TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

Yanqing Cui

Social Networking Services on Mobile Devices: User Interface Designs and User Experience Studies

Julkaisu 1123 • Publication 1123

Tampere 2013

Tampereen teknillinen yliopisto. Julkaisu 1123
Tampere University of Technology. Publication 1123

Yanqing Cui

Social Networking Services on Mobile Devices: User Interface Designs and User Experience Studies

Thesis for the degree of Doctor of Philosophy to be presented with due permission for public examination and criticism in Tietotalo Building, Auditorium TB222, at Tampere University of Technology, on the 17th of May 2013, at 12 noon.

Tampereen teknillinen yliopisto - Tampere University of Technology
Tampere 2013

ISBN 978-952-15-3048-7 (printed)
ISBN 978-952-15-3087-6 (PDF)
ISSN 1459-2045

Abstract

People commonly use social networking services (SNSs) on their mobile devices. Web sites, mobile applications and mobile widgets are the typical user interfaces (UIs) used to access SNSs. These UIs are restricted to content from single services, which constrain people's simultaneous browsing of multiple SNSs. Previous studies propose workarounds – such as displaying SNS content in augmented phonebooks – to combine multiple SNSs. These studies, however, do not provide a genuine solution to the user's problem.

The objective of this dissertation is to explore novel UI designs for in-depth integration of multiple SNSs on a mobile device and to evaluate the user experience (UX) that these designs support. Here UX covers a person's perceptions and responses in using an interactive product.

This dissertation explores mobile use of SNSs from a human–computer interaction (HCI) perspective. Following the design research approach, the study investigated novel means of using multiple SNSs on mobile devices in a concept called 'LinkedUI'. The work focused on SNSs, although the results could also be relevant to mobile use of other Web services.

Three main results emerged from this research.

Firstly, in their use of mobile devices, people prefer to be aware of relevant SNS content when taking micro breaks. They often do not aim for concrete goals other than keeping informed and updated. Current UIs limit these browsing activities, as people need to interact with UI elements intensively before accessing the content in which they are interested.

Secondly, LinkedUI introduces a holistic device UI – regulating all functions of a mobile device – based on hypertext navigation. This supports aggregation of content from multiple services and automatic filtering to highlight relevant content. User evaluations showed that these designs contributed to positive user experiences of SNS use on mobile devices.

The third main result addresses usage patterns and user experiences of LinkedUI like mobile UIs. People frequently check SNSs in brief sessions. They attend to content selectively, mainly content directed to them, recently shared, or shared by relevant contacts. These factors aid in prediction of the relevance of the SNS content. In terms of UX, LinkedUI rewards users with enhanced awareness experience. It is easy to use and grants users a sufficient sense of control in the face of constant information flow.

The main contribution of this dissertation is to characterise user activities on the mobile Web, while the associated research created and evaluated novel means for accessing SNSs on mobile devices. Research discussed in this dissertation resulted in UI designs that explored one potential direction for the future mobile UI development and influenced the Notifications home view of some Nokia Symbian and MeeGo smartphones. This dissertation reveals usage patterns and UX associated with mobile use of SNSs, and it proposes implications for future research and development in this domain.

Acknowledgements

Professor Kaisa Väänänen-Vainio-Mattila was the supervisor for this PhD dissertation. Her encouragement and guidance was essential in completing the last mile of this academic journey.

This dissertation came about as a result of several collaboration projects. Special thanks go to the co-authors of the publications included: Mikko Honkala, Guido Grassel, Kimmo Kinnunen, Virpi Roto, Kari Pihkala, Antti Oulasvirta, Lingyi Ma, and Li Wang. Their intellectual and emotional support made the dissertation possible. The following people too contributed to the projects associated with the publications: Mika Rautava, Olli Immonen, Elina Ollila, Zac Fitz-Walter, David Arter, Shumeng Ye, Shruti Ramiah, Namita Savla, Melanie Wendland, and Katja Tallberg.

Professor Panos Markopoulos from Eindhoven University of Technology and Professor Vassilis Kostakos from Oulu University have pre-examined the dissertation and provided invaluable improvement suggestions. The following have read and commented on early versions of this dissertation: Petteri Nurmi, Akos Vetek, James Reilly, Dhaval Vyas, Zac Fitz-Walter, Kiri Patton, and Anna Shefl. Their suggestions and comments have improved the flow of the argument in the dissertation and the fluency of the language used.

This dissertation was done at Nokia Research Center Helsinki. Nokia funded all published studies forming part of it. A grant from Nokia Foundation helped the writing of the dissertation in its final form.

Dissertation Supervisor

Professor Kaisa Väänänen-Vainio-Mattila
Unit of Human-Centered Technology, Department of Pervasive Computing, Faculty of Computing and Electrical Engineering
Tampere University of Technology, Finland

Preliminary Examiners

Professor Vassilis Kostakos
Department of Computer Science and Engineering
University of Oulu, Finland

Professor Panos Markopoulos
Department of Industrial Design
Eindhoven University of Technology, the Netherlands

Defence Opponents

Professor Matt Jones
Department of Computer Science
Swansea University, the United Kingdom

Professor Panos Markopoulos
Department of Industrial Design
Eindhoven University of Technology, the Netherlands

Contents

List of publications

The thesis consists of a summary synthesising summary discussion of the following original publications. All publications are reprinted with permission from the relevant copyright holders.

P1 Yanqing Cui & Virpi Roto. (2008). How people use the web on mobile devices. *Proceedings of the 17th International Conference on World Wide Web* (WWW '08), ACM, 905–914. DOI=10.1145/1367497.1367619

Copyright 2008 IW3C2.

P2 Yanqing Cui & Li Wang. (2012). Motivations for accessing social networking services on mobile devices. *Proceedings of the International Conference on Advanced Visual Interfaces* (AVI '12), ACM, 636–639. DOI=10.1145/2254556.2254673

Copyright 2012 ACM Press.

P3 Yanqing Cui, Antti Oulasvirta, & Lingyi Ma. (2011). Event perception in mobile interaction: Toward better navigation history design on mobile devices. *International Journal of Human–Computer Interaction 27*(5), 413–435. DOI=10.1080/10447318.2011.552058

Copyright 2011 Taylor & Francis.

P4 Yanqing Cui, Mikko Honkala, Kari Pihkala, Kimmo Kinnunen, & Guido Grassel. (2010). Linked internet UI: A mobile user interface optimized for social networking. *Proceedings of the 12th International Conference on Human–Computer Interaction with Mobile Devices and Services* (MobileHCI '10), ACM, 45–54. DOI=10.1145/1851600.1851611

Copyright 2010 ACM Press.

P5 Mikko Honkala & Yanqing Cui. (2012). Automatic on-device filtering of social networking feeds. *Proceedings of the 7th Nordic Conference on Human–Computer Interaction* (NordiCHI '12), ACM, 721–730. DOI=10.1145/2399016.2399126

Copyright 2012 ACM Press.

P6 Yanqing Cui & Mikko Honkala. (2011). The consumption of integrated social networking services on mobile devices. *Proceedings of the 10th International Conference on Mobile and Ubiquitous Multimedia* (MUM '11), ACM, 53–62. DOI=10.1145/2107596.2107602

P7 Yanqing Cui & Mikko Honkala. (2013). A novel mobile device user interface with integrated social networking services. *International Journal of Human–Computer Studies*. DOI=10.1016/j.ijhcs.2013.03.004

1 Introduction

This chapter briefly introduces the dissertation project. It begins by providing the research motivations: the relevance to real-life user-experience problems and in light of other scientific studies. It then outlines the objectives and research questions of the present dissertation and the studies undertaken to address them. Finally, it highlights the key contributions and gives an overview of the publications included. The latter form an integral part of this compound dissertation.

1.1 Background and Motivation

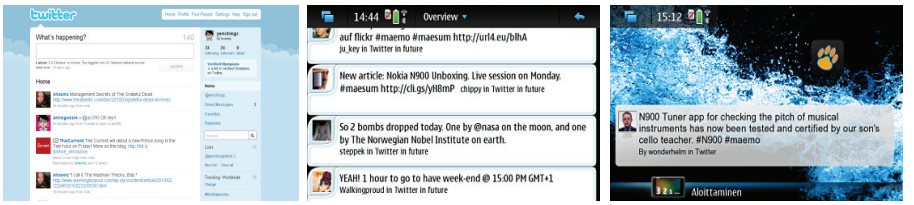
Social networking services (SNSs) are Web-based services wherein people construct a public or semi-public profile, articulate their relationships with other people, and share content with these articulated connections (boyd & Ellison, 2007; Naaman et al., 2010). The most familiar examples include Facebook, Twitter, and Flickr. SNSs are among the most popular Web services worldwide. By the end of 2011, SNSs had reached 1.2 billion users around the world, representing 82% of the world's online population (comScore, 2011). Facebook as arguably the most popular SNS is one of the top sites on the Web, on par with the search engine Google[1]. At the end of March 2012, Facebook had 901 million users who were active in the service at least monthly, and 526 million of these used it on a daily basis[2].

SNSs have become popular on mobile devices, especially on smartphones such as iPhone and Android devices. In a recent survey (comScore, 2011), 64% of smartphone owners in the United States reported having used SNSs in the previous month and nearly 40% reported doing so daily. According to another report, from Facebook, more than 488 million active Facebook users accessed the service from mobile devices in March 2012, representing over half of the monthly active Facebook user base (488 million vs. 901 million). These figures highlight the massive number of current mobile SNS users.

The prevalence of SNS use on mobile devices can be partially attributed to innovations in the mobile user interface. For example, many SNSs have developed standalone applications optimised for use on mobile devices. By the end of 2011, mobile applications had become as important as Web sites in users' access of SNSs from mobile devices (comScore, 2011). This dissertation explores new user interfaces (UIs) for supporting SNSs on

[1] Available from http://www.alexa.com/topsites/, accessed on 21 June 2012.
[2] Available from http://newsroom.fb.com/, accessed on 21 June 2012.

mobile devices, UIs that are designed to improve the user experience (UX) for hundreds of millions of existing mobile SNS users and to help still more people as they start using these services on mobile devices.



(a) a Web browser (b) a mobile application (c) a mobile widget

Figure 1.1. Three conventional UIs for accessing Twitter on the Nokia N900 device: a mobile Web browser (a), a dedicated Twitter application (b), and a mobile widget (c).

Current mobile devices deliver SNSs through mobile Web browsers, mobile applications, and mobile widgets. Figure 1.1 presents Twitter's service in terms of these three types of mobile UI. A mobile Web browser (pane **a**) is a mobile version of a Web browser, supporting direct Web access. A mobile application (pane **b**) is the basic building block of mobile functions. Lately some mobile applications have also included Web content. A mobile widget (pane **c**), placed inside a larger view, automatically delivers a small piece of structured Web information to mobile devices. For example, a widget may retrieve and show the latest Facebook news in the device's home view.

Although they allow access to SNSs, mobile Web browsers, applications, and widgets all have inherent limitations. They confine the content to separate *information 'silos'*. Figure 1.2 illustrates the current SNS silos that fragment the naturally connected contacts and content. The same situation is seen with mobile devices. People must follow distinctive UI structures to check their contacts or access content from multiple services. Navigating in these structures is time-consuming and prone to errors (Marsden & Jones, 2002; Robbins et al., 2008). Therefore, it can be difficult for people to maintain awareness of what is going on in their social networks when they have only a minute or

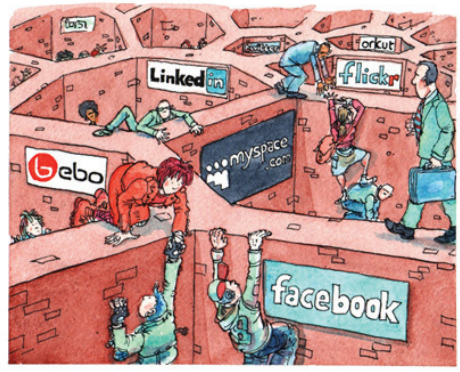
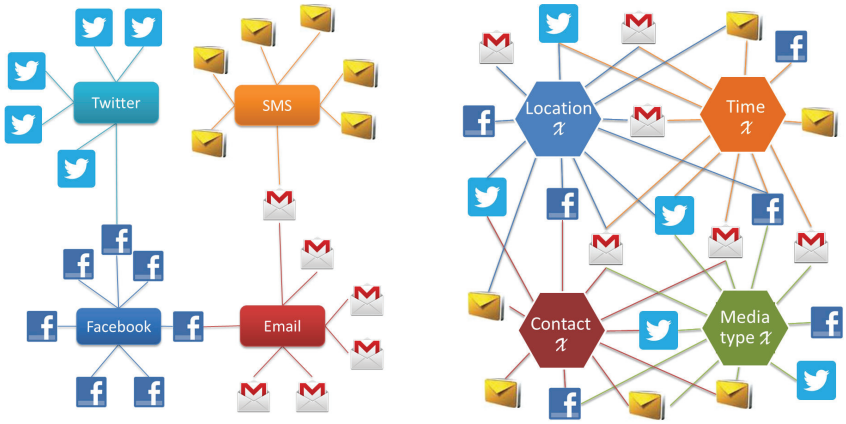


Figure 1.2. Information silos of current SNSs.
Copyright 2012 David Simonds. Reprint with permission.

two between their everyday activities. These use cases are particularly common with mobile devices (Church & Oliver, 2011; Taylor et al., 2008).

One motivation behind this dissertation is to explore novel UIs for individual people's regular use of a multitude of SNSs on mobile devices. This dissertation explores the entire UI system of a mobile device, instead of yet another standalone mobile application. The related UIs are aimed at discarding the boundaries of information silos, and they speak for the integration of content from all online and offline sources into one presentation. The design intention of LinkedUI is to allow people to browse all content on a device fluently, no matter where the content resides.

Figure 1.3 illustrates the new device UI developed in this dissertation project in comparison with a conventional UI. Pane **a** shows that the conventional UI structures all content and functions within information silos of Twitter, Facebook, e-mail, or Short Messaging Service (SMS). Pane **b** shows that the new device UI interlinks content from these services on the basis of associations, such as contacts, locations, and time, thus integrating the content in a unified presentation. People can browse content across services on the basis of, for example, the contacts who shared it or the locations where the content were generated.



(a) conventional device UI (b) new device UI

Figure 1.3. Different logics in the conventional device UI (a) and the new device UI (b) developed in this dissertation's research. The conventional UI structures content as information silos. The new UI enables the integration of all the content into a unified presentation.

The previous studies relevant to this dissertation investigated augmenting device phonebooks and home views with information integrated from other sources (Bentley et al., 2010; Cowan et al., 2010; Oulasvirta et al., 2007).

During the course of this dissertation's research, several commercial systems – for example, Motorola's *Motoblur*, Windows Phone's *People Hub*, and HTC's *Friend Stream* – also started to augment device views with content from multiple Web-based SNSs. A review of these previous studies reveals some limitations of current research literature (detailed below). The present dissertation is, in part, an attempt to fill these gaps.

- Previous studies have touched upon integration of multiple SNSs with the mobile device. The related proposals typically connect data between applications on a case-by-case basis without eliminating the boundaries between individual applications or services at the device level. They were workarounds rather than genuine solutions. Some studies ventured into holistic UIs to break down these silos (Björk et al., 2000; Marsden & Jones, 2002). Despite this, the researchers have seldom fully implemented and evaluated the concepts envisioned.

- User experience is one key perspective from which to evaluate new designs. There is, however, no agreement among researchers about what UX dimensions should to be considered in evaluating mobile UIs for SNSs (Bentley et al., 2010; Cowan et al., 2010; Oulasvirta et al., 2007). Future mobile UI design and research work will benefit from a systematic investigation into the UX dimensions in this domain.

1.2 Objectives and Scope

The research objective is to explore novel means for SNS use from mobile devices. This includes the aims of understanding user practices of using SNSs on current mobile devices, exploring new user interface designs that entail in-depth integration of SNSs into mobile devices, and investigating usage patterns and user experiences associated with these UI designs. These mobile UIs regulate all functions and content on a mobile device; instead of behave like yet another stand-alone mobile application. The design target is to support prompt consumption of SNS content on mobile devices.

This dissertation explores mobile use of SNSs from the human–computer interaction (HCI) angle. Its focus is on mobile UIs for general-purpose SNSs – for example, Facebook and Twitter – although the results may be relevant for all kinds of Web services. As an HCI investigation, this dissertation does not cover technical implementation details of the designs included.

1.3 Terminology and Definitions

Social networking services are 'web-based services that allow individuals to a) construct a public or semi-public profile within a bounded system, b)

articulate a list of other users with whom they share a connection, and c) view and traverse their list of connections and those made by others within the system' (boyd & Ellison, 2007). Three factors distinguish content that people share in SNSs from other communications: 'a) the public (or personal–public) nature of the communication and conversation; b) the brevity of posted content; and c) a highly connected social space, where most of the information consumption is enabled and driven by articulated online contact networks' (Naaman et al., 2010). In this dissertation, 'SNS content' and 'SNS feeds' are interchangeable terms.

A *mobile device* is a pocket-sized computing device that includes a wireless connection capability, a display for output, and a touchscreen or other pointing mechanisms for input. The most common examples are mobile phones and personal digital assistants (PDAs). Tablets and laptops are not included in this study. At the time of this investigation, they were not portable in pocket size and people did not yet commonly use them as pervasively as other smaller devices (Oulasvirta et al., 2012).

Device UI refers to the interactive aspects of computer operating systems that determine the broad interaction style of a device. In the mobile domain, current device UIs typically centre on information silos of individual applications. People need to follow a hierarchical structure in each application to access content. Similar to this dissertation, some recent systems venture to bridge the information silos. For example, Windows Phone aims to consolidate groups of common tasks across applications.

Mobile social networking services refer to SNSs used on mobile devices. They fall into two categories: 1) Web-based SNSs that are designed as Web sites and are later made available for mobile devices and 2) mobile-specific services that are designed for mobile devices only, or require mobile devices for a full experience (Tong, 2008; Ziv & Mulloth, 2006). The first category of mobile SNSs is at the focus of this dissertation.

Social network aggregators 'combine popular social media feeds in separate tabs or in one feed and allow posting status updates to multiple sites' (Jacovi et al., 2011). Some of them are *publisher-initiated* aggregators. Aggregation of this type can occur when people merge their identities and aggregate their *own* content for subscribers. For example, FriendFeed allows users to merge their SNS identities (e.g., Twitter, Facebook, Flickr, and Delicious) into one presentation. The others are *reader-initiated* aggregators. People combine the feeds they subscribe to. The aggregation has no impact on the people who shared the content or on people who have subscribed to the same content. Reader-initiated aggregators are highly relevant for this dissertation.

User experience refers to 'a person's perceptions and responses that result from the use or anticipated use of a product, system or service' (ISO, 2010). In a broad sense, this covers all user emotions, beliefs, preferences,

perceptions, physical and psychological responses, behaviours, and accomplishments that occur before, during, and after use. This dissertation highlights the 'value' or 'worth' perceived by users. 'The intended value of digital artefacts provides a focus for field research, design, and evaluation', Cockton (2006) reminds us.

1.4 Research Questions

This doctoral dissertation addresses the following research questions:

RQ1. What are the contextual characteristics and UI constraints associated with mobile use of Web services, especially SNSs?

RQ2. What kinds of UI designs contribute to the positive user experience of accessing SNSs on mobile devices?

RQ3. What usage patterns and user experiences are associated with device UIs supporting integration of SNSs on mobile devices?

RQ1 addresses contextual characteristics and UI constraints of using Web services – especially SNSs – via current mobile UIs, such as Web browsers and applications. New mobile UI designs should accommodate these established mobile contexts' restrictions and dissolve constraints imposed by the conventional mobile UIs.

RQ2 leads us to explore UI designs aimed at improved user experience with SNSs on mobile devices in comparison with current mobile UIs – i.e., Web sites, mobile applications, and mobile widgets. This dissertation's research advocates integration of content across SNSs and other communication channels, thus avoiding the restrictions of current mobile UIs.

RQ3 involves the key usage patterns and UX dimensions associated with the new device UIs for SNSs. A literature review of empirical studies revealed key UX dimensions associated with mobile UIs for SNSs. These dimensions are further investigated in evaluation of new mobile UIs.

1.5 Methodology and Studies

This dissertation is a design research study that revolves around designing artefacts with relevance and novelty (Zimmerman et al., 2007). The related work must introduce significant invention, articulate the preferred state of their design, and provide convincing support for the conclusion that the designs are effective (March & Smith, 1995; *ibid.*).

The research for this dissertation included a set of background user studies to inform and inspire novel UI designs. On the basis of these background studies, several novel mobile UI functions were created and evaluated in a series of user studies. The prototype supported some key novel user interfaces. As a vital part of the research process, the prototype was both a means and an end for the present research. See **Chapter 3** for details of all studies.

The background user studies explored mobile contexts, user activities, and UI constraints associated with using SNSs and other Web services on mobile devices. The methods included contextual enquiry and diaries (Beyer & Holtzblatt, 1997), along with an adaptation of psychology's event segmentation technique (Newtson, 1973; Zacks & Tversky, 2001); in essence, people annotated films of someone using a mobile device for common tasks. Analysing the annotation results may reveal perception patterns. The purpose of all studies was to answer **RQ1** and to inspire and inform new designs.

The studies with novel mobile UIs included creation of novel UI designs in a new device UI called LinkedUI, which regulate all content and functions of a mobile device. Its objective is to advocate integration of content across an individual application or service. It also introduces the functionality of automatic filtering to address the problem of information overload on mobile devices. The main purpose of these studies was to answer **RQ2** with respect to the new UI designs.

The evaluation of LinkedUI designs included one lab experiment and one field experiment. The lab experiment compared use of LinkedUI to that of SNSs via a state-of-the-art mobile Web browser in order to verify the overall UI concept. The field study compared two variations of LinkedUI as verification of the value of automatic filtering for social networking feeds. The main purpose of these studies was to answer **RQ3** with respect to usage and UX issues associated with the new mobile UI designs.

1.6 Contributions

A series of user studies collected information on context characteristics and UI constraints for the mobile Web then used these user insights to inspire and inform new mobile UI designs. The design target was to promote prompt consumption of SNS content on mobile devices.

The dissertation work developed novel UIs that integrate SNSs into mobile UI across information silos. Instead of adding SNSs as standalone applications, these novel UIs are aimed at redesigning the device UI. They do not use individual applications as the basic building blocks of a mobile UI; instead, they use hypertext structure to associate and present content and functions across the mobile device. In contrast to previous work, LinkedUI designs avoid bringing about the information silos, therefore, make a genuine solution

to the problem. The exploration further included automatic filtering for social networking feeds. These designs advanced the state of the art when this research took place. They also influenced some commercial products – in particular, the 'Notifications' home view of the Nokia N9 smartphone.

