.

   Virpi Roto and I contributed to the study in question and the paper 50% each. I acted as a domain specialist, and Virpi designed the study. We analyzed the results together, I did the statistical analysis and we authored the paper together with Virpi.

3. Roto, V. and Kaikkonen, A. 2003a: Acceptable Download Times in the Mobile Internet. In Stephanidis, C. (ed.): *Universal Access in HCI. Volume 4 of the Proceedings of HCI International 2003*, Crete, Greece, pp. 1467-1471.

   This paper describes a set of results from the same study as publication 2. We authored the paper again 50% each with Virpi Roto.

4. Roto, V. and Kaikkonen, A. 2003b: Perception of Narrow Web Pages on a Mobile Phone. *Proceedings of International Symposium on Human Factors in Telecommunications 2003*, Berlin, Germany, pp. 205-212.

   Virpi had major responsibility in designing the study. I ran half of the of the usability tests and took care of the data analysis in the study and supported also in qualitative analysis. I authored a part of text (1/3 of the text approximately) especially the chapter 3 of the paper.

5. Hyvärinen T., Kaikkonen, A. and Hiltunen M. 2005: Placing Links in Mobile Banking Application. In *Proceedings of the 7th international conference on Human computer interaction with mobile devices & services.* MobileHCI 2005. Salzburg, Austria, pp.63-68

   The study was based on the master's thesis of Tuuli Hyvärinen, so she was responsible of the study. I helped her in planning the study set up and took notes in a half of the test sessions. I helped in authoring the paper and re-analyzing the data.

6. Kaikkonen A., Kekäläinen A., Cankar M., Kallio T., and Kankainen A. 2005: Usability Testing of Mobile Applications: A Comparison between Laboratory and Field Testing. Journal *of Usability Studies, JUS2005*, issue 1; vol. 1 pp. 4-16.

   The study was designed together with entire group; I ran 1/3 of the usability tests, both in the lab and in the field. I took care of the data analysis, but the qualitative analysis was done together. I was co-coordinating the writing process and authored a slightly bigger part of the text than the others.

7. Kaikkonen A. 2006: Usability Problems in Today's Mobile Internet Portals In *Journal of Internet Technology*, Vol. 7, no. 3, pp. 231-237. July 2006.

   I authored this paper by myself based on several usability tests and expert evaluations on mobile portals by different companies and network operators.

8. Roto, V., Geisler, R., Kaikkonen, A., Popescu, A., Vartiainen, E. 2006: Data Traffic Costs and Mobile Browsing User Experience. *MobEA IV workshop on Empowering the Mobile Web*, in conjunction with WWW2006 conference. (6 pages) http://www.research.att.com/~rjana/MobEA-IV/PAPERS/MobEA_IV-Paper_7.pdf

   The user studies described in the paper were run by Virpi Roto Salla Myllylä, Mika Rautava, Elina Vartiainen, and Andrei Popescu. I took part in authoring the paper. My contribution was especially related to the user perception of the cost and providing operator view points.

9. Kaikkonen A., Kekäläinen A, Cankar M., Kallio T and Kankainen A. 2008: Will Laboratory Test Results be Valid in Mobile Contexts? Book chapter in Handbook of Research on User Interface Design and Evaluation for Mobile Technology (Lumsden eds), (2008). Information Science Reference, Hershey. pp. 897-909

   The paper was based on the same study as paper 6. I was again co-coordinating the writing process and authored a slightly bigger part than the others.

10. Kaikkonen A. 2008: Full or Tailored Mobile Web- Where and How do People Browse on Their Mobiles? In *Proceedings of the International Conference on Mobile Technology, Applications, and Systems*, Mobility '08, Yilan, Taiwan, Article No. 28

    I authored this paper alone based on the study I planned, conducted and analyzed myself.

11. Kaikkonen A. 2009: Mobile Internet- Past, present and the future In *International Journal of Mobile Human Computer Interaction (IJMHCI)* vol.1 issue 3 pp: 29-45

    This paper is based on the same study as paper 10. Like paper 10, I authored the paper myself.

I approve the aforementioned publications to be part of this dissertation.

_____

Marko Nieminen

Professor of User Interfaces and Usability

Summary of Publications

All the papers, included into this work, are investigating questions that are relevant in mobile Internet service development and the improvement of the service creation process. The papers reflect their publication time, both on research questions and research methodology. They tie together thematically: all these papers are related to mobile service development and they seek to answer the questions different development teams have had during the mobile service design and development processes. During the period of the publication of the papers, different topics and themes have been relevant. The consolidation of my work with mobile Internet reveals the evolution of the questions and topics over the period of time. In the beginning the focus was on user interface and its design. The papers 2-5 and 7 answer different questions related to service user interface and interaction design. The focus has been on the usability of the services. When the most urgent questions related to user interface and interaction had answers, the researchers and the practitioners started to ask, whether the mobile systems can be reliably tested in laboratory environment. Mobile systems are used in a variety of contexts, are the laboratory tests enough or should the services be tested out in the wild? The papers 6 and 9 take part into this discussion. The last theme in the evolution is related to usage patterns, motivations and emotional aspects when using the mobile Internet services. Themes that can be combined under theme "user experience". Papers 8, 9 and 10 handle these questions. Paper number 1 differs from this evolutionary path. It shows, that already in the early phase of mobile Internet, actual service creation process included questions from all the topics that rose during the coming years: usability and user interface / interaction design, reliable methodology selection and user experience related questions.

In addition to the publications' evolutionary aspect, the papers approach the mobile service development from three perspectives: ***papers 11 and 1*** are describing the starting point and questions that were relevant when mobile Internet services were developed in the beginning. ***Paper 11*** describes also the general evolution from the beginning to current situation. ***Papers 2- 5, 7-8 and 10*** show how mobile services look from user's perspective- papers take both usability and user experience aspects inconsideration. ***Papers 6 and 9*** describe the mobile service user evaluation methods and special questions related to user tests in mobile context. Seven papers out of eleven are directly related actual service development projects. Papers one and five are linked to the development of Merita (Nordea) mobile banking service. Papers two and three are linked to the development of XHTML guidelines and paper four to Nokia mobile browser development. Paper seven is the consolidation of the outcome of the expert evaluations and the usability tests of several mobile portal development projects. Papers ten and eleven are the result of a mobile service consepting project having additional goal to evaluate the user experience with Nokia mobile browser.

1. INTRODUCTION

Internet on mobiles or mobile Internet has been the topic in many doctoral dissertations during the past years. The approach in the user-centric thesis has been mostly academic, even if Kaasinen, (2005) and Roto (2006) both have published papers that are based on research and development (R&D) activities; the focus of their work is on questions that are more relevant to the academic community. Other approach to mobile Internet has been either economical or commercial, like the theses of Kallio (2004) and Saarikoski (2006). According to Väänänen-Vainio-Mattila et al (2008) there is a gap between the approach of academic researchers and industry practitioners. I am bridging this gap with my dissertation.

During the years, my main question has been: How to design and create mobile services that people can use and want to use? Services which are so good, that they create positive impressions and good user experience. Mobile service here means software that has also representation online, not only in device.

When people can use services, it means that the services are easy to use. The ease of use means that both the service interaction and the user interface are properly designed. When doing the good user interaction / interface design, the psychofysiological and the cognitive aspects of user must be taken in consideration. Creating services that people want to use is more complex: the ease of use is one important factor in that, but it is not enough. When designing services that people want to use, also behavioral, social and emotional aspects need to be taken in consideration. In order to take those in consideration, the limitations and the characteristics of the technology build the framework for the possibilities. Business economics models have also their influence on user perception of service value in his life. Within the existing technical and business framework constrains my goal has been to investigate how to make the best possible Internet services that people can use with their mobile phones.

The Internet access on mobiles is no longer a new phenomenon; the first mobile devices supporting web access were introduced over 10 years ago. During the past 10 years many things have changed: technology has evolved, there have been different billing models for mobile services, and the focus of research questions in the field of human- computer interaction (HCI) and mobile HCI (human-computer interaction with mobile devices and services) have changed. In addition to usability, the goal of many studies has been to view users holistically; with improved test tools this is easier than before.

1.1 How the Services Look from Users' Perspective?

There are many ways to approach the mobile services; the topic can be addressed from various technical perspectives, economical/business perspective or human factors perspective. My focus has been in the different aspects of human factors.

1.1.1 Usability: Making Services that People Can Use

Usability is about designing services that people are able to use efficiently and effectively. People should also be satisfied with the service use (ISO 9241-11, 1998). Usability takes inconsideration that the service use is easy from the beginning; service has to be easy to learn. To make that happen, the information needed on humans is related to psychofysiological factors, cognitive neuroscience and cognitive processes. From service perspective the focus of usability work is in user interface and interaction design. Technology, with its possibilities and limitations, gives the framework to work; in practice the existing technology defines what is possible and what is not. These limitations have to be taken into account when designing the user interface and interaction. From the strategic point of view I see usability as a part of risk management. There is often a need to fulfill

multiple, sometimes even contradictory requirements. These requirements may be related to technical constrains, marketing or time-to-market issues. Usability work in service creation organization is about making as a good service as possible within the existing constrains (Hertzum 1999).

1.1.2 Wider Perspective: Making Services that People Want to Use

It is not enough that the service is easy to use, even if that is important. The reason why people want to use the service is its content. People evaluate the goodness of the service based on the content, but also on the cost, the availability and the reliability of the system. Is the service worth trying and after first experience, is it worth using. These aspects are considered to influence on 'user experience' with the system. It is clear, that there are numerous issues influencing 'user experience'. To investigate these issues, the area has to be divided into smaller items.

The perceived value of the service plays an important role: the user has to be able to evaluate if the service adds value to his life. The perceived value has been investigated by Sheth and al (1991) and Kujala and Väänänen-Vainio-Mattila (2009). Sheth defines the value with five dimensions: functional, social, emotional, epistemic and conditional value. Kujala and Väänänen-Vainio-Mattila have more psychological approach and they split the perceived value into seven categories that all derive from different research or theories. Some of these values are such that users are aware of them, some are more subconscious. When people are not aware of their underlying needs, researchers need to do a lot of interpretation. In such situation the researcher perception of the product or service may influence his interpretation. This can lead to false conclusions. Users often need to have an explicit benefit from the new system they buy. A benefit they can rationally explain to themselves (or other people), even if the underlying need would not be functional.

The benefits play an important role in evaluation. According to Gourville (2006) there is a mismatch between the technology sellers and technology users in relation to the perceived value of new technology. The technology sellers tend to value the benefit of the new system higher than the users. It is unfortunate for the technology sellers that the users do not care how the sellers perceive the new technology. Instead of pushing the new solution to users, the people in the companies should try to understand how the new system would bring value for users and how big behavioral changes it requires from them. This information should also be used in service related decision making.

Kaasinen et al (2000) have brought up that in mobile contexts, the content people want to use is as diverse as the content in full web. In addition to that, the timeliness of information has been brought up as an important aspect in the mobile context. Mobile context here means any place or time where mobile devices can be used. The mobile handheld technology has obvious constrains compared to computers. End user can easily evaluate factors related to physical device: Small screen, keyboard and battery life for example. Helping users to find the relevant content easily is important in mobile use. Knowing about the context is the strength of the mobile devices, and that should be utilized more effectively in service design.

Technology can work as an enabler or a barrier for mobile service use. When it is the right moment to introduce the service and what is the right form are important decisions that influence the adoption of the service. If the service requires heavy processing power, fast network or lots of typing, it may not work properly with low end mobile devices and in areas with slow network. The right time to market is often difficult to estimate: there are examples of services and products either appearing too early, when technical infrastructure or potential users are not ready or too late, when the majority of the competitors have already launched their service and users have already started to use them.

From business economic side, the cost, billing model and distribution channels are probably the most visible for users. The cost and awareness on cost generation are important factors when users evaluate the value of the service in their life. Gourville and Dilip Soman (2002) point that cost awareness and transparency are the main elements influencing the consumption behavior. If a user does not know how much the service use costs, it is not possible to evaluate if it is worth paying.

Overall 'user experience' is a consequence of variety of aspects- related to the previous experiences and the present moment of an individual person. It is an intrapersonal event, in a specific moment. Even if it is evoked by interaction with a system, user experience cannot be designed as such. As a concept it includes so many elements, that it should not be used in research or product development to describe the focus of the work.

1.1.3 Mobile Service User Evaluation Methods

During the years the tools helping the service evaluation have been evolving. The specific question in mobile usability and user experience has been related to the ecological validity of the laboratory tests. During the past ten years, the maturity of the technology and the tools used in tests have made it possible to focus on new questions, thus answer a broader range of questions. This has led to the use of a wider spectrum of research and evaluation methods.

1.2 My Contribution

Creating Internet services for mobiles requires the collaboration of professionals from different disciplines. In order to make good devices and services all these areas need to be taken in consideration: human factors, technology and business economics. To make that happen, the technical experts, market specialists, designers, human factors experts and many others need to work together. I come from a human factors background and this has influenced my view and my input to this area. My research has investigated various aspects of humans as mobile Internet users. In this piece of work I try to enlighten also how in industry the human factors area is a part of the bigger picture, how it is related to technical and economical questions.

The studies and papers I have written over time have answered the question ***'how to make mobile Internet services that people can use and want to use'*** from human factors and Human-Computer Interaction (HCI) perspective. The evolutionary aspect of my work is reflected in the questions of the individual papers. The research question has been different in each paper, depending on were the relevant questions in the time of their publication: the first paper highlighted the overall user-centric service creation process. It answered the question '*what is the **design process** when creating services that people can use and want to use'*. Papers 2 to 5 were concentrating on the creation of the service and user interface. The question in these papers was '*how to design the **user interface and interaction** for services that people can use and want to use'*. The outcome of the studies used in these papers was also used in the creation of Nokia's XHTML design guidelines (Forum Nokia 2003, 2004, 2005) Papers 6 and 9 handled the question of the service and user interface evaluation: '*when it is enough to **evaluate** mobile service usability in laboratory and when it is better to run the test in field, when designing mobile services that people can use and want to use'*. Papers 7 and 8 handled the obstacles related to mobile Internet adaptation – paper 7 (Kaikkonen, 2006) was a current state analysis of usability problems in service user interface, paper 8 was analyzing the influence of cost and lack of its transparency as one of the barriers of mobile Internet adaptation. The question in these papers was '*what are the **barriers** of mobile service use? Can people use them and do they want to?*' The last two papers, 10 and 11, evaluate the mobile Internet usage patterns, the motivation and the perception of mobile Internet of users coming from different countries. These last two

papers are evaluating '*what kind of **usage patterns** users have with mobile services when they can and want use them?'*

The focus of my work has reflected the questions that were relevant in the time of their publication. As the research questions have changed, also the methods to get the answers have been different in different papers. I have chosen the methods that answer the research questions in industry context. My research has been mostly empirical; the research methods have been used to answer real world questions during the mobile service development processes. In addition to the usability and human factors perspective, the available technology and dominant business models have influenced the overall picture, sometimes even more than usability. In this consolidation of my work, I reflect my own studies and the other information and try to seek the answer to even broader question than my original question**: *how to make the next mobile Internet success story?***

2. WHAT IS INTERNET ON MOBILES?

The Internet on mobiles can be described in many different ways. In some markets the Internet use on portable computers (laptops) is considered as Internet on mobiles, this is however excluded from my definition. To illustrate the diversity of Internet on mobiles, I use as an example 4 studies on Internet use on mobile handheld devices. All these studies were published during 2008. The description of the Internet on mobiles in these papers gives a good perception on how differently the topic can be approached. Cui and Roto (2008) studied mobile web usage and seem to define the use of the web on mobiles as viewing web pages with mobile browsers; this covers both mobile-tailored and full web content. Hinman et al. (2008) compare mobile phone and computer web use in the context of a computer deprivation study. In this study, the use of the mobile web is mainly related to full web site use on mobiles. Taylor et al. (2008) seem to perceive the mobile web mostly as a source of relevant, mobile-tailored services.

The fourth definition of the mobile web combines three previous approaches: In ***papers 10 and 11***, (Kaikkonen 2008 and 2009) I define the mobile web as any access to the Internet via a mobile device. This approach is rather presenting Internet access on mobiles than mobile Internet. The different alternatives for using and accessing the web on mobiles today can be seen in Figure 1. Web access from mobiles can be divided to browser-accessed and client-accessed. The difference is very clear from the user's perspective. For browser-accessed approaches, there are two alternatives; a site can be either identical to that which the user accesses via a desktop computer or the content can be tailored for a mobile platform. Client-access means that applications connect to a service to fetch specific pieces of data from the web: different approaches support different usage situations, and therefore one service can be accessed multiple ways.

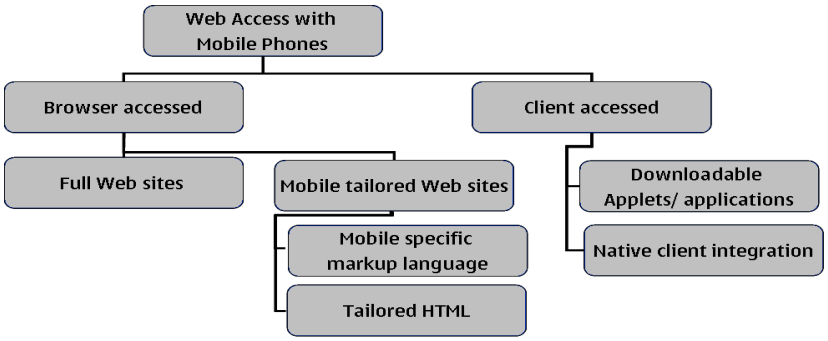


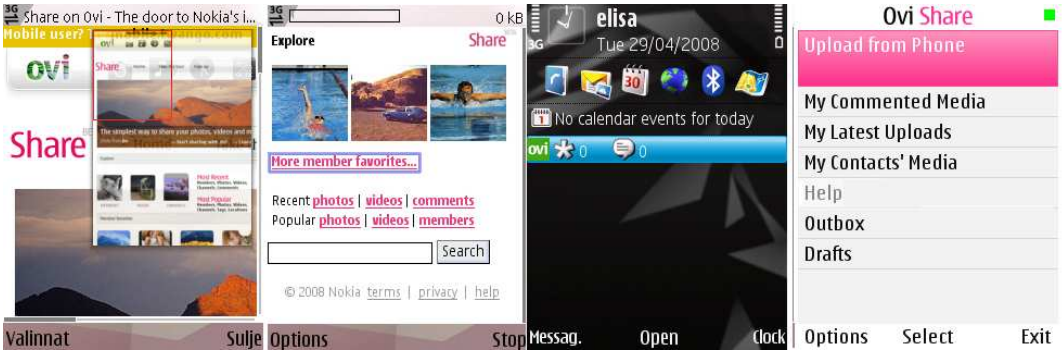
Figure 1: Landscape of the Internet on mobiles

2.1 Full Web on Mobile Phones

Full web sites are sites developed with standard HTML for desktop computer use. The content on a mobile browser is (with some technical limitations) the same as that which the user sees when browsing the site on a desktop computer. Most mobile browsers do not support all audio and video formats; this means that a user may not be able to listen to background music or view video clips on the web sites. In some cases full web site design is optimized for a specific browser, typically Internet Explorer. The layout of such sites may, therefore, look awkward on mobile (or other) browsers to a user who is familiar with the site on a specific browser on a desktop computer.

Full web content on mobile devices is not really a new thing: it has been possible to access full web content on mobiles for as long as it has been possible to access mobile-tailored

content, for example, the Nokia Communicator provided a web browser with HTML support as early as 1996. Kaasinen et al. (2000) demonstrated ways to render web content to fit the screen of a mobile phone. In ***paper 4***, (Roto and Kaikkonen 2003b) we analyzed the problems users have when full pages are rendered to a narrow layout when viewed with mobile browsers. Currently the narrow layout is no longer the only solution; as mobile phone screens have become bigger and screen resolution has increased, more devices are able to show the web site layout in a more comparable manner to the layout seen on a desktop computer. Figure 2A shows how one service, Share on Ovi (a full web page), looks on a mobile device, Nokia N95. I will explain the other figures in the following sections.



A **B** **C** **D**

Figure 2: Different views of the same service on mobile devices.

Lately, an increasing number of companies have started to take mobile browsers into consideration when building their full web sites. The question now is 'how do you best create web sites that fit both desktop computers and mobile devices?' For example, Yahoo! has defined guidelines to help developers to build full web sites that also work well on mobile browsers (Sounders and Theurer 2008).

2.2 Mobile-Tailored Browser Access

Tailoring web content for mobile phones can be done in different ways, as Figure 1 shows. Users can obviously access Internet content with a mobile browser and open websites that are tailored for mobile phones. That is not, however, the only way to tailor web content to mobiles: users can have applications or applets that access Internet content without opening a browser. Figures 2 B-D show how the Share on Ovi service can look on mobile devices: Figure 2B shows the mobile-tailored browser view. It does not really matter to users if the mobile tailoring has been done with a markup language designed for mobile devices (e.g., HDML, WML, cHTML, or XHTML) or standard HTML. What is important is that the content and user interface is tailored to suit the mobile use.

2.3 Client Based Access

The other way of tailoring Internet content for mobile consumption is to develop applications that access the Internet. Figure 2C shows how service content can be visible on a phone's home screen, and 2D is an example of a downloadable application that can access an online service. Phone applications can support the upload or the download of content to and from the Internet. The web access can either be an integrated functionality in the phone's native applications (such as the calendar, photo gallery, music player, or phone idle screen) or it can be a stand alone application downloaded from the web. These

downloadable applications can access specific data from a phone; the applications connect to a specific site for a specific information query or task. For example, they may be used for uploading photos to a photo blog or downloading a game to a mobile phone.

3. FROM USABILITY TO USER EXPERIENCE: WHAT, WHY, AND HOW

Two core terms related to the goal of my work have been 'usability' and 'user experience'. 'Usability' has been a topic in every paper, and 'user experience' is mentioned in eight papers. In this chapter I first tell how I have used these terms in my mobile Internet papers, and then reveal how they have been defined by others and finally analyze how these two terms have been used in MobileHCI and CHI mobile papers during the period from 1998 to 2008.

"Usability" I have linked mostly to errors, efficiency, effectiveness and subjective satisfaction, which has been investigated by subjective rating or users' comments during the test. My definition has been very close to ISO 9241-11 (1998) definition: "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". This definition works well in research and product development, as it is clearly defined and each element can be measured.

"User experience" term has been more diverse: in the ***first paper*** (Kaikkonen and Törmänen 2000) it was related to user satisfaction, frustration and the fulfillment of user expectation. In ***paper 3*** (Roto and Kaikkonen 2003a) it was used almost as a synonym for 'user interface' and in paper ***4*** (Roto and Kaikkonen 2003b) user experience was partly replacing the term 'usability'. In ***paper 6***, written in 2005 (Kaikkonen et al. 2005) the user experience was used to have a clearly wider scope than usability, it was a users attribute, but the term was not defined properly; in ***paper 8*** (Roto et al. 2006) user experience was defined through the components affecting the experience on mobile services. In papers ***9, 10 and 11*** (Kaikkonen et al. 2008, Kaikkonen 2008 and Kaikkonen 2009) user experience included usability, but also motivation, behavior and usage patterns. The user experience is intrapersonal event happening when user is interacting with the system. There are many elements influencing user experience, and user experience can be described in multiple ways. The 'user experience' as term should not be used in research or development, as it as such cannot be unambiguously measured. Research and development should rather talk about motivation, behavior, preference and other aspects that are less ambiguous and that can be measured.

3.1 How Has Usability Been Defined?

There are some common ways to define usability: one of the most commonly referred is defined in ISO 9241-11 (1998). According to this standard, the usability consists of 3 elements, effectiveness, efficiency and satisfaction. These are in relation to specified tasks in specified environment.

Other standard defining usability is ISO 9126-1 (2000). According to this standard, usability is about understandability, learnability, operability and attractiveness. The usability elements defined in ISO 9241 -11, are not part of the usability of ISO 9126-1, but rather a part of overall quality in use. According to Bevan (2001) these two definitions do not however compete with each other, but rather complement each other.

