Mobile Internet:
Past, Present, and the Future

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ABSTRACT

The Mobile Internet is no longer a new phenomenon; the first mobile devices supporting Web access were introduced over 10 years ago. During the past 10 years many user studies have been conducted that have generated insights into mobile Internet use. The number of mobile Internet users has increased and the focus of the studies has switched from the user interface to user experiences. Mobile phones are regarded as personal devices: the current possibility of gathering more contextual information and linking that to the Internet creates totally new challenges for user experience and design. [Article copies are available for purchase from InfoSci-on-Demand.com]

Keywords: Mobile Internet; User Experience; WAP; Web on Mobile Phones

INTRODUCTION

When the mobile Internet was launched in the late 90s it was claimed to be the Internet in your pocket. With hindsight, it is easy to say that this metaphor was not justified, as it did not take the user perception of the Internet into consideration. The huge Wireless Application Protocol (WAP) hype and hangover following the hype have been widely reported (for example, Pannanen (2000), Sokela (2002), and in a 2000 Znet article). This disappointment after such high expectations made it impossible to take WAP seriously in later years. WAP had become merely a joke, albeit many network operators kept on developing services on the WAP protocol (Kaikkonen 2005), and made revenue on these services as increasing numbers of users used these services. For user experience experts it became clear that the technology and protocol behind a service do not really matter to users; what is more important is what you can do with the services. The success of iMode in Japan is well known, but it is rarely mentioned that other Japanese operators, like KDDI, built their suc-

cessful mobile Internet offering on the WAP protocol.

Was WAP a waste of time and effort? The question in itself is not very interesting—it is more interesting to ask what we learned from the first years of WAP. Are these lessons sufficiently valuable that we can consider WAP as a useful—and necessary—step along the path to effectively offering Web access on mobiles?

It does not make sense to ask if we should still have WAP or other mobile-tailored Web support on mobile devices; instead, we should be asking *when do we need mobile-tailored content on mobile devices and when is full Internet content needed*?

DID WE LEARN ANYTHING FROM WAP THAT WE CAN USE IN THE FUTURE?

During the first years of WAP, many researchers published papers related to user interface (UI) design and usability—for example, Buchanan *et al.* (2001), Chittaro and Dal Cin (2002), Kim *et al.* (2002), Kaikkonen and Roto (2003), and Hyvärinen *et al.* (2005), amongst many others. In addition to technology and protocol information, such papers also contain generic information related to the usability of, and design for, small screens and spotty networks; this generic information can certainly inform the future design and evaluation of any services targeted at small screens.

Another obvious lesson is not related to user interface design or usability, but rather to how important it is to take user expectations and mental models into consideration. The disappointment portrayed by the media in early 2000 reflected the mismatch between the message and user perception. In the midst of the hype, analysis of the reasons for the hype took second place to market messages. The companies developing mobile technologies are not, however, entirely to blame; critical public reviews were, in general, pretty rare. The public message on the mobile Internet in Europe and North America failed to take into consideration the perception and mental models of users. The situation in Japan and South Korea shows that the problem was not entirely related to network and device limitations, but was, instead, more complex. When the mobile Internet became available in Japan, the Internet penetration was fairly low (13.4% in 1998) and mobile phone penetration high (57.7% in 1998); as a result, most users did not have a clear perception as to the Internet per se, and so the local operators were able to advertise the mobile Internet by highlighting its benefits. At the same time, Western operators and technology developers continued advertising WAP with gimmicky technical terms. These lessons are not unique to WAP, but they clearly show that you should know your audience, its perceptions and values, and match your message to these!

WHAT IS THE MOBILE INTERNET?

The Mobile Internet can be described in many different ways. To illustrate its diversity, I have chosen 4 studies on mobile Internet use, all of which were published during 2008. The description of the mobile Internet in these papers gives a good impression of how differently the topic can be approached. Cui and Roto (2008) studied mobile Web usage and seem to define use of the Web on mobiles as viewing Web pages with mobile browsers; this covers both mobile-tailored and full Web content. Hinman *et al.* (2008) compare mobile and PC Web use in the context of a PC deprivation study. In this study, the use of the mobile Web is mainly related to full Web site use on mobiles. Taylor *et al.* (2008) seem to perceive the mobile Web as mostly providing more relevant, mobile-tailored services.