Using the new UIs as a research tool, this research discovered some usage patterns and UX dimensions associated with using SNSs on mobile devices. Firstly, people use SNSs on mobile devices in brief and frequent sessions. They attend to highly selective content, mainly content directed at them, content just published, and content published by certain contacts. Secondly, awareness, social interaction, self-expression, usability, sense of control, and breadth of content access are the key dimensions of UX for evaluation of mobile UIs for SNSs. The new mobile UIs explored in this dissertation's research help people to be aware of their social networks. They make it easy to use multiple SNSs on mobile devices, and grant people a sufficient sense of control in the face of constant information flow.

1.7 Overview of the Publications

This dissertation summarises key findings from seven publications. Table 1.1 presents the alignment of the research questions and these publications. The first three publications examine current usage, and the last four have to do with new UI designs and the UX / usage patterns studies. These publications are based on studies conducted from 2007 to 2011. See **Section 3.5** for an overview of all these studies.

Table 1.1. Original publications included in this dissertation and their relevance to the research questions

Research questions	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
RQ1. Contexts and UI constraints for mobile use Web services	X	X	X				
RQ2. New mobile UIs for SNSs				X	X		X
RQ3. Usage patterns and UXs with mobile UIs for SNSs				X	X	X	X

P1. Yanqing Cui & Virpi Roto. (2008). How people use the web on mobile devices. *Proceedings of the 17th International Conference on World Wide Web* (WWW '08), ACM, 905–914. DOI=10.1145/1367497.1367619

P1 examines contexts of use associated with the mobile Web, including SNSs. Some key findings are that users needed quick access to content on mobile devices, on account of their temporal and social contexts, and that they actively browsed the content received but seldom replied to the content on mobile devices. This publication covers user studies conducted in 2007 and before. These studies showed that people predominantly used the Web for 'to-the-point' information seeking tasks such as fact-finding. They only occasionally browsed the Web without specific goals.

My role: I am the main author of this publication, contributing the vast majority of the text. This paper draws on data from a series of interview-based studies and a smartphone log study. For the interview studies, I had the lead role in planning, executing, and analysing a study in India, which led to the key ideas of this paper. For the log study, I received data from an existing study done by my colleagues and analysed its data for the publication.

P2. Yanqing Cui & Li Wang. (2012). Motivations for accessing social networking services on mobile devices. *Proceedings of the International Conference on Advanced Visual Interfaces* (AVI '12), ACM, 636–639, DOI=10.1145/2254556.2254673

P2 investigates user motivations associated with use of SNSs from mobile devices. The main findings are that social connection, awareness, and diversion triggered most SNS sessions. People typically did not pursue a specific goal other than being generally informed or being entertained. 'Notifications', in the form of message alerts, were important triggers, although the import normally associated with the notification channel sometimes annoyed users.

My role: I am the main author of this publication, contributing the vast majority of the text. This paper draws data from one diary/interview study in South Korea. I was in charge of planning, executing, and analysing this study.

P3. Yanqing Cui, Antti Oulasvirta, & Lingyi Ma. (2011). Event perception in mobile interaction: Toward better navigation history design on mobile devices. *International Journal of Human–Computer Interaction, 27*(5), 413–435. DOI=10.1080/10447318.2011.552058

P3 explores restrictions of current mobile UI solutions that deliver SNSs to mobile devices. It introduces event segmentation, from cognitive psychology, for understanding user perception of mobile interactive activities. One key finding is that user operations with UI elements, such as switching applications, were prominent in user activities with existing mobile UIs, which negatively affected user task flows. Thus the study spoke for content-centric design in place of application-centric design in mobile UIs.

My role: I am the main author of this publication, contributing to the majority of the text. This paper draws data from one laboratory study in Finland. I led the research activities for planning, execution, and analysis in this user study. The quantitative data analysis was done mainly by my co-authors.

P4. Yanqing Cui, Mikko Honkala, Kari Pihkala, Kimmo Kinnunen, & Guido Grassel. (2010). Linked internet UI: A mobile user interface optimized for social networking. *Proceedings of the 12th International Conference on Human–Computer Interaction with Mobile Devices and Services* (MobileHCI '10), ACM, 45–54. DOI=10.1145/1851600.1851611

P4 reports on the LinkedUI concept, particularly its hypertext navigation mechanisms. It also reports on a laboratory experiment to compare SNS use on LinkedUI against the benchmark of SNS use via a mobile Web browser. The lab test verified usability advantages of hypertext navigation. It also suggested that people would feel better connected to their contacts if they continued to use SNSs on the systems like LinkedUI. This impact was significantly greater than with the benchmark.

My role: I am the main author of this publication, contributing to half of the text. This paper reports a new mobile UI concept and discusses a lab-based user study. I was responsible for planning, conducting, and analysing the study and designed the UI concept in collaboration with my co-authors. The prototype was implemented by my co-authors.

P5. Mikko Honkala & Yanqing Cui. (2012). Automatic on-device filtering of social networking feeds. *Proceedings of the 7th Nordic Conference on Human–Computer Interaction* (NordiCHI '12), ACM, 721–730. DOI=10.1145/2399016.2399126

P5 details the design, implementation, and evaluation of automatic filtering functionality. The rationale is prioritisation of SNS content and highlighting of a subset thereof on the basis of inferred-user-interest models. The evaluation study revealed that most users were positive about the functionality. On average, the users who received the functionality experienced a better sense of control than their peers who did not receive it. The results also revealed that a minority of users categorically rejected the automatic filtering functionality because of their general tendency to avoid ‘smart’ systems.

My role: I am the second author of this publication, contributing to half of the text. This publication draws data from one field study. I led research activities for planning and executing the user study and performing the UX evaluation data analysis. The prototype implementation was done by my co-author.

P6. Yanqing Cui & Mikko Honkala. (2011). The consumption of integrated social networking services on mobile devices. *Proceedings of the 10th International Conference on Mobile and Ubiquitous Multimedia* (MUM'11), ACM, 53–62. DOI=10.1145/2107596.2107602

P6 explores usage patterns in using SNSs on mobile devices. A log analysis showed that users frequently and briefly 'checked up on' SNSs. In a session, they typically glanced at the timeline for an overview or clicked one or two items if interested. The paper reveals some characteristics pointing to the likelihood of an item being clicked – for example, the people publishing the content, and the delay after the content was published.

My role: I am the main author of this publication, contributing the majority of the text. This paper reports results from a field user study. I led the research activities of planning and executing the user study, and I analysed the results jointly with my co-author. The prototype implementation and logging system were handled by my co-author.

P7. Yanqing Cui & Mikko Honkala. (2013). A novel mobile device user interface with integrated social networking services. *International Journal of Human–Computer Studies*. DOI=10.1016/j.ijhcs.2013.03.004

The publication presents the LinkedUI studies as a whole and examines key usage patterns and UX findings associated therewith. Elements of the key findings are published in **P4**, **P5**, and **P6**, but here special attention was paid to consolidating the findings and emphasising the UX-related findings for social interaction, awareness, usability, and sense of control.

My role: I am the main author of this publication, contributing the majority of the text. The paper reports upon UI concepts and two related user evaluation studies. I created the UI concept collaboratively with my co-authors and led research activities in planning, executing, and analysing the user studies. The related prototypes were implemented by my co-authors.

2 Related Work

This chapter reviews earlier HCI studies involving use of SNSs on mobile devices. Three elements are covered, for their relevance to the research questions introduced in **Section 1.4**. The first part covers studies dealing with the mobile Web and computer use of SNSs, and it characterises uses of SNSs via mobile devices, as explored in **RQ1**. The second part addresses mobile UIs that resemble the designs explored in this dissertation. This is related to the studies addressing **RQ2**. The third section proposes a framework of key UX dimensions for evaluation of mobile UIs for SNSs. This is the foundation for the studies conducted to answer **RQ3**.

2.1 Studies of Mobile Web and SNS Use

The literature related to mobile use of SNSs stems from two research streams: studies of mobile Web and general SNS usage. This section examines these two broad fields before it narrows the focus to SNSs on mobile devices. This review starts from the mobile Web because the SNS addressed in the dissertation is one special kind of mobile Web services.

2.1.1 Characteristics of Mobile Web Use

Previous studies used diaries and interviews to understand mobile Web use (Church & Oliver, 2011; Church & Smyth, 2009; Sohn et al., 2008; Taylor et al., 2008). These studies have differed in scope: all activities enabled by the mobile Internet are at one end of the continuum (Church & Oliver, 2011; Church & Smyth, 2009; Taylor et al., 2008), activities related to one specific purpose at the other (Sohn et al., 2008). Some studies have also used log analysis to investigate user behaviours at micro levels. For example, Böhmer et al. (2011) gathered application usage data from over 4,100 Android users and analysed the data for general patterns, such as duration and frequency of use of Web services in various categories.

Previous studies of the mobile Web have focused on information gathering tasks. For example, studies of information seeking tasks have emphasised that momentary needs – related to the current time and location – trigger most mobile Web usage (Taylor et al., 2008). In these contexts, people need immediate access to the right content. For common tasks such as checking bus timetables, most people prefer dedicated mobile applications over mobile Web browsers. They enjoy having access to tailored, specific content of interest from one simple tap (Church & Oliver, 2011). Once an information need arises, people expect quick access to the relevant

information. If rapid access is not possible, they are likely to postpone or ignore such user needs (Sohn et al., 2008).

The goal of staying current or keeping oneself informed is important for SNSs. Taylor et al. (2008) called it *awareness* motivation. In a diary study, Church and Oliver (2011) reported that awareness motivation triggered almost half of mobile Web use. This category of user activities includes checking mail, news sites, and SNSs such as Twitter and Facebook. SNSs account for close to 30% of mobile Web usage sessions (*ibid*.).

In summary, previous studies have mobile Web use associated with information-related goals. SNSs provide a perspective for understanding other types of mobile Web use. This dissertation's research pays special attention to the mobile Web use without specific information goals.

2.1.2 User Activities on Web-based SNSs

The use of SNSs from computers has attracted interest from the literature. This section reviews some of these studies as a broader backdrop for understanding the mobile use of SNSs.

SNSs support *various types of user activities*. Joinson (2008) identified seven key categories of Facebook use. These are '*social connection*' (keeping in touch with contacts), '*social browsing*' (mainly joining groups or events), '*photographs'* (viewing, tagging, or sharing photos), '*content*' (using applications or games), '*social investigation*' (locating new people), '*social network surfing*' (browsing network of friends of friends), and '*status update*' (updating or viewing status updates).

Social connection is a major motivation for use of SNSs. On Facebook, people mainly reach known contacts rather than initiate new contacts. According to one study with 2,525 university students in 2005–2006 (Lampe et al., 2006), the most important use of Facebook is 'social searching'. People are eager to learn about old friends, to maintain or resume relations – e.g., 'finding out what old friends are doing now' and 'connecting with people you otherwise would have lost contact with' – but are less eager to build new connections (e.g., 'meeting new people' and 'looking at the profiles of people you don't know') (*ibid*.). Some social connection occurs in the form of information exchange. Morris et al. (2010) explored user activities in soliciting interaction via online Q&A. They conducted a survey of 624 Microsoft employees and found that about half of the participants employed Twitter or Facebook to ask questions. Overall, participants preferred asking questions on SNSs as compared to search engines or Q&A sites (*ibid*.). Naaman et al. (2010) analysed Twitter posts from 350 random Twitter users. The results showed that people are driven by sharing information ('Informers') as well as publishing about 'self' ('Meformers').

Informers are more conversational and interactive, and they have more social contacts than Meformer do (*ibid.*).

Surveillance is another motivation for use of SNSs. Individual users track actions, beliefs, and interests of larger groups to which they belong (Shoemaker, 1996). The related activities are invisible to others but form the foundations for visible social interaction. People need to notice content published by others before they can respond to that content or start to 'perform together' in front of an audience (Sas et al., 2009). Surveillance motivates repeated visits to a service. For example, Facebook users fond of 'photograph' and 'status update' content visit the site more frequently than do other Facebook users (Joinson, 2008). Facebook's 'News Feeds' feature is designed particularly for this use case. It enables users to 'check up on Facebook regularly', or maintain 'perpetual contact' (*ibid.*).

The popularity of the surveillance motivation results in dominance of *consuming activities*, such as browsing user profiles (Benevenuto et al., 2009; Jiang et al., 2010). Benevenuto et al. (2009) gathered detailed click-stream data from a Brazilian social network aggregator Web site covering Orkut, MySpace, Hi5, and LinkedIn. They found that content-consuming activities account for 92% of all user activities. These activities involve a larger social network than publishing activities do. Each session of consuming activities lasts longer when involving media content such as photos and videos (*ibid.*). Jiang et al. (2010) measured user activities on Renren, China's largest SNS. This service logs visitor information for each user profile, photo, diary, and blog entry, and it makes the activity log visible to the public. Examining usage history of 61,000 users in a university network over 90 days, the researchers found that latent interactions are more prevalent and frequent than visible events and that profiles' popularity of being browsed is not correlated with the frequency of content updates.

In summary, surveillance and its associated consumption activities are prevalent phenomena in computer-based use of SNSs. This dissertation's research primarily aims for facilitating this type of activities. The dissertation approaches the research questions through design research studies. Previous design research studies have not paid sufficient attention to this domain – in particular, SNS use on mobile devices.

2.1.3 SNSs on Mobile Devices

SNSs are common Web services that people use on mobile devices (Böhmer et al., 2011; Church & Oliver, 2011). In a log analysis study, Böhmer et al. (2011) found that SNSs account for 4.77% of all mobile application launches. Facebook alone consumes 1.91% of the total time people spend using mobile devices. The most attention in previous studies was given to mobile Facebook, followed by mobile social location services that capture

the availability and location information of a user and share it in his or her social network. These reviewed studies address the same type of services as this dissertation's research, although they look at delivery of these services to mobile devices via conventional UIs.

People use Facebook in short 'bursts' on mobile devices (Barkhuus & Tashiro, 2010). They perceive mobile Facebook as a 'notification' tool for keeping constantly 'in touch' with friends and acquaintances. They gain a sense of increased awareness of their social networks by using their phones (Bornoe & Barkhuus, 2011). These findings resonate with *awareness* as a key motivation for mobile Web use. The users checked Web services to stay current, or to keep themselves informed (Church & Oliver, 2011; Taylor et al., 2008). Some people even almost continuously refresh their e-mail inboxes and social applications (Rotman, 2010).

Mobile Facebook has become yet another means of communication complementing SMS, video, and voice calls. Bornoe and Barkhuus (2011) reported a study of user interviews with 22 university students who used Facebook from their mobile phones. They found that people gathered a large network of offline connections on Facebook in order to approach these contacts, without adding them to their phonebook. Barkhuus and Tashiro (2010) also found that people approach the same group of people through online and offline interactions.

People sometimes use mobile Facebook to organise in-person gatherings. It supports three categories of event co-ordination: '*spur of the moment meeting*' initiated via Facebook invitations, '*meeting reminders*' for pre-agreed meetings, and '*social assistance*' in deciding to take part in a special event through monitoring of other participants (Barkhuus & Tashiro, 2010). Some status information may indicate the location of a user. While seldom interpreting these messages as invitations to stop by, most people do use these status messages as a catalyst for further communication, which may lead to spontaneous social gatherings (*ibid*.).

Mobile social location services were the study subject of another group of studies. These services capture the availability and location information of a user and share it in his or her social network. These related studies suggest different user preferences of location sharing. Some people prefer to share their locations on a need-to-know basis (Wagner et al., 2010), while others feel comfortable broadcasting their locations in an unsolicited fashion (Cramer et al., 2011; Lindqvist et al., 2011).

Dodgeball (Humphreys, 2008) used text messaging for distributing location-based information among social networks. After receiving a 'check-in' text message from a user, Dodgeball broadcasts the information to his or her Dodgeball network via text messaging. It also alerts the user of interesting information, such as nearby friends, friends of friends, and interesting

venues. A successor to Dodgeball, *Foursquare* exploits the expressive value of the 'check-in' feature. People can associate themselves with meaningful locations and share these meaningful associations with an articulated audience. This becomes a venue for people's self-expression. For example, a user might actively check in at sport facilities and avoid bars, so as to project a sporty image (Cramer et al., 2011). The service enables a social game. Users may find it fun to gather badges as a form of self-representation and compare achievements with friends (Lindqvist et al., 2011).

Overall, most of the previous studies addressed publication activities but not the consumption activities that occur in the mobile use of SNSs. This trend parallels that seen with the computer-based use of SNSs. Many reasons might contribute to this trend. Using interviews as the instruments, the studies tended to focus on user activities with significant meanings. Consumption activities might well be common, but people often do not remember to report them in user interviews.

In **Section 2.1,** we have now reviewed related studies examining how people use SNSs and other Web services. As a trend, the studies reviewed highlight *publication* activities at the expense of *consumption* activities on mobile devices. Not reviewed in the section, some previous design research studies reflected the same trend. For example, *CenceMe* (Miluzzo et al., 2008), *mGroup* (Salovaara et al., 2006), *CoMedia* (Jacucci et al., 2007), and *Slam* (Counts, 2007; Counts & Fisher, 2008) support capturing and sharing of content in a mobile social network, but none of them explores systematic UI solutions to promote consumption activities. This dissertation's research paid special attention to the latter activities. It creates a novel device UI that allows SNS content to flow freely on a device. The following section reviews more studies that are relevant to this kind of mobile UI designs.

2.2 Designs for SNS Usage on Mobile Devices

This section reviews studies of structuring SNS content on mobile devices. The focus is on novel UIs that have common characteristics as the design this dissertation explores. The dissertation's work experimented with a novel mobile device UI. To break down information silos, the new UIs aggregate multiple SNSs to the mobile device, use hypertext navigation to structure all content and functions on the device, and support automatic filtering of SNS content for presentation. This section reviews UIs with similar features.

2.2.1 Hypertext Navigation and Mobile UIs

Conventional device UIs organise functions by means of hierarchies such as applications and Web sites. They confine the functions into separate information 'silos'. To complete a task, people often need to visit multiple

services, with distinctive hierarchies (Marsden and Jones, 2002; Robbins et al., 2008). Given the limited input and output capabilities and the dynamic mobile contexts, this interaction sequence is slow and error-prone with mobile devices (Church & Oliver, 2011; Taylor et al., 2008).

Hypertext navigation is an alternative, to replace hierarchical structures. Hypertext is the structure of using nodes and links as a medium of thinking and communication for users (Conklin, 1987). This is arguably how people think. The claim that 'the human mind operates by association; with one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts' (Bush, 1945) is supported by previous studies of human memory. People tend to store and retrieve information in an association or semantic network in their memory (Meyer & Schvaneveldt, 1971). *Associative browsing* is a notion related to hypertext navigation; content objects are often associated with each other in various ways. For example, they originate from the same publisher, occur in the same locations, or belong to the same content type. Via these associations, people should be able to access these objects as a group, or quickly jump from one to the relevant others. If you come across one of them, you can also quickly find the rest (Lehikoinen et al., 2007).

Hypertext is likely to be the most familiar UI navigation method for users, thanks to the popularity of the Web, so far the largest hypertext system. From their literature review, Chen and Rada (1996) concluded that hypertext users tend to be more effective than non-hypertext users, particularly when the aim does not lie in specific goals. As a challenge, some users of hypertext systems may have problems in remembering the route taken to arrive at the present node, understanding the relationship to other nodes, and deciding which link to follow (Conklin, 1987).

Previous studies with mobile devices have pointed to the advantages of using hypertext navigation (Ziefle et al., 2007). Many researchers have explored means to improve the usability of hypertext structure on mobile devices (e.g., Buchanan et al., 2001; Jones et al., 1999; Kaikkonen & Roto, 2003). However, this type of navigation is limited to Web applications and seldom used outside Web browsers. This dichotomy is one source of confusion for many mobile users (Kiljander, 2004). One goal of the research for the dissertation is to remove this confusion by unifying the navigation inside and outside Web browsers.

Similar to the design rationale of this dissertation's research, some early studies envisioned and explored the feasibility of supporting hypertext in mobile UIs. For example, Marsden and Jones (2002) envisioned organising the device UI (both WAP and local application functions) in hypertext style, although they did not fully implement the new UI system for user evaluation. Other studies have explored associations between content items on mobile

devices and supported some types of hypertext navigation based thereon. Some such systems are reviewed below.

PowerView introduces the notion of *linkage* to navigate information on mobile devices. It constructs linkage between data of different types and uses these links to generate presentation of all related information for the current view. Figure 2.1 presents the Overview view and the Calendar view. These views show the related content at the side of the screen when people browse some content in focus. Unlike hyperlinks, the links here are used not to provide navigation shortcuts but to offer instead a context for the current view. The links are manually created via user selection or are automatically generated by means of methods from fields such as computational linguistics (Björk et al., 2000).

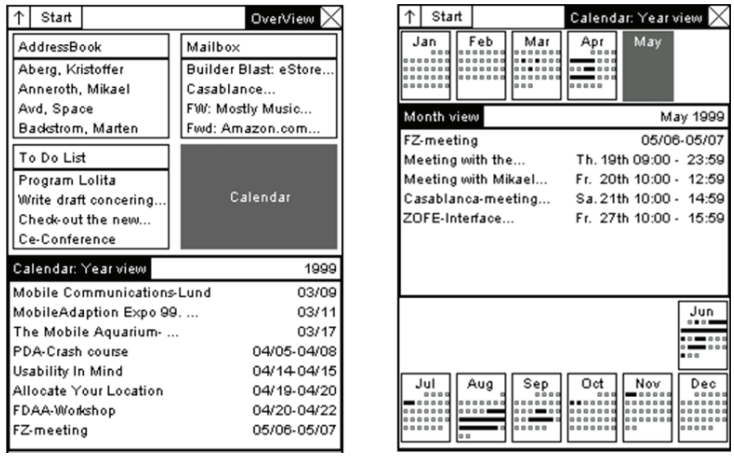


Figure 2.1. The PowerView: the Overview view (left) and the Calendar view (right) (Björk et al., 2000). This system introduces the notion of linkage to navigate information on mobile devices.

TapGlance (Robbins et al., 2008) is intended to bring visualisation and user interface paradigm together in a visually scannable, searchable, and navigable smartphone interface. The system involves three areas of design: spatial data navigation, as seen in AppLens and LaunchTile (Karlson et al., 2005); faceted search; and visually scannable information displays. The researchers considered designs that would pivot between different views of the same data – for example, from a participant list for an event on the calendar to a map view with the meeting attendees plotted on the map. However, the system developed did not support these possibilities, given the infrastructure changes required. Such designs would require mobile devices to support hypertext navigation in the entire device UI.