Nielsen (1993) and Shackel (1984) have made definitions on usability before standardization work was finished. These definitions are a mixture of the definitions of ISO 9241-11 and 9126- 1, as they focus more on learnability and the ease of use. Nielsen sees usability as a part of total system acceptability. The components of usability according to him are the ease of learning, efficiency to use, ease to remember, the number of errors and subjective pleasurably.

There are many other definitions of usability, but there are some advantages of the definitions in ISO standards: the standardization process is run in such way that it requires acceptance from specialist groups in member countries- the definitions are reviewed by experts multiple times during the iterative review process. Due to this process ISO standard definition can be considered as the most commonly agreed definition. In research community the commonly agreed definition of the core term makes it easier to assume that two parties are talking about the same issue and studying the same phenomenon. It is also good that each element of usability has been defined in such extent, that it has been possible to generate both qualitative and quantitative test methods to evaluate the elements of usability. There are several handbooks (Rubin 1994, Wiklund 1994, Nielsen and Mack 1994, Galer et al 1992, Jordan et al 1996) written about the test protocols, test cases, and guidelines for designing products that are easy to use. The elements of usability are considered to have specific metrics that measure these elements:

Effectiveness of the system can be measured in a usability test by "success rate" or "task completion rate". The number of errors can also be considered the measurement of effectiveness.

Efficiency is related to the speed of task completion. The faster the task is completed, the more efficient the system is. Often measuring the task completion time is useful when comparing two different systems.

User satisfaction is a subjective measurement. It can be measured by asking users to fill post-test questionnaire with satisfaction rating or by analyzing the user comments during the test.

The metrics above give some indication of the existence of the problems, but these do not provide any information of *what* the problem is and how it can be fixed. Finding the reasons for problems requires a qualitative analysis of the test sessions. The qualitative analysis is a more difficult part, as it requires more expertise from the test leader and evaluator. There is some evidence that the number of evaluators and their experience have impact on the outcome of the test (the more experienced the evaluator is, the more problems he finds) and especially on problems related to structure and functionality, not only problems on surface (Nielsen 1992a, Jacobsen & al 1998).

3.2 What is User Experience?

Virpi Roto says in her doctoral dissertation (2006), that “Understanding the components affecting the user experience helps us both in defining, designing, and evaluating user experience. In mobile browsing, the number of components affecting user experience is relatively big, because there are so many players on the technology side, and the users and use contexts are diverse.”

The user experience has been defined in different ways. Many definitions of the user experience are defining elements that influence the generation of the experience in general. They point that prior the experience of the users as well as values and expectations build framework to the experience with a product. The experience happens in present and it re-shapes the experience and future expectations. Despite of long discussions and many definitions, there is still lack of common agreement; this was already noted by Forlizzi & Battarbee in 2004. Proper definition would be needed to help define the goals for user experience in the beginning of the product development. This would help to design and develop better products, which is the goal of R&D organization. From the practitioners’ point of view the current definitions have only relative value; they may build the framework

in research area, but do not offer ways to create proper tools that would help in building and evaluating user experience. As the number of different user experience models is big, I only present few of them.

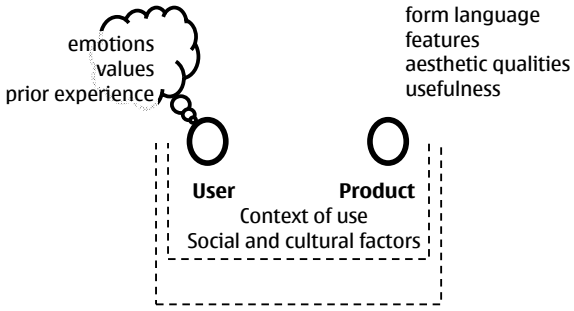


Figure 3 User experience model by Forlizzi and Ford (2000)

In model presenting influences on experience, Forlizzi and Ford (2000) put user and product in center. The context – both physical and socio-cultural – defines the framework for the interaction. The visualization of their model can be seen in Figure 3. Both user and product have a role in the creation of the experience.

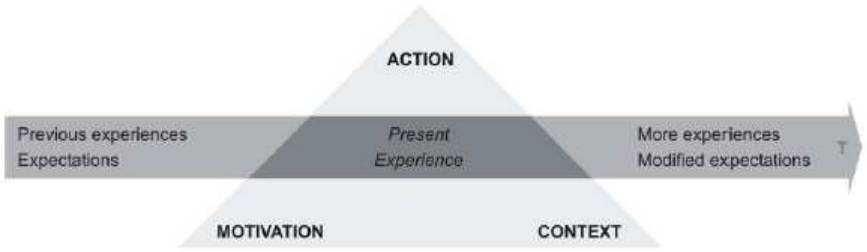


Figure 4 User experience model by Mäkelä and Fulton Suri (2001)

Mäkelä and Fulton Suri (2001) perceive user experience as an evolutionary issue; user is not defined to be a separate part of the model, as the experience is happening inside the user. In Figure 4 can be seen how the experience happens in present. The user brings to the event his history, previous experiences and expectations that influence the experience. The experience in the present moment modifies then the expectation and gives more experience. The model of Mäkelä and Fulton Suri may not give answers to product development, but it seems to be built on the theories of mental model construction, like the dynamic memory model by Schank (1999).

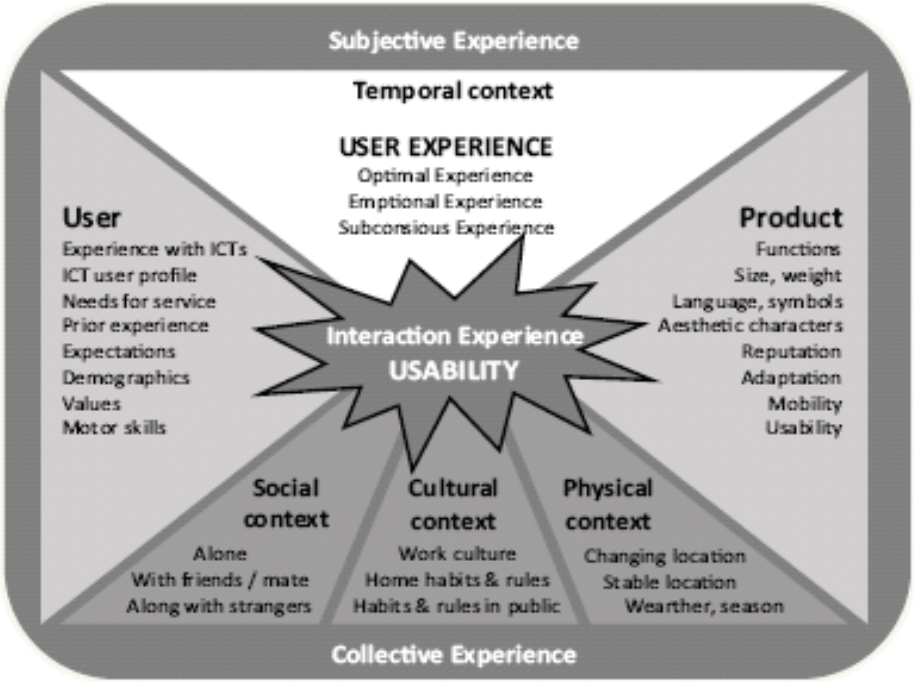


Figure 5 Usability and user experience model by Arhippainen (2009)

Arhippainen and Tähti (2003) define user experience by referring to the experience a person gets when interacting with a product in particular conditions. There are numerous different kinds of people, products and environments that influence the experience that interaction evokes. Figure 5 shows the final version of the evolution, which separates subjective and collective experiences. This version is presented in Doctoral thesis of Leena Arhippainen (2009). User experience happens as a consequence of the interaction between product, user, social and cultural factors and the context of use. This model shows that the same individual can have very different experiences with the same product, depending on multiple factors that are not product related. Opening the "boxes" and listing all the elements of the different influators is problematic: the list can never be complete.

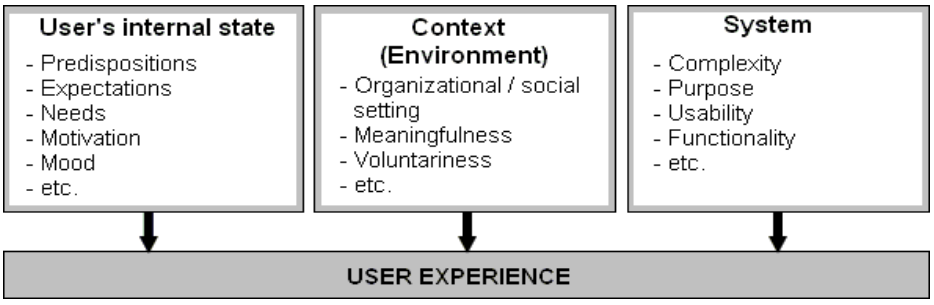


Figure 6 User experience model by Hasselzahl and Tractinsky (2006) as visualized by Virpi Roto (2006)

Hassenzahl and Tractinsky (2006) see user experience as a consequence of three factors: the user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context or the environment (e.g. organizational/social setting, the meaningfulness of the activity, the voluntariness of use, etc.). All these three factors seem to have equal weight in the model. The combination of the factors in the three elements allows innumerable design and experience opportunities. Figure 6 shows visualization of this model as Virpi Roto (2006) saw it in her doctoral dissertation.

The models presented here may be helpful when defining the framework for an academic study. Especially when defining the research questions in such a way that it helps to understand if two studies are actually handling the same phenomenon or problem. From the practitioner and the development point of view the problem with these models is that they do not give tools that would help in designing better products. All these models agree that users' internal state, emotions and experiences do influence on the experience with a specific product. The question from the product or the service development point of view is, is it possible to take all that in consideration when designing a service or a product?

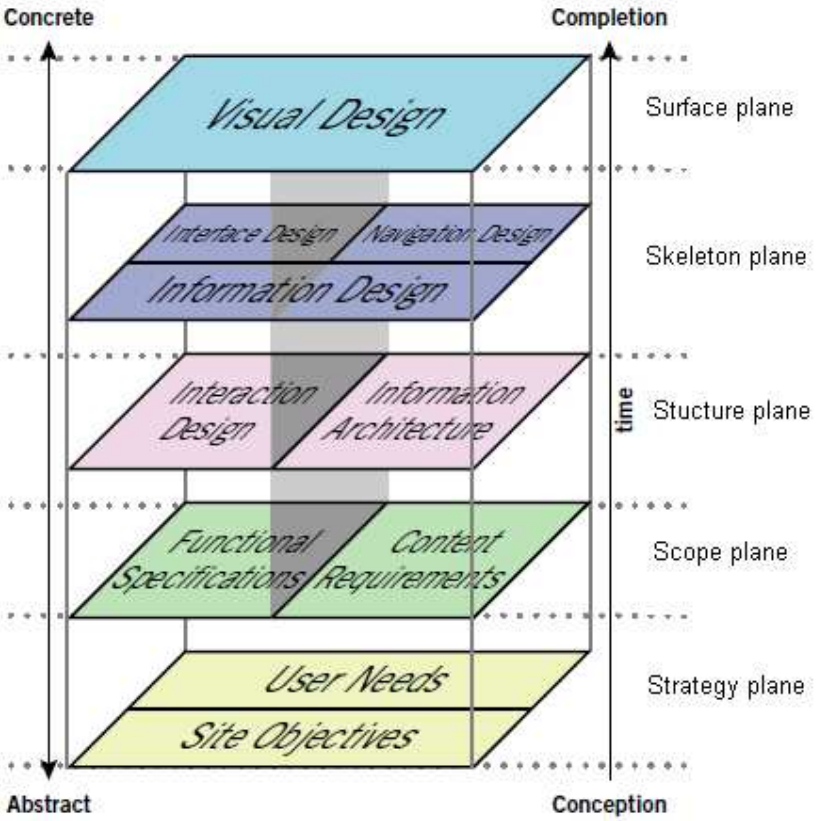


Figure 7 User experience model by Garrett (2003)

In user experience modeling, Garrett (2003) has taken different approach: he is more pragmatic and more focused on design; he defines the different stages of web site design. The model is not defining what the user experience is. It is built to guide designers and management to understand what kind of decisions need to be made in different phases and

where to get information for decision making. The process starts by defining the goal for the service and continues toward more specific decisions, all the time keeping the decision in line with the goal. The Garrett's model is not contradictory to ISO 13407 user centric design model (right in figure 8) or mobile service design model by Kaikkonen and Williams (2000) (left in figure 8), but rather complements these.

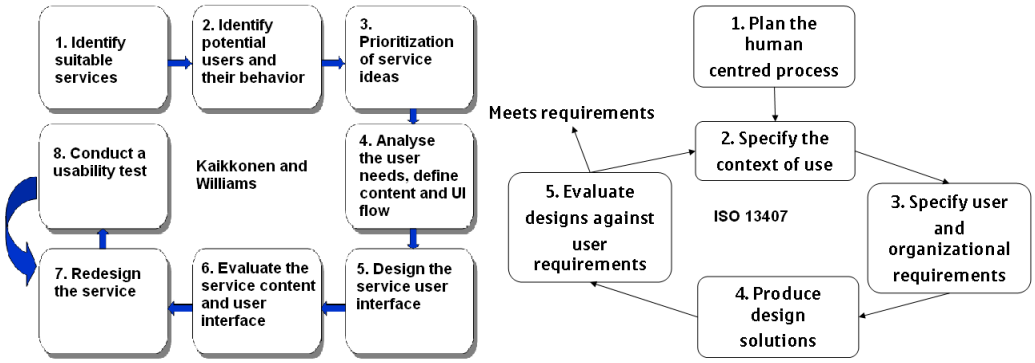


Figure 8 User centric design processes from Kaikkonen and Williams (2000) and ISO 13407

Garrett puts emphasis on the importance of transferring information from the decisions made in the previous plane to the next plane. The model can be seen in Figure 7. The very first decisions are made in **strategy plane**, these are related to the strategic goals and the objectives of the site and defining which user needs are to be addressed. In second phase, **scope plane** the features of the site are decided and functional specification or content requirements are done. The third phase is **structure plane**: here the site structure is designed, including navigation and wireframes. The user interface elements and their placements are defined in **skeleton plane**. Somewhere at this phase the user interface specification needs to be in place, as it usually influences the structure, user interface elements and interaction. The final level is **surface plane** when images, fonts and colors are defined. All phases are important and decisions should always be made to support the previous phase's decisions. People in phases may be different, and therefore communication about the decisions is crucial in order to make good service. People taking part to the service development need to understand how important it is to have good communication, the granularity of information about the users and the focus on the goal. This model does not define the characteristics of the user experience, but rather the process. It tries to ensure that right decisions are made in right time to make better products and good experience for the target users.

3.3 Focus in HCI for Mobiles Is Switching from Usability to User Experience

My papers on mobile Internet usability and usage present well the general evolution of how the terms 'usability' and 'user experience' have been used during the years. In year 2000, when the first (industry) paper was published, it was not very common to talk about "user experience". Later the use of the term 'user experience' has become more common. Benjamin Lee Whorf (1967) analyses in his work on Hopi Indians, how language determines how we see the world. Language builds the framework that we use when we construct the meaning of the world. It is often very difficult for people to understand, that

other people look the world from very different angle. However the increase of the term 'user experience' together with 'usability' in mobile HCI is a sign that the way of thinking and perceiving the area is changing too.

Figure 9 shows how frequently terms 'usability' and 'user experience' were used in the full papers of MobileHCI and CHI conferences from year 1998 to 2008. "Usability" has been all the time a more commonly used term than 'user experience'. The use of 'user experience' has however increased during the recent years. The Figure 9 shows also that the number of mobile research papers has increased overall; not only because MobileHCI has grown as a conference, but also because the number of mobile papers has increased in CHI conference. There are naturally other conferences as well, but these two represent well the general trends in the area of mobile HCI.

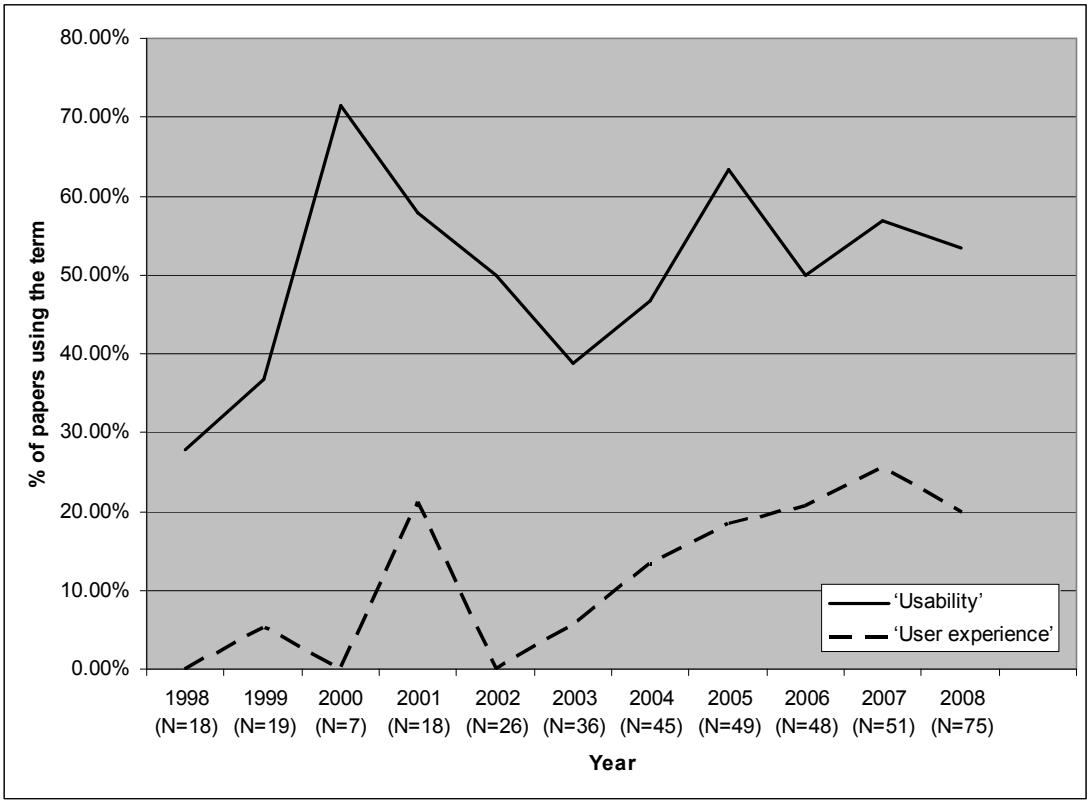


Figure 9 Evolution of use of 'usability' and 'user experience' in CHI and MobileHCI conferences.

Usability is more commonly used in conference papers than 'user experience': usability was mentioned in 201 papers and User experience in 58 papers from the total of 391 conference papers. 167 papers did not mention either term: for example many input test papers were focusing on measurable issues, like speed and accuracy (number of errors), and did not use the vague terms that cannot be directly measured.

The use of term 'user experience' has increased during past years. The increase of the term use, however, is not the only important thing to focus on. Even more important is to understand how these terms are used and especially if they are used in conference papers in such a way that it is possible to know what was actually studied.

According to the theories of semantics, the meaning of the word is the concept or mental idea the word awakens in the person using the word, or the ideas a person associates with the word. (Kangasniemi 1996) In addition to the explicit meaning of the word (denotation), it has connotations, side meanings. These side meanings vary depending on the person: people from different cultures and language groups have different connotations associated with the same word. The connotations may also change with time. In addition to connotations, words have affective meanings linked with them. The same word can raise positive affections to some people, but negative to others. We learn the use of the words in our own environment, Vygotski (1982) goes even so far that he says that thinking is internalized speech we have learned from people around us. Even if the models of thinking have changed since Vygotskis time, there is still valid point: in addition to specific meaning to the word, we also learn connotations linked to it. As the field of human-computer interaction is multi disciplinary, it means that there are people that have learned different connotations to words.

Defining the meaning of the word can be problematic: usually the person using the language does not explicitly think of all connotations attached to the word. In the everyday use of the word it usually does not even matter. However in the area of research it can be problematic if keywords have affective meanings or vague connotations. It is problematic, if scientific models include terms with strong affective meanings, because these affective meanings and connotations can potentially contort the whole model. The scientific definitions to words however only apply inside a specific field. The meaning of the word is very much linked to the context where it is used. It is possible also that word has a different meaning every time it is used, even if the same person uses it. As it is important to know if researchers who have authored the papers actually talk about the same thing, I went through the full papers of two conferences. I analyzed how words ‘usability’ and ‘user experience’ were used in Mobile HCI and CHI from year 1998 to 2008. From CHI conference I selected only the mobile papers. The tables including the papers and the use of the terms can be found from Appendix 1. The terms are very rarely explicitly defined by researchers, so the analysis is very much based on context, especially on research questions and methodology. Most papers mentioning either term, mentioned the term multiple times in different contexts.

Word ‘usability’ was most commonly referring to usability test. Almost 40% of the conference papers were referring to usability tests when mentioning the word ‘usability’. When usability was mentioned alone, in 25% of the papers it referred either explicitly or implicitly to ISO 9241-11 definition. The other common definition was close to the usability definition of Nielsen: the ease of use and learnability (11% of the papers). In over 18% of the papers the ‘usability’ was referring to problem, either related to either one of the common definitions, or as an issue to be solved by user test, using the common usability test protocol. 8.5% of the papers used usability in clearly wider meaning, including behavioral patterns, emotions; as a synonym for ‘user experience’. Over 15% of the papers did not use the term in such way that it would have been possible to define the meaning, but the term was clearly referring to a device or a system.

The meaning of ‘user experience’ was harder to analyze and there were very few papers with an explicit definition of the term. In fact, only two papers from 58 defined the term explicitly. One paper defined user experience as a combination of usability, motivation, behavior and usage pattern, and other via components affecting user experience. In 38% of the papers mentioning ‘user experience’ it was referring vaguely to user in such way that it can be concluded to be an attribute of the person, but in over 12% of the papers it was clearly a system or device attribute. 24% of the papers were using term ‘user experience’ as a synonym of ‘usability’ and in over 25% of the papers it was not possible to make any specific conclusions on what was the term referring to. User experience was not once referring to profession or methodology.

The use of the term 'user experience' has clearly increased during past ten years. There are many reasons for the evolution: in mobile area one reason is the maturization of the technology. The number of mobile devices has increased and web browsing on mobiles has become more common in recent years; Strategy Analytics (2008) estimated that the global number of mobile Internet users passes 400 million users by the end of year 2008. The number of users having experience on mobile browsing in their daily life has increased, and this has influenced the topics of recently published papers. Kjeldskov and Graham (2003) evaluated over 100 mobile HCI papers from eight conferences from year 2000 to 2002, and found out that the number of studies in natural environment, studying the natural behavior of users with mobiles, was relatively low. Based on the terminology review I found that there are more papers with ethnographic perspective now than when Kjeldskov and Graham were doing their evaluation. Early years the papers were focusing on how to make user interface easy and consistent, now the technology is mature to enable studies that focus on usage patterns and motivation.

There is a logical reason why the research focus has changed and this change is visible in the use of terminology. The need for having a bigger picture has increased and now it is also possible to investigate it better. The approach of research has moved from bottom up to top down. My own papers show that the use of the terminology is not always logical or consistent, but I have not been the only one. The other researchers have equally lacked the logic when using these core terms. Especially 'user experience' has been used without definition, in such a way that it was very difficult to figure out what was actually in the focus of the study (the test setups in these papers were measuring mostly behavior, behavioral patterns, opinions or the preference of participants or their perception of own motives). Usability was easier; it is often related to ISO standard or other commonly known definition or things that can be tested with usability test protocol. Sometimes it, however, is used in a clearly wider meaning, thus that is not usually defined.