The fourth definition of the mobile Web combines all three of the previous approaches: Kaikkonen (2008) defines the mobile Web as any access to the Internet via a mobile device- this approach is rather presenting *Internet access on mobiles* than *Mobile Internet*. The different alternatives for using and accessing the Web on mobiles today can be seen in Figure 1. Web access from mobiles can be divided to *browser-accessed* and *client-accessed*. The difference is very clear from the user's perspective. For browser-accessed approaches, there are two alternatives; a site can be either identical to that which the user accesses

via a desktop computer or the content can be tailored for a mobile platform. Client-access means that applications connect to a service to fetch specific pieces of data from the Web: different approaches support different usage situations, and therefore one service can be accessed multiple ways.

Full Web on Mobile Phones

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

Full Web content on mobile devices is not really a new thing; it has been possible to access full Web content on mobiles for as long as it has been possible to access mobile-tailored content; for example, the Nokia Communicator provided a Web browser with HTML support as early as the late 90s. Kaasinen *et al.* (2000) demonstrated ways to render Web content to fit the screen of a mobile phone, and Roto and Kaikkonen

Figure 1. Landscape of the mobile Internet
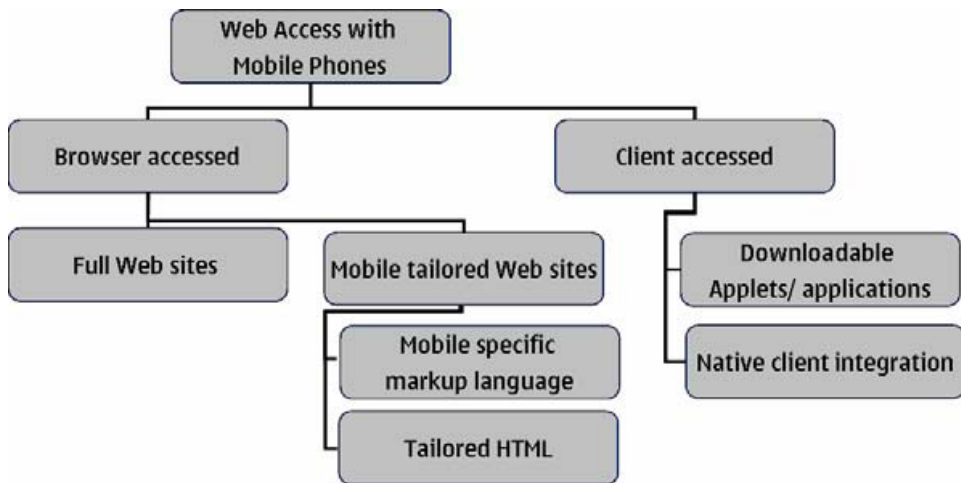
(2003) analyzed the problems users have when full pages are rendered to a narrow layout inside mobile browsers. Currently the narrow layout is no longer the only solution; as mobile phone screens have become bigger; more devices are able to show the Web site layout in a comparable manner to the layout seen on a desktop computer. Figure 2A shows how one service, *Share on Ovi* (a full Web page), looks on a mobile device. I will explain the other figures in the following sections.

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

Mobile-Tailored Browser Access

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

Client Based Access

The other way of tailoring Internet content for mobile consumption is to develop applications that access the Internet. Figure 2C shows how service content can be visible on a phone's home screen, and 2D is an example of a downloadable application that can access an online service. Phone applications can support the upload or download of content to and from the Internet. The Web access can either be an integrated functionality in the phone's native applications (such as the calendar, photo gallery, music player, or phone idle screen) or it can be a stand alone application downloaded from the Web. These downloadable applications can access specific data from a phone; the applications connect to a specific site for a specific information query or task. For example, they may be used for uploading photos to a photo blog or downloading a game to a mobile phone.

WHAT DO PEOPLE DO WHEN BROWSING ON MOBILES?

Mobile browsing has become more common in recent years. Strategy Analytics (2008) estimates that the global number of mobile Internet users will exceed 400 million users by the end of 2008. The growth of the user base has influenced the topics of recently published papers. The number of papers that focus on analyzing empirical data on user behavior has increased. In previous years, the papers focused on how to make the user interface easy and consistent; now the technology is mature, studies are tending to focus on what people do and why.