Associative PDA stores personal information through a network of associations on ubiquitous devices (Diehl, 2006). The intent is to unify the information fragmented across separate applications or devices. Different from this dissertation, the researcher did not address the UI presentation layer of associated content but only the underlying principles. In follow-up work, Falke (2008) sketched out how associations can be created and used in note-taking applications. This paper prototype work, however, does not appear to have been pursued further in the literature.

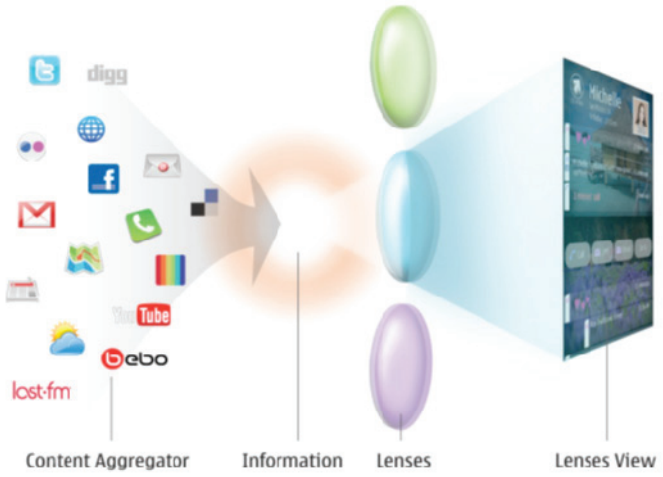


Figure 2.2. The Unified Inbox and Lenses metaphor. Content is aggregated and represented as a light source. Various lenses filter the content and focus it on what the user wants to see (Sohn et al., 2010).

Unified Inbox (Sohn et al., 2010) combines feeds from SNSs and provides users with the concept of a 'Lense' for filtering content. Figure 2.2 presents the design metaphor with aggregation of content from multiple sources and application of lenses for content presentation. Lense creation involves a hybrid of automatic and manual processes. The system recommends certain attributes for users to develop a Lense. The researchers conducted a two-week-long user study with five colleagues. The results showed that the universal inbox combining personal content streams provides easy access to content from a variety of sources. Users create, on average, three lenses (min.: 0, max.: 9), and most frequently access the content stream rather than any of their prepared lenses. This UI concept is of great relevance for this dissertation's research, with the exception of the approaches taken to streaming information flow. The dissertation's research focuses on hyperlink navigation and automatic filtering for content structuring and presentation. The Unified Inbox, in contrast, focuses on creating lenses.

This dissertation's research continued to explore holistic device UIs as pioneered in some previous studies. It aimed at covering Web content as well as other native content into one unified presentation on mobile devices. It delivered a fully functional UI. This level of exploration differed from that seen in previous studies, which envisioned redesigning the mobile device UI system but seldom fully implemented them, because of the development efforts required. With a functional prototype, the present research aimed to investigate real-world challenges such as identity linkage and information overload, and it deployed the prototype in a field study. This level of exploration has not been done in previous studies.

2.2.2 Integration of SNSs into Mobile Devices

Many previous studies experimented with integration of SNSs into mobile devices. They aimed to aggregate content from diverse sources into a unified presentation. These research efforts, however, were often limited to the conventional device UI on the basis of information silos. The users must follow hierarchical structures to access content. For this reason, the previous studies typically suggested workarounds to connect content and functions across information silos rather than utterly discarding the silos as is proposed in light of this dissertation's research.

The related designs first appeared in early work on augmented phonebooks, home views, and other device views, and they have recently emerged in the form of mobile versions of social network aggregators. These studies were related to the dissertation work in two ways. All the systems included some UI features similar to those of the systems in this dissertation's research. This section reviews these UI designs. Most of these systems too were empirically tested in user studies, which are reviewed in **Section 2.3**.

Augmented phonebooks merge visual notifications of the contacts' presence information from other sources into mobile phonebook views. Compared with this dissertation's research, these previous designs resemble the logic of using contacts to hyperlink content. Examples include ContextContact, Connecto, and Motion Presence. *ContextContact* (Oulasvirta et al., 2007) is a tool to capture contextual information – location, movement status, phone profile, and people close by – and display these availability cues in others' phonebooks. Figure 2.3 presents the standard mobile phonebook and the augmented phonebook in ContextContact. The intended use case is users planning their phone calls so as not to disturb the other person. *Connecto* (Barkhuus et al., 2008) and *Motion Presence* (Bentley & Metcalf, 2007) augment the mobile phonebook with location information shared amongst small groups of people. *Connecto* (Barkhuus et al., 2008) supports sharing three kinds of information: the name of a location (first tagged by a user and then automatically detected by the phone), the length of time the user remains in the current location, and the current device profile. *Motion*

Presence (Bentley & Metcalf, 2007) supports sharing motion information so that people can view which contacts are currently moving. The assumption is that people in regular contact usually know the patterns of their friends and family but just do not know exactly when people start to move.

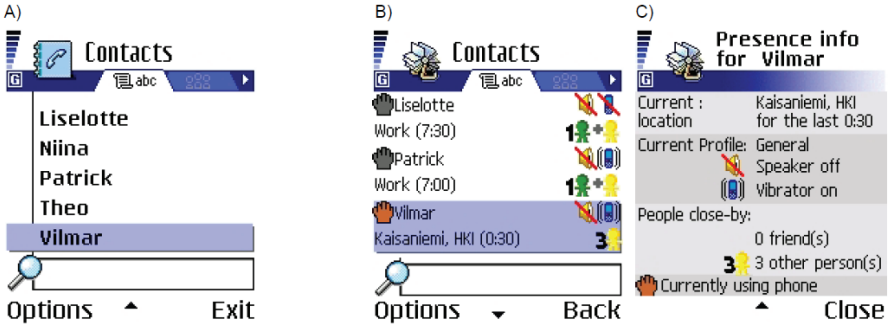


Figure 2.3. Different types of phonebook views. A) The standard, non-augmented phonebook of the Nokia 6600; B) ContextContact, augmented phonebook with presence information; and C) a detail view for a phonebook entry (Oulasvirta et al., 2007).

The *mGuide* application (Milić-Frayling et al., 2007) uses a unified map view to present aggregated information streams that include images, audio messages, and text information. Compare with this dissertation, this design resembles the logic of using locations to hyperlink content. As shown in Figure 2.4, this geo-tagged content is overlaid on a geographical map view that indicates the location of the sender and recipient in real time. The map view includes an interface element called the 'media display pane', which displays a thumbnail of an image, allows users to navigate to other images, and plays audio recordings associated with the image.

Some early designs resemble the logic of using time to associate content. A common case is to present the latest content in mobile device home view. For example, *Emotipix* (Cowan et al., 2010) and *Music Presence* (Bentley & Metcalf, 2009) augment a device's home view with recently shared media content. *Emotipix* (Cowan et al., 2010) displays a recently shared photo and its related conversations in the mobile home view. Its purpose is to support social awareness without causing distraction. Figure 2.5 presents a mobile device home view after installation of Emotipix. Photos taken by an Emotipix user are automatically shared with friends or family members and appear as their phone wallpaper. *Music Presence* (Bentley & Metcalf, 2009) displays what music others have recently played, on the idle screen of the phone. A user can view and give feedback on friends' music history. These quick interactions are aimed at fostering social interaction about the media.

Red (right) or green (left) dots are past or current locations. Camera icons indicate photos and their taken locations.

Enlarged pane displays the image and its associated voice message. Left arrow enables image browsing.

Figure 2.4. Screenshot of the mGuide application. Media display pane in the map overview (left) and in the detailed view (right) (Milić-Frayling et al., 2007). This application showcases unified map views to present aggregated information streams of deferent content types.
Copyright 2007 ACM. Reprinted with permission from the authors.

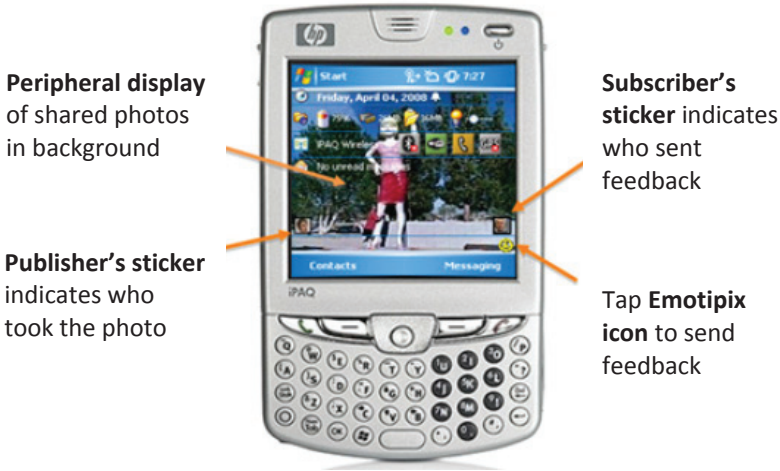


Figure 2.5. Emotipix UI in mobile phone home view (Cowan et al., 2010). It shows a recently shared photo and its related conversations.
Copyright 2010 IEEE. Reprinted with permission from the authors.

Mobile versions of social network aggregators are a recent development in integration of SNSs with mobile devices. They 'combine popular social

media feeds in separate tabs or in one feed and allow posting status updates to multiple sites' (Jacucci, 2011). People combine their subscribed-to feeds from multiple services and link in the identities of their contacts; this aggregation does not affect the publishers of the aggregated content. During the course of this dissertation emerged some commercial mobile social network aggregators including Motorola's *Motoblur*, Microsoft's *Kin*, Microsoft's *People Hub* in its Windows Phone, Vodafone 360, and HTC *Friend Stream*. In one example, *Contact 3.0* (Bentley et al., 2010) showcases the research behind Motorola's *Motoblur*. It integrates SNS content such as status updates and photos into the phonebook. It is designed to remove information silos in which a user needs to launch Facebook, Twitter, and Flickr separately to see updates in these services. All updates for an identity are tied in with the phonebook, which serves as a single place for keeping in touch with family and friends.

In relation to this dissertation, the emergence of previous systems supports the same research direction. These mobile aggregators resemble the work for this dissertation in that both are aimed at combining content from several SNSs into one presentation. As one difference, this dissertation attempts to introduce a new device UI. The mobile aggregators, however, typically focus on complementing the conventional device UI.

In summary, many examples of mobile UI designs promote linking of content via associations and integrating of the SNS content into mobile devices. Following the same vision, this dissertation is intended to explore association of all content and function on a mobile device. It covers content from SNSs and other communication channels brought into a hypertext-based device UI. Compared with that for this dissertation, the previous work aimed mainly at a workaround of bridging the information silos of a device. None of the work examined looked at introducing an alternative UI logic to replace hierarchical structures as this dissertation's research set out to do.

2.2.3 Automatic Filtering for Social Networking Feeds

Mobile content and functions are not perceived with equal importance (Cui, 2007; Paek et al., 2010). 'Triage' of social networking feeds has recently received attention in the literature, although few of the associated studies address mobile devices specifically. For example, with computer users, Paek et al. (2010) found that it was common for two participants to give very different ratings for the same post, suggesting that importance ratings can be quite subjective. Automatic content filtering based on the history of each individual user is a promising way of guiding the user toward interesting content. Several studies in the literature explore the feasibility of this technology, which lays the foundation for its applications in mobile UIs.

This dissertation focuses on on-device filtering for SNS content. Such a system should consider the feedback from only one user in prioritisation of the content. This is often vital from privacy or legal perspectives. This kind of study set-up makes it impossible to apply *collaborative filtering*, wherein central servers aggregate ratings or click data across users (Adomavicius & Tuzhilin, 2005). In contrast, *content-based filtering* can be used for the study set-up of interest here. Under this approach, a model is built by examination of the content that interests the user. Then, similar new content is highlighted (Cai et al., 2010). The process does not require access to data from other users and can be executed on the user's private device.

Wang et al. (2010) experimented with using content-based filtering to rank Facebook and Twitter feeds, with a social aggregator called *SocConnect*. The parameters considered included 'actor' (the contact doing the publishing), 'actor type' (the type of the contacts that are rated by users), 'activity type' (feed type), 'application' (source of the media and applications), and 'user ratings'. The study revealed large between-subjects differences in the importance of these parameters. The parameter 'actor' is the most important for all users. 'Actor type', 'activity type', and 'application' are important for some users but not for others. Paek et al. (2010) ranked Facebook feeds with a hybrid filtering system. They focused on text corpus features and media properties, applying machine learning to multiple users' history for ranking feeds. The results showed textual features as vital for predicting user ratings of social networking feeds. The work also highlighted the importance of personalisation. What is important for one user may not be equally important for other users.

The above-mentioned studies all predicted user ratings (*ibid*.; Wang et al., 2010). This feature is not commonly available in existing systems, and it is not widely used even when it is available (Paek et al., 2010). The present research employs user clicks as *prediction targets*. These implicit user actions are commonplace on mobile devices because of the user actions needed for working with content on their small displays. Freyne et al. (2010) found that implicit feedback (browsing or reading) provides more accurate prediction than more explicit (communication) feedback does.

As a shortcoming, the existing studies often overlooked user experience challenges associated with automatic filtering, challenges that are highly relevant for the present research. In one review paper, Jameson (2008) summarised the challenges of an intelligent system. While aimed at aiding in acquiring information from amidst an explosive information load, an intelligent system may lead to the following key user challenges: *diminished predictability and comprehensibility*, *diminished controllability*, *obtrusiveness*, *infringement of privacy*, and *diminished breadth of experience*. Jameson reported these user challenges as 'usability threats'. Some of these factors clearly extend beyond the conventional borders of

usability considerations and tie in with general UX issues. One recent user-interview-based study revealed that people find their sense of control compromised when using a mobile system that automatically filters social networking feeds (Ozenc & Farnham, 2011). They ask for final approval of what is shown and what kinds of content are automatically filtered in or out.

In summary, **Section 2.2** has reviewed previous studies of device UIs for SNSs. These UIs include some features similar to those in this dissertation's research on developing a holistic device UI – covering all content in a mobile device – via hypertext structure instead of hierarchical structure. The previous studies have touched upon ideas of using hypertext navigation to structure a device UI. Most of these studies, however, did not fully implement the vision, because of technical challenges. The implemented systems in the exceptional studies were typically limited to selective device views such as phonebook, home, and map views.

2.3 UX Dimensions of a Mobile UI for SNSs

UX is one key perspective for this dissertation. ISO (2010) defines it as 'a person's perceptions and responses that result from the use or anticipated use of a product, system or service'. This concept broadly covers all of users' emotions, beliefs, preferences, perceptions, physical and psychological responses, and behaviours and accomplishments that occur before, during, or after use. UX has started to become a common perspective in HCI studies, supplanting that of conventional usability metrics (Kaikkonen, 2009). Usability alone is not sufficient for understanding SNSs. In an early study, Preece (2000) proposes investigation of the online community, a broader concept than the SNS, in terms of sociability as well as usability.

Hart et al. (2008) conducted a heuristic evaluation and a user interview study surrounding Facebook. The heuristic evaluation revealed that Facebook fails in conventional usability terms. The user interview study, however, revealed that Facebook provides positive user experiences in terms of *pleasure*, *curiosity and fun*, *identification and self-expression*, *surprise*, *and serendipity*. *Privacy* is the main user concern. Many users are reluctant to communicate or upload personal photos through Facebook, on account of lack of control over data presentation. This study showed that usability alone might not sufficiently address HCI issues in SNSs.

UX covers a broader arena than usability engineering does and provides a concept covering non-productivity elements (Hassenzahl et al., 2010). The UX concept, however, still lacks clarity. The HCI community largely agrees on three key dimensions of usability (effectiveness, efficiency, and satisfaction) as well as standard procedures for measuring them – i.e.,

usability testing. For UX, however, the HCI community has not yet reached that level of agreement (Law et al., 2009).

The following sections introduce UX dimensions associated with mobile UIs for SNSs. These dimensions play a key role in design and evaluation of new mobile UIs in this dissertation. They were summarised mainly from a bottom-up analysis of the previous empirical studies referred to in **Section 2.2.** The summarisation also considered studies about UX of SNSs on mobile devices. For example, Väänänen-Vainio-Mattila et al. (2010) proposed that the drivers of social UX include *self-expression*, *reciprocity*, *learning*, *and curiosity*, and that the hindrances include *unsuitability of content and functionality*, *incompleteness of user networks*, and *lack of trust and privacy*. Markopoulos et al. (2004) proposed another set of factors. The costs of social communication UX include *obligations*, *expectations*, and *privacy*, and the benefits include *thinking about*, *staying aware*, *being connected*, *sharing experiences*, *recognition*, and *group attraction*.

2.3.1 Awareness

Awareness is for people to be conscious of each other' activities, context or status, and sustain connection between individuals and groups (Markopoulos et al., 2009; Rettie, 2003). Most people want to keep 'in touch with' friends and acquaintances via mobile devices (Barkhuus & Tashiro, 2010). Using SNSs, they experience some level of awareness when browsing broadcasted content (Church & Smyth, 2009; Taylor et al., 2008). The value of this awareness experience manifests itself in two ways: as preparation for possible social interaction and as a private solitary experience.

Awareness helps people to build common ground for future social interactions (Sas et al., 2009). For example, people use SNSs to confirm each other's safety (Bentley & Metcalf, 2007; Jacucci et al., 2007), get to know each other's music tastes and gain a new respect for others that is based on their music choices (Bentley & Metcalf, 2009), and understand the whereabouts of their friends (Humphreys, 2008; Miluzzo et al., 2008).

The value of awareness does not depend on the realisation of follow-up actions (McCarthy, 2011). People experience some kind of companionship among group members – for example, feelings of mediated connectedness, closeness, and communality – when reading each other's contextual information (Bentley & Metcalf, 2007; Oulasvirta et al., 2007), or 'staying in the know' as to each other's locations and activities (Counts, 2007; Counts & Fisher, 2008; Humphreys, 2008; Salovaara et al., 2006). Most Twitter users do not have any specific social purposes (Chen et al., 2011).

2.3.2 Social Interaction

Social interaction is for one to reach out to others by digital or physical means. The early studies considered three types of social interactions.

People can respond to each other within SNSs. People might tease each other for having dubious music tastes via Music Presence (Bentley & Metcalf, 2009) or spend time joking about and discussing the events reported in mGroup (Salovaara et al., 2006) and CoMedia (Jacucci et al., 2007). Emotipix (Cowan et al., 2010) shows shared photos in the device home view, which results in active mobile photo-based communications.

SNSs may aid in co-ordination of other digital communications. When making a call, people use availability cues to avoid disturbing the other person (Barkhuus et al., 2008; Oulasvirta et al., 2007). Users also learn that music-playing information may indicate others' availability (Bentley & Metcalf, 2009). Emotipix affords mutual sharing of photos through others' device home view. People expect their friends to see new pictures promptly, with some even endeavouring to alert their friends of new photos via messages or voice calls (Cowan et al., 2010).

SNS usage can trigger and co-ordinate physical meetings. The use of SNSs from mobile devices can prompt opportunistic meetings (Barkhuus et al., 2008; Barkhuus & Tashiro, 2010; Humphreys, 2008; Oulasvirta et al., 2007; Salovaara et al., 2006) as well as facilitate meetings initiated by other means (Barkhuus et al., 2008; Bentley & Metcalf, 2007; Barkhuus & Tashiro, 2010; Jacucci et al., 2007; Oulasvirta et al., 2007). It is worthy of note that some previous studies questioned the case of opportunistic encounters. For example, Counts (2007) argued that technology 'does not, or rarely, facilitates serendipitous face-to-face interactions, as these are largely dictated by other means, and instead facilitates the communication involved in coordinating these encounters' (Counts, 2007).

2.3.3 Self-expression

Self-expression is publishing of context information or user-generated content for social impressions (Hart et al., 2008; Väänänen-Vainio-Mattila et al., 2010). The associated user need is to express oneself to an online audience more than seeking any social interaction, in the same way as people 'show off' acquisitions in real life (Humphreys, 2008). People tend to present themselves favourably and share with others their best moments and good fortune (Sas et al., 2009). For example, people intentionally play certain music to project their music tastes in the desired fashion (Bentley & Metcalf, 2009), or they may edit their location names to tell an 'interesting' story in their life (Barkhuus et al., 2008).

User-generated content is the key venue for self-expression. In ContextContact (Oulasvirta et al., 2007), people use a status-update-like feature to express their ideas and emotions. In CoMedia (Jacucci et al., 2007), users create reports through text, videos, pictures, and sound, and they share these with offsite members. In Connecto, people combine text strings to tell their stories (Barkhuus et al., 2008).

People often apply much effort to prepare the content geared for self-expression purposes (Sas et al., 2009). For example, people creatively utilise Connecto to tell stories rather than merely providing facts. They are eager to express that they are 'stuck in traffic' rather than 'driving', or that they are at a 'boring accounting lecture' rather than 'indoors' (Barkhuus et al., 2008).

2.3.4 Usability

Usability refers to the degree to which use of an interactive system is effective, efficient, and satisfactory (ISO, 2010). This is an important factor in HCI evaluations (Kaikkonen, 2009). Some early studies have shown low usability of SNSs (Hart et al., 2008). There are, however, few studies exploring usability improvements to these services.

Usability was considered in previous studies. With mGuide (Milić-Frayling et al., 2007), the authors compared the usability of two variations of the application. The results showed that the inclusion of the media display pane supports easy handling of multiple streams of data and does not compromise perceived value or overall appeal. The users experience a better journey by using mGuide with aggregated information. For Emotipix (Cowan et al., 2010), researchers found that peripheral user attention is sufficient for lightweight visual communication. The visually scannable display reduces the effort required to view photos and provides quick feedback. Both studies explored the integration of SNS content with existing devices.

2.3.5 Sense of Control

Sense of control refers to people's subjective feeling of having sufficient control over their behaviours and the environments wherein those behaviours take place. The concept broadly covers different sources of risks that might lead to loss of control as considered in previous studies.

One source of research addresses people's sense of control over their behaviour, in particular, high frequency of device usage. Oulasvirta et al. (2012) examined user habits of frequent checking in mobile device use and concluded that this usage pattern is not yet problematic. Some mobile SNS studies support the same conclusion. Increasing user checking activities do not yet cause annoyance. For example, with Emotipix (Cowan et al., 2010) people regularly notice and interact with shared photos – e.g., when glancing

at the time or checking for missed calls. None of these people finds this distracting or disruptive to their workflow.

Another stream of research addresses people's sense of control over the environments where their behaviours occur. Many Facebook users complained about their lack of control over the presentation of content once shared (Hart et al., 2008; Väänänen-Vainio-Mattila et al., 2010). Users of ContextContact and CenceMe, on the other hand, did not appear to be bothered by this issue (Miluzzo et al., 2008; Oulasvirta et al., 2007). Automation and intelligent UIs may also lead to loss of perceived control (Jameson, 2008). A user interview study found that most people are dubious about fully automatic filtering of SNS feeds (Ozenc & Farnham, 2011).