The need for having broader perspective than 'usability' is understandable especially in consumer electronics. There is a need for understanding the underlying motivations of people that go beyond the area that people are aware of and reach the source of emotional. The problem when investigating this area is that people are not good at going beyond the area they are aware of. According to William James (1984) the mystic experience lasts less than one hour. Afterwards it is almost impossible for people to remember and verbalize the experience, and the experience is independent from person's will. You cannot decide to experience. Similar thoughts can be found also from Mihalyi Csikszentmihalyis (1990, 1998) theory of flow. According to Csikszentmihaly, people seek for good life and happiness. This good life is defined based on the amount of optimal experiences or flow experiences. The experience is always an intrapersonal event. It can be defined only by the person himself, and is not always possible for others to observe. Nevertheless people are able to tell right after the flow experience that they experienced it. This would mean that in order to be even close to reliable, the emotional response has to be asked in the moment when it is happening. The external system can not directly cause the flow experience. Flow is human interpretation and experience. There are, however, elements that facilitate the build up of the flow: The system needs to provide clear goal, if the goal gives value to individual, the better. System should not have elements that break the harmony. Breaking harmony in visual aspects or interaction distracts users' attention so, that going to flow state is less likely. Usability people would call this consistency. Social interaction is not necessarily linked to the flow experience, but is essential for the happiness of people. Therefore the system should encourage or allow social interaction.

3.4 Usability and User Experience in Product Development

No matter what we call the user-centric approach, the users of the technology need to be taken in consideration in all the levels of decision making in product and service development. It is a crucial part of the risk management. The knowledge on the users of the technology should have even higher importance in decision making than it has today: according to WDS Global's media bulletin from July 2006, 63% of mobile products returned due to a fault, did not have fault when investigated. This costs 4.5 billion US dollars every year. The main reasons for 'the fault' are usability problems, false expectations (wrong info from advertising/ sales people) and configuration problems (often usability related issues as well). Bad usability and over expectations cost the industry a lot of money. Making better products that fulfill the expectations of the people is not about answering a few questions. The people working in different phases of development process and the people in different disciplines in industry have specific questions that need to be answered (Ketola and Roto 2008). All these questions are related to product improvement through user understanding.

Roto (2007) is one of the few that has approached the user experience from product development perspective and states that the difference between usability and user experience is that usability is a product attribute and user experience is personal, subjective feeling about the product. It is good to note that if user experience is in fact an intrapersonal event and not a product attribute, it is not possible to design user experience, but rather design enablers for user experience.

Roto also points out that in addition to definition; there should be an understanding of the granularity of the user experience, as well as measurability. These are very good points and first steps towards such approach to user experience that could be truly utilized in product development. I am not convinced that 'user experience' is the right term to use for holistic approach to human centric design, but in order to be useful in product development, it requires three elements:

1) The commonly agreed definition of user experience (or the definition of the goal in good user experience)

2) Ways to measure user experience

3) Design and development guidance: process and methodology description, design guidelines

It is clear that there is not a commonly agreed definition for user experience in the same extent there is for usability. Even if the commonly agreed definition of usability has been achieved through heavy standardization process, this may not be necessary for user experience. User experience is not an attribute of a product, and the standards cannot define how people should feel or react, but rather how the technology should be designed.

Roto and Rautava (2008) suggest that user experience measurement could be done by using a questionnaire. The questionnaire would include at least four elements; two related to pragmatic and two to emotional aspects. Perceived utility (the usefulness and the reliability of the system) and usability (the ease of use, efficiency) are the elements of pragmatic approach and emotional aspects are presented in social value (connecting people, identification) and enjoyment (pleasure, stimulation). These are a good start, these measurements, however, measure only the elements users are aware of and still seem to degrade emotions to the number of observable items. If we will continue the use of 'user experience', the next question is how to measure things that the users are not aware of and elements that are related to social acceptance.

Garrett (2003) suggests that the process is the key to the good user experience. The process described by Garrett does have the same underlying idea as user centered process defined in ISO 13407. The process defined in ISO standard is in very high level, not defining the tools, but the order. It does not define what information on users should be used in different steps, so as well as it works for usability, it could be used for a more holistic approach.

The improvement of the use of the user-centric approach in industry has much bigger challenges than the definition of the terms. Coursaris and Kim (2006) state that the consequences of usability are: the adoption of technology, retention, loyalty, trust and overall satisfaction. These are extremely important issues that any management should take very seriously. Väänänen-Vainio-Mattila et al (2008) bring up that there is a gap between the approach of academic researchers and industry practitioners. Academic researchers do not know what kind of questions and challenges practitioners have and therefore the researchers may put their time and effort to things that do not provide answers to the questions practitioners have or report the results in such form that practitioners are not able to use them. Practitioners in industry have difficulties to participate the discussion, as they usually cannot talk in public about their work. In industry, the holistic approach to user is no means a new thing. The more holistic approach in companies has been owned by market / consumer research people that have very different background from usability /user-centered design practitioners.

3.5 Scripts Build Experience and Expectation

According to Schank (1999) human memory is structured in such way, that it allows us to learn from our experiences. This is a crucial element when people are evaluating new technology and whether it brings value to an individual person's life. The dynamic nature of memory presented in the form of the scripts illustrates well how the past experiences build the basis for present expectations and experiences.

The memory is not static. This means that we carry lots of memories and experiences with us. These memories and experiences have changed our representation of the world, and allow us to view the world in a unique way. With every new input, every experience, memory has to adjust itself. The new experience either assimilates to the existing way of thinking or it changes our perceptions. There is no way of going back in time: a person cannot undo his experiences. Therefore the services and systems that were satisfying 10 years ago would not make us happy today. People do not understand things without referring to what they know already and what they think about the topic. We are very much the prisoners of our mental models and our perception of the environment.

How does this dynamic memory works? To make it easier for us to deal with the complexity of world, we need to simplify it. In this process we create the scripts of common elements. Script is a knowledge structure that ties the pieces of information together and composes a stereotypical event or episode. Script is a generalization of a typical event. Any piece of information can awaken an existing script of an event. For example a word or a technical term can awaken a script. If the term is used outside of its original context there may be a mismatch between the script and the reality. Saying that WAP was 'Internet in your pocket' is a good example of this mismatch.

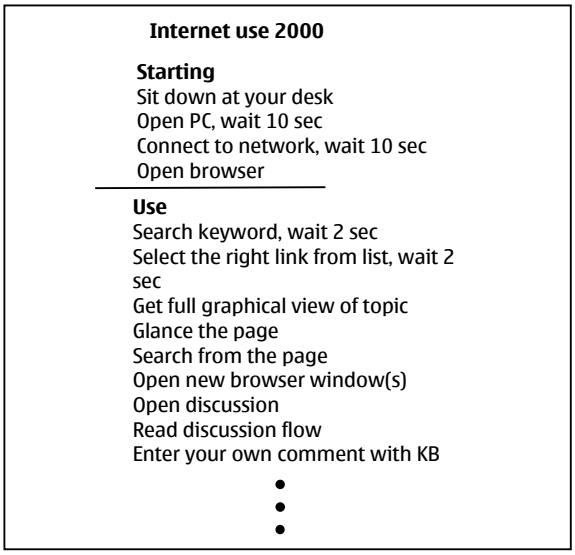


Figure 10 The script of my Internet use from year 2000

Script is a knowledge structure, which ties pieces of information together and composes a stereotypical event or episode. Script is a generalization of the event that describes it. Script differs from "mental model" which is an explanation of someone's thought process for how something works in the real world and is wider and more ambiguous term. For example in year 2000, I had a script of 'Internet use'; my script of that event could have been like the one in Figure 10. My 'mental model' of Internet use would have been very different, including aspects on my perception of how Internet works.

The script of Internet use in 1994 would have been different from this and my script of Internet use in 2009 would be different again. My Internet use script in 2000 is very different from my script from Internet on mobiles use in the same year. An example script can be seen in Figure 11.

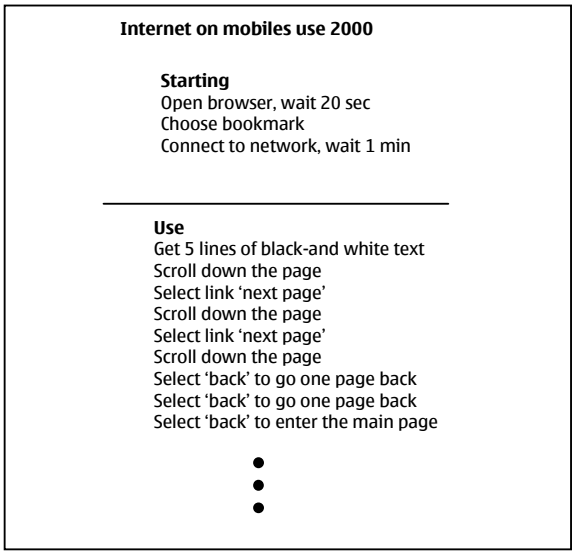


Figure 11 The script of my Internet use on mobiles from year 2000.

4. EVOLUTION OF INTERNET ON MOBILES

The papers I have published during the years are reflections of the publication period in many ways: the focus of the papers, methodology used and terminology reflect the overall situation. In order to understand the evolution related to the studies, it is good to have an overview of the time. Evolution has demonstrated in different aspects; issues related to human factors, technology and business models have evolved during the past ten years.

4.1 Internet on Mobiles – the Beginning

The public discussion on mobile Internet started in late 1990's, when first Wireless Application Platform (WAP) enabled mobile phones were about to be launched. The hype was big in the last years of the previous millennium, just before the launch of first WAP enabled mobile phones. Paananen et al. (2000) wrote in their book about these pre-launch expectations of the WAP. In late 1990s it was predicted that the number of WAP enabled phones would grow strongly in the future. This growth was expected to provide huge potential to the new kind of services; services built on Internet technologies and would be used on mobile phones. WAP was said to be 'Internet in your pocket'. The increasing number of companies specializing to mobile service development was established; though the most of these companies were not able to survive when the hype was over. Initially there seemed to be good building blocks for the creation of the great success. One important block seemed to be either forgotten or misunderstood: the users of these new mobile services. User needs and perceptions in relation to services were not understood. The importance of the cost for users was underestimated: the users' eagerness to try new technology was overestimated. In the middle of the hype, these seemed to be minor issues.

There was strong belief that the mobile services would bring so much value to users that a sufficient number of people would find them worth paying. It was known from the beginning, that using the services was not free, and many corporations wished that the "mistakes" of Internet would not be repeated in mobile (Sokala 2002): the mistake was that the big part of the content in Internet was initially free (the reason for this was, that Internet development was initiated by the research community). Making money for delivering information online was very difficult, when users expected to get this information for free. It is hard to make people pay for something they used to get for free (Dou 2004). WAP was driven by WAP forum (WAP Forum, 2009), the alliance formed by different industry players, including mobile network operators, device and infrastructure manufacturers, and software houses. WAP forum is the early name of the alliance called Open Mobile Alliance (OMA) (OMA, 2009)

Using WAP was not cheap even in the information would have been free: Paananen et al. (2000) calculated in their book that the cost of an individual bill payment was 4, 68 FIM (0.79 €) and stock information retrieval did cost almost 7 FIM (1.18 €). According to Paananen and his co-writers the success of WAP was depending on how well the services could be personalized, how the advertising is enabled and how the location can be utilized in services. This means that success of WAP was believed to depend on how much value services would bring to users in mobile context and how much the cost could be reduced by advertisement. The services at this time meant almost entirely consumer business services, banking services for example. Email was one of the very few social services planned at that time.

Kaasinen et al (2000) showed that mobile Internet users' information needs cannot be satisfied with the tailored mobile content of the time; users' need for information were so diverse that tailoring all the content for mobiles would have been impossible due to development resource constraints. To provide 'all' Internet content to users was one option

to investigate, as only big players, like network operators, news houses and banks could tailor sites specifically for mobiles.

In ***the first paper,*** our industry case study paper in British HCI conference (Kaikkonen and Törmänen 2000) we described the Merita Bank's WAP service development process. The paper describes the service development process, but in the end of the paper there is the statement that shows belief to the future of Internet on mobiles despite of the problems we were aware of:

"Even if WAP as a standard is in a quite premature state, the experiences from this project show that it is possible to develop useful mobile services by using this technology. The critical aspect in development is that the usability issues are taken seriously in consideration during the design process. This means that a good mobile service provides the right content in the right form."

Few years later, when I was evaluating the usability of mobile portals in ***paper 6***, (Kaikkonen 2006) I found out that usability or user needs have not been in the top of the priority list when developing WAP services**.**

4.2 What has Changed During the Years?

Many things have changed and evolved since early 2000. The number of people using mobile phone in their daily lives has increased. Phones have changed in many ways the fundamentals of our communication practices (Kopomaa, 2000, Ito et al 2006).

4.2.1 Evolving Technology

	Nokia 7110	**Nokia N95**
Weight	141 g	120g
Dimensions	125 x 53 x 24 mm	99x53x21mm
Display	Monochrome graphic 96 x 65 pixels	16 mil. Colors, 320x240 pixels, 40x53 mm
Data connectivity: speed and type	Supports 14,400 bit/s Data:CSD – time based, Infrared	up to 3.6 Mbit/s Data: HSCSD,GPRS,EDGE, WLAN, Bluetooth
Browser and content	WAP 1.1 browser WML as script language	Full Internet browser XHTML and HTML as script languages
Ways to access Web	WAP browser	Browser+ applets and applications
Memory	4 MB (internal) – no memory card	160 MB (internal) + MicroSD Memory Card (up to 8GB)
Battery life	4 hour talk time, 260 hour standby	~3 hours talk time, 200 hour standby
Device use	Primarily as mobile phone.	Mobile phone, but camera, music player, browser and maps are popular applications

Table 1 Comparison of Nokia 7110 and N95 mobile phones

Evolving technology has been facilitating these changes; therefore I use two physical devices to show how the technology has changed over time. The reason for having this approach is that changes in mobile devices are visible for users and therefore easy to perceive. Two devices I use are Nokia 7110, launched in 1999 as first WAP 1.1 phone (Nokia 7110, 2009) and Nokia N95, launched in 2007(Nokia N95, 2009). The comparison can be seen in table 1.

It is relatively easy for users to evaluate the evolution through a physical device and its' capabilities (table 1). The first WAP devices were bigger and heavier than the current devices. The common trend of technology miniaturization can be seen here. The first WAP enabled phones also had small, monochrome display, whereas the devices today have large, better quality color displays. The example of the services with Nokia 7110 and Nokia N95 can be seen in figure 12. The screenshot of Nokia 7110 is from a service designed as a part of Wishes EC project. The screenshot of N95 is from the web site of Finnish Meteorological Institute. The screen size does not influence only the esthetics. Large displays with good resolution allow a bigger amount of information to be visible for users and this may help in understanding the context. There is some evidence that reading on the display is faster on bigger screen. (Gostner et al 2008). The latest devices with even larger touch screens have changed the situation even more. Latest statistics have already shown significant change in web browsing patterns on mobiles. (Cellular news 2008)

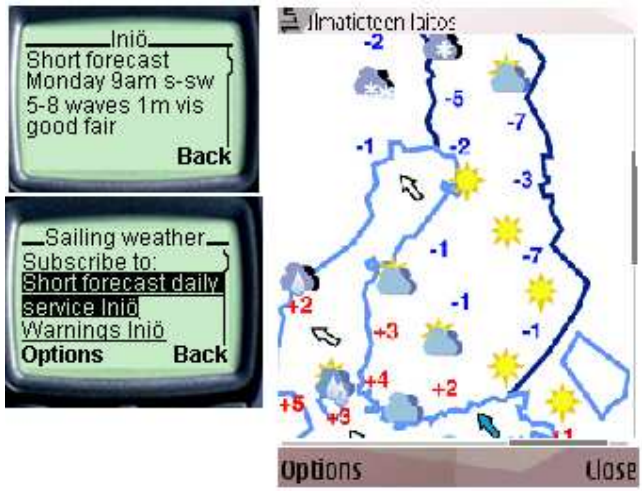


Figure 12 Weather service screenshots of Nokia 7110 and N95

The cost of the service use is no longer based on the length of the connection time, but on the amount of the data transferred. This means that browsing textual, mobile optimized site is cheaper for the user than browsing graphically rich content. Textual site also downloads to mobile device faster than a very graphical site. In ***paper 3***, (Roto and Kaikkonen 2003a) we suggested that the page structuring and graphics should take inconsideration the occasionally slow mobile network, as waiting time acceptable for users seemed to correlate with the perceived value of the page content. Today the network speed has increased and it is not always an issue for user (***paper 6***, Kaikkonen et al. 2005), but the users are not always within the fast network.

Some network operators' today charge based on network capability: by the speed of the data transfer. The limitless flat fee rate has also become cheaper, so that it is in price range

available for an ordinary consumer. There are various ways to connect the mobiles today: devices can support 3G connections, but also low distance connections such as Wireless Local Area Network (WLAN), which can be free for users. In addition to more alternatives and faster network speed, also starting the connection use is easier: in the beginning, users had to manually enter the browser settings and today this information is usually already in the phone or network operators send the settings over the air and user just needs to accept the message.

The browsers today support full web content in addition to mobile tailored content. For the user this means that there is more content available – user can even access the web site of his own hobby group with his mobile phone browser. The user interaction on browser has also improved. Many browsers today have better navigation aids than the first mobile browsers. In addition to the increase of the content, the mobile phones today support multiple ways of accessing the web, not only via browser, but also via applications and applets. This gives more flexibility for the users and for the developers.

The amount of memory on devices has increased and the devices have more processing power than earlier. This makes it possible for the users to store more content of their own in device and share with other people either directly from device to device or via online services. New devices also allow users to create their own content easier: photos and videos for example. The multifunctionality of the mobile phones has changed the use of these devices in many ways: The multifunctional devices allow users to decide more what they want to do with their mobile device. Users can also choose if they want to carry just one multipurpose device or multiple specialized devices with them.

Both the devices and network service have improved, the amount of web sites that users can access with mobile has increased, and devices have become more multifunctional devices. There is one significant thing that has not improved as fast as the other things: the battery life. Even if the battery technology has improved, new devices with powerful connectivity and multiple processing systems allow people to use the devices for multiple purposes. When people use devices more actively, the batteries in new devices drain as fast as in the old devices.

4.2.2 Evaluation of Value and Usage

The infrastructure (devices, networks, billing models etc.) in the early days of mobile Internet was not mature enough to engage users. It became fairly soon clear, that when users weighted the value and the benefit, they came to a conclusion that it often was not worth the money and the effort. From the user point of view, there were better ways to pay bills, find news and other information than mobile Internet could offer.

Gourville (2006) says that people over-value the benefits of the systems they own or use already, in relation to new systems they do not own or use. The attractiveness of the new is evaluated based on subjective or perceived value, not the actual value. What is the perceived value is not a simple thing to understand, even if it has influence on users' decision making. The price is evaluated based on current system person is using (it can be technology or any other way: in finding latest news, mobile Internet value in news reading is analyzed against news papers, TV, radio and web sites). The combination of improvements and cost are evaluated as gains and losses, and the new system must have more gains than losses to have better value than old one. These losses and gains are not only related to money, but also other characteristics- for example with satellite radio, the gain could be a broad selection of music, but loss would be free music. In online grocery shopping the gain would be home delivery, but loss ability to choose the freshest products. Losses weight more on scale than gains. Overall, according to Gourville (2006), the new system has to prove to be 3 times better than the old one to convince people to buy it. The behavior related to the existing

system is considered to be a status quo- the behavior change is most probably considered more often loss than a gain, and we have to remember that loss is valued 3 times the gain.

This means that the gain when switching to new system has to be bigger than the loss. That may be one reason why online grocery shopping has not proven to be success, even if it would save time and effort often with a reasonable amount of money. Companies should be aware of this skepticism people have and take it in consideration when advertising on new products. Instead of seeing the product from users' perspective, companies often overvalue the new product and take it as granted that people perceive the value in the same way as the company. This leads to even bigger balancing problem: when people overweight the existing product 3 times, the companies overweight the new one with 3 times, so the gap between the perception of company and people (as consumers) is 9 times. Both sides being unaware of the bias in their thinking (the user is not the one that should be concerned about this). The first thing the companies developing new products should think is the behavior change expected from people- the bigger it is, the bigger the benefit has to be. The analysis of Gourville is well supporting the rationale of Kaasinen (2005) when she explains in her Technology Acceptance Model for Mobile Service why 'perceived value' describes better the mobile technology adaptation than 'perceived usefulness' used in original Technology Acceptance Model (Davis, 1989).

When running WAP development workshops for Nokias partners in the early years of WAP, I used to ask participants how many of them had changed their diet during past year. Very few had, and those who had, were usually forced to do so due to the health reasons: immediate illness or similar. New diet just to make your life little healthier was not big enough motivation. My main point to workshop participants was: do not expect people to change their behavior if they do not have to or if the benefit is not obvious. And do not expect the change to be fast. When the groups of people are changing their habits, the change is often very slow. People change daily routines usually only if they have to: they start driving a different route, because there is construction work in their old route for example. During the WAP hype, these kinds of warnings were not really heard.

The perceived values of the people can be approached in different ways. Sheth et al. (1991) have developed a theory of consumption values with five value dimensions: functional, social, emotional, epistemic and conditional value. Functional value is related to task fulfillment and efficiency; practically the goals of traditional usability. It is also related to monetary and convenience values. Social value is related to social approval and self image in relation to social context. Emotional value is met when service or system arouses feelings or affective states, for example playing a game. Epistemic value relates to experienced curiosity, novelty or gained knowledge. This is thought to be one of the driving forces in new technology purchase. Conditional value is related to situations with choice and specific context. Even though these values seem to be related rather on purchase process than the usage situation of the system, the same values should be taken inconsideration throughout the system lifecycle. Kujala and Väänänen-Vainio-Mattila (2009) focus in their value model into psychological values. They base their model to psychological and consumer research literature, and came up with following categories: social values, emotional/ hedonic values, stimulation and epistemic values, growth and self-actualization values, traditional values, safety values and universal values. The content of most of these is easy to see, the ones that need clarification are traditional values and universal values. Traditional value is about the respect and the acceptance of existing perceptions and behavioral patterns, universal values are related to the protection of humanity and nature.

4.3 Was WAP a Mistake?

Sokala (2002) says that the main reason for WAP hype was that big companies wanted to ensure they will not stay behind in the development in mobile. According to Sokala the business world was a follower when Internet boom started and academic organizations were leading the development. Sokala believes that one of the reasons why the content was free on Internet was that non-profitable organizations were leading the development. Afterwards it was difficult for companies to make money by selling information. The Internet on mobiles looked more promising: mobile phones and text messaging had been more successful than anyone had believed. A new way of accessing the Internet was thought to be good opportunity to put the price tag into information. Sokala predicted that the rise and the fall of WAP would happen in 3 years (that is, by year 2005). He admits that even in 2002 there were people using WAP without knowing it, as many new phones by various device manufacturers were already WAP enabled. British Market Research Bureau, BMRB International reported in November 2000 that only 2% of British adults used Internet with their mobiles. As the number was so small, it was hard to believe the estimations that in 2001, there would be 12 million wireless Internet users globally (according to Strategy Analysts report 2008, the actual global number of users was over 42 million in 2001). Sokala says that the walled garden was one of the problems with WAP.

Even if controlling the environment made it easier for operators to harmonize service user interfaces and ensure good user experience, it also made it possible to control that users would stay in pre-defined sandbox. The walled garden was criticized in Europe, but interestingly did not come up in iMode discussion, even if the situation was quite the same. Sokala says that overall Japanese operators took end-users better in consideration when marketing the system. Not only NTT DoCoMo on iMode, but also J-Phone and KDDI, who were actually building their mobile Internet solutions on WAP protocol. This is an issue that is often forgotten when talking about the WAP failure. For example Agar (2004) and Ballard (2007) do not even mention the other Japanese operators when talking about the mobile Internet success in Japan. Sokala talks about the iMode coming to Europe and possibility to provide cheaper services to consumers, but forgetting that iMode is rather marketing and business model than actual technological solution. It was not a big surprise that bringing iMode to different environment did not create as big success as in Japan. I claim that the success of mobile tailored Internet in Japan was a result of a good understanding of local users leading to business model driven solution. Users were not given unrealistic promises and the marketing did not use metaphors that would have misled users' expectations. The differences between iMode in Japan and WAP in Europe can be seen in table 2. (Kaikkonen and Williams 2001) It was not only about technology or individual service, but rather the whole package.