Taylor *et al.* (2008) studied 11 mobile Internet early adopters in the U.S. They used user feedback to create a framework that could help in classification of user motivation in relation to mobile browsing. Taylor *et al.* tried to understand users by classifying their motivations, behavior, and physical settings. *Motivations* are divided into two

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

A   B   C   D
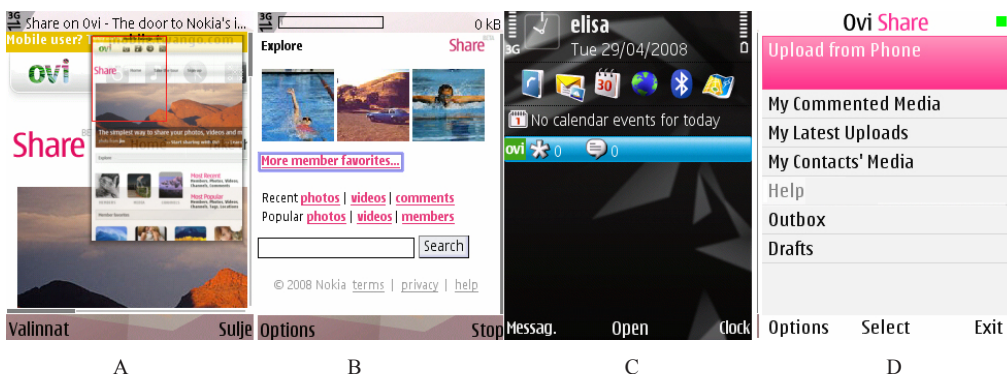
subcategories—*utilitarian* and *hedonic*; although the division was not originally invented by Kim *et al.*, they base their use of this classification on a paper by Kim *et al.* (2002) who studied the use contexts of, and usability problems with, the mobile Internet. *Behavioral* aspects were divided into *info seeking*, *action support*, and *info exchange*. The *Physical* setting is a list of locations or activities, such as 'home', 'work', or 'walking'. Based on this classification, Taylor *et al.* aim to provide tools for more effectively building user scenarios to help product/service creation. Their work focuses on creating tools for future work; as such, it does not provide extensive information on the frequency of different motivations (though so called utilitarian motivations seem to be more common in their study) or behaviors.

Cui and Roto (2008) combined the results from multiple studies published between 2004 and 2007. They analyzed the mobile Web use of 47 people in 6 cities (and countries). The users were familiar with mobile Web use; they were mostly male and could be considered early adopters of technology. Based on contextual inquiries, Cui and Roto found that the mobile Web is often used in stationary, rather than truly mobile, settings. People browse both when alone and in social situations, but browsing sessions are for fairly short periods of time. The length of browsing sessions depends on network access type; people browse for longer when they have WLAN access than when they have cellular network access. According to

Cui and Roto, the cost associated with the different network access types is the main reason for this difference. Cui and Roto divide user activities when browsing on mobile devices into to 3 categories: information seeking; communication; and content object handling. All these can be done for utilitarian or entertainment purposes. The most common activity when browsing was related to communication, and being aware of social networks (via email mostly). Based on their study, Cui and Roto observed that mobile Web use sometimes changes people's daily chores and behavior; for example, people choose routes that have better network connections.

Hinman *et al.* (2008) adopted a very different approach in their study; they studied 8 Internet users in the U.S.; all users were familiar with both mobile and full Web access. For four days, users were allowed to use the Internet only on their mobiles; the usage data was then analyzed together with their 'natural' usage data that had been recorded prior to the deprivation study. Hinman and her colleagues found that users' PC-based Internet browsing experience substantially influenced their perceptions of the Internet. Even when using a mobile browser, users' usage motivation was in line with their desktop computer use—the feeling of being connected was more important than the actual tasks done online. During the deprivation period, users tried to follow, on their mobile device, the same Internet usage patterns they had developed using their

desktop computer, but found it difficult and were unhappy about the situation. A feeling of disconnectedness from social networks was one of the strong feelings reported by users. It was clear that desktop computer usage patterns did not work on mobile devices. Based on their study, Hinman *et al.* draw the metaphorical conclusion that PC-based Internet browsing is like scuba diving, and the mobile-based Internet experience is like snorkeling. Internet browsing on a desktop computer is like scuba diving because it is immersive; it invites exploration and discovery, and it supports multitasking. The mobile Internet experience is like snorkeling because attention is divided, and it is difficult to get totally immersed.