2.3.6 Breadth of Content Access

Breadth of content access refers to the spectrum of content types that people can access relative to the full spread of content in a service. Compared with use of a service from a conventional computer, its use on mobile devices may not offer full access to all content and functions that the users desire in an SNS. Challenges may come from two sources.

The first source of this risk arises from the limitation of SNSs. For example, Väänänen-Vainio-Mattila et al. (2010) emphasised the incompleteness of supported social networks as a major hindrance for social UX. A service needs to prove sufficient content and contacts for users if it is to generate positive user experiences. The dissertation's studies worked with existing Web services as they are. A mobile UI design can specify which SNSs should be covered, but it cannot decide what functions these services offer.

A second source of risk stems from variation in content presentations across mobile UIs. A mobile application may not cover some service functions, or it may emphasise some functions at the expense of others (Jameson, 2008). Accordingly, people may feel unable to access the full functions of the system. This is important for cross-platform services. For example, people expect Web services to support a coherent experience across all devices accessing these services (Wäljas et al., 2010).

In summary, **Section 2.3** reviewed UX dimensions in the domains of mobile UIs for SNSs. Table 2.1 summarises the key dimensions: *awareness*, *social interaction*, *self-expression*, *usability*, *sense of control*, and *breadth of content access*. The first three dimensions are arguably motivational in nature and reward users for using SNSs. The last three do not appear to add value for users, but they are important for maintaining user satisfaction. These dimensions have been instrumental in evaluating new designs in this dissertation's research (see the results reported in **Section 4.3**).

Table 2.1 Key UX dimensions considered in early studies of use of SNSs on mobile devices

UX dimensions	Definitions	Related work
Awareness	To be conscious of people by browsing their broadcast content	Bentley & Metcalf, 2007; Bentley & Metcalf, 2009; Barkhuus et al., 2008; Counts, 2007; Counts & Fisher, 2008; Miluzzo et al., 2008; Humphreys, 2008; Oulasvirta et al., 2007
Social interactions	To reach out to people by digital or physical means	Bentley & Metcalf, 2007; Bentley & Metcalf, 2009; Barkhuus et al., 2008; Counts, 2007; Counts & Fisher, 2008; Humphreys, 2008; Oulasvirta et al., 2007
Self-expression	To publish personal context information or user-generated content for building a desirable image	Bentley & Metcalf, 2009; Barkhuus et al., 2008; Cowan et al., 2010; Humphreys, 2008
Usability	To access content on SNSs in effective, efficient, and satisfactory ways	Cowan et al., 2010; Milić-Frayling et al., 2007; Miluzzo et al., 2008; Sohn et al., 2010
Sense of control	To feel sufficient control over the behaviours and environments where the behaviours take place	Cowan et al., 2010; Miluzzo et al., 2008; Oulasvirta et al., 2007; Barkhuus et al., 2008; Milić-Frayling et al., 2007.
Breadth of content access	To perceive full access to the desired content and functions in a service	Maurer et al., 2010; Väänänen-Vainio-Mattila et al., 2010; Wäljas et al., 2010

2.4 Summary of Related Work

This chapter has reviewed three clusters of related work. Together, the studies discussed provide a foundation for this dissertation and reveal some issues that this dissertation aimed to address.

The first part of the chapter reviewed user studies involving SNSs and other Web services on both conventional computers and mobile devices. Overall,

previous studies have devoted attention to user activities with specific goals at the expense of other user activities. They prioritised content *publication* activities over content *consumption* activities. This was particularly true of design research studies that 'involve the researcher in creating and giving form to something not previously there' (Fallman, 2003). Part of this dissertation is an attempt to fill the gap. In a series of design research studies, the dissertation gives special attention to user activities of consuming SNS content without specific information goals.

The second section has reviewed design research studies advocating novel mobile UIs that serve design goals shared with those for this dissertation. One group of studies explore holistic device UIs. For example, *PowerView* (Björk et al., 2000), *TapGlance* (Robbins et al., 2008), and *Associative PDA* (Diehl, 2006; Falke, 2008) associate all content with some kinds of hypertext structures. Compared with this dissertation, most of these visions remained primarily concepts, without implementations and evaluations. The second group of studies introduce some innovations to deal with the problems of information silos. For example, *ContextContact* (Oulasvirta et al., 2007), *Connecto* (Barkhuus et al., 2008), *Motion Presence* (Bentley & Metcalf, 2007), *mGuide* (Milić-Frayling et al., 2007), and *Contact 3.0* (Bentley et al., 2010) were designed to bridge multiple services in conventional device UIs. These systems implemented are often aimed at *complementing* rather than *replacing* information silos. The third group of studies explore automatic filtering of SNS content. These studies typically do not deal with UIs for mobile devices, nor were they systematically evaluated in terms of user experience.

The third part of the chapter reviewed UX dimensions in evaluation of mobile UIs for SNSs. A framework of UX dimensions was proposed as a summary of the above-mentioned empirical studies together with some studies about general UX issues in the SNS domain. The framework encompasses awareness, social interaction, self-expression, usability, sense of control, and breadth of content access. Previous empirical studies have addressed some of these UX dimensions in individual empirical evaluations but have not summarised these dimensions and employed them as a framework to evaluate a new UI design. This dissertation's research uses the framework in designing and evaluating new mobile UIs.

3 Approach, Studies, and Methods

This chapter outlines the methodological part of the research done for the dissertation. It starts with discussion of the general research approach and overall structure of the research plan, after which, it presents an overview of the studies conducted and the key research methods used in those studies.

3.1 Research Approach

This dissertation followed the approach of *design research* in its exploration of mobile use of SNSs from a HCI perspective. The main thing setting this approach apart is that design research revolves around studying *novel* design artefacts – prototypes in HCI studies. Such knowledge would not have been attainable if design were not a vital part of the research process (Fallman, 2003). Research of this sort should deliver artefacts with relevance and novelty (Zimmerman et al., 2007). The related work must introduce significant inventions, articulate the preferred state of their design, and provide convincing evidence that the designs are effective (March & Smith, 1995; Zimmerman et al., 2007).

This dissertation's research focused on studies surrounding novel means of using SNSs on mobile devices. A major motivation was to dissolve the constraints of current mobile UIs in confining content to individual services. People may find it difficult to use multiple SNSs in mobile contexts of micro breaks. The studies for this dissertation experimented with several novel functions in development of the mobile concept LinkedUI. LinkedUI is not a conventional mobile application. It introduces a holistic device UI governing all content and functions on a mobile device. LinkedUI aggregates and associates content from multiple SNSs, and it supports automatic filtering for SNSs, to address any information overload. The contributions of this dissertation are not in the *implementation* of these UI designs *per se* but in the user studies done to *inspire*, *inform*, and *evaluate* mobile UI designs.

The research covered two tracks of studies. One track was the exploration of user practices with mobile Web services. These studies inspired and informed new mobile UI designs. They are also of relevance to other scientific fields of enquiry into understanding human behaviour. The other line of study involved user interface designs and user experience evaluations of new means for mobile SNSs. The objective was to ground the user interface designs and to explore related usage patterns and user experiences.

3.2 Overview of the User Studies Conducted

This dissertation includes several published user studies. Table 3.1 presents the basic information on these studies and their relationship to the research questions (**Section 1.4**), as well as the details of the publications.

The published studies served several research objectives. **S1**, **S2**, and **S3** aided in forming an understanding of how people use SNSs with Web browsers and mobile applications. They focused on user practices with conventional mobile UIs (**RQ1**). **S4** and **S5** explored new UI designs for using SNSs on mobile devices (**RQ2**). They also investigated the associated usage patterns and opinions through field and laboratory studies (**RQ3**).

Table 3.1 Basic information on the user studies included

ID	Time	Location	Users (*N*)	Research methods	Publication	RQ
S1	April 2007	Bangalore, India	10	Contextual inquiry	P1	RQ1
S2	May 2008	Helsinki, Finland	12	Event segmentations	P3	RQ1
S3	April 2009	Seoul, Korea	12	Contextual inquiry, diary	P2	RQ1
S4	Dec. 2009	Helsinki, Finland	12	Lab experiment	P4, P7	RQ2, RQ3
S5	Aug. 2010	Helsinki, Finland	40	Field experiment	P5, P6, P7	RQ2, RQ3

S1 took place in April 2007 in Bangalore, India, with ten users (two female and eight male) participating. All of them were actively using Web services on mobile devices. That study explored key user activities on the mobile Web and the contextual characteristics of mobility. The research activities included gathering user data via contextual inquiry and analysing the data by means of affinity diagramming. The study also drew data from earlier studies and from a smartphone log study taking place at the same time.

S2 borrowed event segmentation technique from cognitive psychology related to event perception (Newtson, 1973; Zacks & Tversky, 2001). This study took place in May 2008 in Helsinki, Finland. The main research objective was to characterise constraints of current UIs. Twelve people participated in the study. They broke six episodes of mobile interactive activities into segments, organised the segments, and identified those

deemed representative. These videos featured typical mobile Web activities as identified in **S1**. Three of them involved SNSs. The data analysis included a statistical analysis of the quantitative data and content analysis of the user comments.

S3 took place in April 2009 in Seoul, South Korea. The main research objective was to investigate user motivations with mobile SNSs and user requirements for future mobile UIs. Twelve users participated in this study too. They kept a diary of their mobile SNS use for a week and explained their opinions in interviews. The data analysis included statistical analysis of the diary entries and affinity diagramming analysis of the user comments.

S4 was a formal lab evaluation. The main objective was to evaluate the usability of LinkedUI against a benchmark of using SNSs via a mobile Web browser. The study was done in December 2009 in Helsinki with twelve active SNS users. All of them completed certain assigned tasks with LinkedUI and with the baseline system. The data analysis included statistical analysis of the quantitative data and content analysis of the user comments.

S5 was a four-week-long field experiment whose main objective was to explore usage patterns and user experiences associated with use of SNSs in LinkedUI and evaluate the automatic filtering functionality. The study took place from August 2010 to March 2011 in Helsinki and involved 40 users. 20 of them used LinkedUI without the automatic filtering, while the other 20 users used LinkedUI with the automatic filtering. The data analysis included statistical analysis of the quantitative data and affinity diagramming analysis of the user comments. It included data from all user groups, to reveal general usage patterns and user experience with LinkedUI, and compared data between groups to reveal UX-related aspects of the filtering functionality.

3.3 Research Methods

This dissertation's research involved a portfolio of qualitative and quantitative research methods in the above-mentioned studies. Table 3.2 presents an overview of all research methods used for this dissertation. In summary, the research included the commonly used methods of contextual inquiry and diaries in exploratory studies and utilised lab and field experiments to compare UI options. It also adapted the event segmentation method from cognitive psychology. With its origins in studies exploring user understanding of everyday events, this method was used for understanding how people perceive mobile interactive activities.

This section of the chapter focuses on the empirical methods used in the present research. It is worthy of note that literature review was another important method for this dissertation work. For example, **Subsection 2.3.2** reviewed early empirical studies for extraction of key UX dimensions.

Table 3.2. The main research methods used for this dissertation

Research methods	Data gathered	Data analysis	Related studies
Contextual inquiry	Interview notes, observations	Affinity diagram	S1, S2, S3
Diary studies	Reported usage sessions	Statistical analysis	S1, S3
Event segmentation	Breakpoints, segmentation labels	Statistical analysis, content analysis	S2
Lab experiment	Task completion time, interview notes, user ratings	Statistical analysis, affinity diagram	S4
Field experiment	Log data, interview notes, user ratings	Statistical analysis, affinity diagram	S5

3.3.1 Contextual Inquiry

Contextual inquiry is a user-centred design research method that typically involves one-on-one interaction in which the researcher watches the user in his or her own context and discusses observations with the user (Beyer & Holtzblatt, 1997). A key aspect of this technique is collaboration with the user: letting the issues a user encounters guide the interview. Key outcomes are learning what users do, how they do it, why they do it that way, what problems they faced, and what they want to do differently. Contextual inquiry is one major research method in **S1** and **S3**. Figure 3.1 shows a scene of contextual inquiry in **S1** (pane **a**).

Ethnographic techniques form part of the contextual inquiries. **S1** included one home visit for all study sessions. The situations naturally stimulated users' telling the stories that occurred there. It was not possible to follow users for a long time to capture the mobile tasks in full as they arose. Instead, users were asked to draw a timeline of their daily lives and explain their mobile use on these timelines as a guide for the user interview. In **S3**, people were to group their social networks by their closeness or in terms of their communication histories. These tasks triggered users' provision of more details about their real-life stories. These techniques are similar to some used in early studies. For example, Barkhuus and Tashiro (2010) asked people to recall their activities of the past day, and Ozenc and Farnham (2011) asked people to draw personal maps.

(a) a scene of user interview

(b) a scene of data analysis

Figure 3.1. Contextual inquiry data gathering and analysis: A scene of a user interview session, and a sense of affinity diagram analysis [P1].

The *affinity diagram* technique is a common method for qualitative data analysis (Hackos & Redish, 1998). Researchers write key notes from user interviews on slips of paper and group these slips into a structure on the basis of their similarity. As bottom-up analysis, the process of the affinity diagram consolidates findings and reveals emergent themes. In this dissertation, the analysis typically lasted three to five days, which was less than what other content analysis methods would take. The affinity diagram also served as a tool to inspire innovations. After completing the diagram, the researchers 'walked' the affinity diagram to identify any remaining issues or gaps in the data, investigating the key themes to explore new ideas. Figure 3.1 (pane **b**) shows a scene from affinity diagram analysis.

3.3.2 Diary Studies

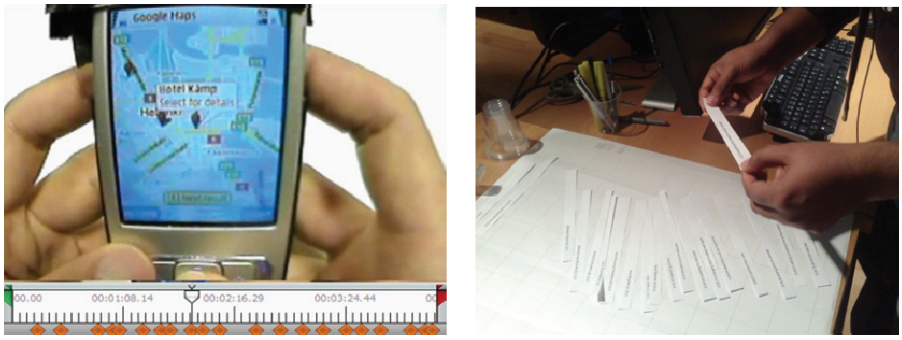
In a diary study, users are asked to report their behaviour – what they did, when, where, for how long, with whom, and from what device – and explain the meaning of their behaviour: why they did it the way they did it (Rieman, 1993). The method is effective in understanding user behaviour and intent in situ, especially when combined with data captured from other media (Carter & Mankoff, 2005; Sellen & Harper, 1997). Diary studies typically gather individual usage sessions as the unit of analysis (Church & Smyth, 2009; Church & Oliver, 2011; Sohn et al., 2008; Taylor et al., 2008). In a usage session, a user accomplishes one goal without a lengthy break (Church & Smyth, 2009; Sohn et al., 2008; Taylor et al., 2008).

A diary study has some advantages over other quantitative methods. For example, compared with log analysis, it calls upon users to make sense of their own behaviour data, which make it easy to distil user insight. Unlike a survey, it is designed to gather user behaviour *in situ* and accumulate more contextual details of the user behaviour.

As for this dissertation, **S1** and **S3** included diary studies. In **S1**, diaries served as a stimulus source for contextual inquires. The diaries did not include details of each usage session at a level sufficient for statistical analysis. In **S3**, diary entries were among the main data points gathered for statistical analysis. Analysis of these diaries revealed mobile usage patterns related to frequency, duration, context of use, and motivations.

3.3.3 Event Segmentation

The *event segmentation* technique has its origins in cognitive psychology. The technique usually involves asking observers to watch film footage of events, such as a person making a bed or assembling a saxophone, and to segment the footage into units as they watch them (Newtson, 1973; Zacks & Tversky, 2001). The main research objective is to decode how people understand everyday events that fulfil specific goals.



(a) the video annotation tool (b) a user organizing out labels

Figure 3.2. Adaptation of the event segmentation technique to mobile UI studies: A screenshot from the video annotation tool (a) and a scene when a participant was organising the printed labels (b) [P3].

Some early studies considered this method in the HCI domain. Adamczyk and Bailey (2004) recorded user activities with computers. Their research objective was to understand how people perceive users' interactive activities with computers, for purposes of notification design. The basic assumption was that notifications should cause the least interruption if they appear when one event perceivably ends and the next event has not yet started.

S2 was a study of applying event segmentation to mobile interactive activities. People annotated videos of someone using a mobile device to complete everyday mobile tasks. They had to identify units from the videos, organise the units into structures, identify the units deemed to represent each video well, and verbally explain their logic. Figure 3.2 presents a screenshot

from the video annotation tool (pane **a**) and a scene in which a user is organising the printed labels (pane **b**). The main objective of this study was to explore history mechanism design for a mobile device. It also revealed various limitations of current mobile UIs.

The study used breakpoints – i.e., points reported by observers at which they perceived one unit as ending and another beginning – as the unit of analysis (Newtson, 1973; Zacks & Tversky, 2001). The video was broken into bins, with analysis of whether users put breakpoints in the same bins and/or classified the breakpoints in the same way. This analysis revealed the extent of user agreement on event segmentation. The study also used event segments as a unit of analysis. An analysis of the labels that users gave to each segment revealed what kinds of segments were important and what kinds were not.

3.3.4 Lab and Field Experiments

In an experiment, a researcher manipulates variables in order to discover cause and effect. For the dissertation research, this method was used to compare LinkedUI against a state-of-the-art mobile UI and to compare two LinkedUI variations. These comparisons were based on the dependent variables of user behaviours, subjective ratings, and user preferences. The research included a laboratory experiment in **S4** and a field experiment in **S5**.

A lab experiment is conducted in strictly controlled conditions. In **S4**, each user needed to use both LinkedUI and the benchmark – using SNSs via a Web browser – in a laboratory setting. The usability metrics employed included effectiveness, efficiency, and user opinions about the systems. The study included several means to improve its ecological validity. It used users' real content in test tasks, which should cause users to be more engaged in the test and therefore reveal more of the potential problems (Genov et al., 2009). The test took place in a coffee house instead of a usability lab and used tasks mimicking real-life activities.

The laboratory experiment gathered quantitative data of subjective ratings on a seven-point scale and task completion time. Both sources were treated as continuous data and processed via statistical analysis. The study also gathered qualitative data of user preference and user interview notes. These data sources fleshed out the reasons revealed by the quantitative data.

A field experiment is an experiment conducted 'in the field' – i.e., in a real-world setting. The method still manipulates the systems under testing but no longer controls the contexts in which the systems are used. People can freely explore the system wherever and whenever they want to. In **S5**, two groups of users participated in a study in which each group received a different version of LinkedUI. One group received the variation with automatic filtering functionality; the other group received a version without.

As an intelligent feature, automatic filtering needs several days of use before it begins to function effectively. This makes a field experiment an appropriate method for evaluation of this functionality.

The field experiment involved logging the metadata of the SNS content and the click history of each user. The logged data were processed for three units of analysis: sessions, views, and content items. Session referred to a sequence of visited views wherein a break between the elements of any neighbouring view pair was less than five minutes.

The field experiment gathered user feedback from subjective ratings and user interviews. It used open-ended questions to probe for general opinions and memorable stories and applied closed-ended questions to gather user preferences and subjective ratings on a Likert scale. The subjects' ratings were examined by means of statistical analysis, and the interview notes were considered with an affinity diagram (Beyer & Holtzblatt, 1997).

3.4 Summary of Approach, Studies, and Methods

Presenting the research approach, user studies, and the related research methods, we have highlighted that the dissertation follows the approach of design research, which has provided a useful perspective for the series of studies conducted. All the related studies focused on user activities and opinions related to use of existing or new mobile UIs. Most of these studies involved in-depth research with a small user group rather than a large sample. They were typically situated in real-world contexts with little environment manipulation.

4 Results

This chapter summarises key results of the exploration of novel means of accessing SNSs from mobile devices. The discussion proceeds in the same order as the research questions: The first part presents the findings about how people use Web services, especially SNSs, on mobile devices. The second section explains some novel UI designs that support integration of SNSs into mobile devices and supply users with an overview of key SNS content at a glance. Finally, the third part presents usage patterns and user experiences associated with SNS use under this new concept.

4.1 Usage Contexts and UI Constraints Associated with the Mobile Web

A summary of the studies to address **RQ1** is in order first. What contextual characteristics and UI constraints are associated with current mobile use of Web services, especially SNSs? The focus is on exploring these in the context of current mobile devices. New mobile UIs need to accommodate the constraints imposed by the mobile Web usage context and dissolve the constraints imposed by the existing mobile UIs.

P1–P3 cover answers to the first research question. Some of the studies reported upon in these publications took place before 2007, when Facebook, Twitter, and other SNSs had not yet become popular on mobile devices. At that time, worldwide there were only 4.0 active mobile broadband subscriptions per 100 people. The figure rose to 15.7 in 2011[3]. As one of the earliest user studies considering the mobile Web, **P1** has been cited by many follow-up investigations (e.g., Böhmer et al., 2011; Church & Oliver, 2011; Kaikkonen, 2009; Lindley et al., 2012).

4.1.1 Usage Contexts of the Mobile Web

P1 and **P2** characterise contextual factors associated with mobile Web use. Overall, the studies reported in these publications have supported the notion of these user activities as *pervasive* in nature. **P1** revealed that people use the mobile Web in stationary locations such as the home as well as on the go. The typical scenarios include using the services while watching television, talking to others, having dinner, or lying in bed. The users choose mobile

[3] Available at http://www.itu.int/ITU-D/ict/statistics/, accessed on 21 June 2012.

devices instead of PCs because they can do so without interrupting their main activity, such as television-watching when lying on the sofa. **P2** revealed that people use SNSs on their mobile devices as part of their daily routine – for example, before they get up in the morning, and after they come back from lunch. These activities often take place in the breaks that people take when switching between their main activities.

'*Micro breaks*' – the moments between planned activities, such as time waiting for a bus or for a friend to arrive – are one common mobile context. They range from a few seconds (for example, when people wait for traffic lights to change) to a few minutes (for example, when people leave the office for a cigarette). The brevity of these breaks dictates temporal restrictions of using various services on mobile devices (Cui et al, 2007b). Using 30-second granularity for usage sessions, a previous log-based study showed that nearly half of these sessions last less than five minutes (Böhmer et al., 2011). This dissertation's research based on user interviews revealed many factors that contributed to brevity of mobile usage sessions. People often need to move on to the next main activity quickly. For example, the awaited bus or friends may show up in no time. Sometimes, people use the mobile Web in the background of on-going activities. For example, people may use it in the presence of others. In these cases, they need to be discreet and do not devote too much attention to it, to avoid social conflicts.