In mobile industry, the two main success stories have been the mobile phone itself and the text messaging. The mobile phone with voice call capability changed the way people communicate, but the beginning was not easy: There were big the doubts on the mobile phone usefulness and success in late 80's, early 90's (Sokala 2002). The other success story, text messaging, changed again the communication patterns (which based on Saarikoski is placed by email on mobile in Japan). The success of text messaging was not clear in the beginning either – still mid 90's there were doubts about the success of text messaging on mobile. After the disappointment on WAP, it was often forgotten that text messaging (SMS) was not an instant success; the first SMS was sent in 1992 (GSM World history 2009) but the start was very slow.

WAP in Europe	iMode in Japan
WAP is a global standard	iMode is NTT DoCoMos proprietary system
Terminal/user interface used is not specified in standard	Used terminals/user interface follows the given specification
Marketed with technology	Marketed with applications/ user benefit
Usage expensive	Usage relatively cheap
Before WAP, SMS usage was widely spread	No prior, widely used, mobile text based communication system in use
Internet access in homes	Internet access rare in homes
Only few applications clearly targeted to defined users	Applications targeted for teenagers or business men (=clear focus)
Uses currently WML as script language	Uses currently cHTML as script language

Table 2 Differences between WAP in Europe and iMode in Japan in 2001

When I joined Nokia in 1998, in first user studies I conducted, users were wondering who would ever need to type 160 characters with phone keyboard and send it to other person's phone. It was difficult for users to see the value of text messaging when that was not a common communication tool in a person's social network. Communication is the common nominator for these two success stories. Both voice calls and text messaging are related to networking and connecting with other people. Already in the early days of mobile Internet, Odlyzko (2001) showed that content has never been a king of any media. People have always been willing to pay more from communication than content. Even if the content does have value, the social interaction is even more important. This is why Odlyzko claims that the (social) connectivity is the real king. Odlyzko predicted in 2001, that the future of the Internet will be about person to person communication. He did not predict the social networking in way Internet provides today, but he was clearly on the right track. Odlyzko also points out that 'growing storage and communication capabilities will be used often in unexpected ways'. When given the freedom of creativity, people start using the technical systems in unexpected ways. The latest Internet boom is about social networking and we have seen how younger generation has moved from email to instant messaging and other social networking services. Also the latest Internet success stories, MySpace (http://www.myspace.com) and Facebook (http://www.facebook.com), are about social networks. Being in contact with the others is one of the key drivers for humans.

Did it make any sense trying out immature technology in late 1990's? Even if there were problems, we did learn a lot during the first years of WAP. Some of the learning can be used later, when developing good Internet services for mobiles. In the area of usability, many researchers published papers related to user interface design, interaction design and usability: Buchanan et al. (2001), Chittaro and Dal Cin (2002) and Kim et al. (2002) amongst many others. I investigated the area in ***paper 2*** (Kaikkonen and Roto 2003), and ***paper 5*** (Hyvärinen et al. 2005). In addition to technology and protocol information, these papers do contain generic information related to the usability of, and design for, small screens and spotty networks. This generic information can certainly be utilized in the future design and the evaluation of any services targeted at small screens. Another obvious lesson is not related to user interface design or usability, but rather to how important it is to take user expectations and mental models into consideration. The disappointment portrayed by

the media in early 2000 reflected the mismatch between the message and user perception. In the midst of the hype, the analysis of the reasons for the hype took second place to market messages. The companies developing mobile technologies are not, however, entirely to blame; critical public reviews were, in general, rare. The public message on the Internet on mobiles in Europe and North America failed to take into consideration the perception and the mental models of users. Japanese companies were doing a better job, building ready-to–use packages for users.

4.4 Evolution of the Penetration in 6 Countries

Mobile Internet penetration has evolved differently in different countries. There are multiple reasons for the differences and several analyses have been published on why Internet on mobiles did not fly in Europe or North America. The amount of publications was especially high after the WAP hype was followed by the disappointment.

When talking about the early days of Internet on mobiles in different countries, it is important to remember how the status of the Internet was in late 1990's. The web penetration on computers varied a lot in different countries, so when mobile Internet was introduced, people in different countries had different knowledge level on Internet. How common the Internet and mobile phone use were in a country has clearly influenced on the penetration growth of Internet on mobiles. If we take mobile Internet 'wonderland', Japan, as the first example: In Figure 12 can be seen that in 1998 the Internet penetration in Japan was only 14% (ITU 2009) This period can be called "pre-Mobile Internet time" in Japan. iMode was launched in 1999 and only one year after the launch, penetration had jumped to 37%. The growing use of mobile Internet explained a lot of this, as in Japan those times it was not common to have Internet connection in homes. In the late 90's, Japanese people did not have much experience on Internet use on computers. Due to lack of personal experience it is very likely that Japanese users had very different perception on what is 'Internet' compared to more experienced users. In the same way we can assume that the Japanese mental model of 'Internet' was very different from people living in countries where Internet penetration on computers was reasonably high already in late 1990's.

Saarikoski (2006) says in his doctoral thesis that the main success indicator for Internet on mobiles in Japan was the adoption of email. He views that the main reason for the slow adoption of email on mobiles in Europe is the popularity of SMS. As Saarikoski is focusing on the differences between Japan and Finland, he is not focusing other markets and does not explain why the US did not adopt Internet on mobiles in the same way as Japan: just like in Japan the interoperability of SMS did not exist in US when WAP was introduced and in both countries the mobile phone market is operator controlled.

Jones and Marsden (2006) note the difference between Japan and USA / UK in Internet penetration in the early years of this millennium. The big difference is that in USA people were using email with their computers and that computers with Internet connection were much more common than in Japan. In USA the use of the pagers was also common those days. Saarikoski draws his conclusions of West, based on Northern European behavior, which is not the whole picture. Saarikoski has used expert interviews as primary method in his work. The expert interviews often give quickly a good overview of the market, but the experts already consolidate the phenomena they observe. This means that the consolidations made from expert interviews are often consolidations of consolidations. When doing so, some information may be missed. The research method may be the reason why the main human motivations were missing from the explanations of Saarikoski. The main motivation is social interaction and connectivity. As Saarkoski notes in his paper, the email on mobile phones in Japan is not about multi-device access to message, but rather communication between two people with mobile phones. From the user point of view the need seems to be

the same as with SMS. Even if SMS is not as technically advanced as email, it is better designed for mobile use, as it shows on phone idle screens and with the tone that message has arrived. The advantage of email comes when sending message to multiple persons, as emailing from mobile is cheaper than SMS, where the cost is higher when sending many messages than when sending just one.

USA has been one of the leaders in Internet penetration on computers. In year 1998 the Internet penetration in USA was almost twice the penetration in Japan: Penetration in USA was 27% in year 1998 and 48% in year 2000. Internet connection was not available only in offices and in schools; many people had Internet access at homes too. This means that it was more common for people in USA to access the Internet and gain usage experience. In USA the Internet on mobiles comes to peoples' awareness around 2000, when the Internet penetration was already closer to 50%, (figure 13) at the same time the mobile phone penetration in USA was relatively low. There are views in literature that there is no relation between fixed PC Internet use and mobile Internet/ SMS use (Funk 2003), but the picture today does not seem that simple. Funk did his work in early years, when the whole evolution was just about to start. This shows how in industry there is need to start drawing conclusions faster than people manage to adjust their behavior.

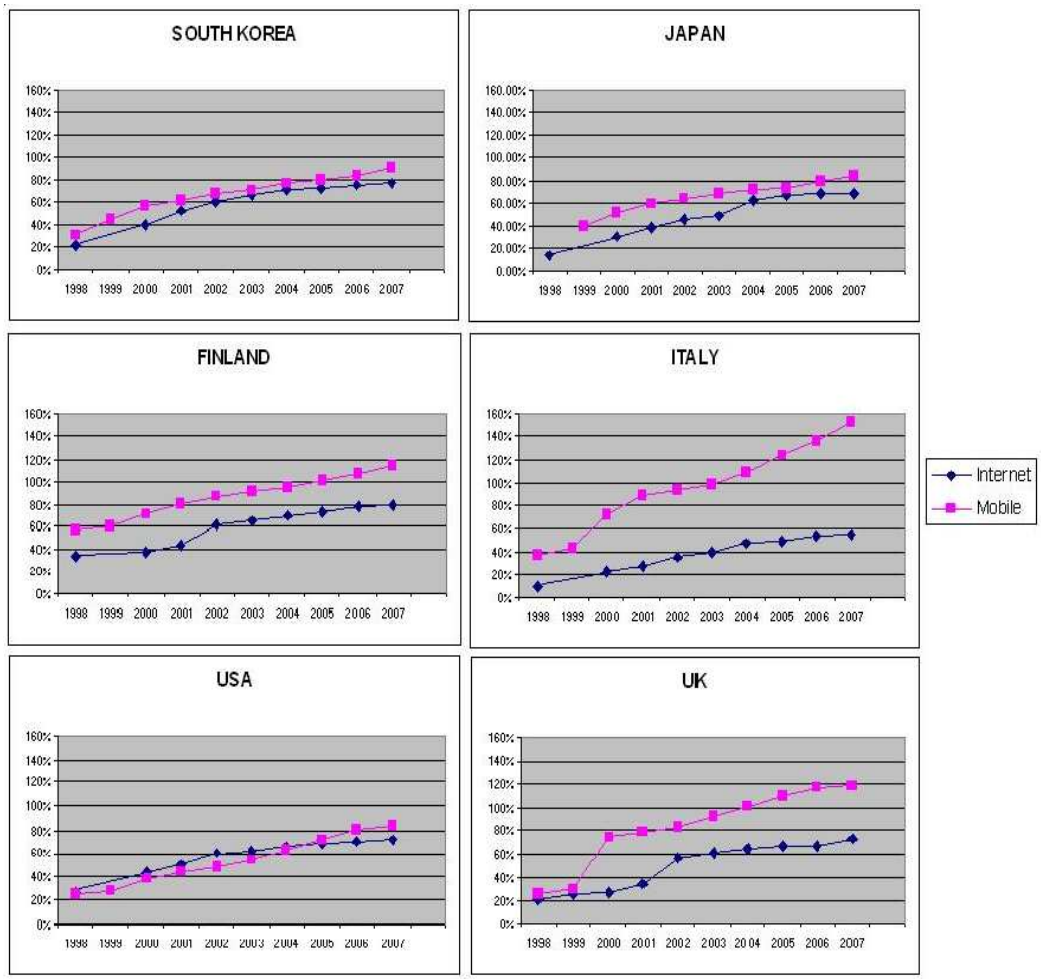


Figure 13 Mobile phone and Internet penetrations in six countries 1998- 2007 (ITU 2009)

High Internet penetration also means that people in USA were already familiar with the concept of Internet and that a large part of the population had already built some kind of mental model of "Internet" before they heard about "mobile Internet". Even if there are no studies concerning people's mental model on Internet from those times, we can assume that the experience with WAP did not match with the peoples' perception of the Internet. In their PC deprivation study, Hinman et al. (2008) found out that users were seeking for the same usage patterns on mobile Internet they were familiar with on computer. When they were not able to realize their needs, they reported about growing anxiety. USA has a long history of computer based Internet use. Figure 13 shows that mobile and Internet penetration in USA have been different from other countries: In most countries, the mobile phone penetration has been higher than Internet penetration for ten years, but in USA the year 2005 has been the first year when mobile phone penetration has exceeded the Internet penetration. This must have had influence on everyday practices amongst the users in USA and their mental models on technology. I believe that the mental models and the expectations rising from them is one of the underlying reasons why Internet on mobiles was success in Japan but not in many other industrialized countries. With less experience of Internet it is less likely that Japanese users had a specific script of Internet use at the time when iMode and other mobile Internet services were introduced. It seems that the decision makers in Japanese companies understood the landscape and were capable in using information in decision making: they did not advertise the mobile services with technical terms, but rather with benefit for users.

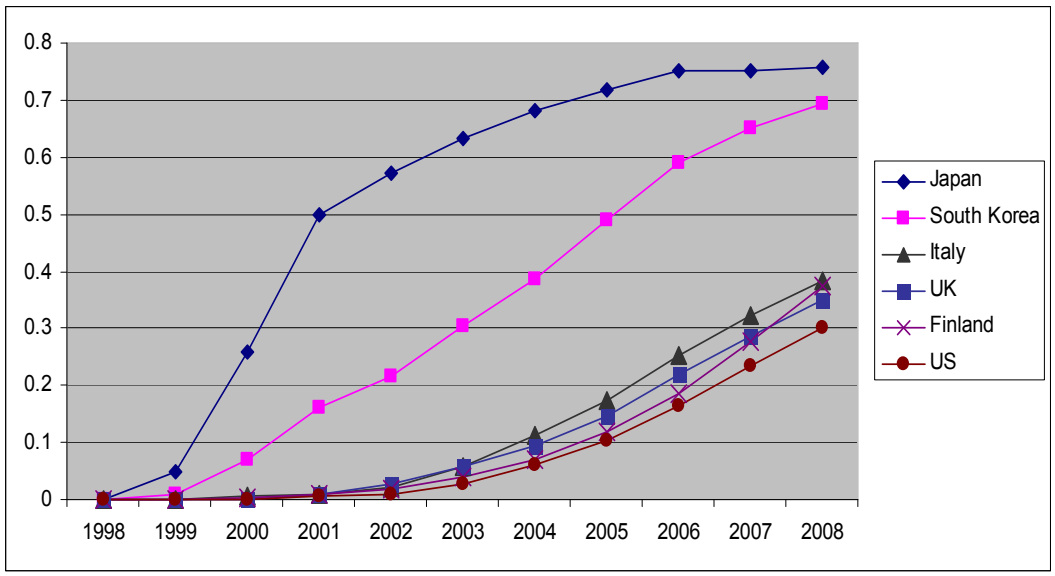


Figure 14 Mobile Internet penetrations in 6 different countries in 1998-2008 (Strategy Analytics 2008, used with permission)

Few years ago there was perception that mobile Internet had failed in Europe and in USA. Despite of these perceptions, the penetration in several countries has been growing steadily (figure 14). Japan and South Korea have been ahead of the other countries, but the penetration has been growing steadily also in Europe and USA. The shape of the growth is very close to the Rogers's (2003) S- cumulative penetration curve (Figure 15). The S-shape was just different in different countries, less steep especially in US and European countries. The disappointment because WAP was not an immediate success was related to mismatch between the user and industry expectations. Industry decision makers in USA and Europe were not able understand user perspective to mobile Internet and took it for granted that

users would see the benefits in the same way as industry did, just like Gourville (2006) has pointed.

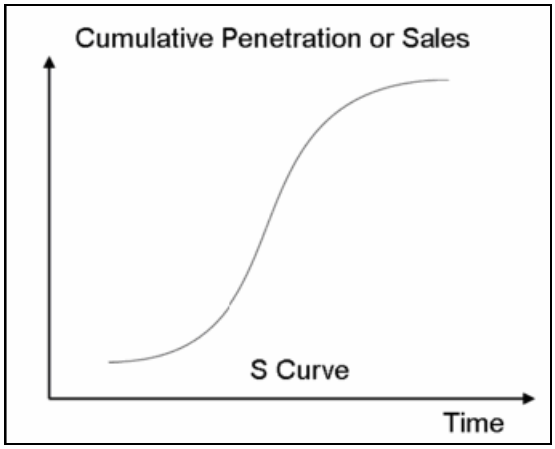


Figure 15 Rogers' Cumulative penetration S-curve

4.5 Internet on Mobiles- Situation Today

Forrester report (Lakshmipathy 2007) says that Internet on mobiles suffers from three major problems today: 1) content is hard to find. Forrester report talks here about the mobile tailored content. 2) Usability is poor: typing with mobiles is difficult, mobile tailored sites are not properly designed for mobile use, but rather modified slightly from Internet offering. There is also lack of consistency between the sites and within the site. The downloadable applications provide better usability, but the applications are hard to find. 3) Access to Internet on mobiles costs a lot and users do not understand how the cost is generated. This would mean that the services are not only difficult to use, but there is no reason to use them and using the services is like giving an open check to the network operator.

Steven Browne (2007) has come to a similar conclusion and says that Internet on mobiles suffers from three major barriers in user friendliness, covering some of the problems pointed in Forrester report: 1) Mobile search is inaccurate 2) carrier / operator portals are ambiguous and 3) input is cumbersome. Browne gives five examples, how Japanese companies have made it easier for users to get the mobile Internet content, most of these are related to finding the content. Japanese companies provide bar codes as shortcuts, applications are pre-installed to phones, web addresses are simplified and mobile phone input is taken inconsideration in addresses. Tags are pushed to users and there are multiple paths to the sites. Links to mobile web sites are sent to users by mobile email, for example. According to Browne, these help in all three barriers he brought up.

If the Internet on mobiles is looked from developers' viewpoint, the scene has not improved from the early days: the number of alternatives has grown, there are more devices than earlier and the devices are more diverse. There is anything from basic mobile phones to very powerful devices with full QWERTY keyboard and good quality display. These different devices and browsers are presenting user interface differently and they support different technologies for application creation. There are various ways to connect to the network, some phones have very slow connection and the other phones support WLAN and other fast networks. The network speed influences for example on what kind of graphics can be used in the service. A developer has to do lots of work when deciding how to develop a mobile service for as big a group of users as possible. In order to get enough content for Internet use

in mobiles, it has to be easy enough for developers to create it by using standard tools that allow creation for multiple platforms.

The Internet on mobiles gives strongest value in timeliness: information can be accessed when user needs it and the device can use the location to help the information search. (The barrier for the implementation of such services is the complexity of the mobile value chain). If a company wants to build a location aware service for company internal use, they may need to co-operate with the network operator or other 'outsider' to implement the service. The Forrester (Lakshmipathy 2007) does put high hopes in the improvement of mobile web in near future. There is too wide range of device and software out in the market that makes the work of the designers and developers too complicated when designing the services for multiple platforms. Cross channel approach can, however, be the key to short term improvement of mobile Internet. One way is to allow users to define on computer what they want to see on mobile, though this works best on markets where users have commonly access to computers. Other way is to integrate all possible ways to access the services on mobiles and not relying only on browser. This would mean creation of separate applications or applets that access the Internet to retrieve specific piece of information**,** or even having part of the service accessible with text messages.

4.6 Challenges in the Future

Based on ***papers 10 and 11***, (Kaikkonen 2008, 2009) the biggest barriers in use of Internet on mobiles are not related only to the ease of use, but also the facilitators the technology; (for example battery life) and business infrastructure (for example the lack of transparency in cost generation.)

4.6.1 Business Infrastructure

The distribution channels and billing model are very visible business infrastructure related issues in service user experience. The distribution channels influence on the availability of the service and how users become even aware of it.

The ***paper 8***, (Roto et al 2006) shows how evident it is that the cost is one of the major influencers in mobile browsing use and satisfaction. The problem is that mobile data traffic cost is hard to understand, follow, and control. The perception of the billing model does influence user behavior: people try to maximize the benefit while they minimize the cost. The user perception of the mobile data billing model is not always right, due to the complexity and the lack of transparency, but people behave based on their beliefs, not the reality. Gourville and Soman (2002) point that cost awareness and transparency are main elements influencing the consumption behavior. People are more likely to use the product or the service when they are aware of the cost and how it is generated, or when they do not need to care about the cost when using the product.

According to Gourville and Soman only very few executives take long term impact of the cost in consideration when defining the billing models. This may be one reason why the billing and cost models in mobile data seems to be changing so slowly. In relation to fixed Internet use, Shenker et al (1996) come out with similar conclusion that the pricing model in Internet has effect on the usage patterns of the consumers. They point that the users with different usage patterns would need different billing model. The cost of starting to use the service should be low for low-volume users, and the volume in long run is the way to get the revenue. However, heavy users rather pay little more for attachment fee and less for usage. This shows that users try to make decisions based on their assumed usage patterns and optimize the cost and perceived benefit. If the reality and the user perception are not in line, this will cause problems and the only way users can control the cost is by decreasing the use. This is what has happened in the mobile use of Internet, when the billing model has not

been clear. It is obvious that user perception, rather than reality, is what counts more and influences the behavior**.** During recent years the operators have introduced flat fee for data and many mobile devices can access WLAN networks, which can be free. In ***paper 10***, (Kaikkonen 2008) I point that WLAN capable mobile phones increase especially the mobile use of full web.

4.6.2 Technology

Mobile devices with new types of form factors have recently entered the market. The barrier between handheld devices and laptop computers is decreasing giving new possibilities for developers and users.

Despite of the improvement, also the battery life continues to be a challenge in the mobile use of Internet. People keep their mobile phones with them because they want to communicate with other people. Users want to make sure they can make and receive calls or text messages. If there is a risk of running out of battery during the day, users start controlling the service use. The battery life in mobile phone may not get significantly longer, even if the battery technology is slowly improving; New, multifunctional mobile devices allow users to do more with the devices than earlier, and people are making use of these new capabilities. Some new devices are built with the idea of being "all the time" connected. When the device is connected, no matter if the connection is network connection via WLAN or 3G or if it is connected to GPS, the battery is being consumed. If the connection is not good, the device will run out of battery power even faster.

In my work I have observed that users exhibiting similar service usage patterns report very different experiences with respect to battery life depending on network they are on: the users of one network may report that they can use their devices a whole day without charging the battery, and the users of other network report that they need to charge their devices more than once during the day. This may reflect that there can be differences between countries and operators with respect to battery life. If the network configuration influences the battery life, it would be one way to improve the experience with the battery. The battery technology is not the only way to improve the battery life; network configuration and smart default settings in mobile device that optimize the power saves in relation to the usage patterns of user and can help situation as well.

4.6.3 New User Groups and Emerging Markets

I have done my user studies in Europe, Asia and North America, where there are advanced mobile devices that can connect to the Internet: the device screens are reasonably large, the devices may have touch screens or full QWERTY keyboards and fast network access. To have global view to the future of mobile Internet, the focus should also be turned to Africa. There is little research data on mobile Internet use in Africa, but there is other evidence showing that Internet on mobiles has good potential there. Operas' report of mobile web use from September 2008 shows that service traffic in Africa had grown 180% during 6 months (Opera web site, 2008). In global the chart of Opera, Egypt and South Africa are amongst top 10 countries in service use. The mobile web browsing has grown rapidly also in many other African countries, especially in Nigeria and Kenya. Nigeria and South Africa are also amongst the top countries of BBC international WAP use (BBC world report 2006) and the overall use of mobile Internet seems to be active in these countries: South Africa is 6^{th} and Nigeria 7^{th} country in the world in mobile Internet access as whole. (AdMob Mobile Metrics Report 2008). The African Internet use on mobiles is mostly use of the mobile tailored content. Mobile tailored content (WAP pages) is usually smaller than full web content; therefore it is cheaper and rather reliable. It is unlikely that the situation in Africa will change in near future. This means that the global evolution of Internet use on mobiles

will be biased: developed countries and developing countries will have different infrastructure and different possibilities and that will lead to different paths in development.

Despite of the differences in infrastructure and the use of mobile tailored system, the mobile Internet in Africa should not be overlooked: BBC was about to close their WAP portal, but cancelled the closing when finding out that there are a significant number of users of their WAP service in emerging market, especially in Africa. Figure 16 shows that in July 2006 87% of BBC international WAP traffic was coming from Africa. 61% of the accesses to International WAP service come from Nigeria only and 19% of the hits come from South Africa.