Based on my experience, this metaphor describes well the experience of users that use both desktop computers and mobile phones to access the Internet. The same experience was described by one user in an unpublished media sharing pilot, when she was describing her flow experience (Flow is an experience theory by Mihaly Csikszentmihalyi (1990, 1998)), namely:

When analyzing my service use and my experiences, I realized that in PC use it was easier and faster to go to flow state. Mobile application is good for uploading photos, but (lack of) speed of the data transfer distracts the flow experience. [Pilot user commenting on flow experience on mobile and PC Web].

WHAT DID I LEARN ABOUT MOBILE INTERNET USE?

In 2007 I conducted a survey-based study of smart phone users' mobile Internet experiences (Kaikkonen 2008). Three hundred and ninety mobile Internet users from various countries responded to the survey, and from these respondents I chose 23 people for in-depth interviews. Interviews were held in Hong Kong, London, and New York during May- June 2007.

Like in other studies described in this article, most of the online survey respondents (80%) were male. It was not surprising that these male users were typically engineers, technical IT professionals, or in managerial/analytical positions. More surprising, was that most females were teachers or worked in healthcare; only 6 women had a technical background. Overall, a large proportion of the survey respondents came from Asia; additionally, the majority of the *female* respondents were Asian. Having many non-technical females amongst the Asian users made Asian responses different overall from the responses received from other continents; Asians were using more mobile-tailored Web and, rather than being early adopters, they could be described to represent early mass. Asian users were most excited about the future possibility of browsing the full Web on mobile devices. European and North American respondents typically had technical backgrounds; they could be described as representing early

adopters of technology. European and North American respondents browsed more full Web sites and had downloaded applications that connect to the Internet. European and North American users saw the future of the mobile Internet as being based on application-integrated use of Internet services.

How does Mobile and Full Web Use Differ on Mobile Devices?

All the survey respondents owned a device with a browser capable of accessing both full Web content and mobile-tailored content. Many of the respondents did take advantage of this capability; almost 70% of the re-spondents browsed both full Web and mobile-tailored Web sites (very often, operator WAP portals). Rarely did a respondent report only browsing full Web sites: only 14% of the respondents mentioned exclusively browsing sites that were available only as full Web sites. Browsing restricted to mobile-tailored sites was more common; 32% of respondents mentioned only browsing sites that are mobile-tailored. The use of downloadable applications, widgets, and native application-integrated solu-tions was not very common; 7% of the respondents mentioned use of applica-tions that access the Web.

Users in different countries accessed the Web in different ways: most respon-dents from Hong Kong browsed only mobile-tailored sites—typically, the WAP portal of their mobile operator. Overall, Asian users browsed fewer full

Web sites than Europeans and North Americans; 23% of Asian respondents only browsed mobile-tailored sites compared to only 10% and 2% of North American and European respondents, respectively. The interviews clarified the reasons behind the behavior: although users everywhere *perceived* that cost is an issue in terms of mobile Internet use, the interviewees in Hong Kong were especially conscious of the perceived difference in cost between accessing full Web and mobile-tailored Web sites from their mobile devices. Operators in Hong Kong had packaged their phone plans in such way that the use of the operator mobile portal was part of the phone plan; users paid the same fee whether or not they used the portal but additional costs were incurred to access other Web sites. As a result, only users that had WLAN support on their phones browsed full Web sites—typically when at a WLAN hotspot.

The respondents of the online survey were asked to list up to 5 recent Web sites they had accessed via their mobile browser. Collectively, respondents iden-tified 999 Web addresses: half of these sites were available only as full Web versions; 25% of the addresses led to sites that were clearly mobile-tailored, and the rest to sites available both in full Web and mobile-tailored formats, such as Google and Yahoo! More users reported browsing mobile-tailored than full Web sites, but there was more diver-sity with regards full Web sites; many users browsing mobile-tailored sites reported accessing the same operator

portals. Users who reported accessing only mobile-tailored sites listed just 1 or 2 Web addresses, whereas respondents who also browsed the full Web on mobile devices reported having viewed at least 4 sites.

When the Web sites viewed, and corresponding motivations of the users in the survey, were divided using the categorization by Cui and Roto (2008)—i.e., *information seeking*, *communication*, and *content object handling*—we observed that 60% of the respondents mentioned accessing sites that supported clear information search motivations—e.g., the use of search engines, news sites, and news areas of operator portals. *Communication* (mostly Web-based email) was mentioned by 20% of the respondents, and object handling, like adding text or photos to a blog, was mentioned by 30% of the respondents.