The constraints of micro breaks contribute to the dominance of consumption activities over publishing activities in mobile Web use. **P1** explores the ratio between consuming and publishing activities. People received 10,502 mail messages but sent only 495 from their mobile mail clients. They often postponed replying to a message until reaching a full-sized keyboard. **P2** examines what kinds of content people publish on mobile devices; people use mobile devices mainly to publish photos, not textual content: sharing of photos takes only a few key presses on modern smartphones.

This dissertation's research revealed that novel mobile UIs need to accommodate micro breaks as important mobile contexts. There is always dynamic new content in Web services, especially SNSs. Some users may repeatedly check the content in order to stay current when taking micro breaks. With a brief moment to spare, they can get the most out of their SNS usage if the device supports overview of new content at a glance and highlights the interesting part of the content. The present research explored several novel UI designs for reaching these high-level design objectives.

4.1.2 User Activities and Motivations with the Mobile Web

P1 and **P2** characterise user activities involving mobile Web services. **P1** covers all kinds of Web services, while **P2** focuses on SNSs. These two

publications cover user studies from 2004 to 2009 and, accordingly, capture some trends visible in user activity's evolution over time.

The first trend is the growth of user activities without specific information goals. In these user activities, people just use the Web to access general information; they do not have a specific goal other than perhaps to be entertained or informed. In the context of social networking services, *awareness* and *diversion* emerge as major user motivations [**P2**]. People do not follow any clear motivations other than simply seeking to kill time or alleviate boredom or to stay current. To maintain awareness, some users repeatedly check dynamic content. The related sessions often occur as a part of daily routines – for example, before one gets up in the morning, before or after a lunch break, and before one finishes work. This is in contrast to the dominance of fact-finding activities in early user studies [**P1**]. In the latter activities, people use the mobile Web primarily to seek a specific piece of information associated with their on-going tasks. For example, they may search for the location of a restaurant when looking for a place to eat or search for the answer to a question when settling a debate with a friend.

The second trend is growth of user-generated content. This refers to media content created by users and often made available to other users in an online system. It usually takes the shape of discrete digital identities, such as digital images, video clips, podcasts, blog items, and forum posts. On mobile devices, people like to publish photos rather than textual content. **P2** revealed that people use mobile devices mainly to share photos but rarely use them to publish textual content. Even with improvements in mobile devices' text entry capabilities, people still avoid composing text at length. It is worth noting that the value of user-generated content goes beyond social networking services. **P1** revealed that the mobile Web extends personal digital spaces. People start to put their content in the 'cloud' for personal access. This use case fits well with the role of mobile devices as an always-on user companion. Alternative storage media enable multiple device access and save users from some concerns of device loss.

Future mobile UIs should accommodate the above-mentioned trends in user activity's evolution. They should support casual browsing as well as information seeking use cases. With more user-generated content accessible from mobile devices, future UIs should hide unnecessary boundaries between applications and service, and should streamline users' interaction with any online content that interests them. Users may also benefit from designs that infer user interest and prioritise content accordingly.

4.1.3 Constraints of Conventional Mobile UIs

Mobile devices are subject to many constraints. Unlike conventional computers, mobile devices support only smaller displays and have limited

input mechanisms. All of these limitations suggest that the common device UI of conventional computers – a UI based on a hierarchical structure – may not work the best for mobile devices. For example, the input and output limitations of mobile devices make it slow to navigate the hierarchical structures in order to locate interesting content. Sporadic Internet connectivity requires offline access to Web content.

The event segmentation study discussed in **P3** revealed that about one quarter of all interactive activities with a mobile device are purely to navigate in the UI rather than directly perform an action with meaningful content. These activities merely enable momentary interaction with devices therefore should not attract much attention in an ideal UI. Their prominence indicates the complexity of current device UIs for the user.

The event segmentation study also revealed the importance of content objects with persistent value for people – for example, photos and messages. People use these content objects as essential references for grouping event segments and rating the importance of a segment. This suggests value in applying a *content-centredness* rationale to design a device UI system, particularly in application-less UI solutions. Conventional mobile UIs often fail in following the content-centredness rationale. They bury content in information silos, which results in tedious steps – such as switching applications and windows – for people to access SNS content. Navigating these structures is time-consuming and prone to errors. This prevents people from having a 'flow' in their experiences of SNS use (Bederson, 2004).

Conventional mobile UIs lack appropriate *notification mechanisms*. **P2** revealed that notifications act as important triggers for accessing SNSs on mobile devices. The notifications bridge various services and communication channels a user employs and help the user to monitor what is going on across these services. In the conventional UIs, the most common notification mechanism is push-message alerts. People complain that these kinds of notifications are distracting. To reduce the distraction, many users temporarily suspend notification of new e-mail or social networking feeds when taking a nap or focusing on working. Users start to miss text messages, which can become lost in a sea of notifications. All of these results indicate that future designs should attempt to minimise undesirable interruptions.

A potential direction is the aggregation of content from multiple sources in one user interface, such that people can notice new content no matter which service they are checking at the moment. The notifications should entail the least possible interruption if people so desire. For example, visual means grab voluntary attention when people attend to their mobile devices.

4.1.4 Summary

We have now summarised the findings related to **RQ1**: What are the contextual characteristics and UI constraints associated with current mobile use of Web services, especially SNSs?

People use the mobile Web in various types of activities. In addition to fulfilling specific information goals, they have started to browse the Web just to be informed or entertained. People have arguably ramped up the latter type of activities over the time of the dissertation work. Among other elements, the evidence includes the growing popularity of SNSs and social media services on the mobile Web.

Users may benefit from quickly browsing for the most relevant content when taking micro breaks between activities. However, current device UIs do not support these use cases well. These UIs tend to break the natural connections between content and squeeze it into the shape dictated by arbitrary UI structures. They also lack appropriate notification mechanisms to receive user attention. This dissertation's research was born of a desire to dissolve these constraints by redesigning the device UI.

4.2 Mobile User Interfaces for SNSs

This section summarises the studies to address **RQ2.** What kinds of UI designs contribute to positive UX of accessing SNSs on mobile devices? The design objective is to support rapid consumption of SNS content that interests a user. To reach this objective, the dissertation explores several novel ways of using SNSs on mobile devices in a holistic device UI that covers all interactive aspects of a device.

The new device UI supports *associative browsing* of functions and content. For example, it links content items that originate from the same contact, are associated with the same location, or are of the same content type. Via these associations, people can access the content items as a group or quickly jump from one to the relevant others (Lehikoinen et al., 2007). This is the key feature of *hypertext navigation* (Bush, 1945; Conklin, 1987). This new UI fetches and interlinks content from multiple sources. Users can navigate from one content object to another as far as there are relational associations: by contact, service, content type, and location (Lehikoinen et al., 2007). This kind of mobile UI design is aimed at helping people quickly and directly access relevant SNS content from any mobile device view.

P4, **P5**, and **P7** explain the key UI designs. **P4** focuses on the hypertext navigation in the basic concept. **P5** looks at the functionality of automatic filtering to help people browse social networking feeds. **P7** reports on the device UI as a whole. This research took place at the Nokia Research Center

and influenced the design of some Nokia smartphones. One example is the Nokia N9's Notifications home view. The N9 aggregates content from various sources – such as SNS content, Web feeds, missed calls, unread messages, and software updates – into a device home view. This is an adaptation of the UIs tested for current application-centric devices.

4.2.1 Hypertext Navigation of Aggregated SNSs

Hypertext is a structure of using nodes and links as a medium of thinking and communication for users (Conklin, 1987). This is arguably how people think and how people expect computing systems to work (Bush, 1945). As one characteristic of hypertext navigation, LinkedUI allows users to explore their content freely as far as the content items are semantically connected to each other. Figure 1.3 (pane **b**) presents how LinkedUI integrates content across information silos into one presentation. For example, time, contacts, and map details are some of the main metadata that can serve as connections (*links*, as in hypertext) to associate SNS content items (*nodes*, as they are termed in hypertext). This diverges from conventional mobile UIs, which focus mainly on hierarchical structures. Those users need to follow separate hierarchies (e.g., applications) to access semantically related content.

Figure 4.1 depicts a navigation sequence in LinkedUI. The UI combines content items from multiple services and presents them in aggregated views based on time (pane **b** in Figure 4.1), contacts (pane **c**), and locations (pane **e**). From one item, a user can jump to other items generated by the same person (panes **b**–**d**) or in the same location (panes **d**–**e**). Pane **f** shows the entire click sequence in the history view. Users can click to revisit these views. More examples of the design are available in a video demo[4].

LinkedUI uses hyperlinks to connect all content into an interwoven network. People can freely navigate from one content item to another (*node*, as in hypertext) as far as there are associations (*link*, as in hypertext). Contacts, time, and map are some of the main types of hyperlinks to associate individual SNS content items.

Contact is a natural connection between SNS content. As shown in pane **c** of Figure 4.1, LinkedUI aggregates updates from all services that a friend uses, thereby enabling people to glance at summaries of the friend' updates in one place. For example, when handling phone calls, people can see the latest content from the caller. To unify the content for each contact, LinkedUI supports a semi-automatic process for joining the various online identities of a person: The UI matches identities automatically, using identifiers such as e-mail address or phone number. It also provides suggestions to assist the user in manually linking remaining disjoined identities.

---

[4] See the LinkedUI homepage, http://research.nokia.com/research/linkedui/.

Using the time connections, LinkedUI highlights the most recent content in various device views. As depicted in pane **a** of Figure 4.1, the home view provides a notification area presenting the latest three feed items. This design resembles a common mobile phone design that automatically fetches and reports new text messages, media alerts, and e mail messages. Most views use reverse chronological order when presenting content. For example, the activity-stream view summarises recent content in timeline order, as depicted in pane **b** of Figure 4.1.

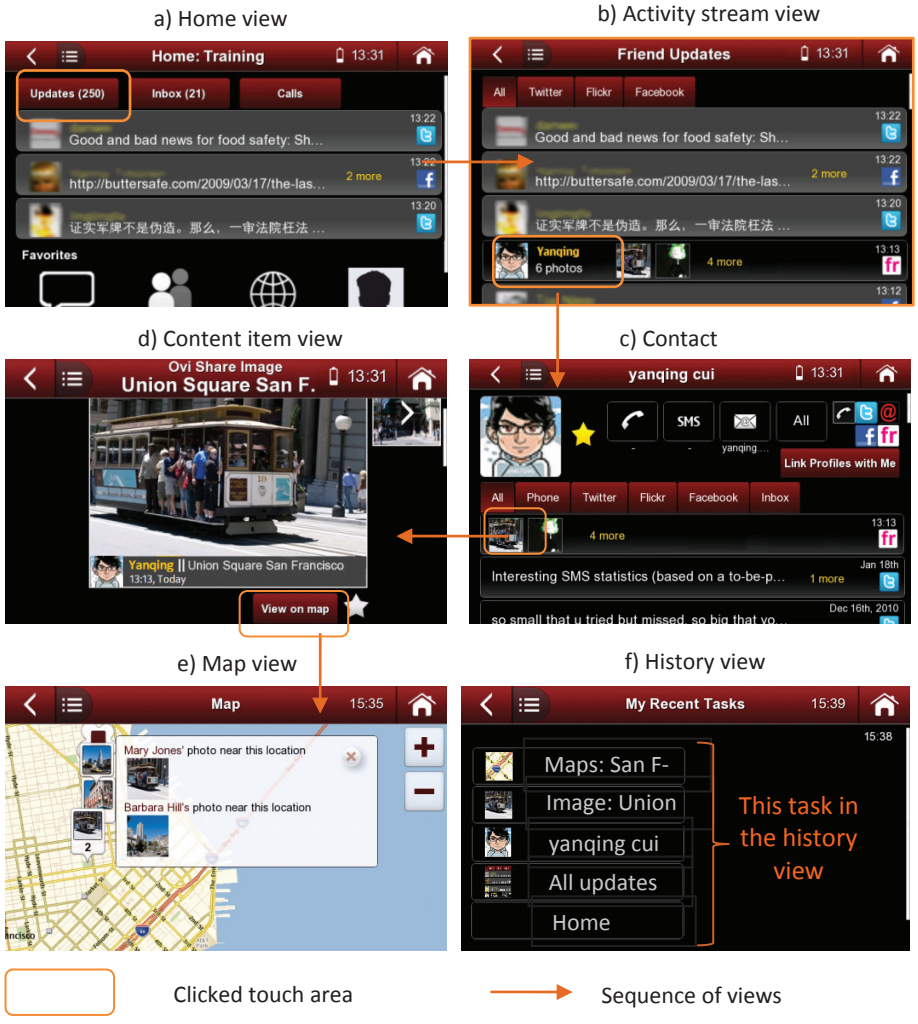
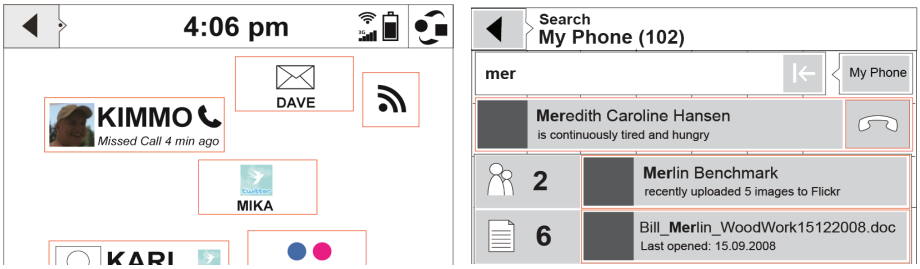


Figure 4.1. LinkedUI key views and hypertext navigation. The UI flow shows that the user directly navigates between content items (hypertext nodes) under the help of relational connections (hypertext links) [P7].

As another characteristic of hypertext navigation, LinkedUI supports common navigation mechanisms encountered in interfaces with the Web. Using the **Back** button, people can go back to the previous view. Using the history function, one can select any state from the recently visited list and thus return to it, as shown in pane **f** of Figure 4.1. Using the search function, people can query cached content on the device. The search is scoped to the items related to the device view from which the user initiates the function.



(a) clustering on home view (b) clustering on search view

Figure 4.2. Early LinkedUI iterations collapsed content into groups. The main design intention was to reduce scrolling operations.

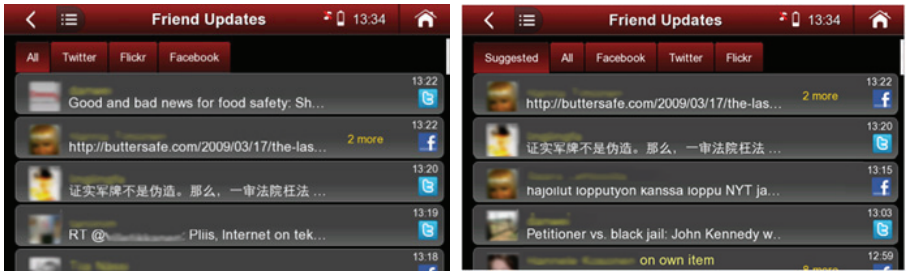
Information overload is one challenge associated service aggregation. To solve this problem, the studies experimented with collapsing content into groups in most device views. Figure 4.2 presents initial designs for a home view and a search view. The home view groups content by contact; the search view groups content by type. The intention behind this design was to show more content in a single overview and reduce scrolling operations. Automatic filtering, as explained in the next section, was the other approach that this research explored in order to solve the same problem.

4.2.2 Automatic Filtering for SNS Content

In LinkedUI, each device view can be associated with a large amount of content. This is seen particularly when content is fetched from many SNSs. Consequently, many people find it difficult to locate relevant content. To solve this user experience problem, the research explored the functionality of *automatic filtering* applied for social networking feeds. As detailed in **P5** and **P7**, the intelligent functionality prioritises social networking feeds, highlights some content items inferred to be important, and de-emphasises the other elements in the UI presentation. For example, the UI visually notifies users of the important content in the device's home view.

Automatic filtering is global functionality. The feeds of high inferred relevance are presented as the default tab for most views and serve as the

main user interface. Pane **a** in Figure 4.3 shows the activity-stream view without the automatic filtering. When landing in the activity-stream view, users see the **All** tab by default. Pane **b** in Figure 4.3 shows the view with the automatic filtering functionality. When landing in the activity-stream view, users see the **Suggested** tab by default, which displays content with high inferred relevance. The full timeline is visible on the **All** tab only after an additional user click. In a similar fashion, the home view shows the top three items in the filtered-in content set; the search view prioritizes the search results according to the predicted relevance.



(a) automatic filtering off (b) automatic filtering on

Figure 4.3. Automatic filtering functionality in the activity-stream view, a) with filtering off and (b) the view with filtering on. The latter option has the extra Suggested tab shown as the default view [P5].

The technical details of the algorithms are beyond the scope of this dissertation. In essence, the automatic filtering functionality was based on engines using sophisticated machine-learning algorithms. Using content metadata and the click history of individual users, these engines calculate the chance of clicking on any content items available, present the most click-associated content on the **Suggested** tab, and filter out the rest. To evaluate the automatic filtering functionality, the studies described in **P5** compared LinkedUI without and with the function, as shown in panes **a** and **b** in Figure 4.3, respectively. The two variations are identical apart from the automatic filtering functionality.

Automatic filtering was one of many intelligent UI functions considered in this dissertation's research. Based on the same algorithms that enabled automatic filtering, the other alternative designs include adaptation of UI components and layout in view of the inferred importance of each element. As shown in Figure 4.2, the buttons in the home view have different sizes. A button grows bigger if a user attends to related content and becomes smaller if the user ignores content of this sort. A device could also change the list of buttons that are visible. For example, the contact view might show buttons for frequently used contacts or means of communication and hide rarely

used ones. This dissertation focuses on overall user acceptance of intelligent SNS presentation. The related studies did not implement the above-mentioned proposals, to simplify the research settings.

4.2.3 Summary

This section has summarised the findings related to **RQ2**, considering what kinds of user interface designs contribute to positive user experience of accessing SNSs on mobile devices. The research done here has introduced a device UI that covers all content and functions on a mobile device. The UI associates the SNS content across services and applications and supports hypertext navigation. It also supports automatic filtering of social networking feeds to help users handle the information load. This function automatically prioritises SNS content on the basis of inferred user interest.

4.3 Usage Patterns and User Experience of Mobile UIs for SNSs

This section summarises the studies to address **RQ3**: What usage patterns and user experiences are associated with device UIs supporting integration of SNSs on mobile devices? A literature review of a corpus of empirical studies revealed the key dimensions of UX explored in the domain of mobile use of SNSs in **Section 2.3**. These dimensions were the key factors considered in the evaluation of the UI designs proposed in this dissertation.

This section answer the research question with one field study, covered in **P5**, **P6**, and **P7**. The study involved two LinkedUI variations: one group of users used the variation without automatic filtering (code-named A1–A20); the other group used the variation with the filtering functionality (coded as B1–B20). This section also refers to results from **P4** when relevant. Another group of users (names coded as U1–U12) used an early version of LinkedUI that did not have automatic filtering functionality.

4.3.1 Usage Patterns for SNSs on Mobile Devices

A log analysis from the field study revealed some general usage patterns associated with SNSs on mobile devices. The users frequently checked up on their social networking feeds when using LinkedUI, with each instance lasting a short time, and attending to certain kinds of content. It is noteworthy that visualisation of user data in this section was done with assistance from other researchers.

Frequent Checking

The users frequently checked SNSs on mobile devices at short intervals. The analysis for the field study used a five-minute timeout for breaking the view sequence into sessions. Figure 4.4 (left pane) presents the cumulative frequency of all breaks between successive sessions. The median of all breaks was 37.63 minutes. In other words, there was a 50% chance of the user checking SNSs again within half an hour after each session. Another analysis shows that users checked the SNSs at any time of day, but the usage time peaked at 3–5pm. On working days, some users often took coffee breaks at this time, while others were likely to be on their way home. The users, especially those with young children, often left the office around 4pm.

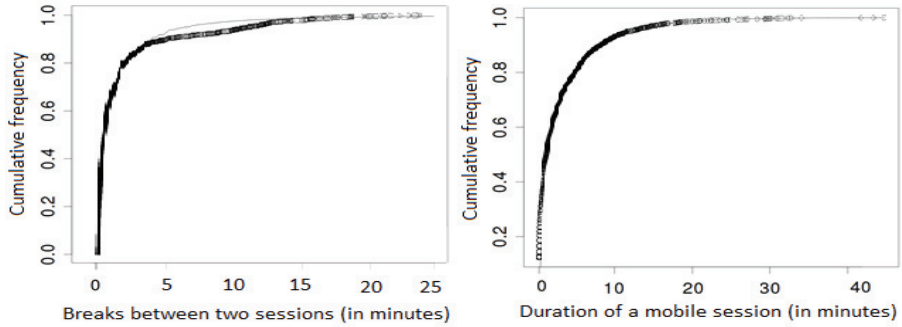


Figure 4.4. Cumulative frequency of breaks between mobile SNS sessions (left), and durations of mobile sessions (right). The results show a 50% chance that a user checked SNSs again within half an hour after each session, and in each session the user stayed for one minute [P6].

In the user interviews, nearly all users stated that they accessed SNSs more often after starting to use LinkedUI. For example, B14 placed the mobile device next to his computer display for the convenience of glancing at it frequently. As quoted below, A13 accessed some SNSs that had not been checked regularly from a mobile device before this study.

A13: '*LinkedUI gets things faster; when I unlock the device, they are all there. I end up using these services more often. I do not check these services this often from other devices. Here it happens all at once, which is nice.*'

Selective Attending

The typical SNS session lasted only a brief moment. Figure 4.4 (right-hand pane) presents the cumulative frequency of the durations of all mobile SNS sessions. The median for all sessions was 1.08 minutes' duration. In a

typical session, the users managed to carefully read only one or two items. From 5,609 sessions, the users did not click any content in 2,970 sessions (53%), clicked one item in 1,077 sessions (19%), clicked 2–5 items in 1,108 sessions (20%), and clicked 5+ items in 454 sessions (8%). In total, the users clicked on only 4.9% of the content received (8,556 items out of 176,208). In LinkedUI, users need to click an item before they can read its full text and its complete conversation history. Before it is clicked, they can see only the first few words and related contacts.