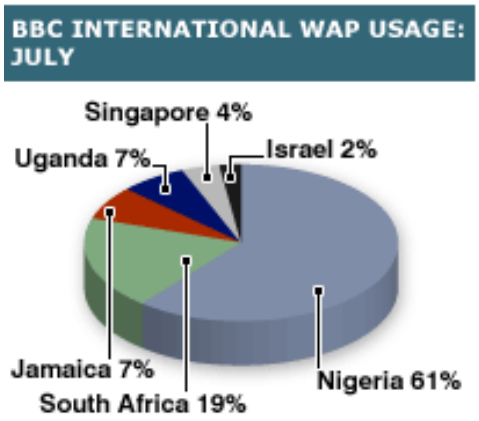


Figure 16 BBC International WAP use in July 2006 (BBC news 2006)

CNN has found similar growth in WAP use in Africa and has re-launched their WAP service, targeting the African market. They had already closed their original WAP service. (Mobile marketing magazine 2007)

What is the reason for such high usage rates in Africa? Most news heard from Africa, makes one assume that people are struggling to survive, and it does not make sense to use mobile Internet in such situation. BBC has a user comment in their web site that explains at least some motivation:

"I'm in Uganda and the only access I have 2 the outside world is this pinhole 2 info"

Ugandan texter to the BBC

The mobile news is the only access to world news to some people, the only way to know what is going on in the other part of the world. The landline telephones or Internet connections are not a solution here, even if from the European perspective that would make more sense. Fixed line connections is often less reliable in African than mobile connections. This sounds weird to people in developed countries, but many African countries suffer from massive cable thefts (Energy Bulletin 2004, Telegraph 2007, Why go South Africa, 2009) that makes it difficult to local people to trust on fixed line connections. The cable theft is not the only problem decreasing the trust on fixed line systems. Davies et al (2008) describe how the fires on electric wires cause problems in the distribution of the electricity. Mobile devices are built in such way, that they do not need to be constantly in power cable, and this makes them more reliable in such conditions.

The urbanization is a growing trend in many African countries; over half of the people in Africa live already in urban area, but majority in very poor areas, in practice in the slums. The wired network may not be built in poor areas, but the wireless access does not differentiate the rich and the poor areas of the city. Even when thinking just practically, for many Africans, mobile access to Internet makes more sense than fixed access. Due to the increasing urbanization, the rural area will have less and less people. In big countries, investing wired system in rural area may not be profitable, so also rural will count on mobile infrastructure.

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5. EVOLUTION OF THE METHODOLODY - FROM USABILITY TO USER EXPERIENCE

Between years 1998 and 2008, the research questions in mobile HCI have changed. As seen in chapter 3, the need for broader understanding of service usage has become more important. User Experience may be too vague term to use in research (or in product development), but the increase in use of the term with broader scope than 'usability' indicates that the scope of the research is widening. As the methods used in research should be selected to answer the questions, it is evident that during this period also the methods have changed.

5.1 User-Centered Design Methods in Mobile Service Development Process

Various methods are needed in service development process to investigate users. These methods are used to find answers to the questions a development team has in different phases of the development process. The questions are often related to the decisions development team needs to make in order to develop the product. As the questions in the phases are different, there has to be a good range of methods in use. How good different methods are and when they should be used has been discussed in literature (Jeffries et al. 1991, Gray et al 1998). Despite of the academic discussion, the outcome is not always useful for the practitioners. Wixon (2003) argues that even if the applied perspective has been discussed in these papers, the outcome has just little relevance to a practitioner. These papers have not given practitioners any additional tools or guidance when they are choosing the methodology.

Academic research is performed by professional researchers. To guarantee the influence to the product development, the development team involvement is recommended. Developers have rarely experience on research. The need for development team involvement has been recognized already before there was discussion about Internet on mobiles. Landauer (1988) emphasizes that user research (whether it is conducted in the beginning of the product development or during the development) is most effective if the development team is actively involved with the research planning and execution. This is one way of avoiding the big problems in the design decision making, relying on intuition and the lack of understanding the variability of user behavior. Even 20 years later, these are common problems in decision making in product development. To decrease these weaknesses in decision making, user studies in the different phases of development cycle are necessary and should include methods that involve the development team.

There are various methods to study users, but if these methods are simplified, there are only two ways to investigate people: people can be observed or they can be asked questions. The alternative ways of observing and asking is numerous and there are many ways of combining the methods. In product development the method must be selected according to the specific question that needs to be answer. Questions are often related to the decisions that are to be made. Choosing the right method is an important part of the risk management. The goal in service development is to create as good product as possible with available resources and the time when product should be on market. (Hertzum 1999) It is important to have right information at the right time, and that the development team can rely on the validity of the data.

Figure 17 Evolution of test facilities in mobile service usability testing. First it was possible to use normal video camera in stand (17A), then minicamera was possible to use in laboratory (17B) and later in the field (17C).

Ecological validity has been a topic especially in mobile service usability studies. Actual field testing of the mobile systems was not possible before miniature cameras become available. In late 1990's and early 2000, it was possible only to monitor the use of the mobile device in test situation with normal video camera by placing it to a stand (figure 17A). Starting from the early years of new millennium, the minicameras become available allowing user to move more freely in test situation, yet monitoring the device screen and finger movements. In the beginning the video storage equipment was so big that it was difficult to move it around, so the test facility was still stable (figure 17B), but later the whole portable usability laboratory equipment developed and made the field usability testing possible (figure 17C). Figure 17A is used with permission of Juha Marila; figures 17B and 17C are from studies where I have been part of the research team.

During the years, I have used various user research methods in my papers. The methods reflect the questions relevant to the specific project phase and the period of time when they were done. Evaluation methods in papers included to this work are presented in this chapter.

5.2 Methods in My Papers Included to This Work

In my papers I have used a variety of methods. This sub-section describes the methods used in the studies for different papers I have included into this work. The user centric design practices often split the methods into design and evaluation methods. As in service development process the goal is to find good design solution, the barrier between the questions is vague. In service development process many evaluation methods can be used as tools to create design solutions, even if it is not as obvious as in paper prototyping.

5.2.1 Paper 1

Kaikkonen Anne, Törmänen Pirjo: User Experience in Mobile Banking. Industrial case study in British HCI 2000

This paper is presenting the process of service development rather than the use of any individual user research method. The paper however covers the gamut of different methods that can be used during service creation process. It is common that published papers, including the majority of my publications, focus on presenting one part of the development process. This is the reason why most papers present only one or two methods.

The service development process presented here is close to one described also in Kaikkonen and Williams (2000) and the modification of the user centered design process described in ISO 13407 User Centered Design for Interactive Systems. The process itself does not define the methods. The methods used in the mobile banking development process are:

In the beginning of the process: Interviews on current service use, log data analysis and literature reviews

During the development phase: usage scenarios, paper prototyping, and low-fidelity usability testing (paper prototypes) and usability testing in laboratory with high-fidelity prototypes

In the end of the development, pre launch phase: Field pilot with internal pilot users (questionnaires, theme interviews, service diary, and log data)

In the end of the development, post launch phase: long-term usage study (online survey, in-depth theme interviews)

5.2.2 Papers 2-4

Kaikkonen Anne, Roto Virpi: Navigating in a Mobile XHTML Application. In Proceedings of CHI2003

Roto Virpi, Kaikkonen Anne: Acceptable Download Times in the Internet on mobiles. In UAHCI 2003 (2nd International Conference on Universal Access In Human-Computer Interaction), June 22-23 2003,

Roto Virpi, Kaikkonen Anne: Perception of Narrow Web Pages on a Mobile Phone. In proceedings of HFT 2003

Two papers of three are constructed based on the same user study. The method used in all papers is usability test in laboratory. In our study we wanted to find answers to questions related to service navigation and user interface development; the original goal was to update Nokia's WAP user interface design guidelines, when the markup language changed from WML in WAP 1.x to XHTML in WAP 2.0. The markup language change had effect on the interaction logic in such way, that we needed to create different interaction models to fictional services and run usability tests with 30 users, by using both low – and high range phones.

5.2.3 Paper 5

Hyvärinen Tuuli, Kaikkonen Anne, Hiltunen Mika: Placing Links in Mobile Banking Application. In Proceedings of MobileHCI 2005.

The method in this paper was usability test in laboratory. The paper handles user interface and navigation. It compares two ways of placing links in an interactive service. Questions were related users' perception and reactions to user interface elements, therefore usability test in laboratory was considered to be suitable method.

5.2.4 Papers 6 and 8

Kaikkonen Anne, Kekäläinen Aki, Cankar Mihael, Kallio Titti, and Kankainen Anu: Usability Testing of Mobile Applications: A Comparison between Laboratory and Field Testing. JUS2005, issue 1; vol. 1

Kaikkonen Anne, Kekäläinen Aki, Cankar Mihael, Kallio Titti and Kankainen Anu: Will Laboratory Test Results be Valid in Mobile Contexts? Book chapter in Handbook of Research on User Interface Design and Evaluation for Mobile Technology (Lumsden eds), (2008)

These two papers are based on the same user study. The methods used in these papers are usability test in laboratory and usability test in the field. The study was about comparing the results gathered with these two methods. The research question led the methodology selection. The motivation for organizing the study was related to questions in our daily work in service development. In R&D environment it is particularly important to optimize the time and effort in development process. We also wanted to take part to the discussion on when the usability testing in laboratory is sufficient and when the field testing is required.

5.2.5 Paper 7

Kaikkonen Anne: Usability Problems in Today's Mobile Internet Portals Journal of Internet Technology 2006.

This paper combines multiple evaluations of the mobile tailored Internet portals: the methods used in evaluations are expert evaluation and usability test in laboratory. The paper combines several case studies that often were part of a renewal process of the mobile portal. The evaluation need rose from the need for analyzing the current state of customers' mobile portal and their local competitors' portals. Depending on case the method was either expert evaluation or usability test in laboratory.

5.2.6 Paper 9

Roto Virpi, Geisler Roland, Kaikkonen Anne, Popescu Andrei, Vartiainen Elina: Mobile Browsing User Experience and Data Traffic Costs Mobea 2006

The method used in this paper is theme interviews and contextual inquiry. The studies were done initially for other purpose, but the interview data was re-evaluated for this purpose.

5.2.7 Papers 10 and 11

Kaikkonen Anne; Full or Tailored Mobile Web- Where and How do People Browse on Their Mobiles?

Kaikkonen Anne: Mobile Internet- Past, present and the future

These two papers are based on the same user study. Methods used in the study are online survey and contextual theme interviews. The research questions were related to the behavioral patterns of users and their perception of mobile Internet. There was a need to gather information from a large group of users to understand the frequency of specific usage patterns, as well as understanding the motivation behind the usage.

5.3 The Reasons for Methodology Selection

In addition to the methods I have used in my work, there is a variety of other methods. I have used 11 different methods in papers, included into this dissertation and open here the rationale of choosing the methods. In most studies I have used multiple methods. Some of the methods excluded from this dissertation are widely used, but I will not explain why I did not choose alternate methods.

5.4 Beginning of the Service Development Process

The service development process often starts by collecting available data on current service use and other way users have in fulfilling the same needs. There has been discussion whether the process should start with actual user study or not. For example Norman (2006) says that the organization should gather constantly data on users and their behavior and not put lots of resources in research when the development process starts. The development team is formed by specialists from different domains, including usability/ user experience practitioners. Usability practitioners may have constructed understanding of user needs and behavior in specific domain, but the challenge often is in transferring this understanding to the whole development team. Different team members make different kinds of decisions and need answers to different kinds of questions.

My research in the papers included into this work has been linked to service development and the goal has been to provide information the development team needed for decision making. The goals related to development have influenced the selection of methods. The methods in the beginning of the process focus on building the understanding of users and their needs for strategic purposes. The material works also as inspiration source for idea and design creation.

5.4.1 Literature Reviews

No matter what kind of service is built, there is lots of information available on users. If similar service is not available in the same technical platform, there has been other ways of fulfilling similar needs. There is almost always some information available; user studies done by universities, research institutes or other companies. Even if there would be plan to run a study when starting the development process, it is good to check what information is available and analyze what are the information gaps. In mobile service creation process there are multiple channels to seek the information, including marketing studies, information about the web service use if the company has such; even the log data of the service use is useful as well as information on competitors' service use. Many companies have customer or user segmentations available and these give valuable information on potential users' demographic and behavior in relation to service. In addition to information related to users, information on company strategies should be kept in mind.

5.4.2 Interviews and Observations (Finding out the User Behavior)

The interviews and the observations of current service use, ways how service use is integrated in the daily life of customers, are good ways of filling the information gaps on users. Equally important is to make sure the development team gets good understanding on users, their life and priorities related to the service use. Sometimes the method used is called Contextual inquiry, (Beyer and Holtzblatt 1998) but interviews and observations have been used by psychologists, sociologists and anthropologists long before user information was needed for product development.

Even if the companies should constantly make sure they have up-to-date information on their customers and the users of their products, it is important make sure this information is

passed to the product development teams. It is good to have user researchers involved in development process. They can help the rest of the development team to understand the users and organize the user interviews and observations. Based on my experience, running a small scale study where users are interviewed and observed is good way to make sure that the development team shares the same vision on users.

There are multiple ways of analyzing the interview and observation data. In the same way as there are multiple data gathering methods. The selection of the analysis method should be based on the research questions. Often the process starts by the transcribing the gathered data. The evaluation of the data is done with grounded theory approach (here the grounded theory is handled as an analysis method of qualitative data), where the data is classified and categorized (Strauss and Corbin 1998). Affinity walls in Contextual inquiry can be considered to be an evolution of the grounded theory. The grounded theory, as well as affinity walls are bottom- up approaches- the raw data is categorized and the generalizations are based on these. The theory and understanding are based on the data that is found. This is good when studying new phenomena that require researchers to keep their mind open.

5.5 During the Development Phase- Creating and Integrating User Interface

The questions and problems during the development process differ from the questions in the beginning of the process. The focus is on questions related to the creation of design solutions and the evaluation of them.

5.5.1 Creating Usage Scenarios

Scenarios are commonly used tool in user interface creation (Carroll 1995, 1996). The method is often based on stories, textual description or the narrative of the usage episode, though the scenarios can be created to be more visual, in the form of a cartoon or even a video. These descriptions of usage situations form the basis for the discussion and analysis on how the technology is (or could be) used. The narratives can help the design team in sharing the views on user's goals, and the context where the user is operating in. Usage scenarios can also help in the prioritization of the use cases.

When creating usage scenarios, I commonly started by creating few personas or user profiles. I often created the personas by using the material from user studies I had conducted in the beginning of the process and market research material (like segmentation material), when such data was available. The personas are useful and credible when there is enough data to match the persona to the target users of the service. The narratives were created to describe how the system should help target users' to meet their common goals. Usually the narratives were created together with the product team, including product managers, designers and implementers, but sometimes users were asked to create the narratives themselves or they were evaluating narratives created by development team.

Important aspect in scenario based design approach is that it is a good tool to use in groups and narratives help the team to discuss the feature prioritization. This way the product manager can also get good feedback for the prioritization from team members and even from end users.

5.5.2 Designing Paper Prototypes with Users

Paper prototyping is a method that allows user involvement in design process very early. It is also a very cheap way to test design ideas with the target users. Paper prototyping can be used both for designing and evaluating early designs. Usability testing with paper prototypes is sometimes called as 'low-fidelity' testing and it can be executed in such way that the user involvement in design is very high- even when running usability test with the

paper prototypes, the parts of the design can be done together with users. Paper prototyping can be done with users in such a way, that users actually participate the design process by influencing the task flow and the placing of the user interface elements; users can interact with designer either by providing information verbally or by drawing their visions on the paper themselves. Development team should be involved with the process, as users cannot be expected capable in taking all the possible problems inconsideration. Team members can ask user questions in the session and use the designs made by users and their comments as basis for the design.

5.5.3 Testing Paper Prototypes with Users (Low-Fidelity Testing)

When testing with paper prototypes, the general idea is that a development team has created system user interface on the paper. (Or the development team has refined the prototypes created with users earlier in the process) The test process can follow generally the same protocol as typical usability test; facilitator gives test user tasks that she complies with the paper prototype. Often the general atmosphere in paper prototype tests is more casual than when testing fully functional system. In paper tests it is good to have one additional person to operate the paper user interface and provide the next step according to user's selection. This method is sometimes called as Wizard of Oz. Even if the testing should be done with target users, the method is more demanding for users than usability test with high-fidelity prototypes: user has to be able to imagine the system responses, and have some perception of the goal and the system. For example, when testing a mobile service, users in paper prototype test should have experience on mobile devices in general: how the lists appear on mobile device, what happens when an item is selected, how text input works on mobile device and so on. The novice users may have difficulties in understanding the framework, thus not be the ideal users in paper prototype test.

After testing the service with paper prototypes, the interactivity of the test system can be increased. When the interactivity increases, the service can be tested with less experienced users, too. It is good to evaluate the user interface and interaction properly before lot of resources is put to implementation and service integration to the actual system.

5.5.4 Expert Evaluations

The expert evaluation reports in my papers are combination of two commonly used methods: cognitive walk through and heuristic evaluations. Good thing about expert evaluations is that they can be done practically at any phase of the design process and the input material can be almost anything: design sketches, usage scenarios, functional and user interface specifications, interactive prototypes or fully functional systems. Ideally the expert evaluations are done by multiple experts: the amount of problems discovered increases when increasing the number of evaluators. (Jacobsen et al 1998)

Cognitive walkthrough is a technique where a user interface expert goes through a product to see whether particular tasks can be accomplished without the user getting confused or lost. The technique is a good start in process, when the expert needs to get acquainted with the system he needs to help improving. It is also often necessary to go through the cognitive walkthrough when planning a usability test.

Heuristic evaluation is a technique where one or more evaluators go through the service with pre-defined principles (heuristics) in mind. The goal is to analyze a product for shortcomings. The heuristics should be based on research and/or industry best practices. Commonly used heuristics are Nielsen's heuristics (Nielsen and Molich 1990) or Schneidermanns eight golden rules (Schneiderman 1992). Also design drivers defined in the beginning of the project can be used as heuristics in evaluation. These pre-defined principles are on high level and it is important that the experts running the evaluation have

common understanding on how they should be implemented on particular area, in mobile service design for example.

5.6 End of the Development Phase- Evaluation of the User Interface and Service

In the end of the development phase the methods are used to test if the design solutions are working well. Focus is to evaluate if the design supports user when he tries to use the service.

5.6.1 Usability Testing in Laboratory (High Fidelity Prototypes)

Usability testing is a common tool used to evaluate the usability of a mobile application in a development process. Usability tests are usually conducted using a think aloud protocol based on K. A. Ericsson and H. A. Simon's work (1980, 1984). Users are given tasks in a test environment and encouraged to think aloud while trying to accomplish the tasks. The goal is to gather information primarily through the behavior of the test user, rather than his opinions.

Usability tests reveal information on how the user interface matches the natural human way of thinking and acting and highlights the features and processes that need improvement. The data gathered with usability tests is both quantitative and qualitative.

The quantitative data includes information on the number of errors, success rate on task, time per task, the category of the error and the severity of the error. The severity of the usability problems is an important factor when defining the urgency of actions related to the problem. The most urgent actions are needed when the problem prevents the completion of the task. Dumas and Redish (1993) use four point scale, where the first severity level represents the most severe problems and the last the least severe. In mobile area Kallio and Kekäläinen (2004) have used three point scale for the severity of problems: high (failure in task execution), medium (not so severe, task can be executed) and low (minor problems).

The qualitative data includes the verbal comments from user, revealing what kind of mental model user creates from the system, what he expects to happen after his selections and why. This information should be differentiated from users' opinions; the number of test subjects is usually so small in usability tests that the opinions of users in one single test do not represent the views of whole target population.

Usability researchers and practitioners have been concerned that laboratory evaluations do not simulate the context where mobile phones are used (Johnson 1998) and therefore lack the desired ecological validity. Interruptions, movement, noise; multitasking etc. (Tamminen et al. 2004) that could affect the users' performance are not usually present in laboratory tests. The surrounding environment and mobility are assumed to set special requirements for mobile applications and services. Usability testing should take these requirements into account. These concerns raised the need to validate the products in the field.

Based on recent studies, like in **paper 6** (Kaikkonen et al 2005) and paper by Holtz Betiol and de Abreu Cybis (2005), it seems that usability tests in laboratory do reveal usability problems when the questions are related to user interface, user interaction with the system, and the usability elements defined according to ISO 9241-11. When the scope of the study is wider, the field test could be considered.

5.6.2 Usability Testing in the Field

In ***paper 9***, (Kaikkonen et al 2008) we show that the usability test in the field reveals also different problems from those uncovered in a classical usability test conducted in a laboratory setting. The comparison studies show that the findings in the field are more related to the user experience and user behavior than usability and user interaction with the device.

Roto et al (2004) as well as ***papers 6 and 9*** (Kaikkonen et al. 2005, 2008) suggest that usability test in the field are to be used when the research questions include wider scope than just users interaction with the system. Like behavior in a natural context, or when studying the use of location-based and context-aware services.

Paper 6 states, that usability test in the field can be run by using similar protocol as the laboratory tests (Kaikkonen et al 2005) or the test protocol can be very different. The main issue is to define very carefully and clearly the scope of the test, and evaluate if it is worth time and effort to organize the test in the field. In many cases it is be better to run few usability test rounds in the laboratory and then field pilot to test the other aspects influencing the user experience. When testing usability in the field, selecting a good location is crucial: wrong location may reveal issues that were not on the focus of the test and may not help in device or service improvements.

When making decision on weather to test usability in the field, it is important to understand the limitations of the method. Potentially in the field the ecological validity is better, but not as much as a researcher would like to. Test users are aware that they take part in the test and the test time is too short for users to forget that they are in a test session. Logistics in field test can be complicated and test situation is more prone to disturbances in field than in laboratory. Potentially when testing usability in the field the control is sacrificed with only limited increase of ecological validity.

5.7 When the Service Is Ready: Pre- and Post Launch Activities. Piloting the Service and Finding out the Real Usage Patterns

When the service is ready, it is important to focus on strategic aspects again. The questions in the end evaluate if the strategic decisions were right (features, use cases service supports), and did the design solutions support the strategy.

5.7.1 Online Surveys

Survey is a commonly used technique to collect information from a big number of users. With online surveys getting users is even easier than with paper or email surveys. Use of the surveys requires that the most of the questions are structured- even if it is possible to add open questions, the majority of the questions should have alternatives for the respondent to choose. The online survey has been used in **papers 1, 10 and 11**. In paper 1 the survey was placed on Merita's online banking web site so, that it was visible only to those users that had record on using WAP banking. Link to the survey used in **papers 10 and 11** was distributed via blogs and different Nokia's contact channels. In the process description of **paper 1** online survey has a minor role, it is just one of the methods used in the process, but in **papers 10 and 11** the online survey has much bigger role.

The online surveys in these studies have been used to collect user feedback and information on mobile service use after the service has been in use for several months. The surveys have included both structured questions, where users can choose the answer from different

alternatives, but also open questions. Open questions have been used especially to ask the description of the latest use of the service and improvement suggestions. Online surveys have not been used only as information channels; they have been used also as a tool to choose suitable users for more in depth studies- interviews and observations.

Online surveys in my studies have been analyzed in multiple ways. They have given quantitative data on the usage frequency, the features used, and the previous experience of users using the services, but also more subjective feedback on expectations and how the service has managed to meet the expectations. One challenge in online survey is that if they are not used as in **paper 1**, where the survey was visible only to those users that had record on using the service under investigation, it is difficult to know if the responded really has experience with the service. There should always be questions that reveal the users that do not have used the system. Open questions are often such reality checkers. Even if open questions are time consuming to evaluate, researcher can often see from them if the system has truly been used. Data from users that do not seem to have experience with the system should not be taken into the analysis. For example in online surveys used for papers 10 and 11, there were originally over 500 respondents. When the respondents, who apparently had no experience on Internet on mobiles, were removed from the database, the number of the respondents was 390.

5.7.2 Analyzing Log Data

Log data is a useful piece of information that reveals the real usage of the service. In my work the log data analysis has been used only as a part of the field pilot. The usage patterns have been analyzed from a bigger number of users. The log data analysis has been used only in paper 1. If the pilot period takes few weeks or longer, it is very difficult for users to remember the details on their service use. What did they do when using the service for the first time, the number of service usage times during the pilot period etc. It is also easier for users, if such data is collected automatically. It is important however to inform the users what data is gathered, and make sure users understand that personal communication information is not gathered (for example in communication survey a number of calls/ text messages is gathered, but not the actual content of the messages). Automatic log data analysis has proved to be a user-friendly way to gather the basic information of the service is use; it gathers the data of time and day, which parts of the service are more popular than others and so on. If an individual user's usage is analyzed, the user should be asked for permission in the beginning of the pilot.