Computer vs. Mobile Device

Most respondents to our survey accessed the Internet with both a desktop computer and a mobile phone. Some of the Web sites they browsed are the same on both platforms. Although some user activities were the same no matter how they accessed a site, there were also differences. When seeking information, users generally read news and searched information based on keywords in search engines; on mobile devices they read smaller amounts of text and browsed for a shorter period of time. Users also read email on both mobile and desktop computers; on mobile devices, however, users read more emails than they wrote. Users also avoided reading very long emails on mobile phones if they were not essential; if they needed to write an email on a mobile phone, their responses were typically shorter than on a desktop computer. That said, although the responses were short on mobile devices, they were no less important than the longer ones written on a desktop computer. Many respondents reported that they followed blogs and discussion group conversations on mobile devices. Writing to, and active participation in, social sites was less common on mobile devices than on desktop computers. One could assume that this is mainly due to the small screen and numeric keyboard but although these do influence behavior, our interviews revealed more reasons: mobile Web sessions were shorter and more prone to interruptions than sessions on a desktop computer, so the latter was considered more appropriate for participating actively in social sites where one needs more time and peace.

Based on the interviews, we observed that there were some activities where mobile phones were linked to the Web via a desktop computer; some users perceived this to represent Internet use on a mobile device. Mobile imaging is one such case: picture viewing usually happened on the mobile phone from the phone's photo gallery; people shared photos by sending them as MMS messages or by transferring the photos to a desktop computer and either uploading

them to a photo service or sending them as an email attachment:

Mobile photos I sync them to my computer, I MMS them to people, on occasion, maybe two or three times in a month, maybe not that often. Because there aren't so many people you'll send it to, so it doesn't actually get through. I have some that I have uploaded to Flickr as well [Interviewee from London].

Mobile Tailored Solutions for Web Access

Hinman *et al.* (2008) applied a diving metaphor to Web browsing. They said that browsing on a desktop computer is like scuba diving, and browsing on a mobile device is like snorkeling. As we have just shown, there are different ways to use the Internet on mobile devices, and in the same way there are different ways of snorkeling. Based on my experience with Internet use on mobile devices, I would extend Hinman *et als'* metaphor: I see full Web browsing on mobile devices as free diving, browsing mobile-tailored Web sites on mobile devices as snorkeling with occasional deeper dives, and Internet use via mobile applications as snorkeling in a swimming pool.

Why Full Web Access on Mobile Devices is Like Free Diving

When browsing the full Web on mobile devices, users looked for specific information that was only available in a full Web version, or users were not aware of a mobile-tailored solution. Full Web site browsing on a mobile device is like free diving because information needs are specific, and users know where to find the information; no matter how deep within a site structure the information is located, a user dives directly to it. Very often the depth of the information is more profound than when browsing on mobile-tailored sites. Information needs are often time critical, and usually the context in which information is being sought does not allow the use of a desktop computer: there is either no desktop computer available, the social context does not allow the use of a desktop computer, or the user knows he/she will be changing location during the information search. The motivation for use is less related to killing time than when browsing mobile-tailored sites:

I used Google at school, with my classmate. I had to look for school information. Because I can't use a normal PC browser at school so I use my mobile, it's so normal for me. I think it's so positive, cos it's very useful to have Internet always with me! [Web survey respondent];

Also I will use it at home. When I'm home I won't just go to my room and sit on my PC all the time, you know parents don't like that. They think I'm a good girl, as I'm not on PC all the time. They do not know I browse with my phone. [Interviewee from Hong Kong].

Why Browsing Mobile-Tailored Web Sites is Like Snorkeling with Occasional Deeper Dives

Browsing mobile-tailored sites is like snorkeling near the surface with occasional deeper dives because mobile-tailored site browsing is often related to killing time or browsing interesting information. When a user sees something interesting when browsing, he/she delves deeper into the information, but usually returns to the surface (for example, the home page of the portal) to browse for the next interesting topic; sometimes the next cue is caught when a user is viewing the deeper information, but that is less common. Sometimes a user just needs to quickly access specific information, like timetables or weather information:

The last service I used was the BBC Traffic News WAP site (I used the "Services" browser for this). I was on my own, just got in the car and about to drive off - checking for congestion etc on my route. I use this a lot - very useful to me! The experience was good - in a way a WAP site rather than a full Website is better for information like this; it gives me the information I need, quickly. [Web survey respondent];

Most of the time I use Hutchison portal, easy to access, easy to link to system and it is cheap. Yesterday I was in a bus and you know Hong Kong is always traffic congested, when I was waiting for the bus to move, I searched the Web, news, *I even watched TV.* [Interviewee from Hong Kong].