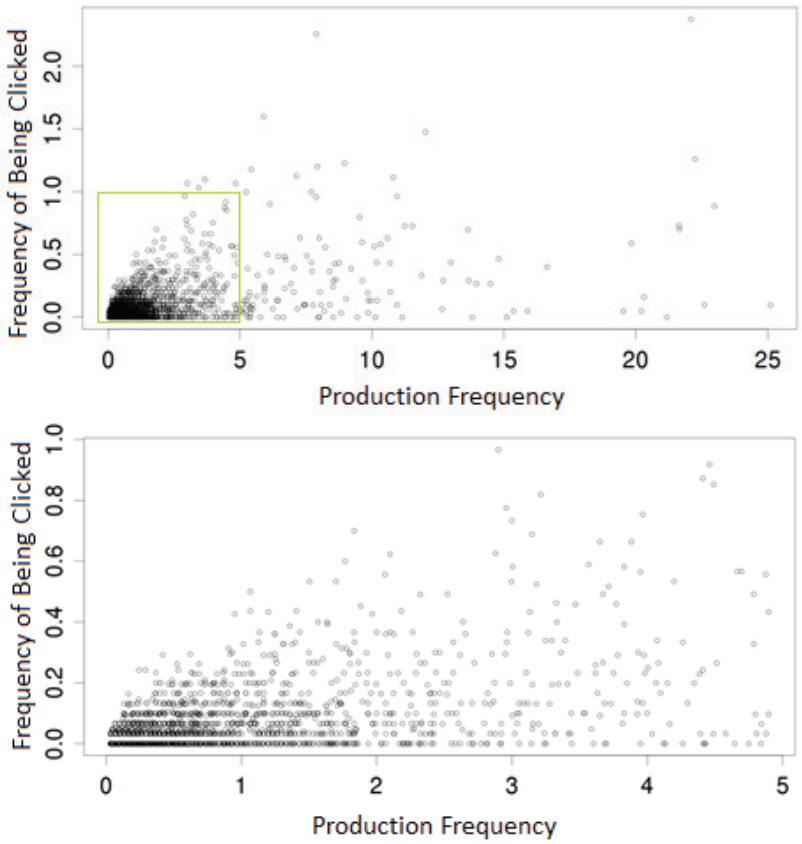


Figure 4.5. Scatterplot of production frequency vs. clicking frequency in days (top). Scatterplot for the contacts who produced five items a day or fewer (bottom). Overall, users appeared to check content from some contacts closely while ignoring content from the others [P6].

With only short bursts of time to spare, users need a shortcut to the most relevant content. Three users borrowed the '*newspaper*' metaphor to explain their reading habits. B7 compared the automatic filtering to a *newspaper's front page* to explain why he liked the functionality.

B7: *'"**Suggested**" was like the front page of a newspaper. It contained the stuff that it thinks interests me. Pretty often, it was right. I went there to check that stuff first. I also went to the **All** tab for other information, especially when I am on the go and do not have other devices.'*

This dissertation's research further analysed what kind of content received user attention. The key indicators were recency, contacts, and content types.

Users tended to click the most recent items. Delays between an item arriving on the mobile device and it being clicked were typically rather short. The median delay was 57.8 minutes (M = 171, SD = 246, N = 5,783). In other words, for a clicked item, there was a 50% chance of the clicking action occurring within an hour. When an item was not clicked shortly after being received, it probably would not be clicked in the end.

As for contacts, a user would follow content from a subset of his or her contacts and ignored content from the others. Figure 4.5 presents two scatterplots of how the content from individual contacts was clicked. The bottom figure is an exploded view of the area marked in the above graph. On the x-axis is the average frequency at which a contact published in a day. The y-axis indicates the average frequency of that contact's content being clicked on in a day. Users checked content from some contacts closely and ignored content from the others. This means that the contact doing the publishing is an important factor determining the content relevance.

4.3.2 User Experiences with Mobile UIs for SNSs

This section of the thesis reports on UX evaluation results for novel mobile UIs for SNSs. The work draws on data from subjective ratings and user interviews from the LinkedUI lab and field experiment studies. In the subjective ratings, the users rated a list of statements on a seven-point Likert scale. Here, 1 represented 'strongly disagree', 4 represented 'neutral', and 7 stood for 'strongly agree'. In the interview data, the users expressed their opinions and their general preferences in relation to benchmark systems.

Figure 4.6 presents the questionnaire results from the lab study as published in **P4** and **P7**. Overall, this result supported the advantage of hypertext-based UI over using SNSs via a Web browser. The users rated the new UI significantly higher than the benchmark for three statements: users liked the UI design of mixing content from multiple services (Q2) (t (11) = 1.89, p = 0.04), they found it easy to track their contacts across services (Q1) (t (11) = 3.34, p = 0.00), and they believed that long-term usage would help them to know their contacts (Q4) (t (11) = 3.32, p = 0.00). As exceptions, the users rated the new UI worse than the benchmark for usability statements: (Q7) (t (11) = 1.97, p = 0.04) and (Q8) (t (11) = 2.40, p = 0.02). The low ratings may be associated with the unfamiliarity with the new UI. These users still performed the usability test tasks better on LinkedUI than on the benchmark.

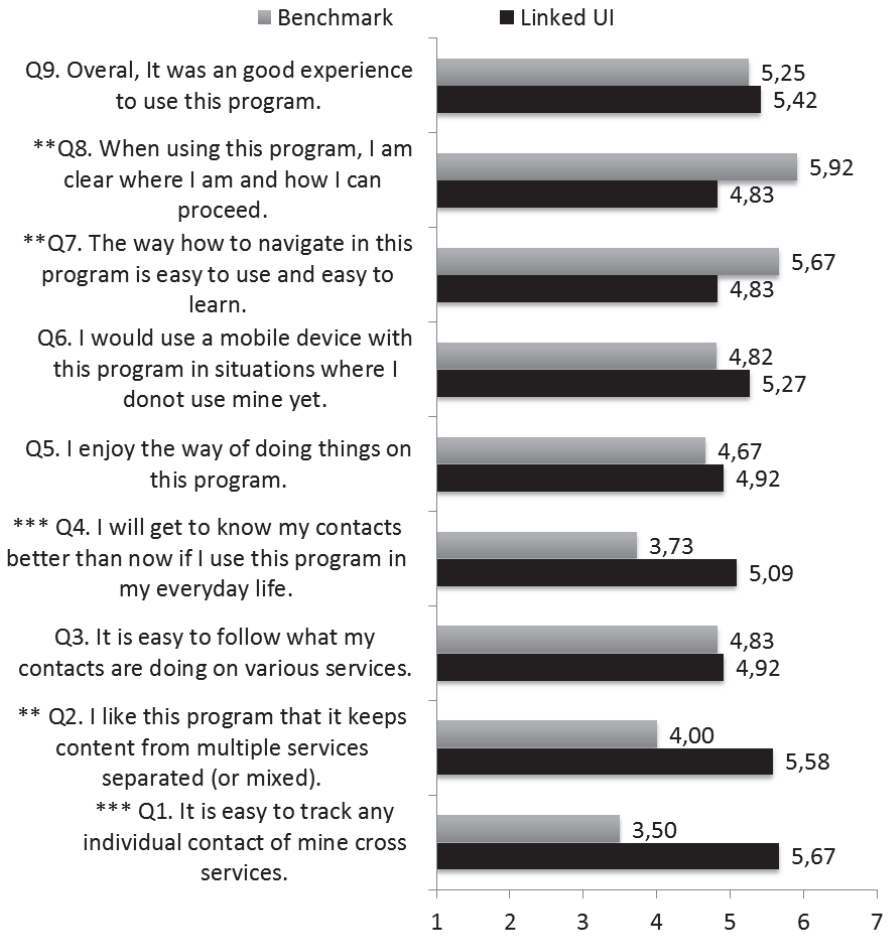


Figure 4.6. The average subjective ratings for LinkedUI and the benchmark (statistical significance of the differences: *** $p < 0.01$, ** $p < .05$). Overall, this result supported the hypertext-based UI as more beneficial than using SNSs via a Web browser [P4, P7][5].

These questionnaire results were in line with overall user preferences. Eight of the lab study's twelve users clearly preferred the new device UI to the benchmark of using SNSs from a Web browser. Three users commented that LinkedUI and the benchmark should complement each other, depending on their usage contexts. Only one user preferred the benchmark. She liked

[5] This chart reports different values for Q9 from the publication [P4]. The chart published in P4 contains errors in that wrong divisors were used to divide the grand totals. The errors had been corrected in the related chart in P7.

content from multiple services to be shown in a single view but would have liked the content from each service to be separate, for things to appear 'organised'. The user attributed this feedback to her negative experiences of a Web-based SNS aggregation service that she tried out before the study.

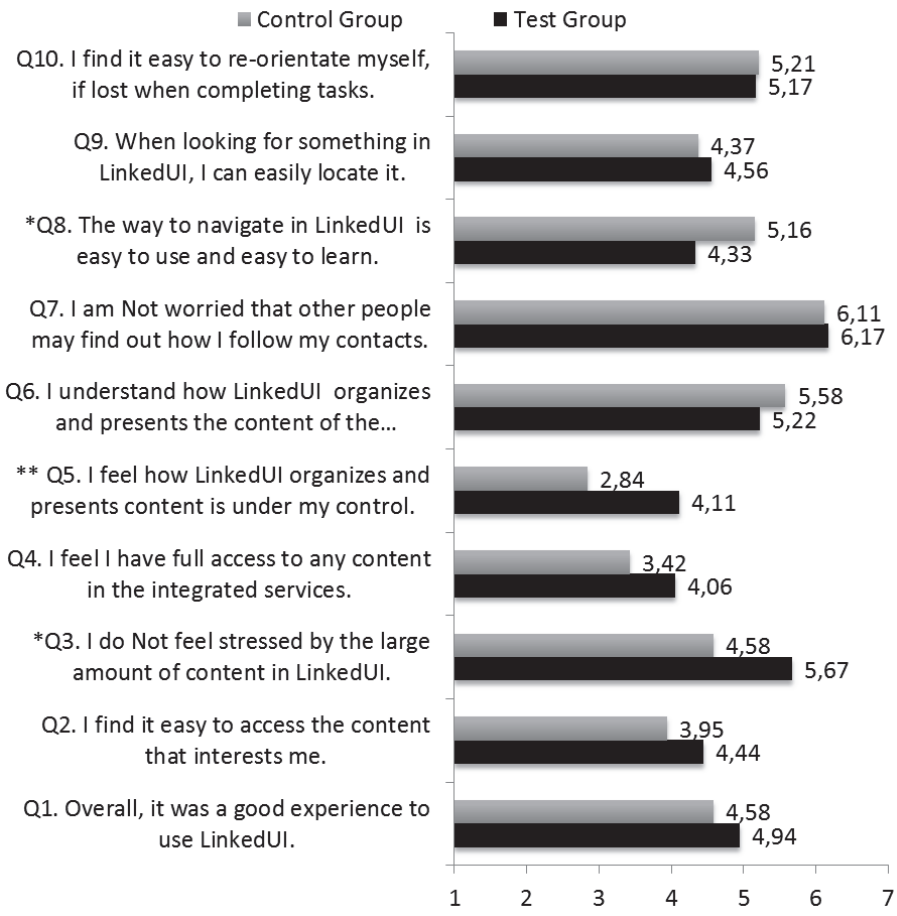


Figure 4.7. The average subjective ratings for the control and test groups (statistical significance of the differences: ** $p < 0.05$, * $p < .10$). With the addition of the filtering functionality, users rated most UX elements (marginally) significant better, while they did not have a significantly much better overall user experiences [P5, P7].

Figure 4.7 presents the questionnaire results from the field study as published in **P5** and **P7**. It evaluated the impact of automatic filtering on user experiences. With the addition of this functionality, users rated some UX elements (marginally) significant better on average, while they did not have a significantly better overall user experiences (Q1). For example, they

felt less stressed by information overload (Q3) (t (35) = 1.77, p = 0.09) and had a greater sense of control of content presentation (Q5) (t (35) = 2.52, p = 0.02). The questionnaire covered a list of other potential user experience risks, based on early studies (Jameson, 2008). None of them emerged as a major problem, apart from general ease of use (Q8) (t (35) = 1.77, p = 0.09).

The pattern was similar for user preference results. Twenty users in the test group used the automatic filtering functionality. Twelve of them agreed with the idea of showing the filtered feeds by default. Four users were positive about the automatic filtering functionality but argued for presenting it only when solicited. The other four were negative about the filtering and suggested removing it. They seemingly avoided a 'smart' system *ab initio* and did not give it a chance. These results show that the majority of people appreciated the addition of automatic filtering for mobile SNS use.

The evaluation results show differences in opinion between individuals. Further analysis reveals several factors contributing to the different opinions. The most important ones appeared to be users' established practices of using SNSs and their attitudes toward 'smart' systems. The users who were positive about the filtering functionality typically did not expect to read all SNS content on mobile devices. When it was not practical to read all content, they just expected to browse the top items of a list. They perceived 'smart' technologies as good means of prioritising content. The users who were negative about the filtering functionality, on the other hand, argued for full access to all SNS content subscribed for. They did not want a system to provide proactive help. When it was not practical to handle all content, they preferred manual customisation to reduce the content flow. Their common strategy was to customise the services' Web sites – for example, hiding or removing contacts – so that they could handle everything in the SNSs.

The following analysis investigates LinkedUI in terms of individual UX dimensions. It is based mainly on user interview results from the field studies published in **P5** and **P7**. Where relevant, it also refers to the lab study published in **P4.** These UX dimensions have been summarised from early UX investigations of mobile use of SNSs, as introduced in **Section 2.3**.

Some user quotations are used to support key arguments. U1–U12, A1–A20, and B1–B20 are all codes for participant identities. U1–U12 were participants in the lab study, and A1–A20 and B1–B20 took part in the field study; 'A' stands for the group not using automatic filtering functionality, while 'B' indicates the group using the functionality.

Social Awareness

In the LinkedUI field study, nearly all users emphasised that a mobile UI with SNSs integrated promoted *social awareness*. Some users commented

that '*it supports an "always-on" feeling*', '*it keeps me up to date*', '*I feel as if the world is under my fingertips*', and '*I feel I am better connected to my friends, as I am better aware what they are doing*'. The constant flow of new content did not lead to anxiety. None of the users complained about this problem. To the contrary, A19 even reported that notification of new content facilitated his autonomy as quoted below.

A19: '*It is kind of "stress-relieving". I do not have to go to some Web site to pull the data all the time. I can just check them out here and then leave it. A good number counter also helps with the stress relief. You will see that you* have *that much today, and you have already read them. So there is no reason to worry.*'

As shown in Figure 4.6, users thought they would know their contacts better if they kept using LinkedUI (Q4), significantly higher than the figure for the benchmark of using SNSs from mobile Web browsers. As U2 explained, '*If I follow someone on Twitter, I may not check their Flickr all the time. But here, Flickr photos will automatically come as well.*' A powerful mobile browser, on the other hand, would not change the users' behaviour much. As one user commented, '*I am not sure I will all the time open my browser to check on my friends*' (U10).

Social Interaction

In the LinkedUI field study, most users suspected that they noticed some content that they might have missed without using the new UI. They started to check on their SNSs more often, which sometimes triggered online social interactions. For example, A10 comforted a friend in a medical situation via Facebook comments. Other examples included announcement of a new-born baby or a vacation; messages about feeling ill; open invitations such as '9:00pm, Pub Amsterdam, Join'; or first-come, first-served offerings.

In the field study, nine users reported the case of coming across content when handling phone calls. Some of them referred to the content read when initiating conversations with occasional contacts or to impress their close contacts. For example, one user tried to impress his wife by referring to what she had published on Facebook, as quoted below. The others did not talk in their calls about what they had read, but they still enjoyed such a possibility. One user was happily surprised to read an old item that her father had published half a year ago when trying to call him.

A1: '*One thing I really like I thought is a delightful feature. You see the latest updates of a person when he is calling. I really like it, especially when my wife is calling. She would ask me: "Did you like my status update on Facebook?" I could say "No, but I read it".*'

The field study did not gather strong evidence as to the impact of LinkedUI usage upon physical meetings. Most users claimed that they did not have any serendipitous meetings triggered by reading some SNS content other than four instances. One user went to drink with a friend after reading the friend's open invitation. Another user got two gig tickets from a friend who gave them away on Facebook.

Self-expression

The mobile UI designs in this dissertation were not intended for encouraging people to publish content. This was reflected in the user interview results. Almost none of the users noticed much change in their publishing activities.

As an interesting finding, the users spontaneously reported their disinterest in publishing significantly more. One user explained that the intent was to keep a 'stable' image. He would not have published more often on the tested SNSs even the publishing had become easier. This result was in contrast to that for consumption activities. Nearly all users acknowledged that they checked SNSs more often when using LinkedUI than they had before.

LinkedUI did not support some publishing functions. The users requested the addition of those functions requiring limited user interactions, such as 'Re-tweet', use of a **Like** button, and 'photo sharing' capabilities. These results echoed those in **P1** and **P2**. The users tended to avoid entering lengthy text on mobile devices, and images emerged as one major type of content captured and shared via mobile devices.

Usability

The user studies generally supported the hypothesis of a usability advantage in aggregating multiple services with mobile devices over using individual Web sites. The introduction of novel UI designs such as automatic filtering functionality could face usability challenges.

The lab test was to verify the usability of the initial version of LinkedUI in three user tasks. The baseline condition was use of the SNSs via a state-of-the-art mobile Web browser. In the study set-up, LinkedUI had all services preconfigured; the baseline had all tested services as background windows. The users performed all three tasks better with LinkedUI than when using the benchmark. They accessed more contacts when browsing freely and were faster when monitoring a specific contact or locating a content item. After performing the brief lab test tasks, the users rated usability of the new system lower than the benchmark as shown Figure 4.6. This result shows that the users need more time before they can comfortably use the new UI.

The field study covered questions about usability of the automatic filtering functionality in terms of subjective ratings. As shown in Figure 4.7, the users using the functionality gave slightly lower ratings to the overall usability statement than did the users not using it. The usability challenge is probably not that serious, given that all users found it equally easy to locate a target when needed and to orient themselves when getting 'lost', whether or not they had the automatic filtering functionality.

Sense of Control

In a mobile UI for SNSs, there are several sources of risk to the user's sense of control. Two of these are 1) the frequent checking-up user activities due to the constant flow of social networking feeds and 2) the automatic filtering functionality that filtered out content without user involvement.

In **P6** and **P7**, the log analysis shows that users checked SNSs at high frequency. None of them, however, reported in the user interviews that they felt obliged to do so or addicted. Nearly all of them agreed that the social networking feeds should be always on. Two users asked for an option of temporally stopping the constant flow, for the sake of saving battery life.

The automatic filtering functionality prioritised content by inferred relevance. It highlighted a small amount and filtered out the majority by default. As one unexpected finding, the users using the automatic filtering reported a better sense of control than did those using the full timeline. As shown in Figure 4.7, the improvement was statistically significant in the use ratings of Q5: '*I feel how LinkedUI organises and presents content is under my control.*' Compared with the users receiving the automatic filtering functionality, users in the control group complained more often about high content volume and lack of support in accessing the relevant items. Some users spontaneously suggested that the filtering functionality fitted well with the nature of mobile contexts. In micro breaks, users needed to glance at their mobile devices quickly and proceed to other tasks.

The studies revealed individual differences in what is deemed the optimal level of sense of control. As mentioned earlier, a small proportion of users complained about the perceived lack of control when using automatic filtering functionality. These users were often the ones who tended to check all SNS content subscribed to, and the ones who did not like a system to provide help proactively. They requested means to disable the automatic filtering functionality and to prioritise the SNS content manually.

B11: '*I do not use the **Suggested** tab, since I do not know what is left out. I am the kind of person who wants to see everything. I do not throw a newspaper away before glancing at the headlines.*'

Breadth of Content Access

Breadth of content access refers to the extent to which the user can access the content. A mobile UI may not cover all of the content, because of limited coverage of service APIs or limited capabilities of mobile devices. Automatic filtering intended to help users with information acquisition takes over much of the work of examining all the content available and selecting the relevant parts. Users may end up learning less about the content than they would in a system without this functionality (Jameson, 2008).

Unlike Web sites, mobile UIs often do not support full access to all content. In the field study, 16 out of 40 users complained about absent SNS functions. The key missing elements included a **Like** button, events, wall posts, and presence information on Facebook and a re-tweet function for Twitter. They typically wished the mobile systems to cover '*at least the same things as a mobile version of the Web site*' and accessed the missing functions from the full Web site. The user should benefit from reference being maintained between the device's view and Web presentation of the same content. For example, the user might see the name of a Facebook event in a device view, and then click that name to visit the event's Web page.

The automatic filtering functionality highlights a subset of the content by default. Users need one extra step to see the fully content-populated timeline. In this study, the system was not found to significantly compromise the breadth of its users' content access. On average, all users felt that they could access all SNS content equally, whether they used the automatic filtering functionality or not. After briefed about the automatic filtering functionality, B1 explained, '*People need a system to set up some routines for them. Otherwise, they will feel frustrated with too many options. Social media are not very critical, so not a big issue if you miss something. You still have a PC, so the chance is small of missing something.*'

4.3.3 Summary

We have now summarised the findings addressing **RQ3**: What usage patterns and user experiences are associated with device UIs supporting integration of SNSs on mobile devices? In terms of usage patterns, people frequently check SNSs in brief sessions. This suggests that the novel UI designs support the mobile use of SNSs in micro breaks, a common characteristic of mobile contexts. People attend to selective content such as content recently shared and content shared by relevant contacts. These factors aid in prediction of the relevance of SNS content for automatic filtering. Table 4.1 presents the results in terms of the UX dimensions proposed in **Section 2.3**. The new UI helps users to be aware of their social networks and the shared SNS content. It does not introduce major problems in terms of usability, sense of control, and breadth of content access.

Table 4.1 Key UX dimensions associated with using SNSs on LinkedUI

UX	Evaluation study results for novel mobile UIs for SNSs
Awareness	People became aware of what was going on in their social networks, and felt getting to know their contacts better. This was the most commonly mentioned benefit of LinkedUI. Some people also used SNSs as social media. They wanted to follow what was going on broadly in the world.
Social interaction	People sometimes discovered SNS content relevant to their contexts – e.g., the content that invites responses and SNS feeds from the contacts of incoming phone calls. Users seldom initiated real-life events when using LinkedUI. This impact may depend on user practices associated with SNSs in question.
Self-expression	People seemingly refrained from increasing their publication for a stable image, even if publication was made easy. They requested support for lightweight publishing such as 'Like' and 'Re-tweet' more than full text editing functions.
Usability	Integration of SNSs with mobile devices helped people to access SNS content faster than conventional UIs did. This promoted frequent and brief checking-up activities. On average, the automatic filtering helped people find relevant content, and the functionality brought some minor usability threats. It should be possible to turn off this functionality, because a minority of users did not like it.
Sense of control	People did not feel stressed by the constant content flow and frequent SNS check-up. None of them, however, felt obliged to do so or felt addicted. Automatic filtering enhanced rather than compromised the sense of control for most users. The related costs of automatic filtering might have been offset by the gains from easy access to relevant content.
Breadth of content access	Mobile UIs needed to support key SNS functions. People could benefit from good interplay between fetched SNS content and its Web page presentation. People did not feel automatic filtering a threat to their breadth of access to their SNS content. Most of them did not expect to check full content on the mobile device UI.