The service diaries can be considered to be manual log data gathering; in diary study, the information on the context of use can be gathered as well. Diaries are commonly used in pre-launch pilots. Filling out the diaries require a lot of commitment from pilot users, especially if the service is used multiple times per day.

5.7.3 Interviews and Observations

Interviews and observations can also be used as ways to gather feedback from users. When using these as data gathering methods in pre – or post launch studies, the focus is different from the situation when the same method is used in the beginning of the development process.

If the interviews and observations are used when starting the service development, the data is used to formulate the assumptions of the user behavior and the priorities in relation to the service. In the end the same method can be used to evaluate if these assumptions were right and if the decisions made during the service development process were supporting the initial assumptions. When interviewing the users in the end of the development process, a part of the interview can be structured. When the features of the service are known it is easier to focus on specific areas. In the end of the development process it easier to gather data that can be

quantified, even when using interviews and observations as data gathering tool. This is especially interesting when the pilot is a comparison study, where the usage and the experience of two services can be compared. Quantification helps in getting the overall feedback quickly, but is by no means sufficient feedback for product development when used as a stand alone method. The structured interviews (like online/ email… questionnaires) give well answer to 'what' but un-structured methods are better in answering the question 'why'.

5.8 The Methodology Evolution in Papers

	2000	2003	2004	2005	2006	2007	2008	2009
Literature reviews	x							
High-fidelity testing in the lab	x	x		x	x		x	
Expert evaluations					x			
Usage scenarios	x							
Paper prototypes	x							
Low-fidelity testing	x							
Log data/ diary	x							
Usability testing in the field				x			x	
Observations				x	x		x	x
Online survey	x				x		x	x
Interviews	x						x	x

Table 3 Methodologies in my papers published during years 2000 to 2009

The methodologies in my papers have varied over the years, as can be seen in the table 3. The first industry paper however shows that the various questions have been discussed within the industry during the service development already in the early years of mobile Internet. Kjeldskov and Graham (2003) found that during the first years of millennium, the studies presented in conference papers were rarely done in natural environment or studied the natural behavior of users with mobiles. The overview of the method in my papers show similar trend: In the time of the Kjeldskov's and Graham's evaluation, the publications were about service user interface and just during the latest years the focus has shifted to user behavior.

The methodology change reflects an overall shift in focus: recently in the area of mobile Internet, the focus has switched from functionality to design. Kuutti (2009) describes how this phenomenon has happened in the field of HCI already earlier: during 1990's the multimedia made breakthrough in HCI. This trend has also influenced the focus of the design that is visible in papers published in domain (Cockton, 2008). The mobile area

followed the trend as soon as the infrastructure and device capabilities made it possible. This trend seems to continue even stronger now that devices with even wider screens with better resolution and touch interaction have started to seize the market, iPhone being the benchmarking device.

Barkhuus and Rode (2007) evaluated the methodology trend in CHI conferences from early 1980's to 2006. They categorized the methods used with taxonomy having axes qualitative-quantitative and analytical- empirical. The description of the categories and my papers included to this work in their publication years can be seen in figure 18.

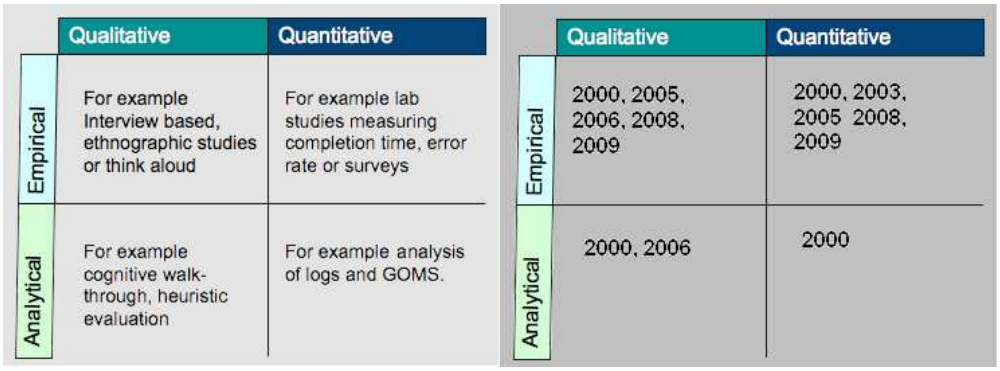

Figure 18 The methodology categories by Barkhuus and Rode (2007) on the right and my papers placed in grid in the left.

Based on the evaluation by Barkhuus and Rode (2007), the empirical studies have become more common in CHI conferences after year 2000. Between years 2000 and 2006 the amount of papers having qualitative empirical has increased. My papers have always included an empirical study. The year 2003 is the only year when the method was leaning towards quantitative, in other years and almost all papers have included qualitative approach. Even the papers in 2003 had some user satisfaction parts that were not entirely quantitative. The tendency of having both qualitative and quantitative approach in empirical papers has not been very common in CHI papers. According to Barkhuus and Rode (2007) most empirical papers have purely quantitative method and evaluation. The number of purely qualitative papers has increased, but the combination of these approaches has been and still is rare. Dunlop and Baillie (2009) have recently brought up the problems in the use of statistical analysis in the field. Quantitative studies often use statistical analysis to verify the results. According to Dunlop and Baillie, the use of the statistical analysis is often misleading. Whilst it is important to evaluate the use and rationale behind the methodology selection, it is equally important to discuss what is achieved with the methods.

In industry, one study needs to cover a wide range of questions; therefore I have been combining different methods in my empirical work. The industry questions have been the starting point in my studies. This has influenced the methodology selection and the way of combining the methods. Other significant difference compared to CHI papers evaluated is the test user selection: during the period of my studies, the mobile phones have been used by both male and female. Therefore the test users in all the studies have had both male and female participants. The papers in 2008 and 2009 however show how the current male-female distributions in relation to Internet use in mobile phones.

6. CONCLUSIONS

My research questions are broad and cannot be answered fully on one work. My publications have investigated five questions that handle the mobile service creation from human-computer interaction perspective. The focus has been on questions that are relevant when developing a mobile service: the design process, user interface and interaction design, evaluation methods, usage barriers and usage patterns.

6.1 How to Make Mobile Internet Services that People Can Use and Want to Use

My papers have contributed to the questions relevant in the time when they were published; the first paper presented the overall user centric service creation process of Merita bank service, the first commercial interactive WAP service. Papers 2 to 5 were providing information for service and user interface design. The outcome of the studies presented in these papers was also used in the creation of Nokia's XHTML design guidelines (Forum Nokia 2003, 2004, 2005). Papers 6 and 9 evaluated service and user interface evaluation methods: with these papers we took part to the discussion on field vs. laboratory testing. Papers 7 and 8 handled the obstacles related to the mobile Internet adaptation – paper 7 was a current state analysis of usability problems in service user interface, paper 8 was analyzing the influence of cost and the lack of the transparency of the cost as one of the barriers of mobile Internet adaptation. The last two papers, 10 and 11 evaluate the mobile Internet usage patterns, the motivation and the perception of users from different countries. These last two papers are evaluating how far the current services are from the ones that users can use and want use.

This consolidation work illustrates how the scene of mobile Internet has changed during the first ten years. The published papers have been focusing on user interface, usability and human factors, but the technological and business infrastructures have influenced the user perception and value evaluation.

The evolution of the terminology used in the field shows the change in the field. In late 1990's usability was already commonly used term in the field. Research was focusing on user interface and interaction. The raise of the term 'user experience' shows that in relation to mobile devices and services, the ease of use, efficiency and effectiveness are not enough to guarantee user satisfaction. In addition to cognitive aspects, wider perspective to humans is needed. 'User experience' as term may not be the best one- it is too vague and broad, and does not define the area well enough. Everything has influence on user experience. Even aspects the designer and developer cannot influence on, like user past experiences, environmental factors, and many others. Nevertheless the increasing use of the term shows the need for wider approach to user than 'usability' can offer.

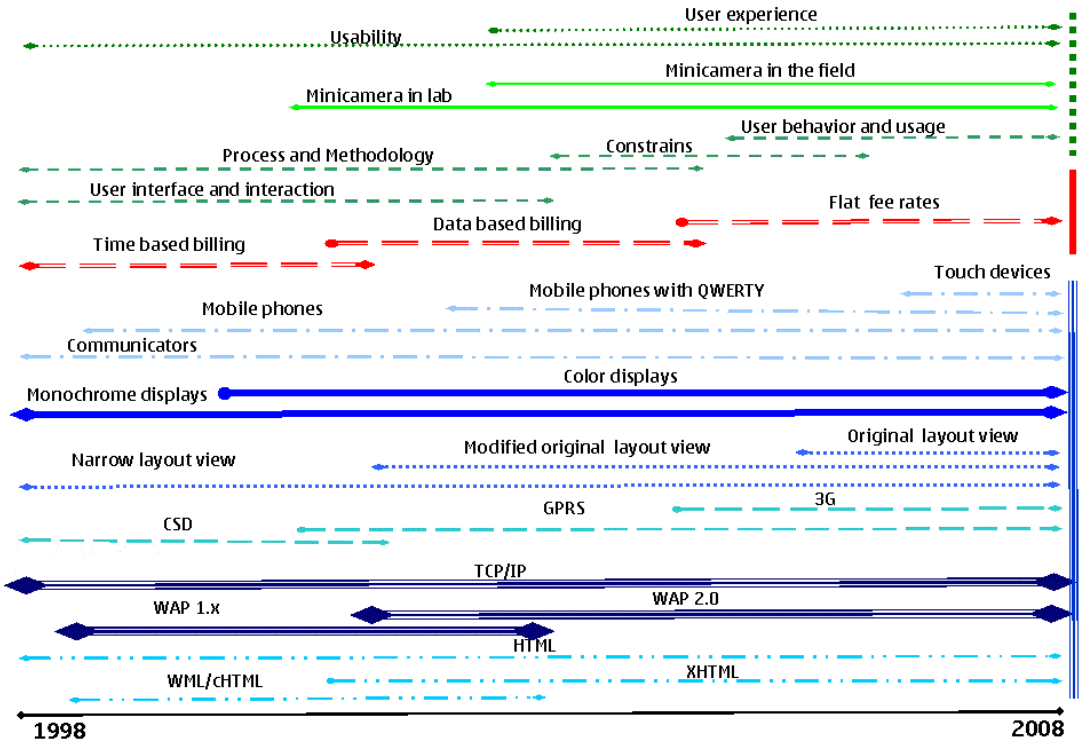

Figure 19 Evolution of technology, billing model and research questions during ten years of Internet on mobiles. Technical aspects are in bottom in blue, multiline, billing model in the middle in red, solid line and HCI research related issues in the top in green, dotted line.

The development during past years has influenced the use of Internet on mobiles. Overall the role of the Internet in people's lives is very different now than it was ten years ago. Figure 19 shows some of the changes. The blue lines (unified with multiline in side) in figure 19 are showing technology evolution, red lines (unified with solid line in side) change in billing model and green lines (unified with dotted line in side) show some items related to human factors research area. The protocol used for access has changed from WAP to TCP/IP, markup language has switched from mobile tailored versions to HTML, network speed has increased, and network technology has moved form Circum Switch data to Packet data (GPRS, 3G) allowing the billing model to change from time based to data based. The mobile browser shows today the web pages often in original layout. The form factors are more diverse today than in the late 1990's. The new usability test tools allow more flexible testing environment. The user centered approach has broadened from usability to cover more behavioral and emotional aspects as well as user preferences. This can be seen in the use of the terms – 'user experience' has increased during past years. Also my research has lately taken more behavioral aspects in consideration.

6.2 What Kind of Design Process should be Used When Creating Services that People Can Use and Want to Use?

Many authors have shown that some user study methods work better in the specific phase of product or service development, Maguire and Sweeney (1989) have matched the methods and the type of data captured with the method. Their evaluation approach table lacks contextual methods, which is understandable when taking inconsideration the period of their work. For example Nielsen (1992b) has matched the task and the development phase when

the activity is recommended to be done. Muller et al. (2000) have defined participatory design methods in relation to the degree of user activity and the position of the activity in development cycle.

Decision making planes (according to Garrett)	**Information on People**	**Sources of information during development**	**Example of evaluation methods**
Surface plane: Visual design	Psycho-physiological information: function of hearing, visual system	Expert consultation, literature references	Usability test, expert evaluation, eye
Skeleton plane: Interface/ navigation design	Cognitive information: information on memory, perception	Expert evaluations, literature,	Usability test with verbal protocols,
Structure plane: Interaction/ Information design	Cognitive information: perception,	Expert evaluations, contextual studies, observations, task analysis	Usability tests, field pilots
Scope plane: Functional specifications/ Content requirement	Behavioral information, goals	Contextual studies, observations, diary studies	Contextual studies, observations, diary studies
Strategy plane: User needs/ site objectives	Social behavior, emotions, consumption patterns, attitudes, behavior/ attitudes of large groups	Contextual studies, theme interviews, diary studies, group interviews, surveys trend analyses, customer segmentation	Contextual studies, theme interviews, diary studies, group

Table 4 Development phases and user information needed in different phases

The approach still missing is the one matching the specific questions that need to be answered during the different phases of development, specific data on users and methods used during the different phases. Ketola and Roto (2008) show that practitioners in different roles need different user related information. The reason for the differences is that these professionals work in the different phases of product or service development or are responsible of different issues. The practitioners need information on users to help in decision making. Professionals in different positions make different kind of decisions in their work. A product manager has his or her own decisions to make that differ from the decisions of a designer or an implementer. Different methods give answers to different questions; therefore multiple methods are needed during the product development process. Table 4 shows what kind of information can be needed on humans and what methods can be used to get this information. These are mapped to the different phases of development process. The process is mapped here to the one described by Garrett (2003).

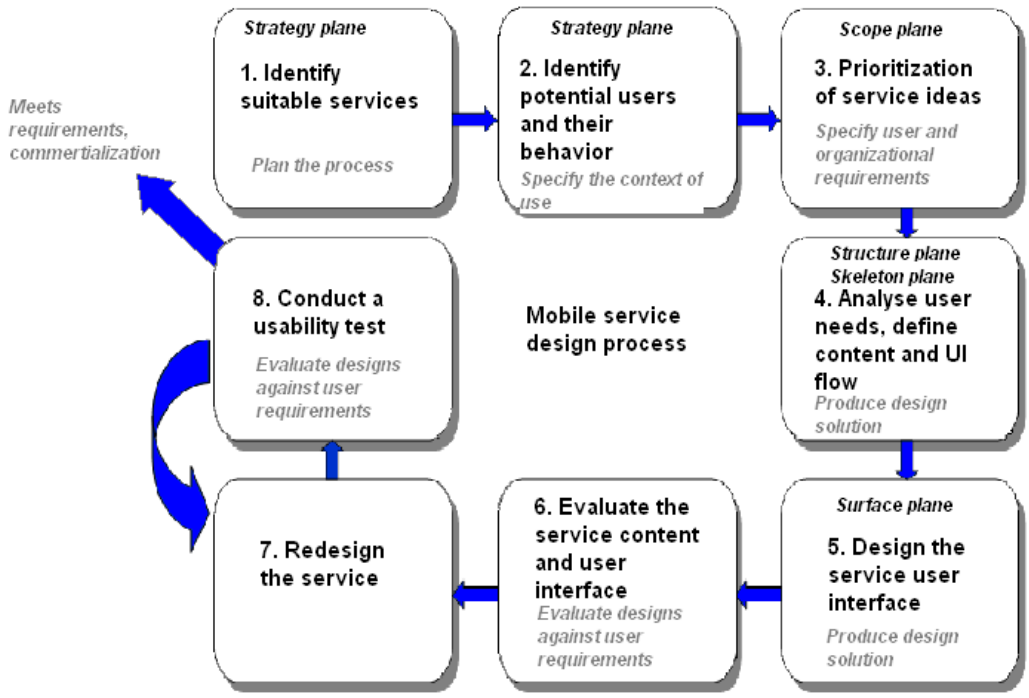

Figure 20 Combination of three different design processes.

The service development processes by Kaikkonen and Williams (2000) and Garrett (2003) may initially look different from each other – and it may be difficult to match them with the framework provided by ISO 13407. The different approaches, however, only complement each other. The different planes of Garrett model and phases of ISO 13407 can be matched to the mobile service design process by Kaikkonen and Williams. In figure 20 the steps defined in the original model of Kaikkonen and Williams are numbered. The planes of Garrett are in italics black and ISO 13407 phases are in italics grey. Garrett model is focusing on steps that include service related decision making, ISO 13407 is taking the evaluation as part of the process. The mobile aspect of mobile service design process may not be evident in high-level picture, but each step includes aspects that are relevant specifically in relation to mobile services: when identifying potential users and their behavior, also the current mobile devices users own and use need to be taken in consideration. When prioritizing the service ideas, the users' infrastructure and experiences with mobile devices and services play big role in prioritization process. It is important to take these questions in consideration, as well as the strategic question: what is the role of the mobile in company's service portfolio. Very few companies have only mobile services, so the mobile has to support the total offering. In mobile service development the need for holistic approach is especially important; the responsibility of the service quality does not end when the service is launched, but the user feedback needs to be gathered for the further improvements of the service.

6.3 How to Design the User Interface and Interaction for Services that People Can Use and Want to Use?

Different solutions for mobile user interface and interaction design have been investigated from very beginning. Jones et al (1999), Buchanan, et al (2001) and Chittaro and Dal Cin (2001) have been among the first ones, but research work related to user interface design solutions has continued from early days. ***Paper 2*** (Kaikkonen and Roto 2003), ***papers 3 and***

4 (Roto and Kaikkonen 2003a and 2003b) and ***paper 5*** (Hyvärinen et al. 2005) contribute this area. Recently Yatani et al (2008) and Gustafson et al. (2008) have studied user interface and interaction techniques for mobiles. Research on user interface on mobile services has been going on for a decade; during the years lots of information has been generated that can be used as a starting point when designing mobile services. The usability problems in current mobile services are not due to the lack of information. The main problems are the unawareness of this information and the lack of capability in using it. The lack of knowledge can be due to the busy schedules in product development and existing design practices that do not always support the use of the usability data. Designers are not always able to utilize the available information, as research documents are not often written in the form that would make it easy for designers and practitioners to comprehend. Väänänen-Vainio-Mattila and al. (2008) have brought up this gap between the academic researchers and industry practitioners. Decreasing the gap requires dialogue between the two parties. The gap cannot be decreased only by focusing research on questions that are relevant to practitioners, but the outcome of the results should be formulated in such a way that the language and presentation would be more familiar to designers and practitioners.

6.4 When It Is Enough to Evaluate Mobile Service Usability in Laboratory and When It Is Better to Run the Test in Field, when Designing Mobile Services that People Can Use and Want to Use?

When running user studies and evaluations with users, the test method should be in line with questions that need to be answered. During the product development, there are both questions that require high ecological validity and questions that require a high degree of control. When testing the behavior of people in natural context, the ecological validity is very important. The questions can be related to what is the context of use, what parts of the service are used most and what is the order of the tasks during the service usage session. When testing how well the user interface is designed and if users actually can use the service, running the test in natural context may not bring additional value. Testing psychofysiological aspects, like the influence of light in the legibility of the text on the screen, it is important to run the test in controlled environment, so that the parameters of different conditions are known and can be varied in controlled manner.

To answer the different questions rising during the product creation process, multiple methods are needed. Some studies need to be conducted in natural context, for some studies the laboratory tests are good and often more cost efficient. Testing usability with common usability test protocols in laboratory environment reveals often the problems in user interface and interaction.

6.5 What Are the Barriers of Mobile Service Use- Can People Use Them and Do They Want to?

The available technical solutions and business models build the framework for technology use and adoption. Sometimes these can also work as usage barriers. Two barriers discussed here are the lack of transparency in billing and the battery life. Battery technology has developed during past years, but at the same time new devices allow users to do more tasks and even simultaneously. When users are utilizing these new features, the batteries do not last long enough to meet the changed usage patterns and the requirements of users. The battery life is related to many important issues, like the cost, the device performance and the features. Developers need to be able to balance between these. The battery life can be increased for example with appropriate network configuration, the intelligent use of screensavers and network timeouts in mobile device. The right balance in battery life optimization requires a good understanding of users' tasks and usage context.

The lack of transparency in billing model has been a known problem already with fixed Internet (Gourville and Dilip Soman, 2002). From user perspective it seems that the operators have acted as if they did not want customers to use Internet on mobiles. If that is not correct and they actually have wanted people to use Internet on mobiles, it is difficult to understand why the mistakes of early fixed Internet were repeated. The reasons can be multiple, maybe the operators have not been ready for a large number of users in mobile data network or maybe the management has been afraid of making too big changes and breaking the existing status quo in the market. They may have preferred to stay in the familiar solutions and not being willing to ‘‘think outside the box’’ trying to solve problems in new ways. This kind of management patterns has been pointed out by Cyert and March (1992). With the cost and its transparency, the situation is getting better for users. The first steps towards the flat fee with unlimited data have been taken and it is only a matter of time before a large amount of operators find appropriate ways to package the price and their offer.

6.6 What Kinds of Usage Patterns Users Have with Mobile Services when Users Can and Want Use to Them?

When users have freedom of choice the usage patterns will be diverse. Today the usage patterns of users in different areas are different: Asian users are using more mobile tailored solutions, whereas American and European users browse more full web sites and download applications that can access web for tailored solutions. (***Paper 10,*** Kaikkonen, 2008) The reason for differences are related to available mobile devices, network infrastructure, pricing and available content. Some Asian operators have packed their mobile service offering to include the operator WAP portal. It costs the same for the user whether he uses the portal or not. Those American users having WLAN enabled phones can have relatively fast and free Internet access by using the available WLAN hotspots. The full web sites and their structures may be familiar to users; the usage supports the existing mental models of the user, so browsing them can be a natural choice.

New emerging markets, where there is different network infrastructure, different context and users have very different mental models on technology use, the usage patterns may evolve very differently from the existing markets. Even if we have ten years of experience with Internet on mobiles, we need to approach the new markets with a humble mind; listening and learning the realities of the people, and not with an assumption that the services and technologies that have been successful in Europe and North America, would automatically be successful there. The user centric methods can work well as starting point, but there may be need to adjust them accordingly, like Gary Marsden (2008, Marsden et al 2008) points based on his experience.

7. DISCUSSION

The papers included into this work have been produced as a part of research and development activities. This means that the realities of R&D have influenced the research questions and methodology selection in my studies. The methods are selected to produce sufficiently reliable answers to R&D questions in a reasonable time. This is a very important issue during the device and service development. For example in the study in ***papers 10 and 11*** (Kaikkonen 2008 and 2009) I was not able to do further contextual observations due to the time constrains. Even if the development constrains have influenced the methodology selection in my studies, it has also enabled this work. Alongside I have had freedom to investigate the questions that have wider interest within the development community or have even academic value. Even if my studies have been a part of the development, I have not been asked to restrict my publications. I have been able to bring up also critical material when necessary.

I have conducted the empirical field studies in various European countries, in USA and in industrialized countries in Asia. It is possible and even likely that the outcome of these studies is not fully applicable in emerging markets. All test users in studies have been literate, and many have had previous experience of mobile phones and computers. People in emerging markets may perceive the environment so differently from the people in developed countries, that it influences the user interface and interaction with the service. It is possible that instead of designing services for people in new markets, we should develop systems that local professionals can use to create services for local people. There is also some evidence (Marsden 2008, Marsden et al 2008) that the methods and processes commonly used in HCI should be evaluated before using them in emerging markets. When doing research and development in new markets, we have to go there with a very humble mind.

7.1 How to Make the next Mobile Internet Success Story?

During the first ten years of mobile Internet, there have been very few true success stories. In early years, the Japanese operators managed to create a success out of the mobile Internet services provided for users. Many refer to iMode, which was the leading service, but also other Japanese operators built successful mobile offerings. After Japanese success, it took very long before the next success story emerged. Eight years later RIM and Apple with iPhone changed the use of the mobile Internet in USA. This is the market where mobile phone penetration was lower than Internet penetration until 2005.