Why Internet Use via Mobile Applications Is Like Snorkeling in a Swimming Pool

Internet use via mobile applications is not yet very common, but it is likely to become more popular. It can be likened to snorkeling in a swimming pool because it is only possible to do specific tasks related to the application: the user often cannot browse outside the specific information source or service. The common use cases reported were related to time- and situation-critical activities—e.g., uploading photos to photo sharing sites and checking time-critical information. Often these situations were related to social activities, either with a group of friends physically present or with friends present online:

I was using Widsets- I was in a bar with some friends. We needed to get some facts I knew I could find quickly. I think it was a fairly typical use case, now with Widsets my mobile browsing has diminishing. The whole thing worked ok (turned out I was right! [Web survey respondent];

I used VOX during lunch break- it enables me to blog from anywhere I want. I love using mobile technology. I had a great experience. [Web survey respondent].

HOW MOBILE IS MOBILE WEB USE?

People can browse the Internet on their mobile devices in any context and situation, but our online survey revealed that the most common place was when at home alone. The study conducted by Cui and Roto (2008) revealed the same pattern in relation to location, but in their study social use was as common as solitary use. Home was a place where many respondents typically had desktop-based Internet access, but there were situations when it was just more convenient to browse on a mobile device. This issue came up both in our online survey and during the interviews. People browsed on mobile devices in places where desktop computer use was not possible, such as on their living room sofa. In general, with one exception, any Web activity could happen on mobile devices at home; the exception being that blog updates and photo sharing on mobile devices happened less frequently at home than other online activities.

Even though it was common for people to use the mobile Web at home, it was also common for users to browse the mobile Web from mobile devices while traversing multiple locations during one usage session. In these situations, people specifically chose to use the mobile Internet *because* they knew they would change location during the task:

I used it [mobile browser] to check the weather; I was at work on the way back home. I used a mobile because I could use it while I was leaving the building. The situation was absolutely normal for me. I use Mobile Web browsing since about 5 years, beginning with black&white wap pages. [Web survey respondent].

Using the mobile Internet was also common when people were on the move. When using public transportation, people often need to sit and wait either for, or in, their transportation (e.g., a train or bus); the mobile Internet is good way to 'kill time' and create private space in public environments:

I used Web browser on my N93 during my traveling to/from school by mass transport (tram, underground). I check RSS feeds, browse main Web servers about politics, economy, mobile phones, tech etc. I am connected through 3G cellular network. In school or at home i usually use Wi-Fi. The Web browser in N93 is superb, Web pages look same as on desktop and that's very important. [Web survey respondent].

Work and office usage typically happened either during breaks (e.g., lunch and coffee breaks) or as a secondary task when a user's desktop computer was occupied for work-related activities.

Even though the mobile Internet could be used in any social context, users were often alone when browsing on a mobile device; this included when they were at home, moving around, and in work situations. When reporting on their most recent usage situations,

people in both the online survey and in the interviews said that, when approached by a person, they stopped browsing and started interacting with the person. There were two reasons for this: the mobile device was regarded as a personal device, and mobile phone use was not seen as polite in most social situations. Interviewees did not consider the situations when they were surrounded by strangers in public places as 'social situations'.

Social usage happened at school, in cafés and pubs, and even outside. In these situations, the mobile Internet was typically used to verify something that came up during discussion:

Browser is pretty important for me. I use it a lot. Like when I went out to eat with my friends, I used it to view reviews of the restaurant before we made decision where to go [Interviewee from New York].

WHAT ISSUES WILL THERE BE IN MOBILE BROWSING IN THE FUTURE?