5 Discussion

The main objective of this dissertation was to explore novel means of using social networking services on mobile devices. Following the design research approach, the dissertation explores current user practices of using SNSs and other Web services, and the work involved building and evaluating several mobile user interface designs for using these services. This chapter explores the generalisability of these findings beyond the designs tested, ties in the findings with previous studies, and discusses limitations of this research.

5.1 UI Requirements for the Mobile Web

The convergence of the Web has changed how people use mobile devices. A multitude of Web activities – such as information seeking, social networking, and online transactions – have become common mobile tasks [**P1**]. Today's mobile devices have the technical capabilities to support nearly all regular Web sites. Hence, they are beginning to be used for demanding tasks that used to require a PC. For example, Kamvar et al. (2009) found that Web use on iPhones is comparable to usage styles on PCs as opposed to conventional feature phones. Maurer et al. (2010) have shown that people using smartphones (such as the iPhone or Android phones) prefer using original Web sites instead of mobile versions of the sites.

Previous HCI studies explored mobile UIs optimised for the Web, with the initial ones focusing on mobile Web sites (Kaikkonen & Roto, 2003; Heimonen & Käki, 2007) and mobile Web browsers (Baudisch et al., 2004; Roto et al., 2006). At that time, mobile devices still faced challenges in rendering regular Web sites. This line of research entered a decline with the advent of modern smartphones (such as the iPhone or Android phones) that could smoothly render regular Web sites. Instead, researchers started to explore issues around mobile applications, another means of using the mobile Web. For example, Vartiainen (2009) compared the characteristics of a mobile application and a mobile Web browser, Girardello and Michahelles (2010) explored means of locating an application from a vast application store, and Böhmer et al. (2011) analysed what mobile applications people are using and how they are using them.

This dissertation's research revealed user needs for a new type of mobile UIs. For many users, the mobile Web is becoming a part of daily routines [**P1**, **P2**]. When attending to their mobile devices, they often do not have a concrete task other than being informed or entertained. This finding is in agreement with other recent studies of Web use on mobile devices

(Oulasvirta et al., 2012) and on PCs (Lindley et al., 2012). The popularity of these use cases has significant implications for relevant mobile UI studies.

Firstly, people may benefit from *associative browsing*. Natural associations exist between content in separate Web services. Via associative browsing, people can use associations – such as publisher, place, time, and media type – as means to access content (Lehikoinen et al., 2007). This is not possible with conventional UIs that confine content to a hierarchy of application structures [**P3**]. Recent smartphones have started to support easy switching among windows. This workaround alleviates but does not solve the problem. It is of note that associative browsing can also lead to side effects that future studies need to address. Without careful designs, people may become disoriented in the system when performing tasks aimed at specific goals.

Secondly, people may be open to the UI design of *intelligent content presentation*. With mobile devices, people often have only a short burst of free time to spare. In such a micro break, they may not expect to check a service thoroughly. Instead, they might want a quick view of relevant information or stimuli and then return to their offline activities [**P6**]. This UI design appears to work for non-critical content – for example, content from social media and anonymous sources such as news and e-commerce – although it may not work for critical content such as directed messages.

These two design options form the foundation for this dissertation. The research experimented with these design options in the domain of SNSs, with the choice to work with SNSs instead of other kinds of Web services stemming from 1) SNSs' status as one of the most popular categories of service and 2) their support for well-structured content.

5.2 Mobile UIs Supporting Integration of SNSs

The research done for the dissertation experimented with a novel device UI for a unified presentation for all content on a mobile device. The main design objective was to support rapid consumption of relevant SNS content. The UI called LinkedUI regulates all content and functions on a mobile device. One of its main novel elements is use of hypertext navigation as the mechanism in place of hierarchy-based structures [**P4**]. It unifies presentation of content from the Web or from a device, thereby solving a consistency problem found with conventional mobile devices: Web sites follow hypertext navigation, and mobile applications follow hierarchy-based structures (Hjelmeroos et al., 1999; Kiljander, 2004).

This new mobile UI implements a vision of a holistic device UI as suggested in earlier studies (Björk et al., 2000; Marsden & Jones, 2002; Sohn et al., 2010). Related systems with restricted scope include an augmented home

view (Cowan et al., 2010) and phonebook view (Bentley et al., 2010; Oulasvirta et al., 2007).

Following the same track of UI evolution, various commercial products started to appear after LinkedUI was published in 2009, among them Windows Phone's *People Hub*, Motorola's *Motoblur*, and HTC's *Friend Stream*. These systems aggregate SNSs and integrate them with contact, calendar, and photo views. The emergence of these systems strengthens the relevance of the present research. None of these existing systems, however, aims for a holistic device UI based on hypertext navigation as advocated in this dissertation's research. Neither do these commercial systems yet support automatic filtering of social networking feeds, which is another novel element of the UI explored in this dissertation.

The dissertation has covered a series of evaluation studies considering in-depth integration of SNSs with mobile devices. Overall, these studies suggested advantages of integration designs over information silos [**P4**, **P7**]. They also revealed some issues that deserve more attention in future studies. The dissertation has made some inroads into tackling some of these issues.

Firstly, it may not be feasible to have all SNS functions integrated into a mobile device all at once. On one hand, mobile UIs may not be able to cover all ever-changing service functions. The UIs should support regular manual reconfiguration – for example, by a third-party developer – to keep the system up to date when a service adds new functions. The UIs should also support good interplay of local views and Web pages. For example, a user can view the details of an event on its Web page by starting with its overview presentation in a calendar view. On the other hand, the mobile UI may not support an adequate 'look and feel' for a Web service. For example, LinkedUI aggregated content from multiple SNSs and presented the content differently from the individual website. Future studies should explore whether this presentation sufficiently delivers the look and feel of a service.

Secondly, mobile UIs should leverage more associations between content items for hyperlinking. In this study, LinkedUI considered time, contacts, content types, and geographical locations as key dimensions for association of content. One limitation arises in relation to contacts: a system can automatically merge a limited number of identities belonging to one person; it must rely on users to link other identities manually. People need to be convinced by rewards for building connections; the rewards could be either personal or related to social value. Future studies should continue exploration of these and other associations. This is especially relevant as a system begins integration of other kinds of Web services, such as news portals, audio/video sharing services, and mobile commerce.

Thirdly, people may find it difficult to locate personally relevant content. This research introduced *automatic filtering* to solve this problem [**P5**].

Given small slices of time in mobile contexts, people may expect to see 'just enough' functionality from their mobile devices. The full functionality only needs to be available once extra user effort is applied. This principle echoes the 'satisficing' strategy in human decision-making. People settle with a good enough solution rather than searching for the best solution to a problem (Simon, 1956). The design of automatic filtering matches this user strategy in accessing SNSs. It is worthy of note that manual customisation remains important in mobile UIs. A small proportion of users need this option because they categorically reject intelligent UIs. People expect such options even though most of them are unlikely to customise the system.

5.3 UX Evaluation of Mobile UIs for SNSs

The dissertation has covered several user experience evaluations for the mobile UI with integrated SNSs [**P4 – P7**]. In view of a literature review, it focused on the following UX dimensions: awareness, social interaction, self-expression, usability, sense of control, and depth of experience.

Awareness: The mobile UI designs with integrated SNSs enabled people to maintain awareness of their social sphere in their periphery and to refer to it whenever they needed a diversion from their main tasks. This result was consistent with early studies of general mobile usage patterns called habitual check-ups. Habits refer to automatic behaviours triggered by cues of external situations and emotional states (Oulasvirta et al., 2012). In line with the earlier study, people generally did not feel annoyed by the frequent check-ups (Barkhuus et al., 2008; Cowan et al., 2010; Humphreys, 2008).

Social interaction: The study did not reveal strong evidence as to the impact of mobile UI designs on serendipitous meetings. The impact appeared to be lower than that found in some earlier studies (Bentley & Metcalf, 2007; Barkhuus et al., 2008; Humphreys, 2008). This result may be contingent on SNSs included. For example, in Facebook (the predominant service tested in this dissertation), 'the primary way in which Facebook contributes to socializing isn't by offering a medium through which people can meet and communicate with others. Instead, it's by acting as a virtual watering hole that dispenses information about peers' (Bumgarner, 2007).

Self-expression: The mobile UI designs examined in this dissertation did not introduce designs aimed at encouraging users to publish more often via SNSs. Neither were the users enthusiastic about publishing more often through integrated SNSs in this dissertation's research. They intended to maintain the same level of publishing activities, even if the publishing were made easier to accomplish on mobile devices.

Usability: The mobile UI designs with integrated SNSs could support greater usability than use of SNSs through individual Web sites. Using the Web for a long time, people are experienced in associative browsing, which is an effective and efficient way to use multiple services. A small proportion of users categorically rejected the automatic filtering functionality. They may have experienced some usability problems if unable to turn it off.

Sense of control: The mobile UI designs with integrated SNSs increase the information flow when automatically fetching content from SNSs. Users did not report feeling annoyed by the frequent content flow, but they often found it difficult to find relevant content. Automatic filtering highlighted some relevant SNS content and promoted a sense of control for mobile users. This result was different from findings from earlier studies of similar intelligent functions (Ozenc & Farnham, 2011).

Breadth of content access: The mobile UI designs with integrated SNSs might not support all functions available on a Web site. A design needs to consult users in the selection of features. Mobile versions of these service Web sites are good reference points. The automatic filtering did not seem to diminish the breadth of content access for SNS content, which is a risk often associated with similar intelligent functionalities (Jameson, 2008).

These UX dimensions are arguably motivations or hygiene factors, according to the *motivation–hygiene* theory proposed by Herzberg et al. (1959). The theory originated from employee satisfaction studies. Its key argument is that satisfaction and dissatisfaction are separate processes. Satisfaction is associated with presence of motivation factors, while dissatisfaction is connected to absence of hygiene factors (*ibid.*). Awareness, social interaction, and self-expression are arguably motivation factors. These reward users for using SNSs on mobile devices. Usability, sense of control, and breadth of content access can be hygiene factors. They do not provide value to users *per se* but are important for avoidance of dissatisfaction. Early studies also introduced UX categorisation. Markopoulos et al. (2004) used the subcategories of benefits and cost. Väänänen-Vainio-Mattila et al. (2010) used the subcategories of drivers and hindrances.

These UX dimensions constitute a framework for evaluation of mobile UIs for SNSs. The evaluation target is the mobile UIs independent of the services. The separation is important because design research on mobile UIs does not necessarily have direct control over the services. For example, when creating mobile UIs of Android, Google designers cannot control the design of Facebook. This focus has set the present research apart from previous UX studies (Hart et al., 2008; Markopoulos et al., 2004; Väänänen-Vainio-Mattila et al., 2010), which focused on the services themselves.

5.4 Limitations of the Research

The user groups included in this dissertation's research may have biased the findings in several ways. 1) Users in this dissertation's studies were actively using SNSs and other mobile Web services. People who are less active with these services may not be as likely to access their social networks frequently. 2) The majority of the studies' participants were working adults. A study with younger users such as teenagers or university students might have revealed more spontaneous co-ordination cases (Barkhuus & Tashiro, 2010). 3) Most users in this dissertation's research lived in urban areas in developed countries. They were not exposed to problems common among other, less privileged user groups, such as low access bandwidth, concern over transaction costs, high risk of device loss, and common practices of device sharing (Cui et al., 2007a). 4) The research involved too small a user sample to investigate individual differences in relation to the new UI designs. The individual differences appeared to be associated with user attitudes and existing usage patterns associated with SNSs, mobile technologies.

Some restrictions of LinkedUI prototype development and deployment may have limited the validity of this research. 1) LinkedUI for purposes of this dissertation covered Facebook, Twitter, and Flickr as the key SNSs and did not involve other types of SNSs. For example, it did not support social location services – such as Foursquare – that leverage the unique characteristics of mobility and enable high synergy between SNSs and mobile devices. 2) LinkedUI was a research prototype and therefore had limited capabilities. Over the course of a four-week user trial, the system could become very slow for people following more than 200 Twitter contacts. The studies described in this dissertation did not include the most active volunteers, on account of this restriction. This may have had an impact on the results for automatic filtering for social networking feeds; the active users might have benefited most from that functionality. 3) LinkedUI employed user clicks as the indication of user interest. This logic was not always valid; for example, some items were so short that a user could see the entire post without clicking. The system also emphasised reverse chronological order in sorting of content. This made it difficult to quantify the recency feature in user click predictions. 4) LinkedUI was deployed on a special mobile device. The users often needed to carry this test device along with their primary mobile phone during the study. This might have reduced users' reliance on LinkedUI. A field study 'in the wild' may have been a better research method (Ferreira et al., 2012). The latter methods were considered but not used, on account of the scope of the LinkedUI concept. The aim was to replace the entire device UI, which made it infeasible to be released as a mobile application for an open field study.

6 Conclusions

This chapter revisits the original research questions, and summarises the key results. Following that, it highlights key contributions and suggests future studies that could validate and expand upon the present findings.

6.1 Key Findings

RQ1. What are the contextual characteristics and UI constraints associated with mobile use of Web services, especially SNSs?

People often use mobile Web services when taking micro breaks [**P1**]. This contextual characteristic makes it critical to support quick access to the relevant content. This is especially the case when people freely browse a large amount of SNS content without specific information goals [**P2**]. The existing designs of mobile Web browsers and mobile applications require a significant amount of user effort to navigate in the UIs [**P3**]. This restricts users' browsing of content from multiple SNSs at the same time.

RQ2. What kinds of UI designs contribute to the positive user experience of accessing SNSs on mobile devices?

The research experimented with novel UI designs for accessing SNSs on mobile devices. Firstly, the thesis introduced a device UI – regulate all content and functions of a mobile device – based on hypertext navigation. The UI associated the SNS content across services and applications into one unified presentation [**P4**]. To handle the overwhelming amount of content, the UI supported automatic filtering for social networking feeds that was based on a model for inferred user interest [**P5**]. The relevant user evaluations showed that these novel mobile UI designs contribute to positive user experience of using SNSs on mobile devices [**P7**].

RQ3. What usage patterns and user experiences are associated with device UIs supporting integration of SNSs on mobile devices?

People perform frequent and brief check-ups of SNSs when using mobile devices integrated with these services. This usage pattern indicates a good match of these UIs with mobile contexts populated with micro breaks. People attend to content that is directed to them, recently generated, or generated by relevant contacts [**P6**]. All these identified factors should be considered in development of the automatic filtering functionality.

The mobile UIs with integrated SNSs help people to be aware of their social networks and the circulated SNS content [**P7**]. This user benefit came up in

the user studies more often than other benefits, such as supporting social interaction and enhancing self-expression. Overall, the UIs support better usability than using SNSs in a mobile Web browser [**P4**]. Partially due to this, people start to frequently check their SNSs. Such frequent behaviour is not yet perceived by people as annoying, or posing a threat to their sense of control. Neither is automatic filtering of SNS content. People reported an enhanced sense of control when using the automatic filtering functionality, because they found it made easier to access relevant content from a large amount of SNS content available [**P5**].

6.2 Contributions

This dissertation has explored context characteristics and UI constraints for the mobile Web, using these user insights in exploring new mobile UI designs. These designs aimed to promote consumption of SNSs on mobile devices.

The dissertation work included the creation of novel mobile UIs for use of SNSs. Instead of developing yet another application, it explored a holistic UI system for a mobile device. The system does not use applications as the basic building blocks of a mobile UI; therefore, it avoids bringing about the information silo problem. The exploration also included automatic filtering for social networking feeds. These UIs advanced the state of the art at the time when this research took place. It influenced some commercial products – in particular, the Notifications home view of the Nokia N9 smartphone. The N9's Notifications view aggregates content from various sources – such as SNS content, Web feeds, and software updates – into a device home view. This is an adaptation of LinkedUI for an application-centric device UI.

The dissertation work uncovered some usage patterns and UX dimensions associated with mobile UIs for SNSs. Firstly, people frequently use SNSs in brief sessions – i.e., micro breaks. They attend to selective content, mainly content directed at them, content that has just been published, and content published by certain contacts. Secondly, awareness, social interaction, self-expression, usability, sense of control, and breadth of content access are key UX dimensions to evaluate mobile UIs for SNSs. The mobile UIs explored in this dissertation's research help people to be aware of their social networks. They make using multiple SNSs easy on mobile devices and grant people sufficient sense of control when facing dynamic information flow.

6.3 Future Work

The research described in this dissertation experimented with a novel device UI supporting the integration of Web services into mobile devices. It

provided early evidence of its validity for delivery of social networking services. Future studies should continue to explore its relevance, to other social networking services – for example, services that leverage unique mobility characteristics, such as Foursquare – as well as other kinds of Web services with structured data, such as news, audio/video sharing services, and e-commerce. As a general device UI governing all functions and content on a mobile device, these novel designs are not limited to SNSs.

This dissertation has identified several open issues that deserve attention in future research. It explored using hypertext navigation to replace hierarchy in mobile UIs for user tasks without specific goals. Future work should explore its support for user tasks with specific information goals as well. It should go beyond the universal search styles – locating targets by means of key words – devised in this research. The dissertation has explored automatic filtering for social networking feeds. The function simply added a separate stream of highlighted content in addition to the full timeline. Future work should explore other kinds of UI designs. For example, an alternative system could highlight the important content by using various visualisations or means of notification. This dissertation's research focuses on consumption of social networking services. These consumption activities could be gathered and published for social networking purposes. Some on-going studies of the dissertation author explore sharing viewer's context information in a mobile photography services. The initial results support potentials in this research direction (Cui et al., 2013; Vyas et al., 2012).

The dissertation has provided a list of UX dimensions for evaluation of mobile UIs for SNSs. Future work should verify this list by applying other research methods – such as factor analysis of large-scale surveys – and develop instruments for measurement on these UX dimensions. Future work should also cover both online and offline activities in order to understand the effects these systems have on our lives, especially for the social interaction dimension, which is difficult to assess without covering offline activities.

Social networking services are one key growth area in mobile computing. Future work should continue to investigate novel UI solutions, to enable new user experiences for mobile devices. Mobile devices are connected to a network and readily available for use. They have potential to connect our online and offline lives. For example, they can make online content readily available for current real-life situations, and gather offline events for sharing in the virtual world whenever we so desire. User interface design and user experience evaluations provide one key perspective that can guide future development in this domain to be useful, usable, and meaningful.

References

Adamczyk, P.D. & Bailey, B.P. (2004). If not now, when?: The effects of interruption at different moments within task execution. *Proceedings of CHI '04*, ACM, 271–278. DOI=10.1145/985692.985727

Adomavicius, G. & Tuzhilin, A. (2005). Toward the next generation of recommender systems: A survey of the state-of-the-art and possible extensions. *IEEE Transactions on Knowledge and Data Engineering, 17*(6), 734–749. DOI=10.1109/TKDE.2005.99

Barkhuus, L. & Tashiro, J. (2010). Social networking on the go: Students' socialization in the age of Facebook. *Proceedings of CHI '10*, ACM, 133–142. DOI=10.1145/1753326.1753347

Barkhuus, L., Brown, B., Bell, M., Sherwood, S., Hall, M., & Chalmers, M. (2008). Friendship, awareness and repartee: Sharing location on the go. *Proceedings of CHI '08*, ACM, 497–506. DOI=10.1145/1357054.1357134

Baudisch, P., Xie, X., Wang, C., & Ma, W. (2004). Collapse-to-zoom: Viewing web pages on small screen devices by interactively removing irrelevant content. *Proceedings of UIST '04*, ACM, 91–94. DOI=10.1145/1029632.1029647

Bederson, B.B. (2004). Interfaces for staying in the flow. *Ubiquity*, *5*(27), 1. DOI=10.1145/1074068.1074069

Benevenuto, F., Rodrigues, T., Cha, M., & Almeida, V. (2009). Characterizing user behavior in online social networks. *Proceedings of IMC '09*, ACM, 49–62. DOI=10.1145/1644893

Bentley, F.R. & Metcalf, C.J. (2007). Sharing motion information with close family and friends. *Proceedings of CHI '07*, ACM, 1361–1370. DOI=10.1145/1240624.1240831

Bentley, F.R. & Metcalf, C.J. (2009). The use of mobile social presence. *IEEE* Pervasive *Computing, 8*(4), 35–41. DOI=10.1109/MPRV.2009.83

Bentley, F.R., Kames, J., Ahmed, R., Zivin, R.S., & Schwendimann, L. (2010). Contacts 3.0: Bringing together research and design teams to reinvent the phonebook. *CHI Extended Abstracts '10*, ACM, 4677–4690. DOI=10.1145/1753846.1754210

Beyer, H. & Holtzblatt, K. (1997). *Contextual Design: A Customer-centered Approach to Systems Designs*. San Diego: Academic Press.

Björk, S., Redström, J., Ljungstrand, P., & Holmquist, L.E. (2000). PowerView: Using information links and information views to navigate and visualize information on small displays. *Proceedings of HUC '00*, Springer-Verlag, 46–62. DOI= 10.1007/3-540-39959-3_4

Böhmer, M., Hecht, B., Schöning, J., Krüger, A., & Bauer, G. (2011). Falling asleep with Angry Birds, Facebook and Kindle: A large scale study on mobile application usage. *Proceedings of MobileHCI '11*, ACM, 47–56. DOI=10.1145/2037373.2037383

Bornoe, N. & Barkhuus, L. (2011). Online social networks on-the-go: An exploration of Facebook on the mobile phone. *CSCW Horizon, CSCW '11*. Retrieved on 7 July 2012, from http://cseweb.ucsd.edu/~nbornoe/papers/p773.pdf

boyd, d. m. & Ellison, N.B. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication*, *13*(1), Article 11. Retrieved on 7 July 2012, from http://jcmc.indiana.edu/vol13/issue1/boyd.ellison.html

Buchanan, G., Farrant, S., Jones, M., Thimbleby, H., Marsden, G., & Pazzani, M. (2001). Improving mobile Internet usability. *Proceedings of WWW '01*, ACM, 673–680. DOI=10.1145/371920.372181

Bumgarner, B. (2007). You have been poked: Exploring the uses and gratifications of Facebook among emerging adults. *First Monday*, *12*(11). Retrieved on 7 July 2012, from http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/2026/1897

Bush, V. (1945). As we may think. *Atlantic Monthly 176*, 101–108. Retrieved on 23 March 2013, from http://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/

Buxton, B. (2007). *Sketching User Experiences: Getting the Design Right and the Right Design*. San Francisco: Morgan Kaufmann.