The Japanese mobile devices in early 2000 differ from the devices used in USA today; especially iPhone seems to be built with design in mind rather than a large number of features. Are these success stories coincidences? Do they have something in common that would explain the success and the others could learn from? First of all, it is hard to find the right term or even a definition to describe these three systems. Japanese mobile Internet, RIM and iPhone are not just devices; they are not just services or user interfaces. The common nominator for these is that they are well defined packages that combine all these, in such way that makes it easy for users to start using them. They are all examples that link together the technology, business model and users. It seems that during the development of these the decisions are done with same vision in mind. Based on these examples, this seems to be the key to the success in mobile Internet.

The study in ***papers 10 and 11*** (Kaikkonen 2008 and 2009) showed that users having a phone with WLAN capability did not only browse more than users with no WLAN capability, but they also browsed differently. WLAN users browsed more full websites than users using only cellular network. Future research should investigate further the influence of WLAN accessibility and flat fee rates to the browsing and communication patterns. There is

already evidence that iPhone users do not only browse more than users of other mobile phones, but they also browse richer websites (Cleary, 2008). However there are multiple reasons that can explain this. What is the role of the WLAN, flat fee package, display size, interaction style on touch screen, the sales channel and the user demographic of the iPhone in the user behavior? The possibility to be always connected to your social network online can change not only the browsing habits, but also our communication practices. Other topic for future research is the influence of touch screens in browsing patterns. Norman (2007) says that good search engines in computer based Internet, has made users return to command based browsing. Typing the keywords has essential role in the information search and the browsing experience. The mobile devices with touch screens and virtual keyboards seem to be more optimized for point- and-click browsing. It would give good advice for web designers and device manufacturers to know if users browse differently with full QWERTY devices and touch devices having virtual keyboard.

Like Kuutti (2009) describes, there has been change in the focus of HCI over the past years from functionality to design, from cognitive to emotional. The future challenges are going to mix these two. The technology has developed to allow better contextual and social network awareness. Emotional aspects play important role in social networking, social media and social proximity, but cognitive issues are equally important. We need to understand how people perceive this new environment and how we can support the understanding of control and privacy. Social networking services seem to have changed the use of the words too: There are lots of people in social networking services with hundreds of 'friends'. If people have hundreds of 'friends', how will they call those people that are the most important ones- the ones that were earlier called 'friends', when the wider social network were 'acquaintances'. How do people manage to control the public and private overall and how can we support them with right technical and design solutions? These are questions that the researchers should investigate in near future.

7.2 Why to Believe that Internet on Mobiles Has Potential in Africa?

The figures from developed countries show that the mobile Internet penetration grew faster in countries where the computer Internet penetration was low and mobile phone penetration was high. In many African countries this is exactly the case. If the figures from developed countries show global trend, the Internet on mobiles should be successful in Africa. (Vnunet, 2008)

According to Rogers (2003), there are five dependencies for a product to be successful in the market: 1) what is the first knowledge of the innovation, 2) how does the attitude toward the innovation form, 3) is the decision to adopt or reject the technology 4) will the new idea be implemented and 5) is the decision of the adoption confirmed.

There are again five aspects to support the adoption of the new technology, in relation to mobile Internet use in Africa, many of these look positive:

1) There has to be relative advantage to user – this means that the innovation should be perceived better than the previous solution. In Africa, there was no existing solution, Internet use is minimal and suffers form reliability problems, the same with fixed telephones. Mobile phones have been considered more reliable for communication.

2) The new technology has to be compatible – the innovation should be perceived to be consistent with the values and the experience of the person. There is evidence that in Africa, mobile phones are valued over other technologies. This might mean that mobile phones are at least supporting more the values of the local people than other communication technologies.

3) The new technology should not be overly complex – the benefit of the technology should be higher than the effort that is put in understanding how it is used. The benefits of mobile phone are social and communication value at least. This is also the case in Africa. The mobile phones are already familiar devices to many people in African countries; therefore building the services on familiar platform has better potential than non-familiar (Marsden et al 2008).

4) It should be possible for user to try out the technology - how much it is possible for users investigate the innovation before deciding to purchase one.

5) The use of the technology should be visible for others - the social network should be able to observe the use of the technology and the benefit of it should be clear for the social network too. In Africa the mobile device itself has value as such.

If two additional factors are added to the Roger's list (Karahanna et al., 1999; Barnes and Huff, 2003) like done by Kaasinen (2005) that is actually showing even stronger potential for mobile phones and mobile Internet in Africa:

6) The image of the system – how much the adoption and the use of the innovation is perceived to enhance one's image or status. In Africa the mobile phone is preliminary perceived as valued technology. (Scott et al 2004)

7) Trust to the system- the extent to which the innovation adopter perceives the innovation provides to be trustworthy. Cable thefts and other problems in the maintenance of the infrastructure make the mobiles more reliable than the fixed line systems.

Each individual person evaluates and prioritizes these factors from his or her own perspective. The Rogers diffusion aspects show that many of the benefits are heavily linked to person's social network.

One of the issues supporting the mobile Internet success in Africa is the local peoples' attitude. The mobile is not only perceived as more reliable than landline connection but people seem to value mobile devices more than computers. Wireless connection is also available in rural area and other areas where wired connections are not built.

Like other continents have their own characteristics, so does Africa. The systems and services built for global market may not be fully useful for African market. Gary Marsden highlights (interview in 2008, Marsden et al 2008) that the traditional perception of internationalization does not work in Africa. In order to make successful services it is important to understand that the western ways of perceiving the environment may not work in other countries. Marsden uses the menu structures as an example and says that many South Africans have difficulties in understanding hierarchical structures. He emphasizes that the responsible approach in Africa is to create tools and systems the local developers can use to create services and applications for local people. Jones and Marsden (2006) give an example of a young South African student, who says that mobile phones force her to think in English; therefore she sends messages to her mother in English, not in her native language. The hierarchical structure of the mobile phone may be one reason that forces this student to think in English. For mobile device and infrastructure developers this means, that systems developed for other markets should not just be copied and translated for African market. The development should rather focus on making enablers that local developers can use when creating the services for local markets. The African mobile Internet may not be focusing on the use of full websites from mobiles, but rather on the use of local mobile tailored services.

The researchers should seek the answers to the questions that would help the mobile Internet development in Africa, and other emerging markets. The range of the questions is massive, as all those questions that have been relevant during the 10 years of mobile Internet need investigation in emerging markets. What kind of user interfaces for mobile systems should be designed, this should include the ways how information from Internet is sent to the device as well as overall Internet service design. Researchers should also investigate the methodologies; what kind of participatory design and evaluation methods are most suitable when doing research in emerging markets. The usage patterns of mobile Internet need also investigation; do the usage patterns and context differ in emerging markets? These questions have been investigated in developed countries over last ten years, and are relevant when designing mobile Internet for emerging markets too.

7.3 What the Companies Can Do to Make Their Mobile Offering More Satisfactory for Users?

The mobile Internet 'success stories' show, that building the total offering instead of a small piece of a service or a device, seems to be successful in mobile service area. Most companies cannot build everything themselves, but they can make alliances with partners.

To make good mobile services, the decisions makers should have right information covering available technical solutions, possible business models and the users of the service and their context. The granularity of information may apply to all these fields, but my expertise is mostly on use of the information of humans as technology users.

In different phases of the mobile service development, decision makers need different kind of information on people. HCI research traditionally serves information needs in R&D, which has influenced the methodology used in the field. Market research serves primarily the business goals; therefore, market research outcome serves well the management defining the service strategy. Market research commonly covers information on the trends, the usage patterns of large groups, appeal, potential revenue, benchmarking and may cover partly even high-level motivational aspects. When the development process proceeds, the people responsible of next phase are challenged with different questions. Market research does not provide information needed to evaluate different design solutions, for example.

The need to have wider perception of humans is well understood in industry. Market research people have typically been responsible for providing this information (often called 'consumer research'). In the same way as in the area of HCI, in market research the need for creating the holistic view of humans has emerged. This can be seen for example by noticing that some market research companies have added 'usability test' or 'user experience evaluation' in their offering. The approaches of market research and HCI research to humans are different. Market research has more top-down approach and HCI more bottom-up approach. In the middle there is a 'grey area' where both approaches can contribute. Optimally this gray area provides space for market researchers and HCI researchers and practitioners to have dialogue on holistic view on humans. These both approaches can contribute when designing devices and services for people.

In the area of HCI, there is ongoing discussion on 'usability' and 'user experience'. In HCI literature term 'usability' seems to be well established which can be seen in way how the term is used. 'Usability' mostly refers to device, service or system and how easily and effectively users can do what they want with them. It can also refer to test method used to evaluate the system, professionals trained to run the test and translate the outcome of the tests to support user interface and system development. The term 'user experience' has been used in situations where 'usability' has not been enough. The problem with 'user experience' is that it has been used without proper definition, in such way that it is very difficult to find out what has been studied. The lack of commonly agreed terminology has

lead to situation where each study of ‘user experience’ investigates slightly different thing. This leads to a situation, where the studies are not comparable with each other. The evaluation of the methodology in conference papers handling ‘user experience’ showed, that methods measured mostly behavior, behavioral patterns, opinions or preference of participants or their perception of their own motives. This is a significant reduction of the term. It seems that ‘user experience’ is too wide and too vague a term to be used, at least in research papers. In research papers it would be better to use terms that are measurable and easier to understand, like “user behavior” and “user preference”. However, it may be difficult to change the use of the terms after they have started to establish in common use. Human Computer interaction is a multidisciplinary domain. We will continue living in an environment where fuzzy terms are used. Even people are called differently: some call them ’users’ and some ’consumers’. We just have to be aware of the connotations linked to these terms and how people from different backgrounds have internalized the terms and their connotations, like Vygotski (1982) describes.

In industry it may be difficult to justify that humans are called with different terms. People are called ‘users’ in R&D, and sometimes it is even understood, that information on usability is based on factual data on users. In user experience research, user experience seems to be reduced to behavior, behavioral patterns, preferences and the perception of own motivations, which are measurable things. How the term is actually used in different situations reveals that it means something else than these measurable things. In such cases there is a risk that user experience driven approach actually leads to opinion based decision making, instead of factual information.

The future challenge for mobile service HCI is related to the new perspectives to humans. One challenge is related to emotional aspects, the other to new user groups. Even if we cannot design the experiences and the emotions of people, we can design and develop systems that do not hinder the users of having positive emotions and good moments, when using the devices and services. When developing systems for new user groups, we have to be prepared that the existing practices and solutions may not work. In new markets, like in Africa, the infrastructure is different and peoples’ perception of their environment may differ a lot from the perception of people in other continents. The service content and structure has to adapt to local needs. Also in developed countries we have people that are new to mobile Internet. Elderly people have different perception of technology than younger people. Young generation, sometimes called as ‘Internet natives’, has grown in an environment full of media. They perceive the media and social network tools differently form older generations. These conceptual differences in perception and thinking may mean that very different services are needed. The variety of perception is sometimes undervalued, as humans are good at adapting their behavior to technology.

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APPENDIX 1

MobileHCI 1998	numbers: 0=no,1=usability, 2=UX, 3=both	Usability ISO 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional ...)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute
Chris Johnson. Rebuilding the Babel Tower.	1								1							
Peter Johnson Usability and Mobility; Interactions	1		**1**		1											
Tom Rodden, Keith Chervest, Nigel Davies and Alan Dix	0															
Mikael Goldstein, Robert Book, Gunilla Alsio and Silvia	1	1														
Stephen Brewster, Grégory Leplâtre and Murray CreaseUsing	1	1														
Helen Petrie, Stephen Furner, Thomas Strothotte:	1	1														
Steinar Kristoffersen, Jo Herstad, Fredrik Ljungberg,, Frode	1	1	1													
Jason Pascoe, Nick Ryan, and David Morse: Human-	0															
Peter J. Brown: Some Lessons for Location-Aware	0															
Nigel Davies, Keith Mitchell, Keith Cheverst, Gordon	1	1														
Maria R. Ebling and M. Satyanarayanan: On the Importance of	1	1														
Keith Cheverst, Nigel Davies, Adrian Friday: Developing	0															
Jo Herstad, Do Van Thanh and Steinar Kristoffersen:	0															
Malcolm McIlhagga, Ann Light and Ian Wakeman: Giving	0															
Kaisa Väänänen-Vainio-Mattila and Satu Ruuska: User	1				1	1										

MobileHCI 1999	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability =Ux	device attribute	Usability other	UX= usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Dunlop, M. D. & Crossan, A. (University of	0																
Goldstein, M. & Chincholle, D. (Ericsson Radio	0																
Brown, B., O'Hara, K. & Sellen, A. (Hewlett-Packard Labs,	0																
Schmidt, A. (University of Karlsruhe, Germany)	1	1															
Graham, R. & Carter, C. (HUSAT Research Institute, University of	0																
Koskinen, T. (Nokia Mobile Phones, Finland)Mobile	0																
Walker, A. & Brewster, S. (University of	1							1									
Eldridge, M., Lamming, M. Flynn, M., Jones, C. &	0																
Hjelmeroos, H., Ketola, P. & Raiha, K-J. (Nokia and	1		1		1												
Koppinen, A. (Nokia Mobile Phones, Finland)Design	1			1													

MobileHCI 2001	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Keith Cheverst, Keith Mitchell and Nigel Davies : Investigating	1	1	1														
Luca Chittaro and Paolo Dal Cin : Evaluating Interface	1	1															
Oscar De Bruijn, Robert Spence and Min Yih Chong: RSVP	1			1													
Mikael Goldstein , Gustav vist, Mandana Bayat -	1	1															
Simon Holland and David R. Morse: Audio GPS:spatial	1	1															
Helge H?auch and Mikael Norman: PocketCERO –	1				1												
Shahram Izadi, Mike Fraser, Steve Benford, Martin	1									1							
Thomas Rist and Patrick Brandmeier: Customizing	1			1													
J?Roth: Patterns of Mobile Interaction	0																
Albrecht Schmidt, Tanjev Stuhr, and Hans Gellersen:	0																
Georg Strom: Mobile Devices as Props in Daily Role	2										1						
Satu Ruuska-Kalliokulju, Matthias Schneider-	0																

MobileHCI 2002	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional ...)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
F. J. González-Castaño, L. Anido-Rifón and E. Costa-	1				1												
Matt Jones, George Buchanan and Harold Thimbleby:	1							1									
Jani Mantyjarvi and Tapio Seppanen : Adapting	1							1									
Simon Holland, David R. Morse & Henrik Gedenryd:	0																
Emmanuel Dubois, Philip Gray, Laurence Nigay	1							1									
G. Pospischil, M. Umlauft, E. Michlmay:r	1		1		1												
Thorsten Bohnenberger, Anthony Jameson,	0																
Stacie Hibino, Audris Mockus Handimessenger:	0																
L. Nigay, P. Salembier, T. Marchand, P.	1							1									
Vibha Sazawal, Roy Want, and Gaetano Borriello: The	0																
Martin Colbert: A Diary Study Of Rendezvousing:	1				1		1										
M. Gelgon and K.Tilhou: Automated Multimedia Diaries	0																
Justin Lin, Robert Laddaga, and Hirohisa Naito:	0																
Elaine Huang, Michael Terry, Elizabeth Mynatt,	1				1	1		1									
Sachi Mizobuchi, Koichi Mori, Xiangshi Ren, Yasumura	0																
Scott I. MacKenzie: KSPC (Keystrokes Per Character) As A	0																
Didier Chincholle, Mikael Goldstein, Marcus Nyberg,	1								1								
Gustav Öquist and Mikael Goldstein: Towards An	1				1			1									

mobileHCI 2003	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Sakari Tamminen, Antti Oulasvirta, Kalle Toiskallio, Anu	0																
Mattias Esbjörnsson, Oskar Juhlin, Mattias Östergren: Mobile	2										1						
Giulio Iacucci, Antti Juustila, Kari Kuutti, Pekka Pehkonen,	0																
Kent Lyons: Everyday Wearable Computer Use: A Case Study of	0																
Miika Silfverberg: Using Mobile Keypads with	0																
Juha Marila, Sami Ronkainen: Time-out in mobile text input:	0																
Jun Rekimoto, Yuji Ayatsuka, Michimune Kohno: SyncTap: An	0																
Jakob Bardram, Thomas A. K. Kjær, Christina Nielsen:	1							1									
David Pinelle, Jeff Dyck, Carl Gutwin: Aligning Work	0																
Gustavo Zurita, Miguel Nussbaum, Mike Sharples:	1		1		1			1									
Johan Sanneblad, Lars Erik Holmquist: OpenTrek: A	0																
Adrian David Cheok, Siew Wan Fong, Kok Hwee Goh, Xubo	0																
Rachel Fithian, Giovanni Iachello, Jehan Moghazy,	1	1															
Christian Borntrager, Keith Cheverst, Nigel Davies, Alan Dix,	0																
Carmine Ciavarella, Fabio Paternò: Design Criteria for	0																
Kai Richter, Marita Enge: Multi-modal Framework to	0																
Somnath Banerjee, Arobinda Gupta, Anupam Basu :	0																
Karin Coninx, Kris Luyten, Chris Vandervelpen, Jan	0																
Francesco Bellotti, Riccardo Berta, Alessandro De	1							1	1								
Verena Giller, Rudolf Melcher, Reinhard		1			1												

MobileHCI 2004	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional ...)	usability= Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Christopher Campbell, Peter Tarasewich: What Can You Say	0																
Lance Bloom, Rachel Eardley, Erik Geelhoed, Meera	0																
Martina Ziefle, Susanne Bay: Mental Models of a Cellular	0																
Joy Goodman, Phil Gray, Kartik Khammampad,	0																
Shirlina Po, Steve Howard, Frank Vetere, Mikael Skov: Heuristic	1	1	1		1	1	1		1								
Jesper Kjeldskov, Mikael B. Skov, Benedikte S. Als, Rune	1	1	1		1												
Tiiu Koskela, Kaisa Väänänen-Vainio-Mattila, Lauri Lehti:	1				1				1								
Barbara Schmidt-Belz, Fabian Hermann: User validation of a	1																
Chris Baber, Oliver Westmancott: Social Networks and Mobile	0																
Gustav Öquist, Anna Sågvall-Hein, Jan Ygge, Mikael	0																
Parisa Eslambolchilar, Roderick Murray-Smith: Tilt-Based	1		1														
Dynal Patel, Gary Marsden, Steve Jones, Matt Jones: An	0																
Andrew Crossan, Rod Murray-Smith: Variability in Wrist-Tilt	0																
Joanna Lumsden, Andrew Gammell: Mobile Note Taking:	0																
Gillian Hayes, Shwetak Patel, Khai Truong, Giovanni Iachello,	1							1									
Georgios Marentakis, Stephen Brewster: A Study on Gestural	0																
Jiraporn Buranatrived, Paul Vickers: A Study of Application and	3	1					1	1		1							
Michael Hinz, Zoltan-Fiala, Frank Wehner: Personalization-based	0																
Renata Bandelloni, Silvia Berti, Fabio Paterno: Mixed-	0																
Bonnie MacKay, Carolyn Watters, Jack Duffy: Web Page	1								1								
Russell Beale, Peter Lonsdale: Mobile Context Aware	1			1													
Tiiu Koskela, Inka Vilpola: Usability of MobiVR Concept:	3			1	1					1							1
Gennaro Costagliola, Sergio Di Martino, Filomena Ferrucci,	1	1							1								

MobileHCI 2005	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional	usability= Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage	through the components affecting the experience	UX organization (UX specialist,	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Dan Hong, Mingxuan Yuan, Vincent Y. Shen: Dynamic	2														1		
Stavros Antifakos, Nicky Kern, Bernt	1								1								
Michimune Kohno, Jun Rekimoto ; Searching common	0																
Jesper Kjeldskov, Jeni Paay : Just-for-us: a context-aware mobile	1						1										
Risto Sarvas, Antti Oulasvirta, Giulio Jacucci : Building	0																
Juwon Ahn, Jeffrey S. Pierce : SEREFE: serendipitous file	3				1					1						1	
Keith Cheverst, Alan Dix, Daniel Fitton, Chris Kray, Mark	0																
Georgios Marentakis, Stephen A. Brewster : A comparison of	1			1					1								
Tuuli Hyvärinen, Anne Kaikkonen, Mika Hiltunen : Placing	1	1			1												
Hendrik Knoche, John D. McCarthy : Design requirements for	3								1		1						
Silvia Gabrielli, Valeria Mirabella, Stephen Kimani, Tiziana	1	1			1												
Renata Bandelloni, Giulio Mori, Fabio Paternò : Dynamic	0																
Rainer Simon, Florian Wegscheider, Konrad Tolar : Tool-supported	3	1									1						
Benoît Martin : VirHKey: a VIRtual Hyperbolic KEYboard	1	1			1												
Luca Chittaro, Stefano Burigat : Augmenting audio messages with	0																
Frode Eika Sandnes : Evaluating mobile text entry strategies with	1				1				1								
Sachi Mizobuchi, Mark Chignell, David Newton : Mobile text	1				1				1								
Thorsten Büring, Harald Reiterer : ZuiScat: querying and	1								1								
Tero Hakala, Juha Lehikoinen, Antti Aaltonen : Spatial	1			1	1												
Julien Pauty, Paul Couderc, Michel Banâtre: Using	3				1						1						
Dimitrios Raptis, Nikolaos Tselios, Nikolaos Avouris:	1		1						1								
A. K. Amin, B. T. A. Kersten, O. A. Kulyk, P. H. Pelgrim, C. M.	1						1		1								
Antti Oulasvirta, Mika Raento, Sauli Tiitta: ContextContacts: re-	1			1													
Keith Mitchell, Nicholas J. P. Race, Michael Clarke:	3								1								1
Bonnie MacKay, David Dearman, Kori Inkpen, Carolyn Watters: Walk	1	1	1		1												
Nigel Davies, Keith Cheverst, Alan Dix, Andre Hesse :	3	1			1						1						
Weining Yue, Shu Mu,	1								1								

MobileHCI 2006	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional ...)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Pekka Parhi , Amy Karlson&Benjamin Bederson University	0																
Dynal Patel&Gary Marsden , Matt Jones , Steve Jones :	1				1												
Satu Jumisko-Pyykkö& Vinod Kumar M.V., Jari	0																
Nuria Oliver, Fernando Flores-Mangas : MPTrain: A	0																
Arjan Geven, Reinhard Sefelin, Manfred Tscheligi:	0	1															
Motoki Miura, Susumu Kunifuji (School of	1								1								
Mark Weal, Eva Hornecker, Don Cruickshank , Danius	2										1						
Marcos Serrano, Laurence Nigay, Rachel Demumieux,	1								1								
Fabio Buttussi, Luca Chittaro, Daniele Nadalutti: Bringing	0																
Lorna Brown, Stephen Brewster, Helen Purchase:	0																
Henry Been-Lirn Duh: Usability Evaluation for Mobile Device: A	1				1		1										
Jaakko Lehikoinen, Anne Kaikkonen: PePe Field Study:	3						1						1				
Enrico Costanza, Samuel A. Inverso, Elan Pavlov,	2										1						
Christian Kray, Keith Cheverst, Daniel Fitton, Corina Sas,	1				1												
Ashweeni Beeharee, Anthony Steed : A Natural Wayfinding -	3				1						1						
Kristin Vadas, Nirmal Patel, Kent Lyons, Thad Starner, Julie	0																
Hannu Korhonen, Elina M.I Koivisto Playability Heuristics	1	1															
John Williamson Steven Strachan, Roderick Murray-	1		1						1								
Stefano Burigat, Luca Chittaro, Silvia Gabrielli):	0																
Younghee Jung Jan Blom, Per Persson : Scent Field Trial -	3	1	1								1						