Cost has been known to be an issue from the early days of WAP; "Wait and Pay" was, in fact, one popular interpretation of the acronym. Roto *et al.* (2006) demonstrated the extent to which cost influences mobile browsing user experiences: perception of cost and lack of control affect user behavior and interaction with a system. Users often perceive that the mobile data traffic

cost is high, but it is also hard for the users to understand, follow, and control how the cost is generated! Users try to maximize the benefit while they minimize the cost; perception of the billing model—whether right or wrong—influences their usage. To facilitate mobile Internet adoption to other than early adopters, flat fee data should be more commonly available for users and cost generation should be transparent. This is not a new concept, nor is it related only to the mobile Internet. Gourville and Soman (2002) pointed out that cost awareness and transparency are the main elements influencing consumption behavior in general. People are more likely to use a product or service when they are aware of the cost and they know how it is generated. Today, users are very often not aware of the actual cost of their typical browsing—never mind situations when they are traveling and roaming in foreign networks. When downloading a game to a mobile phone, users may be informed about the cost of the game, but not the cost of the data transfer. For global stores, it may actually be impossible to provide this information because there are so many different billing models. In some cases, users are informed about the size of the game, but it may be difficult for a user to calculate how much it will cost to download 3MB of data to his/her phone. The cost issue needs to be handled as more 'always connected' devices come to market—otherwise users may get very unpleasant surprises when they receive their phone bills. Since they can-

not predict and control the cost, many users today solve the problem simply by not using services any more.

Another barrier for mobile Internet use is battery life. Users keep their mobile phones with them for communication purposes; they want to make sure they can make or receive calls or text messages in critical situations. If there is a risk of running out of battery, users start controlling their service use. The situation with respect to battery life is not getting significantly better; display sizes are growing, and larger displays consume more battery life than smaller ones. Some of the newer devices are built with the idea of being online "all the time". When such a device is connected to a network—irrespective of whether the connection is via WLAN or 3G—battery life is being consumed. If the connection is not good, a device will run out of battery power even faster. In my work I have observed that there seems to be differences between countries and operators with respect to battery life; across different operator networks, users exhibiting similar service usage patterns report very different experiences with respect to battery life: users of one network can report that they can use their devices for a whole day without charging the battery, where users of other network report that they need to charge their devices more than once during the day. It would be beneficial for user experience researchers to co-operate with technical researchers to investigate this area; if the network configuration can influence battery life

expectancy, it would be very useful to have good data in this regard.

In relation to these two barriers to usage—cost and battery life—the mobile technology industry seems to be overly optimistic about how users will behave and adopt the technology. I would encourage researchers and developers, as well as business professionals, to evaluate their perceptions and be careful not to get too excited.

The studies discussed in this article do not consider device design in general, but the design of a device does influence usage patterns. Although screen size and keyboard did not surface explicitly in studies as issues influencing usage patterns, it is clear that they do exert influence on interaction. Many new mobile devices have touch screens and are designed to support information scanning and point–and-click interaction. Norman (2007) has noted that good Internet search engines have encouraged users return to engage in "command based" browsing. The challenge is not only, therefore, how best to design services that work both for touch screens and non-touch screens, but also increasingly how best to design services that simultaneously support mobile device- and desktop computer-based access—especially when the devices support such different interactions.

Application integrated services were only familiar to a small number of users in 2007- 2008, but this approach may be increasing for mobile devices. As mentioned earlier, European and North American early adopters believe

that is the path to take. Social networking service access is already possible on mobile devices; when that becomes more common, it will potentially change the level of awareness of our social networks. For many years I have discussed a particular concern with users: they have seen positive aspects related to services that allow them to be more connected with their friends, to know where their friends are, and what they are doing, but they have also, however, expressed an occasional need for privacy, even from their closest friends. Of course it is always possible to turn a service off, but people do not want to have to later explain to friends why they were not available at a particular time: users comment that they already have to explain too often why they did not answer their phone or immediately respond to text messages. Users also distinguish between friends they have on their mobile phones and friends on social network services; they do not necessarily want to give hundreds of online 'friends' access to their very personal mobile device (e.g., phone).

Since we carry mobile devices with us all the time, it is possible to gather information about the environment we are in. This potentially automatically generated/collected data is richer for mobile devices than would be possible for data gathered by a stationary device. With current mobile devices, it is possible to upload the information in real time; it is also much easier to link together contextual information, information about (and on) a device,

and services information to create data pools that were not previously possible. This information could be used for good or bad; it can potentially harm people, even (or especially) if they do not know about it. In many countries children start to use mobile phones and online services at a very early age—so young that they have no idea about the potential risks and, because mobile devices are perceived as personal devices, parents may not know all the things children do on their mobiles.

As technology researchers and developers, we need to think about, and evaluate, the potential side effects on people's lives of the systems we create. We should do whatever we can to decrease the negative influence without sacrificing the positive.

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