Cai, X., Bain, M., Krzywicki, A., Wobcke, W., Kim, Y., Compton, P., & Mahidadia, A. (2010). Collaborative filtering for people to people recommendation in social networks. *Proceedings of AI '10 (LNCS 6464)*, Springer, 476–485. DOI= 10.1007/978-3-642-17432-2_48

Carter, S. & Mankoff, J. (2005). When participants do the capturing: The role of media in diary studies. *Proceedings of CHI '05*, ACM, 899–908. DOI=10.1145/1054972.1055098

Chen, C. & Rada, R. (1996). Interacting with hypertext: A meta-analysis of experimental studies. *Human–Computer Interaction, 11*(2), 125–156. DOI=10.1207/s15327051hci1102_2

Chen, J., Nairn, R., & Chi, E. (2011). Speak little and well: Recommending conversations in online social streams. *Proceedings of CHI '11*, ACM, 217–226. DOI=10.1145/1978942.1978974

Church, K. & Oliver, N. (2011). Understanding mobile web and mobile search use in today's dynamic mobile landscape. *Proceedings of MobileHCI '11*, ACM, 67–76. DOI=10.1145/2037373.2037385

Church, K. & Smyth, B. (2009). Understanding the intent behind mobile information needs. *Proceedings of IUI '09*, ACM, 247–256. DOI=10.1145/1502650.1502686

(Cockton) Cockton, G. (2006). Designing worth is worth designing. *Proceedings of NordiCHI '06*, ACM, 165–174. DOI=10.1145/1182475.1182493

comScore. (2011). *Top 10 Need-to-Knows about Social Networking and Where It's Headed*. Retrieved on 7 Feb 2013, from http://www.comscore.com/Insights/Presentations_and_Whitepapers/2011/it_is_a_social_world_top_10_need-to-knows_about_social_networking

Conklin, J. (1987). Hypertext: An introduction and survey. *Computer, 20*(9), 17–41. DOI=10.1109/MC.1987.1663693

Counts, S. (2007). Group-based mobile messaging in support of the social side of leisure. *Computer Supported Cooperative Work, 16*(1–2), 75–97. DOI=10.1007/s10606-007-9040-9

Counts, S. & Fisher, K.E. (2008). Mobile social networking: An information grounds perspective. *Proceedings of HICSS '08*, IEEE, Article 153, 10 pages. DOI=10.1109/HICSS.2008.320

Cowan, L.G., Griswold, W.G., Barkhuus, L., & Hollan, J.D. (2010). Engaging the periphery for visual communication on mobile phones. *Proceedings of HICSS '10*, IEEE, 1–10. DOI=10.1109/HICSS.2010.184

Cramer, H., Rost, M., & Holmquist, L.E. (2011). Performing a check-in: Emerging practices, norms and 'conflicts' in location-sharing using Foursquare. *Proceedings of MobileHCI '11*, ACM, 57–66. DOI=10.1145/2037373.2037384

Cui, Y. (2007). Messaging design and beyond: learning from a user study on holiday greeting messages. *Proceedings of Mobility '07*, ACM, 159–166. DOI=10.1145/1378063.1378091

Cui, Y., Chipchase, J., & Ichikawa, F. (2007a). A cross culture study on phone carrying and physical personalization. *Proceedings HCII '07*, Springer-Verlag, 483–492. DOI=10.1007/978-3-540-73287-7_57

Cui, Y., Chipchase, J., & Jung, Y. (2007b). Personal TV: a qualitative study of mobile TV users. *Proceedings of EuroITV '07*, Springer-Verlag, 195–204. DOI=10.1007/978-3-540-72559-6_21

Cui, Y., Kangas, J., Holm, J., & Grassel. G. (2013). Front-camera video recordings as emotion responses to mobile photos shared within close-knit groups. *Proceedings of CHI '13*, ACM, 981–990. DOI=10.1145/2470654.2466125

Diehl, J. (2006). *The Associative PDA – an Organic User Interface for Mobile Personal Information Management*. Unpublished master's thesis. Aachen, Germany: RWTH Aachen University. Retrieved on 22 March 2013 from http://hci.rwth-aachen.de/materials/publications/diehl2006.pdf

Falke, E. (2008). The associative PDA 2.0. *CHI Extended Abstracts '08*, ACM, 3807–3812. DOI=10.1145/1358628.1358934

Fallman, D. (2003). Design-oriented human–computer interaction. *Proceedings of CHI '03*, ACM, 225–232. DOI=10.1145/642611.642652

Ferreira, D., Kostakos, V., & Dey, A. (2012). Lessons learned from large-scale user studies: Using Android Market as a source of data. *International Journal of Mobile Human Computer Interaction*, 4(3):28–43. DOI=10.4018/jmhci.2012070102

Freyne, J., Berkovsky, S., Daly, E.M., & Geyer, W. (2010). Social networking feeds: Recommending items of interest. *Proceedings of RecSys '10*, ACM, 277–280. DOI=10.1145/1864708.1864766

Genov, A., Keavney, M., & Zazelenchuk, T. (2009). Usability testing with real data. *Journal of Usability Studies*, *4*(2), 85–92.

Girardello, A. & Michahelles, F. (2010). AppAware: Which mobile applications are hot?. *Proceedings of MobileHCI '10*, ACM, 431–434. DOI=10.1145/1851600.1851698

Hackos, J. & Redish, J. (1998). *User and Task Analysis for Interface Design*. New York: Wiley.

Hart, J., Ridley, C., Taher, F., Sas, C., & Dix, A. (2008). Exploring the Facebook experience: A new approach to usability. *Proceedings of NordiCHI '08*, ACM, 471–474. DOI=10.1145/1463160.1463222

Hassenzahl, M., Diefenbach, S., & Göritz, A. (2010). Needs, affect, and interactive products - Facets of user experience. *Interacting with Computers*, 22(5), 353–362. DOI=10.1016/j.intcom.2010.04.002

Heimonen, T. & Käki, M. (2007). Mobile Findex: Supporting mobile web search with automatic result categories. *Proceedings of MobileHCI '07*, ACM, 397–404. DOI=10.1145/1377999.1378045

Herzberg, F., Mausner, B., & Snyderman, B.B. (1959). *The Motivation to Work*. New York: Wiley.

Hjelmeroos, H., Ketola, P., & Räihä, K.J. (1999). Coping with consistency under multiple design constraints: The case of the Nokia 9000 WWW browser. *Proceedings of MobileHCI '99*, ACM, 51–56. Retrieved on 7 July 2012, from http://www.dcs.gla.ac.uk/mobile99/papers/hjelmeroos.pdf

Humphreys, L. (2008). Mobile social networks and social practice: A case study of Dodgeball. *Journal of Computer-Mediated Communication, 13*(1), 341–360. Retrieved on 22 March 2013 from http://jcmc.indiana.edu/vol13/issue1/humphreys.html

ISO (2010). *Ergonomics of Human–System Interaction – Part 210: Human-centred Design for Interactive Systems* (Rep. No. ISO 9421.210: 2010). International Organization for Standardization.

Jacovi, M., Guy, I., Ronen, I., Perer, A., Uziel, E., & Maslenko, M. (2011). Digital traces of interest: Deriving interest relationships from social media interactions. *Proceedings of ECSCW '11*, Springer-Verlag, 21–40. DOI=10.1007/978-0-85729-913-0_2

Jacucci, G. (2011). Designing integration of sharing, messaging and awareness for mobile users. *PsychNology Journal, 9*(2), 123–135.

Jacucci, G., Oulasvirta, A., Ilmonen, T., Evans, J., & Salovaara, A. (2007). CoMedia: Mobile group media for active spectatorship. *Proceedings of CHI '07*, ACM, 1273–1282. DOI=10.1145/1240624.1240817

Jameson, A. (2008). Adaptive interfaces and agents. In A. Sears & J.A. Jacko (eds), *The Human–Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications* (2nd ed.) (pp. 433–458). Boca Raton, Florida, USA: CRC Press.

Jiang, J., Wilson, C., Wang, X., Huang, P., Sha, W., Dai, Y., & Zhao, B. (2010). Understanding latent interactions in online social networks. *Proceedings of IMC '10*, ACM, 369–382. DOI=10.1145/1879141.1879190

Joinson, A. (2008). Looking at, looking up or keeping up with people?: Motives and use of Facebook. *Proceedings of CHI '08*, ACM, 1027–1036. DOI=10.1145/1357054.1357213

Jones, M., Marsden, G., Mohd-Nasir, N., Boone, K., & Buchanan, G. (1999) Improving Web interaction on small displays, *Computer Networks*, *31* (11–16), 1129–1137. DOI=10.1016/S1389-1286(99)00013-4

Kaikkonen, A. (2009). *Internet on Mobiles: Evolution of Usability and User Experience*. Doctoral dissertation. Finland: Helsinki University of Technology. Retrieved on 22 March 2013 from http://lib.tkk.fi/Diss/2009/isbn9789522481900/

Kaikkonen, A. & Roto, V. (2003). Navigating in a mobile XHTML application. *Proceedings of CHI '03*, ACM, 329–336. DOI=10.1145/642611.642669

Kamvar, M., Kellar, M., Patel, R., & Xu, Y. (2009). Computers and iPhones and mobile phones, oh my!: A logs-based comparison of search users on different devices. *Proceedings of WWW '09*, ACM, 801–810. DOI=10.1145/1526709.1526817

Karlson, A.K., Bederson, B.B., & SanGiovanni, J. (2005). AppLens and LaunchTile: Two designs for one-handed thumb use on small devices. *Proceedings of CHI '05*, ACM, 201–210. DOI=10.1145/1054972.1055001

Kiljander, H. (2004). *Evolution and Usability of Mobile Phone Interaction Styles*. Unpublished doctoral dissertation. Finland: Helsinki University of Technology. Retrieved on 22 March 2013 from http://lib.tkk.fi/Diss/2004/isbn9512273209/

Lampe, C., Ellison, N., & Steinfield, C. (2006). A face(book) in the crowd: Social searching vs. social browsing. *Proceedings of CSCW '06*, ACM, 167–170. DOI=10.1145/1180875.1180901

Law, E.L., Roto, V., Hassenzahl, M., Vermeeren, A., & Kort, J. (2009). Understanding, scoping and defining user experience: A survey approach. *Proceedings of CHI '09*, ACM, 719–728. DOI=10.1145/1518701.1518813

Lehikoinen, J., Aaltonen, A., Huuskonen, P., & Salminen, I. (2007). *Personal Content Experience: Managing Digital Life in the Mobile Age*. Sussex: Wiley.

Lindley, S.E., Meek, S., Sellen, A., & Harper, R. (2012). It's simply integral to what I do: Enquiries into how the web is weaved into everyday life. *Proceedings of WWW '12*, ACM, 1067–1076. DOI=10.1145/2187836.2187979

Lindqvist, J., Cranshaw, J., Wiese, J., Hong, J., & Zimmerman, J. (2011). I'm the mayor of my house: Examining why people use Foursquare – a social-driven location sharing application. *Proceedings of CHI '11*, ACM, 2409–2418. DOI=10.1145/1978942.1979295

March, S.T. & Smith, G.F. (1995). Design and natural science research on information technology. *Decision Support Systems, 15*(4), 251–266. DOI=10.1016/0167-9236(94)00041-2

Markopoulos, P., de Ruyter, B., & Mackay, W. (2009). *Awareness Systems: Advances in Theory, Methodology and Design. Human-Computer Interaction*. London: Springer.

Markopoulos, P., Romero, N., van Baren, J., IJsselsteijn, W., de Ruyter, B., & Farshchian, B. (2004). Keeping in touch with the family: home and away with the ASTRA awareness system. *CHI Extended Abstracts '04*, ACM, 1351–1354. DOI=10.1145/985921.986062

Marsden, G. & Jones, M. (2002). Ubiquitous computing and cellular handsets – are menus the best way forward? *South African Computer Journal*, 28, 67–74.

Maurer, M.–E., Hausen, D., De Luca, A., & Hussmann, H. (2010). Mobile or desktop Websites? Website usage on multitouch devices. *Proceedings of NordiCHI '10*, ACM, 2010. DOI=10.1145/1868914.1869018

McCarthy, J. (2011). Bridging the gaps between HCI and social media. *Interactions, 18*(2), ACM, 15–18. DOI=10.1145/1925820.1925825

Meyer, D.E. & Schvaneveldt, R.W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology*, 90, 227–234. DOI=10.1037/h0031564

Milić-Frayling, N., Hicks, M., Jones, R., & Costello, J. (2007). On the design and evaluation of web augmented mobile applications. *Proceedings of MobileHCI '07*, ACM, 226–233. DOI=10.1145/1377999.1378011

Miluzzo, E., Lane, N.D., Fodor, K., Peterson, R., Lu, H., Musolesi, M., Eisenman, S.B., Zheng, X., & Campbell, A.T. (2008). Sensing meets mobile social networks: The design, implementation and evaluation of the CenceMe application. *Proceedings of SenSys '08*, ACM, 337–350. DOI=10.1145/1460412.1460445

Morris, M.R., Teevan, J., & Panovich, K. (2010). What do people ask their social networks, and why?: A survey study of status message Q&A behavior. *Proceedings of CHI '10*, ACM, 1739–1748. DOI=10.1145/1753326.1753587

Naaman, M., Boase, J., & Lai, C. (2010). Is it really about me?: Message content in social awareness streams. *Proceedings of CSCW '10*, ACM, 189–192. DOI=10.1145/1718918.1718953

Newtson, D. (1973). Attribution and the unit of perception of ongoing behavior. *Journal of Personality and Social Psychology*, *28*(1), 28–38. DOI=10.1037/h0035584

Oulasvirta, A., Petit, R., Raento, M., & Tiitta, S. (2007). Interpreting and acting on mobile awareness cues. *Human–Computer Interaction*, *22*(1–2), 97–135. DOI=10.1080/07370020701307799

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing, 16*(1), 105–114. DOI=10.1007/s00779-011-0412-2

Ozenc, F.K. & Farnham, S. (2011). Life 'modes' in social media. *Proceedings of CHI '11*, ACM, 561–570. DOI=10.1145/1978942.1979022

Paek, T., Gamon, M., Counts, S., Chickering, D.M., & Dhesi, A. (2010). Predicting the importance of newsfeed posts and social network friends. *Proceedings of AAAI '10*, AAAI, 1419–1424.

Preece, J. (2000). *Online Communities: Designing Usability, Supporting Sociability*. Sussex: Wiley.

Rettie, R. (2003). Connectedness, awareness and social presence. Presented at the 6th Annual International Workshop on Presence, 6–8 October 2003, Aalborg, Denmark. Retrieved on 7 July 2012, from http://eprints.kingston.ac.uk/2106/

Rieman, J. (1993). The diary study: A workplace-oriented research tool to guide laboratory efforts. *Proceedings of CHI '93*, ACM, 321–326. DOI=10.1145/169059.169255

Robbins, D.C., Lee, B., & Fernandez, R. (2008). TapGlance: Designing a unified smartphone interface. *Proceedings of DIS '08*, ACM, 386–394. DOI=10.1145/1394445.1394487

Rotman, D. (2010). Constant connectivity, selective participation: Mobile-social interaction of students and faculty. *CHI Extended Abstracts '10*, ACM, 4333–4338. DOI=10.1145/1753846.1754149

Roto, V., Popescu, A., Koivisto, A., & Vartiainen, E. (2006). Minimap: A web page visualization method for mobile phones. *Proceedings of CHI '06*, ACM, 35–44. DOI=10.1145/1124772.1124779

Salovaara, A., Jacucci, G., Oulasvirta, A., Kanerva, P., Kurvinen, E., & Tiitta, S. (2006). Collective creation and sense-making of mobile media.

Proceedings of CHI '06, ACM, 1211–1220. DOI=10.1145/1124772.1124954

Sas, C., Dix, A., Hart, J., & Su, R. (2009). Emotional experience on Facebook site. *CHI Extended Abstracts '09*, ACM, 4345–4350. DOI=10.1145/1520340.1520664

Sellen, A. & Harper, R. (1997). Paper as an analytic resource for the design of new technologies. *Proceedings of CHI '97*, ACM, 319–326. DOI=10.1145/258549.258780

Shoemaker, P.J. (1996). Hardwired for news: Using biological and cultural evolution to explain the surveillance function. *Journal of Communication, 46(*3), 32–47. DOI=10.1111/j.1460-2466.1996.tb01487.x

Simon, H.A. (1956). Rational choice and the structure of the environment. *Psychological Review, 63*(2), 129–138. DOI= 10.1037/h0042769

Sohn, T., Li, K.A., Griswold, W.G., & Hollan, J.D. (2008). A diary study of mobile information needs. *Proceedings of CHI '08*, ACM, 433–442. DOI=10.1145/1357054.1357125

Sohn, T., Seltur, V., Mori, K., Kaye, J., Horri, H., Battestini, A., Ballagas, R., Paretti, C., & Spasojevic, M. (2010). Addressing mobile information overload in the universal inbox through lenses. *Proceedings of MobileHCI '10*, ACM, 361–364. DOI=10.1145/1851600.1851666

Taylor, C.A., Anicello, O., Somohano, S., Samuels, N., Whitaker, L., & Ramey, J.A. (2008). A framework for understanding mobile internet motivations and behaviors. *CHI Extended Abstracts '08*, ACM, 2679–2684. DOI=10.1145/1358628.1358744

Taylor, C.A., Samuels, N., & Ramey, J.A. (2009). Always on: A framework for understanding personal mobile web motivations, behaviors, and contexts of use. *International Journal of Mobile Human–Computer Interaction, 1*(4), 24–41. DOI=10.4018/jmhci.2009062603

Tong, C. (2008). *Analysis of Some Popular Mobile Social Network Systems* (Rep. No. TKK-CSE-B). Espoo, Finland: Helsinki University of Technology. Retrieved on 7 July 2012, from http://www.cse.tkk.fi/en/publications/B/1/papers/Chang_final.pdf

Vartiainen, E. (2009). *Design Implications for Mobile User Interfaces of Internet Services*. Doctoral dissertation. Finland: Helsinki University of Technology. Retrieved on 22 March 2013 from http://lib.tkk.fi/Diss/2009/isbn9789522481429/isbn9789522481429.pdf

Vyas, D., Cui, Y., Ojala, J., & Grassel, G. (2012). Producing while consuming: Social interaction around photos shared within private group. *Proceedings of ACE '12*, ACM, 133–150. DOI=10.1007/978-3-642-34292-9_10

Väänänen-Vainio-Mattila, K., Wäljas, M., Ojala, J., & Segerståhl, K. (2010). Identifying drivers and hindrances of social user experience in web services. *Proceedings of CHI '10*, ACM, 2499–2502. DOI=10.1145/1753326.1753704

Wagner, D., Lopez, M., Doria, A., Pavlyshak, I., Kostakos, V., Oakley, I., & Spiliotopoulos, T. (2010). Hide and seek: location sharing practices with social media. *Proceedings of MobileHCI '10*, ACM, 55–58. DOI=10.1145/1851600.1851612

Wang, Y., Zhang, J., & Vassileva, J. (2010). Personalized recommendation of integrated social data across social networking sites. In F. Cena et al. (eds), *Proceedings of the International Workshop on Adaptation in Social and Semantic Web* (pp. 19–30). Retrieved on 7 July 2012, from http://ceur-ws.org/Vol-590/sasweb10_3.pdf

Wäljas, M., Segerståhl, K., Väänänen-Vainio-Mattila, K., & Oinas-Kukkonen, H. (2010). Cross-platform service user experience: A field study and an initial framework. *Proceedings of MobileHCI '10*, ACM, 219–228. DOI=10.1145/1851600.1851637

Zacks, J.M. & Tversky, B. (2001). Event structure in perception and conception. *Psychological Bulletin*, *127*(1), 3–21. DOI= 10.1037/0033-2909.127.1.3

Ziefle, M., Schroeder, U., Strenk, J., & Michel, T. (2007). How younger and older adults master the usage of hyperlinks in small screen devices. *Proceedings of CHI '07*, ACM, 307–316. DOI=10.1145/1240624.1240676

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research through design as a method for interaction design research in HCI. *Proceedings of CHI '07*, ACM, 493–502. DOI=10.1145/1240624.1240704

Ziv, N. & Mullth, B. (2006). An exploration on mobile social networking: Dodgeball as case in point. *Proceedings of ICMB '06*, IEEE, Article 21, 7 pages. DOI=10.1109/ICMB.2006.8

Included Publications

P1

Yanqing Cui & Virpi Roto. (2008). How people use the web on mobile devices. *Proceedings of the 17th international conference on World Wide Web* (WWW' 08), ACM, 905–914. DOI=10.1145/1367497.1367619

P2

Yanqing Cui & Li Wang. (2012). Motivations for accessing social networking services on mobile devices. *Proceedings of the International Conference on Advanced Visual Interfaces* (AVI'12), ACM, 636–639.
DOI=10.1145/2254556.2254673

P3

Yanqing Cui, Antti Oulasvirta, & Lingyi Ma. (2011). Event perception in mobile interaction: Toward better navigation history design on mobile devices. *International Journal of Human Computer Interaction 27* (5), 413–435. DOI=10.1080/10447318.2011.552058

P4

Yanqing Cui, Mikko Honkala, Kari Pihkala, Kimmo Kinnunen, & Guido Grassel. (2010). Linked internet UI: A mobile user interface optimized for social networking. *Proceedings of the 12th international conference on human computer interaction with mobile devices and services* (MobileHCI'10), ACM, 45–54. DOI=10.1145/1851600.1851611

P5

Mikko Honkala & Yanqing Cui. (2012). Automatic on-device filtering of social networking feeds. *Proceedings of the 7th Nordic Conference on Human-Computer Interaction* (NordiCHI '12), ACM, 721–730. DOI=10.1145/2399016.2399126

P6

Yanqing Cui & Mikko Honkala. (2011). The consumption of integrated social networking services on mobile devices. *Proceedings of the 10th International Conference on Mobile and Ubiquitous Multimedia* (MUM'11), ACM, 53–62. DOI=10.1145/2107596.2107602

P7

Yanqing Cui & Mikko Honkala. (2013). A novel mobile device user interface with integrated social networking services. *International Journal of Human–Computer Studies*. DOI=10.1016/j.ijhcs.2013.03.004

Tampereen teknillinen yliopisto
PL 527
33101 Tampere

Tampere University of Technology
P.O.B. 527
FI-33101 Tampere, Finland

ISBN 978-952-15-3048-7
ISSN 1459-2045