MobileHCI 07	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional ...)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Sung-Jung Cho, Roderick Murray-Smith, Yeun-Bae Kim	1				1				1								
Simone Braun, Wolfgang Gräther : Mobile support for	1								1								
Merja Haveri, Jan Blom, Jyri Virtanen, Mikko Tarkiainen,	2										1						
Roderick Murray-Smith, Andrew Ramsay, Simon	1				1				1								
Natasa Milic-Frayling, Martin Hicks, Rachel Jones,	0																
Maiju Markova, Anne Aula, Teija Vainio, Heli Wigelius, Minna	3	1		1	1	1			1			1					
Richard Harper, Tim Regan, Shahram Izadi, Kharsim Al	2														1	1	
Kristijan Mihalic, Manfred Tscheligi : 'Divert: mother-in-	0																
Ahmad Rahmati, Angela Qian, Lin Zhong :	1						1		1								
Leonard M. Ah Kun, Gary Marsden : Co-present photo	0																
Juha Häikiö, Arto Wallin, Minna Isomursu, Heikki	3								1						1		
Andreas Lorenz, Dorit Mielke, Reinhard	1								1								
Karen P. Tang, Jason I. Hong, Ian E. Smith, Annie Ha, Lalatendu	0																
Michael Rohs, Georg Essl : Sensing-based interaction for	1				1												
Tomi Heimonen, Mika Käki : Mobile findex: supporting	0																
Maryam Kamvar, Shumeet Baluja : The role of context in	2	1								1							
David Arter, George Buchanan, Matt Jones, Richard	0																
Konrad Tollmar, Ted Möller, Björn Nilsved: A picture is worth a	1								1								
Koji Yatani, Khai N. Truong : An evaluation of stylus-	2														1		
Ye Kyaw Thu, Yoshiyori Urano : Positional mapping	0																
Kris Luyten, Kristof Verpoorten, Karin Coninx : Ad-hoc co-	1							1									
Riccardo Dini, Fabio Paternò, Carmen Santoro : An	2														1		

MobileHCI 08	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability= Ux	device attribut e	Usability other	UX=usa bility	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organizatio n (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Cameron Ross Dunne, Thibault Candebat, David Gray: A	0																
Karen Church, Barry Smyth, Keith Bradley, Paul CotterA large	2									1							
Arjan Geven, Reinhard Sefelin, Norman Höller,	2															1	
Youngwoo Yoon, Yuri Ahn, Geehyuk Lee, Sungmoo Hong,	0																
Antti Oulasvirta Designing mobile awareness cues	0																
Maiju Vuolle, Mari Tiainen, Titti Kallio, Teija Vainio, Minna	3	1			1	1			1							1	1
Satu Jumisko-Pyykkö, Miska M. Hannuksela: Does context matter in	1	1			1				1								
Nanja J. J. M. Smets, Guido M. te Brake, Mark A. Neerincx,	1	1															
Paul Holleis, Albrecht Schmidt, Susanna Paasovaara, Arto	3				1	1			1						1		
Christina Dicke, Shaleen Deo, Mark Billinghurst, Nathan	1								1								
Jan Willem Streefkerk, Myra P. van Esch-	3				1			1		1							1
Shaun K. Kane, Jacob O. Wobbrock, Ian E. Smith: Getting off the	2				1			1									
Keith J. Oliver, Gary E. Burnett :Learning-oriented vehicle	1	1															
Marco de Sá, Luís Carriço : Lessons from early stages	1		1		1				1								
Sabine Schröder, Martina Ziefle : Making a completely icon-	1								1								

MobileHCI 08	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability	usability= Ux	device attribut e	Usability other	UX=usa bility	No definition	usability, motivation, behavior	through the components affecting the	UX organizatio n (UX	UX- persons attribute, no clear	UX= device attribute	UX Other
Stefano Burigat, Luca Chittaro, Edoardo Parlato : Map,	1	1															
A. Engström, M. Esbjörnsson, O. Juhlin: Mobile	0																
Michael Leitner, Peter Wolkerstorfer, Reinhard Sefelin,	3		1		1			1		1					1		
Davy Preuveneers, Yolande Berbers : Mobile phones	1				1				1								
James Clawson, Amy Voida, Nirmal Patel, Kent Lyons :	3						1								1		
Simon Robinson, Parisa Eslambolchilar, Matt Jones: Point-to-	3	1		1							1						
Alina Hang, Enrico Rukzio, Andrew Greaves Projector	1	1															
Anirudha Joshi, Nikhil Welankar, Naveen BL, Kirti Kanitkar, Riyaj	1				1												
Ying Liu, Kari-Jouko Räihä : RotaTxt: Chinese pinyin input	1	1			1												
Iris Herbst, Anne-Kathrin Braun, Rod McCall, Wolfgang	1								1								
Robert Hardy, Enrico RukzioTouch & interact: touch-based	1	1															
Rodrigo de Oliveira, Nuria Oliver: TripleBeat: enhancing	0																
Jeroen Keijzers, Elke den Ouden, Yuan LuUsability	1	1	1		1												
Thomas Olsson, Hannu Soronen, Kaisa Väänänen-Vainio-	1						1		1								
Will Bamford, Paul Coulton, Marion Walker, Duncan	3				1					1							
Hendrik Witt, Michael Lawo, Mikael Drugge : Visual	1				1												

CHI 98	numbers: 0=no,1=usability , 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional ...)	usability =Ux	device attribut e	Usability other	UX=usa bility	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organizati on (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Kyokuni KAWACXUYA and Hkoshi ISFEKAWA:	0																
Beverly ;. Harrison, 'Kenneth P. Fishkin, Anuj Gujar, Carlos	0																
Annette Adler ', Anuj Gujar ', Beverly L. Harrison ', Kenton	0																

CHI99	numbers: 0=no,1=usability , 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional ...)	usability =Ux	device attribut e	Usability other	UX=usa bility	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organizati on (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
I. Scott MacKenzie and Shawn X. Zhang: The Design and	1			1	1												
Mikael Goldstein, Robert Book, Gunilla Alsiö, Silvia Tessa:	1	1			1												
Nitin Sawhney, Chris Schmandt: Nomadic radio: scaleable and	0																
Masaaki Fukumoto, Yoshinobu Tonomura: Whisper:	1								1								
Richard C. Davis, James A. Landay, Victor Chen,	0																
Roy Want, Kenneth P. Fishkin, Anuj Gujar, Beverly L.	2										1						
Angel R. Puerta, Eric Cheng, Tunhow Ou, Justin Min: MOBILE:	0																
Daniel Salber, Anind K. Dey, Gregory D. Abowd: The context	0																

CHI 00	numbers: 0,1,2,3	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Anne McCiard, Patricia Somers: Unleashed: Web	1		1		1				1								
Miika Silfverberg, I. Scott MacKenzie, Panu Korhonen:	0																
Keith Cheverst, Nigel Davies, Keith Mitchell, Adrian	1								1								
Brad A. Myers, Kin Pou ("Leo") Lie, and Bo-Chieh ("Jerry")	0																
Jennifer Mankoff , Scott E. Hudson, Gregory D. Abowd :	1	1															
Orkut Buyukkokten, Hector Garcia-Molina, Andreas	1	1															
Anu Mäkelä Verena Giller Manfred Tscheligi Reinhard	1				1												

CHI 01	numbers: 0,1,2,3	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Boriana Koleva, Ian Taylor, Steve Benford, Mike Fraser,	1								1								
Les Nelson, Sara Bly, Tomas Sokoler: Quiet Calls: Talking	0																
Orkut Buyukkokten, Hector Garcia-Molina, Andreas	0																
John C. Tang, Nicole Yankelovich, James "Bo" Begole, Max	3				1						1						
Christina L. James and Kelly M. Reischel: Text Input	2									1							
Arman Danesh, Kori Inkpen, Felix Lau and Keith Shu	1				1				1								
Rick Borovoy, Brian Silverman, Tim Gorton, Jeff Klann,	0																

CHI 02	numbers: 0=no,1=usability , 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Holger Schnädelbach, Boriana Koleva,	0																
Shumin Zhai, Alison Sue, Johnny Accot: Movement Model,	0																
Poika Isokoski and Mika Käki: Comparison of Two	0																
Ellen Isaacs, Alan Walendowski, & Dipti Ranganthan:	0																
Abigail J. Sellen, Rachel Murphy, Kate L. Shaw: How	1					1											
Antti Pirhonen, Stephen Brewster, Christopher Holguin:	1	1	1		1												
Paul M. Aoki, Rebecca E. Grinter, Amy Hurst, Margaret	1			1													
Alex S. Taylor and Richard Harper: Age-old practices in the	0																

CHI 2003	numbers: 0=no,1=usability ,2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional ...)	usability =Ux	device attribut e	Usability other	UX=usa bility	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organizati on (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Scott R. Klemmer, Jamey Graham, Gregory J. Wolff,	1		1						1								
Shumin Zhai, Per-Ola Kristensson: Shorthand writing on	1				1												
R. William Soukoreff, I. Scott MacKenzie : Metrics for text entry	0																
Leysia Palen, Paul Dourish : Unpacking "privacy" for a	0																
Desney S. Tan, Darren Gergle, Peter Scupelli, Randy	0																
William W. Gaver, Jacob Beaver, Steve Benford: Ambiguity	1								1								
Kathleen Luchini, Chris Quintana, Elliot Soloway: Pocket	1								1								
Anne Kaikkonen, Virpi Roto: Navigating in a	1	1			1												
Erica Newcomb, Toni Pashley, John Stasko : Mobile computing	1				1												
Paul M. Aoki, Matthew Romaine, Margaret H.	1						1										
Sara Berg, Alex S. Taylor, Richard Harper: Mobile	1			1													
Rebecca Grinter, Margery Eldridge : Wan2tlk?: everyday	0																
Stephen Brewster, Joanna Lumsden, Marek Bell, Malcolm	1	1															
Patrick Baudisch, Ruth Rosenholtz; Halo: a technique for	0																
Martin Flintham, Steve Benford, Rob Anastasi, Terry	0																

CHI 2004	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Stephen S. Intille, Ling Bao, Emmanuel Munguia Tapia, John	0																
Masanori Sugimoto, Kazuhiro Hosoi, Hiromichi	0																
Daniel Wigdor, Ravin Balakrishnan : A comparison of	0																
Jeffrey T. Hancock, Jennifer Thom-Santelli, Thompson	0																
Kathleen Luchini, Chris Quintana, Elliot Soloway : Design	1								1								
Tim Harter, Sander Vroegindeweij, Erik Geelhoed, Meera	3								1		1						
Eric Paulos, Elizabeth Goodman: The familiar	0																
Antti Oulasvirta: Finding meaningful uses for context-	1				1												
Carsten Schwesig, Ivan Poupyrev, Eijiro Mori: Gummi: a	1				1												
Robert St. Amant, Thomas E. Horton, Frank E. Ritter:	1								1								
Andriy Pavlovych, Wolfgang Stuerzlinger: Model	0																
Andy Crabtree, Steve Benford, Tom Rodden, Chris	0																
Dag Svanaes, Gry Seland: Putting the users center stage:	1				1												
John D. McCarthy, M. Angela Sasse, Dimitrios Miras:	0																
Scott Counts, Eric Fellheimer : Supporting social	1								1								
Sachi Mizobuchi, Michiaki Yasumura : Tapping vs. circling	3								1						1		
Magnus Ingmarsson, David Dinka, Shumin Zhai: TNT: a numeric	0																
Kent Lyons, Thad Starner, Daniel Plaisted, James	1			1	1												
Min Lin, Wayne G. Lutters, Tina S. Kim : Understanding the	0																

CHI 2005	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability =Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Sunny Consolvo, Ian E. Smith, Tara Matthews, Anthony	1				1												
Giovanni Iachello, Gregory D. Abowd: Privacy and	0																
Paul M. Aoki, Allison Woodruff: Making space for stories:	3	1													1		
Amy K. Karlson, Benjamin B. Bederson, John	1				1				1								
Jun Gong, Peter Tarasewich: Alphabetically	1	1															
Eric Paulos, Tom Jenkins: Urban probes: encountering	1	1															
Younghee Jung, Per Persson, Jan Blom: DeDe: design and	0																
Frank Vetere, Martin R. Gibbs, Jesper Kjeldskov, Steve	1								1								
Enrico Costanza, Samuel A. Inverso, Rebecca Allen:	1								1								
Mike Schneider, Sara Kiesler: Calling while driving: effects	0																
Irina A. Shklovski, Scott D. Mainwaring: Exploring technology	1								1								
Alex S. Taylor, Laurel Swan: Artful systems in the home	0																
Boreum Choi, Inseong Lee, Jinwoo Kim, Yunsuk Jeon: A	1				1												
Xing Xie, Hao Liu, Simon Goumaz, Wei-Ying Ma: Learning	2									1							
Heidi Lam, Patrick Baudisch : Summary thumbnails: readable	0																
Steve Benford, Duncan Rowland, Martin Flintham,	0																
Stuart Reeves, Steve Benford, Claire O'Malley, Mike	0																
QianYing Wang, Clifford Nass: Less visible and wireless:	0																
Morris Williams, Owain Jones, Constance Fleuriot,	0																
Joyce Ho, Stephen S. Intille : Using context-	0																

CHI 2006	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability= Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Virpi Roto, Andrei Popescu, Antti Koivisto, Elina	3		1		1				1						1		
Gerard McAtamney, Caroline Parker: An examination of the	0																
Karen P. Tang, Pedram Keyani, James Fogarty, Jason I.	3		1												1		
Carman Neustaedter, A. J. Bernheim Brush: "LINC-ing" the family:	1				1												
Jordan L. Boyd-Graber, Sonya S. Nikolova, Karyn A.	0																
Margit Kristensen, Morten Kyng, Leysia Palen: Participatory	0																
Joseph Luk, Jerome Pasquero, Shannon Little, Karon MacLean,	1				1												
Jonas Landgren: Making action visible in time-critical work	0																
Jakob Bardram, Jonathan Bunde-Pedersen, Mads	3			1													1
Miguel A. Nacenta, Samer Sallam, Bernard Champoux,	0																
Pourang Irani, Carl Gutwin, Xing Dong Yang: Improving	1		1														
Georgios N. Marentakis, Stephen A. Brewster: Effects of	1		1		1				1								
Marek Bell, Matthew Chalmers, Louise Barkhuus, Malcolm	2														1		
Steve Benford, Andy Crabtree, Stuart Reeves, Jennifer	0																
Sunny Consolvo, Katherine Everitt, Ian Smith, James A.	1							1									
Tapan S. Parikh, Paul Javid, Sasikumar K., Kaushik Ghosh,	1	1	1		1												

CHI 2006	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability	usability= Ux	device attribut e	Usability other	UX=usa bility	No definition	usability, motivation, behavior	through the components affecting the	UX organizatio n (UX	UX- persons attribute, no clear	UX= device attribute	UX Other
Jeffrey Nichols, Brad A. Myers, Brandon Rothrock: UNIFORM:	1							1									
Frank Bentley, Crysta Metcalf, Gunnar Harboe: Personal vs.	0																
Maryam Kamvar, Shumeet Baluja: A large scale study of	0																
Amy K. Karlson, George G. Robertson, Daniel C. Robbins,	1		1	1													
Abhishek Ranjan, Ravin Balakrishnan, Mark Chignell:	0																
Muhd Dzulkhiflee Hamzah, Shun'ichi Tano, Mitsuru Iwata,	0																
Tovi Grossman, Ken Hinckley, Patrick Baudisch, Maneesh	1							1									
Kenton O'Hara, Alison Black, Matthew Lipson: Everyday	0																
Pamela J. Ludford, Dan Frankowski, Ken Reily, Kurt Wilms,	0																
Giovanni Iachello, Khai N. Truong, Gregory D. Abowd,	3	1			1											1	
Frank Biocca, Arthur Tang, Charles Owen, Fan Xiao: Attention	0																
Antti Salovaara, Giulio Jacucci, Antti Oulasvirta, Timo Saari,	0																

CHI 2007	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability= Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
David Kirk, Abigail Sellen, Richard Harper, Ken Wood :	3								1							1	
Vaiva Kalnikaité, Steve Whittaker: Software or wetware?: discovering	1	1															
Scott Carter, Jennifer Mankoff, Jeffrey Heer: Momento: support for	3		1		1				1						1		
Duncan P. Brumby, Andrew Howes, Dario D. Salvucci : A	1					1											
Dario D. Salvucci, Daniel Markley, Mark Zuber, Duncan P.	0																
Martina Ziefle, Ulrik Schroeder, Judith Strenk, Thomas	1		1		1												
Shane Ahern, Dean Eckles, Nathaniel S. Good, Simon King,	0																
Jingyu Cui, Fang Wen, Rong Xiao, Yuandong Tian, Xiaoou Tang:	3				1			1		1							
Leysia Palen, Sophia B. Liu: Citizen communications in	0																
Gonzalo Ramos, Andy Cockburn, Ravin Balakrishnan, Michel	1							1									
Will Seager, Danae Stanton Fraser: Comparing physical,	1		1				1										
Enrico Costanza, Samuel A. Inverso, Rebecca Allen, Pattie	1								1								
Kenton O'Hara, April Slayden Mitchell, Alex Vorbau: Consuming	1							1									
Morgan Ames, Mor Naaman : Why we tag: motivations for	1								1								
Divya Ramachandran, Matthew Kam, Jane Chiu, John Canny,	1		1		1												

CHI 2007	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability	usability= Ux	device attribut e	Usability other	UX=usa bility	No definition	usability, motivation, behavior	through the components affecting the	UX organizatio n (UX	UX- persons attribute, no clear	UX= device attribute	UX Other
Matthew Kam, Divya Ramachandran, Varun Devanathan, Anuj	1		1														
Rafael Ballagas, Faraz Memon, Rene Reiners, Jan Borchers: iStuff	0																
Antti Salovaara: Appropriation of a MMS-based comic	0																
Antti Oulasvirta, Lauri Sumari: Mobile kits and laptop trays:	1							1									
Per Ola Kristensson, Shumin Zhai: Command strokes	0																
Kenton O'Hara, Tim Kindberg, Maxine Glancy, Luciana	0																
Giulio Jacucci, Antti Oulasvirta, Tommi Ilmonen, John Evans,	1	1															
Jeffrey Nichols, Duen Horng Chau, Brad A. Myers: Demonstrating	1					1		1									
Jonas Landgren, Urban Nulden: A study of emergency	0																
Frank R. Bentley, Crysta J. Metcalf: Sharing motion	0																
Shengdong Zhao, Pierre Dragicevic, Mark Chignell, Ravin	3				1		1	1							1		
Xiang Cao, Shumin Zhai: Modeling human performance of pen	0																
Paul Holleis, Friederike Otto, Heinrich Hussmann,	0																
Michael Pettitt, Gary Burnett, Alan Stevens: An extended keystroke	2														1		

CHI 2008	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability professional …)	usability= Ux	device attribute	Usability other	UX=usability	No definition	usability, motivation, behavior and usage pattern	through the components affecting the experience	UX organization (UX specialist, designer)	UX- persons attribute, no clear definition	UX= device attribute	UX Other
Susan P. Wyche, Paul M. Aoki, Rebecca E. Grinter: Re-placing	1						1										
Tero Jokela, Jaakko T. Lehikoinen, Hannu Korhonen: Mobile	1		1	1	1	1											
Steve Benford, Gabriella Giannachi: Temporal trajectories	0																
Maria F. Costabile, Antonella De Angeli, Rosa Lanzilotti,	3	1								1					1		
Tim Kindberg, Eamonn O'Neill, Chris Bevan, Vassilis	0																
Robert J.K. Jacob, Audrey Girouard, Leanne M. Hirshfield,	0																
Koji Yatani, Kurt Partridge, Marshall Bern, Mark W.	0																
Elaine M. Huang, Khai N. Truong: Breaking the disposable	0																
Timothy Sohn, Kevin A. Li, William G. Griswold, James D.	0																
Lena Mamykina, Elizabeth Mynatt, Patricia Davidson,	1		1					1									
Emily Troshynski, Charlotte Lee, Paul Dourish:	0																
Louise Barkhuus, Barry Brown, Marek Bell, Scott Sherwood,	1						1										
Simon B. Larsen, Jakob E. Bardram : Competence	0																
James Clawson, Kent Lyons, Alex Rudnick, Robert A. Iannucci, Jr.,	2									1							
Shumin Zhai, Per Ola Kristensson: Interlaced QWERTY:	0																
Stefan Parry Carmien, Gerhard Fischer: Design, adoption, and	1				1		1										
Christopher A. Le Dantec, W. Keith Edwards: Designs on	1		1	1													
Kristina Höök, Anna Ståhl, Petra Sundström, Jarmo	0																
Tuck Leong, Steve Howard, Frank Vetere: Choice: abidcating or	2																1

CHI 2008	numbers: 0=no,1=usability, 2=UX, 3=both	Usability Iso 9241	usability as problem	Nielsen	Usability method	usability organization (usability	usability= Ux	device attribut e	Usability other	UX=usa bility	No definition	usability, motivation, behavior	through the components affecting the	UX organizatio n (UX	UX- persons attribute, no clear	UX= device attribute	UX Other
Rowena Luk, Melissa Ho, Paul M. Aoki: Asynchronous remote	2														1		
Brian DeRenzi, Neal Lesh, Tapan Parikh, Clayton Sims, Werner	1		1	1	1												
David Dearman, Jeffery S. Pierce: It's on my other	2														1		
Sean Gustafson, Patrick Baudisch, Carl Gutwin, Pourang Irani	0																
Kenneth Majlund Ba h, Mads Gregers Jæger, Mikael B. Skov, Nils	0																
Victoria Bellotti, Bo Begole, Ed H. Chi, Nicolas Ducheneaut,	3		1	1											1		
Holger Schnädelbach, Stefan Rennick Egglestone, Stuart	0																
Kenton O'Hara: Understanding geocaching practices	0																
Leah Findlater, Joanna McGrenere: Impact of screen size on	1							1									
Yang Li, James A. Landay: Activity-based prototyping of	0																
James Lin, James A. Landay: Employing patterns and layers for	1		1		1			1									
Kevin A. Li, Patrick Baudisch, Ken Hinckley: Blindsight:	0																
Amy K. Karlson, Benjamin B. Bederson: One-	1				1												
Michael Rohs, Antti Oulasvirta: Target acquisition with	0																
William Gaver, Andy Boucher, Andy Law, Sarah Pennington,	0																
Christine Szentgyorgyi, Michael Terry, Edward Lank:	0																
Clint Heyer, Margot Brereton, Stephen Viller: Cross-channel	1			1													
Sin-Hwa Kang, James H. Watt, Sasi Kanth Ala: Social copresence	0																
Eve Hoggan, Stephen A. Brewster, Jody Johnston:	1								1								
Christine Satchell: Cultural theory and real world design:	1		1		1			1									
Saleema Amershi, Meredith Ringel Morris: CoSearch: a	1							1									
Ing-Marie Jonsson, Helen Harris, Clifford Nass: How accurate	0																
Gilly Leshed, Theresa Velden, Oya Rieger, Blazej Kot, Phoebe	1							1									
Mor Naaman, Rahul Nair, Vlad Kaplun :	0																

PUBLICATIONS USED IN LEXICAL SEMANTICS ANALYSIS

First Workshop on Human Computer Interaction with Mobile Devices , Mobile HCI 1998. Glasgow, Scotland

Chris Johnson: Rebuilding the Babel Tower.

Peter Johnson; Usability and Mobility; Interactions on the move.

Tom Rodden, Keith Chervest, Nigel Davies and Alan Dix: Exploiting Context in HCI Design for Mobile Systems

Mikael Goldstein, Robert Book, Gunilla Alsio and Silvia Tessa: Ubiquitous Input for Wearable Computing: Qwerty Keyboard without A Board

Stephen Brewster, Grégory Leplâtre and Murray Crease: Using Non-Speech Sounds in Mobile Computing Devices

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Ellen Isaacs, Alan Walendowski, & Dipti Ranganthan: Hubbub: A sound-enhanced mobile instant messenger that supports awareness and opportunistic interactions

Abigail J. Sellen, Rachel Murphy, Kate L. Shaw: How Knowledge Workers Use the Web

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